Physics in Canada
La Physique au Canada

Volume 68 No. 3
July - September 2012
juillet à septembre 2012

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Articles related to the 2012 Congress, medals and awards
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PHYSICS IN CANADA
LA PHYSIQUE AU CANADA

Volume 68 No. 3 (July-Sept. 2012 / juil. à sept. 2012)

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ARTICLES DE FOND

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Top: "Bonds in Focus" by Socrates Li, Sir John A. Macdonald Secondary School, Waterloo, ON -- 1st Prize (High School Individual Category), 2012 Art of Physics competition. See http://www.cap.ca/aop/art.html

Bottom: Various images relating to the 2012 CAP Congress at the University of Calgary.

En haut: « Bonds in Focus » par Socrates Li, Sir John A. Macdonald Secondary School, Waterloo, ON – 1er prix (catégorie école secondaire, individuelle), Concours l'Art de la physique 2012. Voir http://www.cap.ca/aop/art.html.

En bas : Plusieurs photos reliées au Congrès de l'ACP 2012 qui a eu lieu à l'Université de Calgary.

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PHYSICS IN CANADA
LA PHYSIQUE AU CANADA
The Journal of the Canadian Association of Physicists

La revue de l'Association canadienne des physiciens et physiciennes

ISSN 0031-9147

ANNUAL SUBSCRIPTION / ABONNEMENT ANNUEL :
$43.00 Cdn + GST or HST (Cdn addresses),
$43.00 US (US addresses); $48.00 US (other/foreign addresses)

Advertising, Subscriptions, Change of Address/
Publicité, abonnement, changement d'adresse:
Canadian Association of Physicists /
Association canadienne des physiciens et physiciennes,
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Numéro de convention pour les envois de publications canadiennes : 0484202

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THE CHANGING RESEARCH CLIMATE IN CANADA

A little over a decade ago, the Canada Research Chair (CRC) and Canada Foundation for Innovation (CFI) programs were created to reverse the brain drain. They ushered in a remarkable renewal period in Canadian academic research. Coupled to an NSERC Discovery Grant Program (DGP) envied worldwide for its stability and flexibility, Canadian universities were able to recruit talented new faculty from within the country and abroad, thereby significantly enhancing the research intensity of many universities. New faculty members received not only CFI funding but, in addition, often received a large piece of equipment from the Research Tools and Instrumentation (RTI) program. These investments may explain why Canada is the only G7 country to increase its scientific output above the world average between 2005 and 2010 [1,2].

With the recent developments at NSERC and changes in national labs, we are entering an era with new priorities and new challenges. We have been told that the situation is considerably better than perceived by many: Large infusions of cash continue to bring research dynamism to universities, through programs such as the Canada Excellence Research Chairs (CERCs) and NSERC Collaborative Research and Training Experience (CREATE), as well as large grants to very successful researchers. CERCs come with significant funding and offer great opportunities for recipient universities to make a major impact. The government cuts to NSERC have been much less than those imposed upon most other federal programs. Research funding has been spared in recognition of the importance of innovation. Basic research has been protected despite a lack of support from industry [3]. Nevertheless, the announcement of the elimination of NSERC's Major Resources Support (MRS) and Research Tools and Instruments (RTI) programs (the latter partially re-instated) has come as a shock, and the recent changes in its Discovery Grant Program (DGP) have been greeted with resentment by many researchers [4]. The CAP initiated an on-line survey on the NSERC changes, and they were the subject of animated discussions at the CAP Annual Congress in Calgary last June [5].

RTI's, as their name says, keep labs operational by providing upgrades, replacements, and essential tools to maintain excellence. What surprised many is that the elimination occurred primarily for bureaucratic reasons. The RTI program relied on surplus funds from various portfolios to maximize the amount that could be distributed to applicants. A budget-cutting exercise undertaken by the Federal government has led to the disappearance of those surpluses, leading NSERC to eliminate the program. NSERC argued that new equipment needs can be fulfilled by the CFI program whose funding has been renewed to the tune of $500M. However the focus of the CFI is funding of large initiatives and not maintaining existing facilities, even if highly successful, in training Highly Qualified Personnel (HQP) or doing high-impact research. Pressure from the community has led NSERC to reconsider its decision, but only limited funding is available for the current competition [5]. Thus pressure will have to be kept on NSERC to bring back the funding of this program to an adequate level. In the current climate, this may take several years to realize. Healthy DGP and RTI programs, which support a broad base of research initiatives, are important to maintain diversity in fundamental research. No public policy can predict where emerging technologies might arise. The increased competitiveness of the NSERC DGP program and its focus on established stars create an environment less conducive for new faculty candidates to be tomorrow's stars.

The cancellation of NSERC's Major Resources Support (MRS) program has broader implications, jeopardizing the future of many facilities, such as the Canadian Neutron Beam Centre at Chalk River and the Polar Environment Atmospheric Research Laboratory (PEARL) [3,4]. Ironically, we were told by NSERC at the CAP Congress that the MRS program is the victim of its own popularity: too many applications led to a bureaucratic and financial burden on NSERC. This cancellation appears as an attempt to download financial responsibility to academic institutions with already strained resources. The impact of the elimination of the MRS program extends throughout the natural sciences. In biological- and environmental-related sciences, this decision coincided with significant cuts to federally-funded environmental research. Neglecting research that informs us about the state of our planet cannot lead to good policy decisions [6]. There is a widespread perception that, for our current federal government, ideology trumps evidence. This has led to the "Death of evidence" demonstration on Parliament Hill in June 2012 and an international call to the government to justify its decisions [6,7].

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On the other hand, the government has recently been exploring innovative funding initiatives. The new Brain Canada program (http://www.braincanada.ca/) is an example of a possible new funding formula. The Canada Brain Research Fund is a public-private partnership designed to encourage Canadians to increase their support of brain research. Brain Canada has committed itself to raising $100 million from private donors and non-governmental sources, to be matched by government on a 1:1 basis.

The nature of academic research is changing. There is a move away from curiosity-driven research and a greater emphasis towards targeted research with potential economic benefits. Technology transfer is a high priority, as Canada lags behind other OECD members in innovation. The government argues that their overall support of research is the most generous of all industrialized nations. Their support however includes the multi-billion dollar Scientific Research and Experimental Development (SRED) Tax credit, an indiscriminate subsidy program (it has been significantly scaled back, in the last federal budget in March 2012 from its nearly $4B maximum). It may have helped the competitiveness of existing industries, but it is not an effective way to improve innovation [8,9]. A broad range of activities qualify, as touted by accounting firms, helping companies to benefit from the program. It has also been noted that more than a third of the money is pocketed by accountants, likely mostly in small companies [8]. Even in the high tech sectors it seems to be used for incremental improvements, as this 1998 submission by the Canadian Advanced Technology Association (CATA) reveals [10]:

"Product and technology cycles (are) continually being shortened – in some areas to even less than a year. The result has been the development of product, production, launch and marketing strategies that are highly integrated and multi-disciplinary. In contrast, historically, more step-wise, linear, segmented development, production and marketing processes have permitted the experimental stage to be more easily identified and separated from other activities, greatly simplifying the assessment process of claims."

This quote depressingly highlights the main challenge of academic researchers, an industrial sector mainly interested in incremental improvements in their existing technologies. Andreas Mandelis (University of Toronto), who has successfully transferred technology to industry, argues [11] that companies in Canada are overly prudent and reluctant to invest in new ideas, relying instead on government to fund innovative new technologies:

> "In fairness, governments have several arm's length organizations and programs, whether they are federal or provincial, to provide funds, such as the Ontario Centres of Excellence, I2I (ideas to innovation) and Collaborative Research and Development (CRD) grants, for instance. These are the vehicles that industries are using for much of the support they give to university research. However, they resist putting significant additional money into the project. It is hard to find good industrial partners who pay their fair share for what they get in terms of R&D from academia! But academics have to seek them out because you cannot get any serious research money in Canada unless you have an industrial partner. It is also true that industry cannot get robust solutions to science-based technical problems unless it has an academic partner expert in the field. So, the need for each other is mutual and research funding dynamics should reflect this interdependence."

Such thoughts have been echoed by other colleagues. Academics are often frustrated by two obstacles in their interactions with industry: a partner unwilling to contribute the matching funds required to secure NSERC funding (for instance), or the fact that the project involved is only incremental and of little scientific interest. Such projects may be useful to the company and keep them competitive. However, from the perspective of the researcher, as Andreas Mandelis argues, it is not optimal:

> "All significant academic research is rooted in novelty. If the outcome is something incremental, it is not going to be very worthwhile because somebody has probably already commercialized it."

In summary, an increasing amount of NSERC funds is focused on targeted research and innovation. There are interested academics, and more would be interested if the industrial sector was more open to new ideas, and ready to fund them. Industry argues that it should lead academic research, but an industry-led innovation strategy will not make Canada a world leader in leading-edge technology. To be fruitful, the interactions between academia and industry must be beneficial to both sides. The interactions have to be about novel ideas of substance that can lead to research advances worthy of a PhD thesis and publications. These are more likely to lead to revolutionary new products that will give Canada an edge. In the absence of industrial partners with the right expertise, creating a start-up may be the only option, but that is a challenge of a different order.

Academics working in applied research would benefit from industrial interactions by keeping their work grounded in realism [12]. Germany has a steady pipeline of "innovation that runs from university and government research labs to manufacturers" [13]. There are long term partnerships between industry and academic researchers and common movement of researchers between the two sectors [13].

Finally, the current preoccupation with technology transfer and innovation should not undermine the excellent fundamental curiosity-driven research that is present in Canada [1,2]. It is from that research that physical principles underlying new technologies will emerge. To maintain a diversified and thriving academic research environment, the DGP program should remain a priority and will need a healthy RTI program to support it.

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L' ÉVOLUTION DU CLIMAT DE LA RECHERCHE AU CANADA

Il y a un peu plus de 10 ans, les programmes de chaires de recherche du Canada (CRC) et la Fondation canadienne pour l'innovation (FCI) ont vu le jour, visant à inverser l'exode des cerveaux. Ce fut l'aube d'une période remarquable de renouvellement de la recherche universitaire au pays. Fortes du Programme de subventions à la découverte (PSD) du CRSNG, dont la stabilité et la souplesse faisaient l'envie du monde entier, les universités canadiennes ont pu recruter de nouveaux professeurs talentueux chez nous et à l'étranger, stimulant ainsi sensiblement la recherche dans de nombreuses universités. Les nouveaux professeurs recevaient des fonds pour de gros équipements non seulement de la FCI mais aussi du programme Outils et Instruments de recherches (OIR). De tels investissements peuvent expliquer pourquoi le Canada est le seul pays du G7 où la hausse de la production scientifique a été supérieure à la moyenne mondiale entre 2005 et 2010 [1,2].

A la suite des changements récents au CRSNG et dans les laboratoires nationaux, nous entrons dans une ère de nouvelles priorités et de nouveaux défis. On nous a dit que la situation est bien meilleure que ce que beaucoup perçoivent : les fortes injections de capitaux, par des programmes tels les Chaires d'excellence en recherche du Canada et le Programme de formation orientée vers la nouveauté, la collaboration et l'expérience en recherche (FONCER) du CRSNG, et les grosses subventions aux chercheurs très réputés, continuent de dynamiser la recherche dans les universités. Ces chaires sont assorties d'un financement important et offrent aux universités bénéficiaires d'excellentes occasions d'avoir un impact majeur. Les compressions gouvernementales ont été beaucoup moindres au CRSNG que pour la plupart des autres programmes fédéraux. Le financement de la recherche a été épargné en raison de l'importance de l'innovation. La recherche fondamentale a été protégée en dépit du peu d'appui de l'industrie [3]. Néanmoins, l'annonce de l'élimination des programmes d'Appui aux ressources majeures (ARM) et Outils et instruments de recherche (OIR) (celui-ci ayant été rétabli en partie) du CRSNG a causé un choc et les changements récents au PSD ont suscité du ressentiment chez nombre de chercheurs [4]. L'ACP a tenu un sondage en ligne sur les changements au CRSNG et ils furent le sujet de nombreux débats au congrès annuel de l'ACP à Calgary en juin dernier [5].

Comme le nom l'indique, les OIR maintiennent l'exploitation des laboratoires en fournissant des mises à jour, des pièces de rechange et des outils essentiels au maintien de l'excellence. Ce qui en a surpris plus d'un, c'est que l'annulation a eu lieu surtout pour des raisons d'ordre bureaucratique. Le programme OIR misait sur les fonds excédentaires de divers portefeuilles pour maximiser le montant à distribuer aux demandeurs. La réduction budgétaire entreprise par le gouvernement fédéral a fait disparaître ces excédents, ce qui a amené le CRSNG à éliminer le programme. Celui-ci a affirmé que le programme de la FCI, dont le financement a été renouvelé à hauteur de 500 millions de dollars, permettra de répondre aux nouveaux besoins en équipement. Cependant, la FCI vise à financer les grandes initiatives et non à maintenir les installations existantes, même si elles sont très réputées, en formant un personnel hautement qualifié (PHQ) ou en menant des recherches susceptibles d'un impact considérable. Les pressions de la collectivité ont amené le CRSNG à revoir sa décision, mais seul un financement limité est à la disposition des concurrents pour la compétition en cours [5]. Il faudra donc maintenir ces pressions sur le CRSNG afin de ramener le financement de ce programme à un niveau adéquat. Dans le climat actuel, il faudra peut-être plusieurs années pour y parvenir. Il importe d'avoir de solides programmes PSD et OIR, soutenant un large éventail d'initiatives de recherche, pour maintenir la diversité en recherche fondamentale. Aucune politique publique ne permet de prédire d'où viendront les nouvelles technologies. La compétitivité accrue du programme PSD du CRSNG et son accent sur des vedettes établies créent un milieu moins favorable et des obstacles plus grands pour les nouveaux professeurs aspirant à être les étoiles de demain.

L'annulation du programme ARM du CRSNG a un impact plus grand, car elle menace l'avenir de bien des installations, tels le Centre canadien de faisceaux de neutrons à Chalk River et le Laboratoire de recherche atmosphérique en environnement polaire (PEARL) [3,4]. Le CRSNG a, ironiquement, affirmé au congrès de l'ACP que ce programme est victime de son propre succès. Le trop grand nombre de demandes a occasionné un fardeau bureaucratique et financier au CRSNG. Cela semble une tentative pour rejeter la responsabilité financière sur les établissements universitaires dont les ressources sont déjà lourdement grevées. L'impact de l'annulation du programme ARM s'étend à l'ensemble des sciences naturelles. Pour les sciences connexes de la biologie et de l'environnement, cette annulation a coïncidé avec de fortes compressions fédérales dans la recherche en environnement. Le peu d'intérêt pour la recherche qui nous renseigne sur l'état de notre planète ne peut susciter de bonnes décisions stratégiques [6]. Il est généralement admis que, pour le gouvernement fédéral en place, l'idéologie l'emporte sur la preuve. Cela a mené à la manifestation de la « Mort de la preuve », sur la colline du Parlement en juin 2012, et à un appel international au gouvernement à justifier ses décisions [6,7].

Dans son nouveau programme (http://www.braincanada.ca/fr/node/12), La Fondation Neuro Canada affirme que le gouvernement est aussi en train d'expérimenter avec de nouvelles formules de financement. Le Fonds canadien de recherche sur le cerveau est un partenariat public-privé qui vise à inciter les Canadiens à accroître leur soutien à la recherche sur le cerveau. La Fondation Neuro Canada s'est engagée à recueillir 100 millions de dollars auprès de donateurs du secteur privé et de sources non gouvernementales et le gouvernement, à fournir une somme équivalente.

La nature de la recherche universitaire est en évolution. On s'éloigne de la recherche visant à satisfaire la curiosité pour privilégier la recherche ciblée qui comporte d'éventuels avantages économiques. Le transfert de technologies est hautement prioritaire, car l'innovation canadienne est en retard par rapport à celle des autres pays de l'OCDE. Le gouvernement affirme que le soutien à la recherche au Canada est le plus généreux de tous les pays industrialisés. Ce soutien inclut cependant les milliards de dollars en crédits d'impôt aux activités de recherche scientifique et de développement expérimental, qui est un programme de subventions général (au dernier budget fédéral il a été grandement réduit de son maximum de près de 4 milliards). Il peut favoriser la compétitivité des industries existantes, mais ce n'est pas un moyen efficace de renforcer l'innovation [8,9]. Un vaste éventail d'activités est admissible, comme l'avancent les cabinets comptables qui aident les entreprises à profiter du programme. On a en outre mentionné que les comptables empochent plus du tiers de l'argent, possiblement surtout pour les petites entreprises [8]. Même dans les secteurs de haute technologie, il semble servir à la mise en oeuvre d'améliorations progressives, comme l'affirme l'Alliance canadienne pour les technologies avancées (CATA) dans son mémoire présenté en 1998 [10] :

> « Les cycles des produits et des technologies sont sans cesse abrégés – à moins d'un an, même, dans certains domaines. Cela a donné des stratégies hautement intégrées et multidisciplinaires de mise en oeuvre de produits, de production, de mise en marché et de marketing. Par contre, historiquement, des processus de mise en valeur, de production et de marketing davantage axés sur les étapes, linéaires et segmentés ont permis de cerner et de distinguer plus facilement le stade expérimental des autres activités, ce qui a beaucoup simplifié le processus d'évaluation des demandes. »

Ces propos mettent en lumière le désolant défi des chercheurs universitaires, un secteur industriel qui s'intéresse surtout à la mise en oeuvre d'améliorations progressives à leurs technologies existantes. Comme l'affirme Andreas Mandelis (Université de Toronto), qui a réussi à transféré des technologies à l'industrie [11], les entreprises canadiennes sont trop prudentes et réticentes à investir dans de nouvelles idées, se fiant sur le gouvernement pour financer les nouvelles technologies novatrices :

> « Par souci d'équité, les gouvernements ont plusieurs entités et programmes indépendants, tant fédéraux que provinciaux, pour octroyer des fonds, tels les Centres d'excellence de l'Ontario, le programme « De l'idée à l'innovation » et les subventions à la recherche-développement coopérative, par exemple. Voilà les moyens que les industries emploient pour une bonne part du soutien qu'elles octroient à la recherche universitaire. Cependant, elles refusent de consacrer d'importantes sommes d'argent supplémentaires au projet. Il est difficile de trouver de bons partenaires industriels qui paient leur juste part de ce qu'ils obtiennent des universitaires sur le plan de la R.-D.! Mais ceux-ci doivent faire la démarche eux-mêmes, car on ne peut obtenir de fonds importants

pour la recherche au Canada, à moins d'avoir un partenaire industriel. Il est également vrai que l'industrie ne peut obtenir de solutions sûres aux problèmes techniques d'ordre scientifique, à moins d'avoir un partenaire universitaire qui est expert dans le domaine. Chacun a donc besoin de l'autre et la dynamique du financement de la recherche devrait refléter cette interdépendance. »

D'autres collègues ont confirmé ces réflexions. Les universitaires sont souvent frustrés par deux obstacles dans leurs interactions avec l'industrie : un partenaire qui n'accepte pas de contribuer les fonds de contrepartie nécessaires au financement du CRSNG (par exemple), ou le fait que le projet n'ait qu'une envergure et un intérêt scientifique minimes. Ces projets peuvent être utiles à l'entreprise et protéger sa compétitivité. Cependant, sous l'angle du chercheur, comme l'affirme Andreas Mandelis, cela n'est pas optimal :

« Toute recherche universitaire d'importance découle de la nouveauté. Si le résultat est de faible envergure, cela ne vaut guère la peine, car quelqu'un l'aura probablement déjà commercialisé. »

En résumé, une part croissante de fonds du CRSNG est axée sur la recherche et l'innovation ciblées. Des universitaires sont intéressés et ils seraient plus nombreux à l'être si le secteur industriel était plus ouvert aux nouvelles idées et disposé à les financer. L'industrie affirme qu'elle devrait diriger la recherche universitaire, mais une stratégie de l'innovation axée sur elle ne fera pas du Canada un chef de file mondial dans les technologies de pointe. Pour que les interactions entre les universitaires et l'industrie soient fructueuses, elles doivent profiter aux deux parties. Elles doivent avoir trait à de nouvelles idées de fond capables de susciter des percées de la recherche qui soient dignes d'une thèse de doctorat et d'être publiées. Celles-ci offrent plus de chances de mener à de nouveaux produits révolutionnaires capables de procurer un avantage au Canada. En l'absence de partenaires industriels possédant l'expertise voulue, démarrer une entreprise peut être la seule option, mais c'est là un défi d'un autre ordre.

Les universitaires qui oeuvrent en recherche appliquée profiteraient des interactions de l'industrie en maintenant leurs travaux ancrés dans le réalisme [12]. En Allemagne, il y a un flux constant « d'innovations des laboratoires de recherche universitaires et gouvernementaux vers les fabricants [13] ». On observe des partenariats à long terme entre l'industrie et les chercheurs universitaires ainsi qu'un mouvement commun de chercheurs entre les deux secteurs [13].

Enfin, la préoccupation actuelle pour le transfert de technologie et l'innovation ne devrait pas miner l'excellente recherche fondamentale, observée au Canada, visant à satisfaire la curiosité [1,2]. C'est de cette recherche que jailliront les principes physiques sous-tendant les nouvelles technologies. Pour maintenir un milieu de recherche universitaire diversifié et florissant, le programme PSD doit demeurer prioritaire et aura besoin de l'appui d'un bon programme OIR.

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CELEBRATING 50 YEARS OF CONNECTING SCIENCE EDUCATION AND RESEARCH IN ATLANTIC CANADA

BY LOIS WHITEHEAD

Lois Whitehead <lois.whitehead@scienceatlantic.ca> is the Executive Director of Science Atlantic.

The community dates back to 1961, when a handful of university administrators met to discuss how to strengthen research in the Maritimes. They believed that linking scientists in universities and government labs and fostering communication among science students would enhance the post-secondary environment. As a result, the first meeting of the Atlantic Provinces inter-University Committee on the Sciences (APICS) was held in 1962, with the physics division established at that first gathering.

Renamed 'Science Atlantic' in 2011, the association's member institutions continue to work together to improve post-secondary science education and research. The streamlined name and puzzle-piece imagery reflect what members are passionate about: discovery, problem solving, cooperation, networking, and linking many disciplines and institutions in Atlantic Canada with a united vision.

The most important connection fostered by the organization is between science education and research. Dr. Keith De'Bell, former Chair of Science Atlantic's governing council and now Associate Vice-President Research for St. Francis Xavier University, states:

SUMMARY

The Physics community in Atlantic Canada is both diverse and tightly knit. Eight universities in the region offer undergraduate degrees, while others provide first and second year courses to whet the student appetite. The Science Atlantic Physics & Astronomy Committee ties these schools together, overseeing an annual student conference and coordinating a speaker tour in partnership with the Canadian Association of Physicists.

The Mission of Science Atlantic

Science Atlantic is dedicated to advancing post-secondary science education and research in Atlantic Canada by:

- providing opportunities that foster and enrich students;
- supporting and inspiring researchers and educators; and,
- using its collective voice to address important regional science issues.

"The intertwined nature of research and education is, in my view, absolutely key. One of the reasons I have been proud to be associated with this organization is that it supports and promotes this perspective. In particular, through its conferences and other activities, we emphasize the importance of research for undergraduates as part of their learning experience."

AUPAC (THE ATLANTIC UNDER-GRADUATE PHYSICS AND ASTRONOMY CONFERENCE)

In 1977, after working for a decade on a common high school physics curriculum with the Maritime Departments of Education, the Physics Committee turned its hand to coordinating a regional undergraduate physics conference (later including astronomy). Atlantic faculty were keen to provide the benefits of an academic conference to students like those made possible through the Canadian Undergraduate Physics Conference (CUPC) which was founded 12 years earlier.

Today, the two-day event hosts approximately 150 students and faculty each year, giving undergraduates a platform to present their research, with research and

Bob Hawkes and Kyle Hill, Mount Allison University (© Mount Allison University, 2006)

science communication awards for top presenters. The event is complemented by a keynote lecture and a grad fair attended by schools from across Canada who hope to recruit some of the best senior Canadian undergraduate students.

In an interview, Dr. David Tindall, a recently retired physics professor at Dalhousie University and Dalhousie representative to the Science Atlantic Physics & Astronomy Committee for 32 years, commented:

> "By having a forum to present their work at the AUPAC, our students have developed considerably over the years, particularly in their presentation skills. Without the guiding hand of Science Atlantic, there would have been no AUPAC and our undergraduate experience would have been much poorer for it. [1]"

AN EXAMPLE: AUPAC'S IMPACT ON ONE STUDENT

Kyle Hill (BSc Honours, Physics, Mount Allison University, 2006; MSc, Medical Imaging, University of Oxford, 2007; PhD, Surgery, University of Oxford, 2011; Sauvé Scholar, Education, McGill University, 2011) presented at AUPAC in three years of his undergraduate career, including winning the top research prize in 2004 and going on to win at CUPC.

As a first year observer at AUPAC, Kyle recognized the need for a presentation venue for young scientists at Mount Allison, and the Science Undergraduate Research Fair (SURF) was born. Quoted in University Affairs (September 2011), Mr. Hill commented that he benefited from his experience at AUPAC by contrasting its friendly atmosphere with the intimidating experience of many scientific gatherings. [2] Now 10 years strong, SURF is ensconced in Mount Allison's undergraduate science program.

Physics professors Michael Steinitz and David Tindall receive Science Atlantic Outstanding Contributing Member Awards, April 27, 2012 (© Heidi Steinitz, 2012)

THE PEOPLE WHO MAKE IT POSSIBLE

Science Atlantic members are the driving force for the organization's achievements. In particular, the Physics & Astronomy Committee has had numerous champions, and five of the 14 outstanding members recognized by the association over the last 50 years are physicists. Each has contributed more than 25 years to the organization: Dr. Merrill Edwards (University of New Brunswick), Dr. Cyrus MacLatchy (Acadia University), Dr. Michael Steinitz (St. Francis Xavier University, also recognized nationally in 2006 with the CAP-COMP Peter Kirkby Memorial Medal for Outstanding Service to Canadian Physics), Dr. David Tindall (Dalhousie University), and Dr. Francis Weil (Université de Moncton).

OUTSTANDING UNDERGRADUATE TEACHING, BAR NONE

These distinguished members are not the only faculty in the region to contribute to enhancing the undergraduate physics education experience. Dr. Robert Hawkes (Mount Allison University), a 3M teaching award winner, has been recognized numerous times for his teaching skills, including receiving the CAP Medal for Excellence in Teaching Undergraduate Physics in 2000 and being the first recipient of the APICS/Science Atlantic Science Communication Award in 2001. Three more CAP Excellence in Physics Teaching winners hail from Atlantic Canada: Dr. Peter Williams (Acadia University) in 2006, Dr. Adam Sarty (Saint Mary's University) in 2008, and Dr. Jeffrey Dahn (Dalhousie University) in 2009.

1 Katherine Wooler, Dal News, May 18, 2012: Scientific honours: Science Atlantic's Hall of Fame inductees (http://www.dal.ca/news/2012/05/18/scientific-honours.html)

2 Tim Lougheed, University Affairs, November 7, 2011; After 50 Years, Introducing Science Atlantic, (http://www.universityaffairs.ca/after-50-years-introducing-science-atlantic.aspx)

Science Atlantic 50th anniversary member recommitment, April 27, 2012 (© Rick Mehta, 2012)

AND WE DO IT ALL AGAIN …

There are nine standing discipline committees in Science Atlantic: Aquaculture & Fisheries, Biology, Chemistry, Computer Science, Earth Science, Environment, Mathematics & Statistics, Physics & Astronomy, and Psychology. Issue-based committees include the Animal Care Committee and a Working Group on Research.

Each discipline committee facilitates an annual academic student conference like AUPAC, drawing approximately 1000 students, faculty and researchers in total. The conferences and committees of Science Atlantic provide rich opportunities for networking and sharing research interests and best practices in teaching. In addition, several committees coordinate speaker tours. As needed, specific projects, such as the Mathematics & Statistics Committee's Preparing for University Calculus handbook and the Environment Committee's Thinking Green brochure, are coordinated by the committees.

THE NEXT 50 YEARS

At the 50th Anniversary celebration in April 2012, the representatives for Science Atlantic's 18 member institutions signed a pledge renewing commitment to the association's original principles: to promote communication and cooperation, to help students and scientists participate in scientific endeavours, to increase awareness and encourage solution of problems that require scientific research, and to help coordinate the development of science research and teaching in the region.

The faculty, scientists, and students that comprise Science Atlantic will continue to advance collaboration, science education and research in the region in the coming decades.

Follow @ScienceAtlantic on Twitter and join the biweekly newsletter *The Science Atlantic Minute* for news relevant to scientists, researchers and students in the region and nationally: http://bit.ly/SAMinute.

50th 1962 2012

Science Atlantique
le lien entre l'enseignement des sciences et la recherche

In 2005, the Division of Nuclear Physics (DNP) created a PhD Thesis Prize competition for best thesis in Experimental or Theoretical Nuclear Physics by any student receiving their PhD degree from a Canadian University in the current or prior calendar year (see http://www.phys.uregina.ca/dnp/prize). DNP is pleased to announce that the recipient of the 2010-11 DNP Thesis Prize is Richard Hydomako. Dr. Hydomako was awarded his PhD by the University of Calgary in November 2011 for the work "Detection of Trapped Antihydrogen". A summary of Dr. Hydomako's thesis work appears below.

DETECTION OF TRAPPED ANTIHYDROGEN IN ALPHA

BY RICHARD HYDOMAKO

Antihydrogen, the bound state between an antiproton and a positron, is an ideal system for testing fundamental symmetries. Specifically, as the simplest anti-atomic system, antihydrogen can be used to directly probe CPT (charge-parity-time) symmetry between matter and antimatter. Moreover, since it is electrically neutral, measurements of the gravitational action on antihydrogen can proceed without the difficulties imposed by stray electromagnetic fields which are an inherent problem with gravitational experiments on charged antiparticles. To their benefit, studies of the properties of antihydrogen have the distinct advantage of being directly comparable with measurements of the well-studied hydrogen atom. Likewise, with enough study and control, the properties of antihydrogen might ultimately be determined with the same precision as their hydrogen counterparts.

Low-energy antihydrogen was first synthesized in 2002 by the ATHENA [1] and ATRAP [2] experiments. The ALPHA collaboration was subsequently formed in 2005 with the experimental goal of trapping antihydrogen atoms for the purpose of performing precision measurements. To this end, ALPHA has constructed a dedicated apparatus in the Antiproton Decelerator (AD) hall at the CERN facility, located just outside of Geneva, Switzerland. As depicted in Figure 1, the ALPHA apparatus combines a Penning-Malmberg trap for the confinement and manipulation of charged particles with a magnetic neutral-atom trap for the confinement of antihydrogen. Atoms in low-field seeking states with energies within the trap well depth ($< 50\ \mu$eV) will be confined in the minimum-B region of the neutral-atom trap due to the magnetic dipole interaction between the antihydrogen atom an the inhomogeneous magnetic field. The stable confinement of antihydrogen atoms is an essential step towards precision measurements, as it provides the opportunity to probe the antihydrogen atom in isolation for extended periods of time. Recently, ALPHA demonstrated the successful confinement of antihydrogen atoms [3] for times as long as 1000 seconds [4], which lead to the first observation of resonant microwave transitions in trapped antihydrogen atoms [5].

The ALPHA apparatus includes a dedicated antihydrogen detector, consisting of three concentric layers of silicon strip detection modules. The silicon modules are sensitive to the passage of charged particles and can determine the point where the particles cross through their active volume. As such, the silicon detector is capable of detecting the charged annihilation products released when the antiproton in the antihydrogen atom comes into

SUMMARY

This article describes the ALPHA silicon detector and how it was used to demonstrate the first magnetic confinement of antihydrogen atoms.

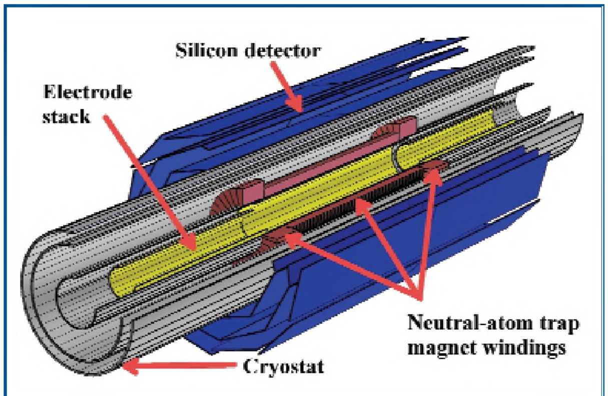

Fig. 1 Schematic diagram of the trapping region of the ALPHA apparatus. The grey cylinders show the apparatus cyrostat, the gold cylinders show the electrodes of the Penning-Malmberg trap, the magenta volumes show the location of the magnet windings for neutral-atom trap, and the blue rectangles show the positions of the silicon detector modules. This entire section of the ALPHA apparatus is located inside the bore of a solenoidal magnet (not shown), which provides the axial magnetic field for the Penning-Malmberg ion trap.

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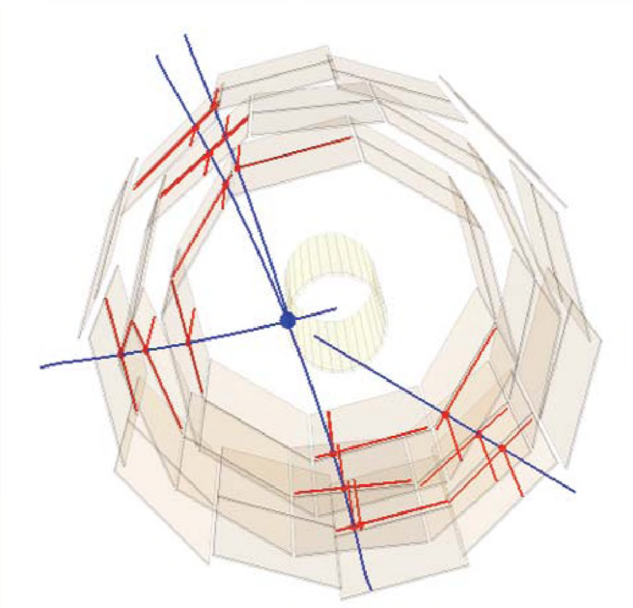

Fig. 2 Example of a 3-dimensional vertex reconstruction. The grey rectangles show the placement of the silicon detector modules, and the light yellow cylinder shows inner surface of the ALPHA apparatus (the rest of the apparatus material has been removed for clarity). The red line segments represent the silicon strips recording hits, the blue curves show the interpolated track trajectories, and the blue circle shows the determined vertex position.

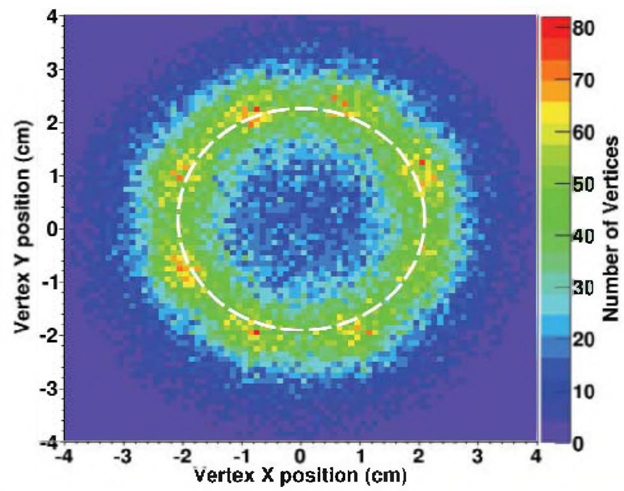

Fig 3 A transverse projection of the distribution of reconstructed vertices for unconfined antihydrogen annihilation in the magnetic field of the neutral-atom trap. The dashed white circle represents the radius of the inner surface of the apparatus.

contact with a proton or neutron. Moreover, the three layer detector configuration allows for the reconstruction of the charged particle trajectories, which can then be extrapolated back to the primary annihilation position (often called the vertex position). Figure 2 shows the reconstruction of an observed annihilation event which produced four charged particle tracks, with the blue curves depicting the extrapolated particle trajectories and the blue circle showing the determined vertex position.

The strength of the vertex reconstruction technique is apparent when many vertices are summed and the resulting distributions examined. Figure 3 shows an example transverse projection of a distribution of unconfined antihydrogen within the magnetic field of the neutral-atom trap. The ring-like shape is due the unconfined atoms annihilating on the inner wall of the apparatus. Since the charged particles must travel through several centimetres of apparatus material (including the windings of the neutral-atom trap), the reconstructed vertex positions are smeared due to multiple-scattering. This unavoidable scattering limits the vertex position resolution to about half a centimetre, which is more than acceptable for the ALPHA trap, which is about 15 centimetres in axial extent.

Because of the shallow neutral-atom trap well-depth, only very low-energy antihydrogen atoms are magnetically confined. Consequently, the detection of trapped antihydrogen amounts to a rare event search and it is critically important to have a good understanding of the detector response and the relevant backgrounds. For the ALPHA detector, the dominant background is due to cosmic-ray muons, which can leave tracks which mimic annihilation events as they pass through the detector. However, the vast majority of the cosmic-ray events can be identified and rejected using carefully placed selection criteria. These selection criteria (or 'cuts') focus on aspects of the event reconstruction where the annihilation and cosmic-ray events strongly differ, such as in the number of observed tracks and the location of the reconstructed vertex. To avoid introducing unintentional experimenter biases, a blinded analysis procedure was used when determining the placement of the selection cuts. This analysis used proxy signal and background datasets to ensure that the selection criteria were not over-fit to the specific case of the trapping experiment data. Unconfined antihydrogen annihilation events comprised the signal dataset, while the background dataset used cosmic-ray events collected while no antiparticles are present in the apparatus. After optimization, the selection cuts reject $(99.54 \pm 0.02)\%$ of the cosmic-ray background set, while retaining $(64.4 \pm 0.1)\%$ of the annihilation signal [6]. This results in a false-acceptance rate of $(47 \pm 2) \times 10^{-3}$ events/s, which is more than adequate to perform sensitive antihydrogen trapping experiments.

In addition to cosmic-ray muons, another possible background for the ALPHA detector are annihilations from mirror-confined antiprotons. Because of the adiabatic conservation of their magnetic moments, antiprotons with large transverse momenta can be confined (or 'mirror-trapped') in the inhomogeneous magnetic field of the neutral-atom trap. This background is particularly worrisome as a mirror-trapped antiproton annihilation has the same signature in the silicon detector as an antihydrogen annihilation. Although an electric field is pulsed across the trap axis in an effort to push the mirror-confined antiprotons out of the trap, it is difficult to ensure that all of the charged particles are removed in this procedure. To control for any remaining mirror-confined antiprotons, a reversible static electric bias field, similar to the previous pulsed field, is established during the detection window when the magnetic field of the neutral-atom trap is disengaged. Any remaining mirror-confined antiprotons will then be deflected in the direction of the bias field, with the neutral antihydrogen atoms will be unaffected. The reconstructed vertex positions can then be used to distinguish between events due to mirror-confined antiprotons, and those due to trapped antihydrogen [7]. As expected, the number of observed events attributable to mirror-confined antiprotons was found to be very low and the vast majority of events were found to be consistent with trapped antihydrogen.

In summary, the silicon detector and vertex reconstruction methods were an important part of the ALPHA experiment and were a crucial element in the demonstration of the magnetic trapping of antihydrogen. Indeed, for antihydrogen trapping experiments described in Ref. [3] the silicon detector recorded over six hundred events in total, which, using the selection criteria described above, was ultimately reduced to a set of 38 annihilation events consistent with the release of trapped antihydrogen. Furthermore, this detector, and these techniques, will continue to be employed as part of future spectroscopic measurements in ALPHA. As such, these methods will prove invaluable in the on-going comparison between hydrogen and antihydrogen.

ACKNOWLEDGEMENTS

This work was supported by NSERC, AIF, and the Killam Trust.

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PROFILE OF A LIVING PHYSICIST: A CLASS PROJECT TO LEARN ABOUT WORKING AS A PHYSICIST

BY MAGDALEN NORMANDEAU*
UNIVERSITY OF NEW BRUNSWICK

It is difficult for undergraduate students to know what it is like to work as a physicist. This paper presents a term project designed to address this issue, wherein each student interviews a physicist to learn about that person's work and about the education and career path that lead there.

INTRODUCTION

There is a big difference between undergraduate course work and the work done after graduation. It is entirely possible for a student to enjoy learning physics in a class setting but to be less than thrilled by physics research. Equally, a student may have the inquisitive mind needed to become a good physicist but be uninspired by course work. How do we help the first student choose a path that will expose him to exciting science without involving inquiry-based work? How do we motivate the second student to persevere through the laying of groundwork necessary for an inquiry-based career?

To address this, I have introduced an interview-based project in two of my upper level courses. As part of this project, each student investigates the work of a living physicist then interviews that person to find out more about his/her work and how the interviewee came to be in his/her current position.

The initial implementation of the Profile of a Living Physicist project was part of the winter 2010 offering of "Nuclear and Particle Physics" which was completed by eight students. In winter 2011, an improved version of the project was run with the nine students in "Introductory Astrophysics".

IMPLEMENTATION

The project's timeline is shown in Figure 1 and its key stages are described in detail below.

The Volunteers

In order to open the students' eyes to the variety of possible career paths, it is important to recruit potential interviewees representing a broad spectrum of relevant endeavours and work styles. It is also beneficial to have volunteers representing all career stages. The younger volunteers can provide detailed information and advice about the next few steps after undergraduate studies. The mid-career scientists are possible future thesis advisors or employers. The late career scientists and emeriti have a rich experience to share. Finally, including a few physicists working abroad highlights the international character of scientific endeavours.

When the project is first announced, the students are pointed to a web page that includes the names of the volunteers, their institutional affiliations, and brief descriptions of the type of work they do. Where possible the volunteer's name is linked to his/her web page, otherwise a link is made to his/her institution or some additional information is given, *e.g.* one volunteer suggested three representative publications.

The Initial Stages of Research

To hold a productive interview, the student first must become somewhat familiar with his/her subject's work. For research-

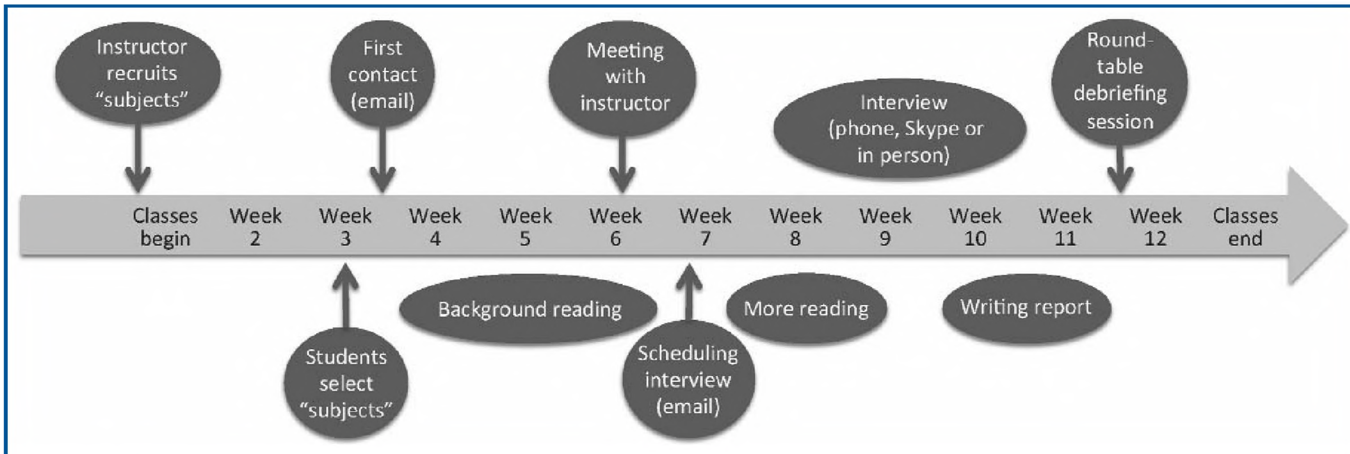

Fig. 1 Timeline

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active volunteers, this involves first carrying out literature searches to ascertain major topics of interest, then consulting textbooks to lay groundwork and learn the context in which the research is done. The students are not expected to fully understand their subjects' scientific papers but they must understand the general context. By the end of the project, the students should be familiar with their subjects' work at the level of a magazine like Scientific American. It is beneficial at this stage to spend some time introducing the students to literature search engines and databases; a session with a science librarian can be extremely helpful.

For the second run of this project, I met with each student before they contacted their subjects. They related what they had learned thus far and listed their sources. I then clarified a few matters and suggested other sources to consult or threads to follow. If they demonstrated that they were on track, I suggested that they contact their subjects soon to set up a date and time for the interview. It is important that they should do this well in advance of the interview, that they not wait until they feel ready for the interview, because their subject may not be available when it suits them. This was particularly important for the astrophysics course because several of the subjects had research-only positions and were therefore not tied to their institution during our term time.

The Interview

The only restriction on the format of the interview was that it be "live"; email was not an approved mode. Most students conducted their interviews by phone. Some used Skype, which had the advantage of offering a visual interaction. Each year, one student did his interview in person, taking advantage of a previously planned trip to visit his subject on home turf.

The interviews are meant to focus on three main topics: 1) the subject's work, 2) the subject's education and career path, and 3) what it is like to work in the subject's field. The first provides additional content that complements what is studied in class. The second is meant to give the students some ideas of options to consider if they are interested in pursuing a career in this field. Which courses were most valuable to the interviewee? How did the interviewee decide where to go for graduate work? Does the interviewee have any regrets related to choices made as a student? How did the interviewee go about finding a job after graduation? The third topic is particularly important and it is here that the interview is most useful. The stories told in the course of the interview give a glimpse into the working life of a physicist.

Sharing Information

Because the main goal of this project is to inform students about possible careers, it is important that they learn about all the interviewees. Each student is given a copy of all the reports but, on its own, this would be a waste of paper as it is unlikely that they would read the documents. To pique their curiosity and insure that at least the essential points are transmitted, a round-table debriefing session is held. This format leads to relaxed discussions wherein the students are comfortable asking follow-up questions and remarking on elements mentioned by others which they encountered in their own interview. This brings to the fore common threads from the different careers.

The sessions highlighted a few aspects of working as a physicist that the students had not anticipated. They were struck by the prevalence of collaborative work. They had been aware of the existence of small research groups within an institution but had not appreciated that multi-institution collaborations, some of them quite large, are common. Further, the discussions brought home the international character of physics research. The students were surprised by the ubiquity of international collaborations and by the fact that most interviewees had studied and worked in more than one country. Finally, arguably the greatest discovery for the students was the importance of communication skills, particularly written communication. Every student spoke of their subject's grant proposals, observing proposals, etc., and several shared that their subject had stressed that writing well and convincingly can make a big difference in a physicist's career.

RESULTS AND FEEDBACK

From the Students

The first implementation of the project, in Introductory Nuclear and Particle Physics, was a mitigated success. There was no obligatory meeting with me prior to contacting their subject to insure that the background reading had been done well and in a timely manner; this meeting is crucial for most students who otherwise delay far too much. In addition to procrastination-induced problems, it is simply more difficult with some research topics than with others to grasp the essence without understanding the details, and particle physics surely ranks among the most difficult. This contributed to several students struggling with the project. Without the debriefing session, it is likely that few would have been positive about the project, however the round-table discussion was lively and reminded them of how much they had learned. They took pleasure in sharing with their classmates and realized the value of the project.

For the astrophysics version of the project, feedback was gathered using anonymous end-of-term surveys. Figure 2 summarizes the results. Most of the students enjoyed doing the project but one was on the negative side and another was neutral about the experience. When asked how much they had learned from the project, all agreed that they had learned substantially, even the student who disliked doing the project. The student who disliked doing the project considered that it was a poor use of his time investment for this class, suggesting that she or he would have preferred to work on more standard problem sets, while the others considered that it had been a good use of their time for this course.

From the Volunteers

It is important to consider whether or not participating was a good use of the volunteers' time. In addition, having the subject

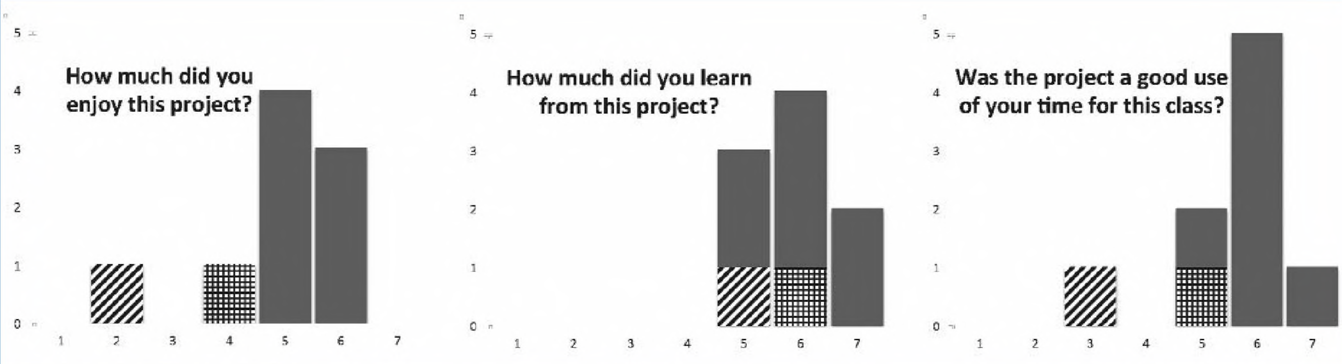

Fig. 2 Student Feedback

of a project give feedback on how the students worked on the project is an interesting twist that yielded suggestions for improvement. Feedback was sought from the astrophysics interviewees, and unsolicited comments were offered by some of the subatomic physicists.

All the volunteers who responded indicated that they would be happy to participate again. One offered that he found the interview to be "a pleasantly stimulating experience." Several volunteers highlighted the interest and enthusiasm of the interviewers. Good preparation by the students was underlined as being key to the process being positive for the interviewees, as one said "the amount of time it took and the knowledge the student brought to the interview made the process very easy and enjoyable."

The interviewees were asked for suggestions that might help improve the project. The most common theme was a desire for some form of preparatory interaction before the interview. Some suggested emailing a few questions or general themes to allow them to prepare. This would need to be weighed against the fact that this increases the time investment for the volunteers and against the danger of the interviews drifting away from being "live". Others suggested that the interview be in two parts or that there be an ice-breaker conversation before the real interview. They felt that this would help the students be more relaxed during the interview. Finally, some of those who were interviewed by phone ventured that a video interview might have been preferable.

CONCLUSIONS

Because this project involves volunteers giving of their time, it should only be undertaken if a high fraction of the students in the class are interested in pursuing studies or a career in this subfield. It is advisable to prepare two versions of the syllabus, one with and one without the project, then distribute the appropriate version after polling the students concerning their interests.

The Profile of a Living Physicist project can open students' eyes to certain career paths and provides information concerning how to embark on such a path. It gives them a hint of what is involved in the type of work done and the type of people who do it, "real people who are actually more normal than you might think" according to one interviewee. It highlights how different the work done is from course work but also how important course work is to opening doors to interesting future possibilities. In the words of one student: "I'm very glad I did (the project), as it made me realize that I am preparing for my career here, and need to start taking it seriously."

ACKNOWLEDGEMENTS

My thanks to all who agreed to be potential interviewees and particularly to those who shared of their time with my students. Additional thanks go to those who provided feedback.

CONGRATULATIONS

STUDENT COMPETITIONS / COMPÉTITIONS ÉTUDIANTES

(SEE EXTENDED ABSTRACTS OF THE WINNERS ON PAGES 134-150 PLUS PHOTOS ON PAGE 133 /
VOIR RÉSUMÉS DES GAGNANTS AUX PAGES 134-150 ET PHOTOGRAPHIES À LA PAGE 133)

The Canadian Association of Physicists has established these awards to recognize student members giving the best oral and poster research presentations at the annual CAP Congress. Up to three awards in each category, each consisting of a certificate of recognition and a cash prize, will be made each year. In addition, a number of CAP Divisions offer prizes for the best student presentations at the divisional level.

Eligibility, selection procedure, and selection criteria for the competitions are available through the Congress website each year. The full list of winners, including divisional prize winners and honourable mentions, can be found on the CAP website, under medals/awards.

L'Association canadienne des physiciens et physiciennes a créé ces prix afin de récompenser les membres étudiants auteurs des meilleures communications au congrès annuel. Elle décernera tous les ans un maximum de trois prix dans chaque catégorie, chacun consistant d'un certificat de mérite et d'une somme. De plus, plusieurs divisions offrent des prix pour leurs meilleures présentations étudiantes.

Admissibilité, modalités et critères de sélection pour les prix sont sur le site web de l'ACP. Le liste complète des gagnants et mentions honorables, incluant les prix aux niveaux divisionnels, se trouvent sur le site internet de l'ACP, sous la rubrique médailles/prix.

CAP DIVISION PRIZES / PRIX DES DIVISIONS DE L'ACP

Division prizes included a cash prize of $200 for first, $100 for second, and $50 for third.
Les prix des divisions incluent une somme de 200 $ (1er), 100 $ (2e) et 50 $ (3e).

ATMOSPHERIC AND SPACE PHYSICS / *PHYSIQUE ATMOSPHÉRIQUE ET DE L'ESPACE*

PLACEMENT	NAME/AFFILIATION
Oral - First	Gareth Perry, Univ. of Saskatchewan
Oral - Second	Alex Cushley, RMC
Poster - First	Patrick Perron, RMC

CONDENSED MATTER AND MATERIALS PHYSICS / *PHYSIQUE DE LA MATIÈRE CONDENSÉE ET MATÉRIAUX*

PLACEMENT	NAME/AFFILIATION
Oral - First	Bradley Hauer, Univ. of Alberta
Oral - Second	Sarah Purdy, Univ. of Saskatchewan
Oral - Third	Joshua Crone, Univ. of Waterloo
Poster - First	Maryam Taheri, Brock Univ.
Poster - Second	Muhammad S. Ahmed, Western Univ.

MEDICAL AND BIOLOGICAL PHYSICS / *PHYSIQUE MÉDICALE ET BIOLOGIQUE*

PLACEMENT	NAME/AFFILIATION
Oral - First	Mari Boesen, Univ. of Calgary
Oral - Second	Roshan Achal, Univ. of Calgary
Poster - First	Stefano Peca, Univ. of Calgary

PARTICLE PHYSICS / *PHYSIQUE DES PARTICULES*

PLACEMENT	NAME/AFFILIATION
Oral - First	Tina Pollmann, Queen's Univ.
Oral - Second	Corina Nantais, Queen's Univ.
Poster - First	Tina Pollmann, Queen's Univ.

AECL EACL

AECL-SPONSORED PRIZE

Best oral : Danilar Marlisov, Univ. of Alberta

ATOMIC, MOLECULAR AND OPTICAL PHYSICS, CANADA *PHYSIQUE ATOMIQUE, ET MOLÉCULAIRE ET PHOTONIQUE, CANADA*

PLACEMENT	NAME/AFFILIATION
Oral - First	Andrew MacRae, Univ. of Calgary
Oral - Second	Arghavan Safavi-Naini, MIT
Poster - First	Arghavan Safavi-Naini, MIT

INSTRUMENTATION AND MEASUREMENT / *INSTRUMENTS ET MESURES*

PLACEMENT	NAME/AFFILIATION
Best Overall	Mojtaba Rezaei, Univ. of Calgary (oral)

PLASMA PHYSICS / *PHYSIQUE DES PLASMAS*

PLACEMENT	NAME/AFFILIATION
Oral - First	Yelu Liu, Univ. of Saskatchewan

THEORETICAL PHYSICS / *PHYSIQUE THÉORIQUE*

PLACEMENT	NAME/AFFILIATION
Oral - First	Golnoosh Bizhani, Univ. of Calgary
Oral - Second	Eric Brown, Univ. of Waterloo
Oral - Third	Jonathan Ziprick, Perimeter
Poster - First	Michael Skotiniotis, IQIS

INDUSTRIAL AND APPLIED/ *INDUSTRIELLE ET APPLIQUÉE*

PLACEMENT	NAME/AFFILIATION
Poster - First	Jakob Emmel, UBC

WOMEN IN PHYSICS/ *LES FEMMES EN PHYSIQUE*

PLACEMENT	NAME/AFFILIATION
Poster - Tie	Tina Pollmann, Queen's Univ.
Poster - Tie	Maryam Taheri, Brock Univ.

STUDENT COMPETITIONS WINNERS / COMPÉTITIONS ÉTUDIANTES GAGNANTS

CAP AWARDS - POSTERS

Poster prizes included a certificate of recognition and a cash award of $400, $200, and $100 respectively for the top three placements, partially sponsored by TRIUMF. Book prizes generously donated by Pearson Education Canada were awarded to each of the six finalists.

PLACEMENT	NAME/AFFILIATION
First	Tina Pollmann (Queen's Univ.)
Second	Arghavan Safavi-Naini (MIT)
Third	Stefano Peca (Univ. of Calgary)
1st Hon.Men.	Jakob Emmel (UBC)
2nd Hon.Men.	Patrick Perron (RMC)
3rd Hon.Men.	Maryam Taheri (Brock Univ.)

2012 Best Student Poster Presentation competition winners (from left to right):
Jakob Emmel, Michael Skotiniotis, Stefano Peca, Patrick Perron, Tina Pollmann, Maryam Taheri, and Arghavan Safavi-Naini
(presenter on far right: J. Michael Roney)
Missing: Muhammad S. Ahmed

CAP AWARDS - ORAL PRESENTATIONS

Oral prizes included a certificate of recognition and a cash award of $400, $200, and $100 respectively for the top three placements, partially sponsored by TRIUMF. Book prizes generously donated by John Wiley & Sons Limited were awarded to each of the nine finalists.

PLACEMENT	NAME/AFFILIATION
First	Bradley Hauer (Univ. of Alberta)
Second	Andrew MacRae (Univ. of Calgary)
Third	Roshan Achal (Univ. of Calgary)
Finalist-HM	Tina Pollmann (Queen's Univ.)
Finalist-HM	Golnoosh Bizhani (Univ. of Calgary)
Finalist-HM	Gareth Perry (Univ. of Saskatchewan)
Finalist-HM	Corina Nantais (Queen's Univ.)
Finalist-HM	Matthew Kostka (Univ. of Calgary)

2012 Best Student Oral Presentation competition winners (from left to right):
Tina Pollmann, Corina Nantais, Joshua Crone, Andrew MacRae, Arghavan Safavi-Nain, Sarah Purdy, Alex Cushley, Gareth Perry, Roshan Achal, Maryam Taheri, Eric Brown, Jonathan Ziprick, Golnoosh Bizhani, Daniiar Marsilov
(presenter on far right: J. Michael Roney)
Missing: Mari Boesen, Bradley Hauer, Matthew Kostka, Yelu Liu, and Mojtaba Rezaei

Thanks to our generous sponsors / Merci à nos commanditaires généreux :

Pearson Education Canada   John Wiley & Sons Limited   and/et TRIUMF

and to the CAP's Past President at that time, Dr. Robert Mann of the University of Waterloo for his extraordinary efforts in organizing this event. Our thanks are also extended to all of the judges and competitors.

FÉLICITATIONS

The winners of the 2012 CAP Best Student Oral Presentation Competition at the CAP Annual Congress, 2012 June 11-15, in Calgary, Alberta are listed on page 133. The extended abstracts of those winners of the CAP prizes who submitted them for publication are reproduced below. Ed.

DISSIPATION MECHANISMS IN THERMOMECHANICALLY-DRIVEN SILICON NITRIDE NANOSTRINGS

BY BRADLEY D. HAUER, ABDUL SUHEL, TUSHAR S. BISWAS, KEVIN S.D. BEACH, AND JOHN P. DAVIS

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A. Suhel,
T.S. Biswas,
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A silicon nitride nanostring is a very interesting nanomechanical device that has the geometry of a doubly-clamped beam [1] but behaves like a string due to its high intrinsic tensile stress [2,3]. The resonance frequency of the n^{th} mode of such a device is given by

$$\nu_n = n\nu_1 = \frac{n}{2L}\sqrt{\frac{\sigma}{\rho}} \qquad (1)$$

where ν_1, σ, ρ, and L are the resonance frequency of the first mode, intrinsic stress, density, and length of the nanostring, respectively [4]. It is also worth noting that the resonance frequency of a nanostring depends only on the length of the device, not its width or thickness. This feature is very useful, since we only need to concern ourselves with the fabrication tolerance in one dimension, as opposed to three.

Because of their unique properties, silicon nitride nanostrings have generated a lot of scientific interest, ranging from applications in mass [5] and temperature sensing [6], to more exotic measurements, such as the observation of quantum motion of a mesoscopic resonator [7]. In each of these applications, the mechanical quality factor (Q) of the device is often used as a figure of merit. Q is proportional to the total energy stored in a system divided by the amount of energy dissipated per cycle and, for devices with a high Q, is defined to be

$$Q = 2\pi \times \frac{\text{Energy Stored}}{\text{Energy Dissipated per Cycle}} = \frac{\nu_n}{\Delta\nu} \qquad (2)$$

where $\Delta\nu$ is the full width at half maximum (FWHM) of the resonance peak [2]. We can see from this equation that at a given frequency, the larger the Q of a device, the narrower the resonance peak. This is advantageous because for a constant area under the curve — as is the case for thermo-mechanical motion — a narrower peak means a larger amplitude and a larger single-to-noise ratio (SNR), making the motion of such a device easier to detect. As well, the narrower the resonance peak, the easier it is to resolve the device's resonance frequency, allowing for improved resolution in sensing applications [5,8]. From these effects, it is easy to see that the higher the Q of a nanostring, the better it will perform in each of its applications. It is therefore important to understand the dissipation mechanisms of a nanostring, which will allow us to increase its Q, thus improving its performance.

SUMMARY

The dissipation mechanisms in silicon nitride nanostrings are investigated by observing their thermomechanically driven motion.

The Qs of our silicon nitride nanostrings are very high (~10^5, see Fig. 2), which results from increasing the amount of energy stored in the devices, due to their high internal tension, while maintaining constant dissipation [2,9]. To understand what causes such a high Q in these devices, and to guide our efforts to push it to even higher values, we have developed a model for Q which incorporates the three main dissipation mechanisms in our nanostrings

$$Q_n = \frac{m\omega_n}{\gamma_n} \approx \frac{m}{\tilde{\gamma}^{\text{visc}}\omega_n^{-1} + \tilde{\gamma}^{\text{anchor}} + \tilde{\gamma}^{\text{bulk}}\omega_n} \qquad (3)$$

Here, m is the mass of the nanostring, and Q_n, ω_n, and γ_n denote the Q factor, angular frequency, and damping coefficient for the n^{th} mode of the nanostring [4]. The tilde decorated quantities are damping coefficients that have been stripped of their mode dependence, corresponding to viscous damping, as well as damping at the anchor points and in the bulk of the nanostring. Our experiment operates in a vacuum of ~10^{-6} torr, which is sufficiently low enough to allow us to neglect viscous damping of our resonator $\left(\tilde{\gamma}^{\text{visc}} \approx 0\right)$ [10]. We can then investigate the other two damping mechanisms by observing the thermomechanically actuated motion of our devices.

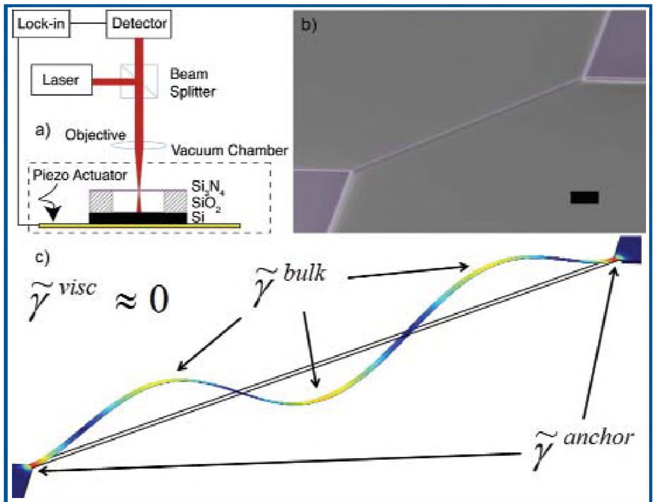

Fig. 1 (a) Schematic of the experimental set-up. (b) Scanning electron microscope image of the 215 µm nanostring. The scale bar is 20 µm. (c) Finite element analysis (FEA) simulation of the 215 µm nanostring. The dissipation locations as decribed in Eq. 3 are labelled.

To detect the motion of our silicon nitride nanostrings, we use the simple optical interferometric setup shown in Fig. 1(a). We exploit the geometry of our system, forming a Fabry-Perot cavity between the silicon nitride nanostring and the silicon base of the chip. As we shine a 632.8 nm HeNe laser through this cavity, the light follows two separate paths, which recombine at the resonator, encoding its motion in the resultant optical interference pattern. This optical signal is then converted to a voltage using a photodetector (PD), which is recorded using a lock-in amplifier (Zurich Instruments HF2LI). The rest of the apparatus consists of an optical access vacuum chamber that houses the sample, as well as a piezoelectric transducer. The piezoelectric allows us to drive the chip at its resonance frequency, increasing the signal and allowing us to find the device's resonant modes.

Once we have found each of these modes, we deactivate the piezoelectric and observe the thermally driven Brownian motion of our nanostrings, using our lock-in amplifier as a spectrum analyzer to record the data. We are then able to calibrate the motion of these resonant modes by utilizing the equipartition theorem, which tells us that each mode of the nanostring contains $k_BT/2$ of thermal energy [11].

The calibration procedure is performed by investigating the measured power spectral density (PSD) of our resonator, which we determine by squaring the recorded voltage data and dividing by the measurement bandwidth. An example of such a spectrum can be seen in the inset of Fig. 2. We then fit to the voltage PSD data the following function[11]

$$S_V(\nu) = S_V^w + \alpha S_z(\nu) \tag{4}$$

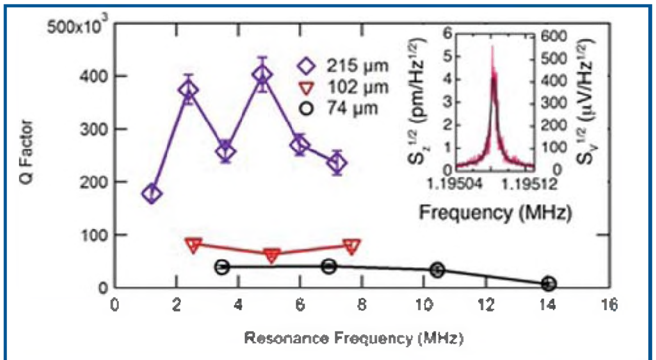

Fig. 2 Plot of mechanical quality factor (Q) vs resonant frequency for three nanostrings. The nanostrings used for this plot have a thickness of 250 nm and widths ranging from 1.0-2.1 µm. Inset – Fitted PSD for the first mode of the 215 µm nanostring, in terms of raw voltage and calibrated displacement.

Here, S_V^w is the white noise of the detector, α is a conversion factor from volts to meters (in units V^2/m^2), and $S_z(\nu)$ is the theoretical PSD for a damped harmonic oscillator as a function of frequency ν. This last term has the form

$$S_z(\nu) = \frac{k_B T \nu_n}{m\pi^3\left[\left(\nu_n^2 - \nu^2\right)^2 + \left(\nu\nu_n / Q\right)^2\right]} \tag{5}$$

where we have taken $m = \rho lwt$ to be the geometric mass of the nanostring (with l, w, and t being the length, width, and thickness, respectively) using $\rho = 3000$ kg/m^3 as our measured density of the nanostring [4]. From this fit function we can extract the α parameter, allowing us to convert from a PSD in terms of voltage, to one in terms of displacement. We are then able to take the square root of this displacement PSD to determine the peak displacement of our nanostrings in units of $\mathrm{m}/\sqrt{\mathrm{Hz}}$.

By plotting peak displacement vs. resonance frequency, we are able to see a trend emerge, in which there are displacement degeneracies between certain modes of different nanostrings. This can be seen in Fig. 3(a). As the devices we investigated had similar mode shapes and displacements [see Fig. 3(b)], with two anchor points each, the only difference in dissipation mechanisms between these nanostrings is the ratio of dissipation occurring in the bulk to that occurring at the anchor points. Therefore, if the largest nanostring has the highest Q, since it has the most bending points in the bulk of the nanostring, we would expect dissipation at the anchor points to dominate. If the smallest string has the largest Q, however, we would expect dissipation in the bulk of the nanostring to dominate. Looking back at Fig. 2(a), we can see that the largest string does indeed have the highest Q, telling us qualitatively that we would expect dissipation at the anchor points to dominate.

We are also able to quantify the ratio of dissipation in the bulk to dissipation at anchor points by looking at the expected frequency dependence for the peak displacement Δz of the nanostrings over an arbitrary frequency interval $\Delta\nu$. This is given by

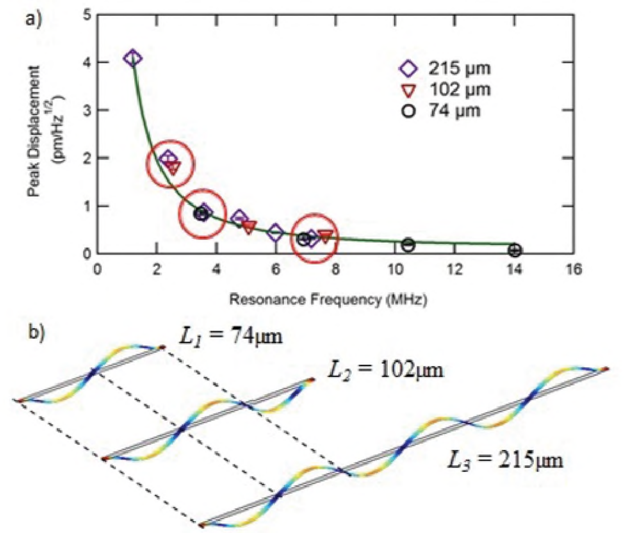

Fig. 3 (a) Peak displacement vs. resonance frequency for the same three nanostrings as in Fig. 2. The solid green line is a fit to Eq. 6. Degeneracies between certain modes of different nanostrings are highlighted with colored circles. (b) FEA simulation showing the mode shapes of all three strings for the highest frequency degeneracy triplet.

$$\Delta z = \sqrt{S_n\left(\nu_n^{\max}\right)\Delta\nu} \sim \frac{1}{\nu_n^{3/2} + \tau\nu_n^{5/2}} \tag{6}$$

where

$$\tau = \frac{\pi\tilde{\gamma}^{\text{bulk}}}{\tilde{\gamma}^{\text{anchor}}} \tag{7}$$

gives us a quantitative measure of the ratio between these two dissipation mechanisms [4]. From the fit seen in Fig. 3(a), we find that $\tau = (-0.3 \pm 2.5) \times 10^{-7}$s, again confirming that the dissipation mainly occurs at the anchor points in our nanostrings.

In conclusion, by observing a trend in the frequency dependence of the thermally actuated peak displacements of our nanostrings, we were able to pinpoint the location at which the majority of the dissipation occurs in this system. We now wish to focus on understanding what is causing this dissipation. Two leading theories suggest that this damping mechanism is related either to phonons tunneling out of the nanostring at its anchor points [12] or dissipation due to local strain mismatch at the anchor points [13].

Our future work involves using nanostring arrays to isolate and remove phonon tunneling from our nanostrings [14]. It is hoped that by using these structures, we will increase the Q of these devices even further, greatly improving their sensitivity, expanding the horizons for many new applications, as well as improving the ones that already exist.

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GENERATION OF ARBITRARY QUANTUM STATES FROM ATOMIC ENSEMBLES

BY ANDREW MACRAE, TRAVIS BRANNAN, ROSHAN ACHAL AND ALEXANDER I. LVOVSKY

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A holy grail in quantum information processing is the ability to obtain complete control over a particular subspace [1]. Such quantum state engineering has been recently accomplished in the optical [2], microwave [3] and trapped ion [4] regimes. A natural next frontier is to extend these methods to collective spin excitations (CSEs) of atomic ensembles. In addition to applications in long distance quantum communication [5] and quantum metrology [6], engineering of CSEs is of fundamental interest as it allows one to explore the isomorphism between the Hilbert space of a CSE and a single electromagnetic mode [7]. So far, engineering of CSEs has been limited to squeezed spin states [8] and a single CSE quantum state [9]. Here, we present a general method for producing arbitrary superpositions of CSE states and provide the first proof of principle experiment to this end.

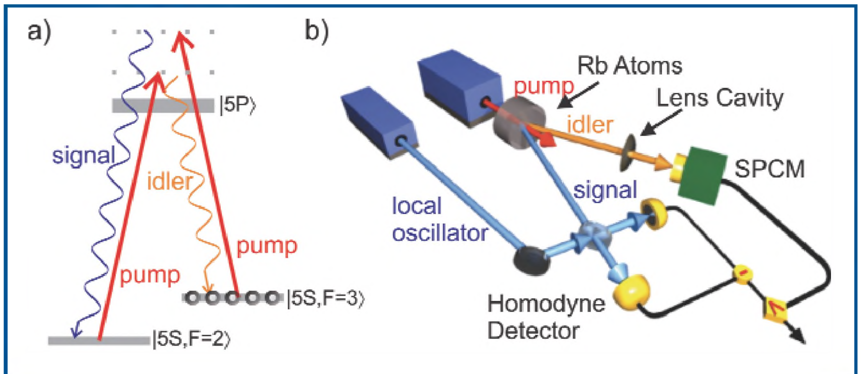

Fig. 1 (a) The atomic level diagram. Raman scattering of the pump leads to the creation of a collective spin excitation into the F = 2 state, followed by immediate recycling back into F = 3. This results in a correlated pair of signal and idler photons. (b) Sketch of experimental setup.

The single CSE quantum state can be prepared by Raman scattering from an atomic ensemble conditioned on detection of an *idler* photon according to the idea of Duan, Lukin, Cirac and Zoller (DLCZ) [5]. While DLCZ utilize only the first-order term of the evolution under the system's Hamiltonian, higher-order terms can be used in combination with specific measurements on the scattered optical mode to produce arbitrary quantum CSE states akin to [2]. To measure the produced state, the readout stage of the DLCZ protocol may be employed, in which the CSE is converted into the optical domain via the *signal* channel. Full information about the retrieved optical state, and hence about the CSE, can then be acquired using optical homodyne tomography.

SUMMARY

Using a four-wave mixing process in atomic vapour, we generate nonclassical states of light and propose a method of manipulating the collective quantum state of an atomic ensemble.

In order to test the feasibility of the above protocol, we simultaneously write-in and read-out the CSE in accordance with the DLCZ protocol using a single laser, then measure the state of the signal channel conditioned on the detection of an idler photon (Fig. 1). Ideally, the creation of a single CSE should accompany a single photon Fock state in the signal channel, but loss and background photons will lead to a mixture with vacuum and incoherent light. In order to filter background photons, we employ a monolithic spherical Fabry-Perot cavity with a 55 MHz linewidth constructed from a standard lens with high reflectivity coating on each side, that can be tuned by varying its temperature [10].

Idler photon events occur at a rate of ≃ 300 kHz. Upon each event, the signal channel is measured using a balanced homodyne detector (HD) with a 100-MHz bandwidth [11]. The local oscillator for the HD stems from a separate diode laser that is phase locked at a frequency 3.035 GHz higher than the pump [12]. The spatial mode of the local oscillator is matched to that of the signal photon by injecting an auxiliary laser beam into the idler channel, which interacts with the pump inside the cell to generate a bright field in the signal and idler modes [13]. A quadrature measurement Q_θ of the heralded state is obtained from the homodyne current by integrating over its temporal mode

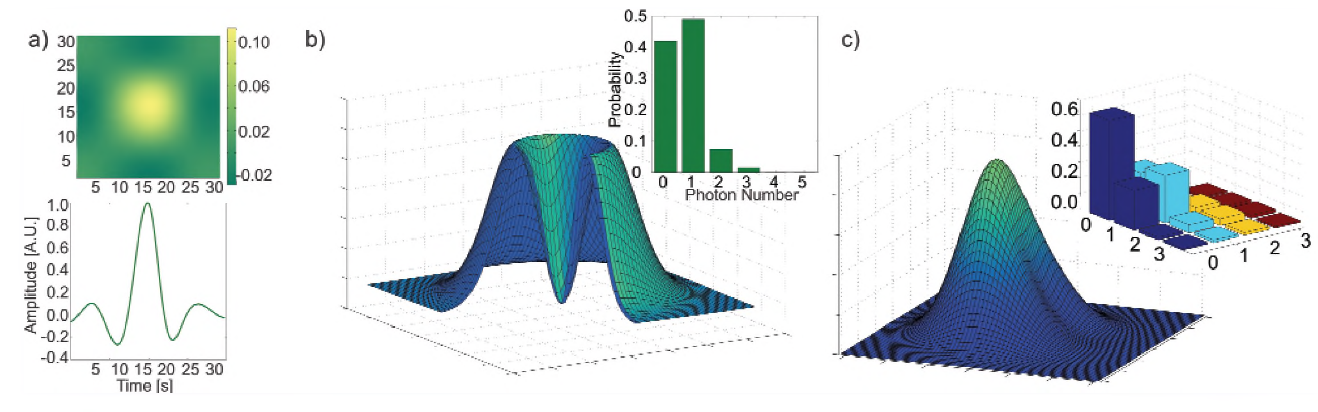

Fig. 2 (a) The symmetry of the autocorrelation matrix (upper) indicates a pure temporal mode, given by the principle eigenvector (lower) (b) The reconstructed density matrix and Wigner function of the narrowband photon reaches a value of -0.0045 at the origin. No corrections are made for losses in this plot. (c) The Wigner function of a coherent superposition of 0 and 1 photons, corrected for the 20% loss in the experiment.

function $\psi(t)$:

$$\psi(t):Q_{\theta}=\int_{-\infty}^{\infty} q_{\theta}(t)\psi(t)dt$$

where $q_\theta(t)$ is proportional to the instantaneous homodyne detector output photocurrent, and θ is the phase of the local oscillator with respect to the quantum state.

To determine ψ (t), which is not know a priori, we observe the autocorrelation $< q(t_1)\, q(t_2) >$ of the HD photocurrent as a function of delay from the trigger, corresponding to the density matrix of the heralded state in the time domain (Fig. 2(a)). The autocorrelation function has a round shape, showing high purity of the temporal mode of the heralded photon. This observation is further confirmed by the eigenvalue spectrum of the autocorrelation matrix. The eigenvector corresponding to the primary eigenvalue yields the temporal mode function as shown in Fig. 2(a).

We measure the marginal quadrature distribution corresponding to the determined temporal mode for 10^5 samples and reconstruct the density matrix using a maximum likelihood technique [2]. The density matrix shows an approximate 49% single photon component and the corresponding Wigner function becomes negative at the origin reflecting its nonclassical nature [14].

By weakly seeding the trigger channel with a coherent state α of comparable mean photon number to that emitted by the 4WM process, the detection of an idler photon from α is indistinguishable from a detection stemming from the creation of a CSE. This results in a coherent superposition of 0 and 1 CSEs $|\psi\rangle = a|0\rangle + b|1\rangle$, with coefficients a and b determined by the phase and magnitude of the coherent state. To verify the creation of this state, we collect quadrature data for a number of angles in phase space and reconstruct the Wigner function as above. The resultant Wigner function (Fig. 2(c)) shows both a coherent displacement as well as a dip near the origin, characteristic of a coherent superposition of 0 and 1 photons. Moving to the pulsed regime as in DLCZ, we can employ conditional measurements akin to [2] and engineer increasingly complex superposition states. This work thus not only provides a high quality source of quantum light, but also opens the door to extend previous quantum optical state generation to collective spin excitations.

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EXPLORING THE MYSTERIES OF THE HUMAN BRAIN WITH PHYSICS

BY ROSHAN ACHAL AND JÖRN DAVIDSEN

The human brain is arguably the most important organ in the body. It regulates biological processes, and allows us to think and interpret the world around us. In spite of the importance of this remarkable organ, little is understood about how it functions due to its complexity. One of the principal questions regarding the brain is the relationship between its neural network structures and their function. With advances in technology, the spiking activity of individual neurons in networks can be recorded [1], creating data sets, which may contain information that can help improve the current understanding of this relationship. Many methods have been developed [1-4] to extract the causal connections and network architectures of neural networks from these data.

Each method, however, has limitations that reduce their practical utility, leaving the need for improved methods. Some of the common limitations include: computationally expensive calculations, which make an analysis unfeasible for large data sets; prior knowledge of the number of largely independent clusters in a network, which isn't always available; and difficulties with detecting and including the presence of inhibitory neural connections [1].

The ability to determine when a neural impulse causes the activity of other nerve cells, and through which path, is imperative to developing new diagnostic and treatment techniques for many brain disorders such as epilepsy. It is also a cornerstone in understanding complex neural functions such as the storage and recall of memory.

To accurately determine the causal connections between neurons, both inhibitory and excitatory connections must be identified and included; both are not only important in the function of the system but also the structure. Here, the Functional Clustering Algorithm (FCA) [5] was selected for its potential to resolve many of the limitations present in other methods and successfully detect both inhibitory and excitatory connections. The benefit of the FCA is that it was primarily designed for neural spike train data, collected as a neuron fires over time, and it requires no initial knowledge of the number of groups in a network [5]. Also, activity of each neuron need not be similar for analysis, one neuron could only have several spikes where as another could have hundreds. It was postulated that extreme dissimilarity could hint at the presence of inhibitory neurons.

SUMMARY

We develop an algorithm to determine connections between neurons to help better understand the relationship between structures and functions of neural networks in the brain.

The ability of the FCA to identify and group purely excitatory connections between neurons was evaluated with a method similar to the one described in [1]. Specifically, small simulated neural data sets with known architecture and causal connections were created such that the results of the algorithm could be directly compared with them, to determine its success. The ability of the FCA to detect inhibitory neural connections was then evaluated by studying an inhibitory connection of varying strength between two neurons. Finally, the FCA was tested on networks consisting of both excitatory and inhibitory connections to evaluate if the presence of inhibitory connections hindered the detection of excitatory connections, as documented for other methods in [1].

BACKGROUND

Basic Neural Properties

To create appropriate and biologically plausible simulated data, the key behaviours of neurons must be understood. Neurons are complicated biological systems, which can exhibit different behaviours depending on their environment and physiological makeup [6]. However, this level of complexity is not necessary to intuitively understand the basic behaviours of a neuron. A neuron can be viewed as a system that has both a rest state and a spiking state [7], with the ability to transition between the two depending on the applied stimuli. General properties of the neuron include the membrane potential, all-or-nothing threshold, refractory period and the ability to create either excitatory or inhibitory postsynaptic potentials in connected neurons. For more specific details on the biological structure and functions of neurons, in-depth discussions can be found in [6,8].

The membrane potential can be considered as a description of the current state of the neuron. For most

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neurons, the resting potential is approximately -65 mV [9]. At this potential the neuron is inactive and waiting for stimulation. If the connection (synapse) between two neurons is excitatory, then the presynaptic neuron increases the membrane potential of the postsynaptic neuron with an excitatory postsynaptic potential each time it fires. The postsynaptic neuron is now brought closer to its threshold. If this neuron is stimulated with excitatory postsynaptic potentials multiple times in quick succession, the sum of the excitations may raise the membrane potential passed its threshold (typically between -40 mV and -55 mV [10]). Once the membrane potential has been increased by any magnitude over its threshold value, the neuron fires a characteristic action potential spike that can be measured and related to signal transmission. This behaviour is known as the all-or-nothing response of the neuron.

Following an action potential spike, the neuron enters a refractory period during which the membrane potential is brought below its resting potential and the neuron is typically unable to immediately fire again. This ensures unidirectional travel of the signal from neuron to neuron [8]. With a similar mechanism, an inhibitory neuron creates an inhibitory postsynaptic potential that lowers the membrane potential of the connected postsynaptic neurons. This brings their state farther away from the threshold; additional stimulus of the postsynaptic neurons is now required for their membrane potentials to surpass the threshold and fire a potential spike.

Simulated Neuron Model

To encompass the basic neuronal behaviours discussed above and produce biologically relevant data for testing, the Izhikevich simple neuron model [1,9,10] was selected. It is a reduction of Hodgkin-Huxley-type neuronal models to a two-variable system [10]. This model is able to reproduce the spiking patterns and behaviours of many types of neurons [10], making it extremely versatile. The versatility of the model gives the capability to test different types of neurons in networks without having to use a different model for each. In addition to the versatility of the Izhikevich neuron model, one of its major benefits is that it is not computationally expensive, unlike most Hodgkin-Huxley-type models. A basic first order Euler's method of integration can be utilized to numerically solve the system. Stochastic stimuli can also be added to the model to simulate the intrinsic noise found in biological neurons. The intrinsic noise is necessary to increase the biological plausibility of the model because living neurons can often spontaneously fire without stimulation from other neurons [1,8,10]. Figure 1 shows an example of a small scale neural network that was created for testing, with both excitatory neurons (solid) and inhibitory neurons (dashed) present.

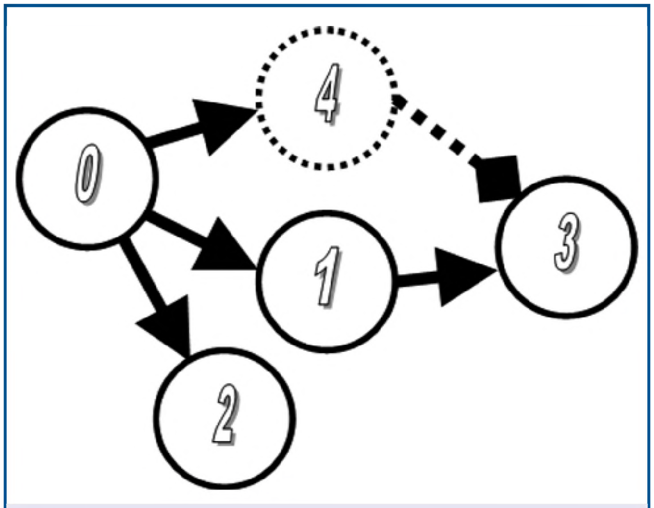

Fig. 1 Example of a small scale neural network that was created for testing, with both excitatory neurons (solid) and inhibitory neurons (dashed) present. The ratio of excitatory neurons to inhibitory neurons of 4:1 matches that found in a typical mammalian cortex [10] to increase the biologically plausibility of the simulations. The excitatory connections between neurons were successfully detected, even in the presence of the inhibitory neuron.

METHODS

The Functional Clustering Algorithm (FCA)

The FCA was first implemented according to the specifications presented in [5]. It was designed to analyze neural spike data; however, it is generic enough to be applied to any type of discrete multivariate event data [5], which makes it of interest for other applications as well [11]. First, the algorithm calculates the similarity in pairs between the activities of each neuron with all other neurons in the network according to a similarity metric. These values are used to form a matrix of similarity values. Next, spike train data from the pair of neurons with the largest similarity are removed from the rest of these data and joined (clustered) into a new data set. This allows for continued comparison between them and the other remaining (unclustered) neurons. This process is repeated until there are no significant matches left, or all the neurons have been joined into a single spike train. Figure 2 illustrates the joining process for sample data from a network of three neurons.

To establish the significance of the similarity between two neurons, the distance in time from each spike in one train to the closest in the other, and vice versa, is summed into a distance value; the smaller this distance value is the more likely the connection is significant. The significance of this value is then determined by comparing it to a large distribution of distance values generated from random surrogate data pairs created from the original data.

RESULTS, CONCLUSION AND OUTLOOKS

Through working with the FCA in various testing scenarios a new algorithm was also developed, the First Pass Clustering Algorithm (FPCA), which matched the functionality of the FCA at a reduced computational expense. This new algorithm also has the potential to provide additional network connectivity information that the FCA cannot provide.

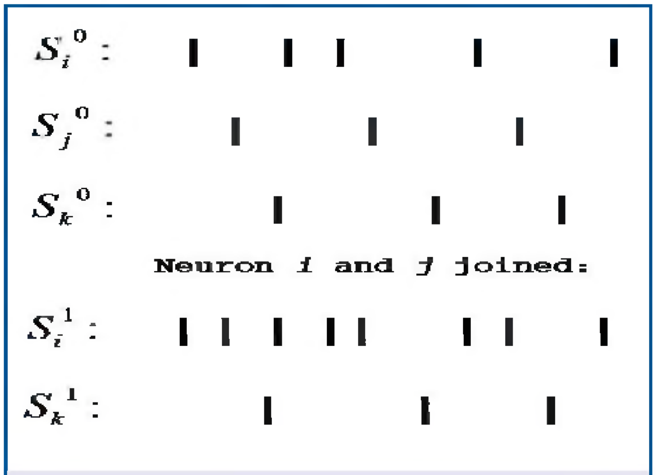

Fig. 2 A graphical representation of three data trains from neurons *i*, *j*, and, *k* before the first iteration of the FCA. Each vertical line represents a spike in the membrane potential of that neuron. In the first iteration the algorithm has determined that neuron-*i* and neuron-*j* are connected, so their spike trains are joined. The process is repeated until there are no more significant matches, or all of the neurons have been joined.

The FCA and its derivative, the FPCA, were found to be insensitive to the presence of inhibitory connections between neurons. The algorithms with the current similarity metric provide no way of distinguishing an inhibitory connection between neurons and no connection at all. In their present state the FCA and the FPCA are, hence, unable to resolve the limitation of other algorithms in detecting inhibitory connections.

In terms of excitatory connections, the FCA and FPCA were successful in identifying causally connected clusters of neurons in all of the networks tested. In networks consisting of both excitatory and inhibitory connections, both algorithms were also able to successfully identify the excitatory causally connected clusters. The presence of the inhibitory connections in the small scale tests did not interfere with the algorithms' ability to group the excitatory connections, which is a limitation present in other methods [1].

The FPCA was also able to determine the specific excitatory connections between neurons within a cluster in a large number of test networks. There were a few networks, however, where the FPCA was unable to successfully determine the specific excitatory network connections within a cluster of neurons in that network, while still successfully identifying the cluster itself. There is potential that, with further refinement, the FPCA will be able to overcome this and reliably detect the specific excitatory network connectivity between neurons in all networks. If this is possible, the FPCA will provide a new tool to help study the relationships between neural network structures and their functions in the brain. This will ultimately aid in working towards a better understanding of one of the fundamental questions regarding the human brain; what is the relationship between its neural network structures and their function?

ACKNOWLEDGEMENTS

We would like to acknowledge financial support from the following funding agencies: Alberta Innovates - Technologies Futures (formerly Alberta Ingenuity), m-prime (formerly MITACS), and NSERC.

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DESIGN AND TESTING OF A 4π TPB EVAPORATION SOURCE

BY TINA POLLMANN (FOR THE DEAP COLLABORATION)

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Many astronomical observations today can best be explained by postulating the presence of large amounts of never before observed non-baryonic particles. At the same time, many extensions to the standard model of particle physics predict new types of particles. Both fields call for a particle that does not interact through the strong force or electromagnetically and is thus invisible, or "dark." Attempts to detect interactions between normal matter and this Dark Matter have so far been unsuccessful or inconclusive because of the small interaction cross section.

The DEAP (Dark matter Experiment using Argon Pulse-shape discrimination) experiment aims to directly detect Dark Matter particles in the form of Weakly Interacting Massive Particles (WIMPs). At the center of the DEAP detector, shown in Fig. 1, are 3600 kg of liquified argon, which emits UV scintillation light in the rare event that a WIMP recoils from it. The argon is contained in an acrylic vessel with a radius of 85 cm to which photo multiplier tubes (PMTs) are optically coupled.

The inside of the acrylic vessel is coated with a thin film of the organic wavelength shifter 1,1,4,4-tetraphenyl-1,3-butadiene (TPB). It absorbs the UV scintillation light and reemits it as visible light, to which acrylic is transparent and to which the PMTs are most sensitive. The TPB will be applied by vacuum evaporation, and the thickness of the TPB layer determines the reemission efficiency. TPB comes as a crystalline powder with a nominal evaporation temperature of 205°C.

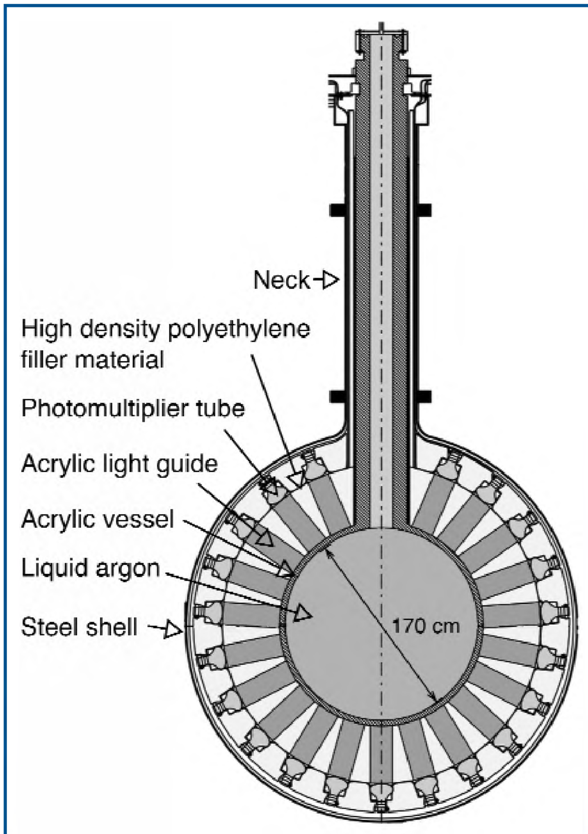

Fig. 1 Cross section of the DEAP-3600 dark matter detector. The TPB needs to be applied to the inside of the acrylic vessel.

DESIGN OF THE EVAPORATION SOURCE

An evaporation source needed to be designed with the following requirements: Heat TPB up to its evaporation temperature and coat the 9 m^2 inner surface of the spherical acrylic vessel with a uniform and mechanically stable 0.90±0.25 μm [1,2] thick layer of TPB, without rotating the source or the vessel. No loose TPB must fall into the vessel and the source must fit through the detector neck.

A prototype TPB evaporation source was designed and built, shown in Fig. 2, which consists of an 11 cm diameter aluminum sphere punctured by 20 holes 1.3 cm in diameter, and a cylindrical copper crucible hanging in its center. The holes are arranged evenly on the surface while leaving as much of the bottom and the top of the sphere as possible closed, and the area of the holes was calculated such that random motion of the TPB molecules inside the sphere is ensured.

SUMMARY

We describe the design and testing of the evaporation source that will be used to coat the inside 9 m^2 surface of the spherical acrylic vessel of the DEAP dark matter detection experiment with the organic wavelength shifter tetraphenyl butadiene.

Fig. 2 The prototype large area TPB evaporation source.

The sphere is heated by running a current through the kapton-insulated nichrome wire wrapped around it, and the crucible with the TPB in it is heated radiatively from the sphere. The evaporation is controlled with two temperature sensors attached to the crucible and to the inside of the sphere.

TESTING

To test the performance of the source, a vacuum chamber in the shape of a cross was constructed, with the arms spanning the diameter of the acrylic vessel. Each arm was instrumented with a quartz crystal deposition monitor and the evaporation source was suspended from the top of the system to hang in the center of the cross.

Three evaporation trials were run with 9.5, 4.2 and 6.3 g of TPB evaporated, at a pressure of 1 to 9×10^{-5} mbar in the system. Acrylic beads were placed in the system for the third trial to simulate the rest-gas atmosphere in the DEAP-3600 vessel. Besides the thickness readings from the deposition monitors, the TPB uniformity and thickness on glass and acrylic samples placed in the system during each evaporation were evaluated using a stylus profile meter.

An average heat-up rate not larger than 2.6°C per minute was maintained to prevent micro-explosions and premature melting of the TPB in direct contact with the crucible. Once evaporation temperature was reached, the power to the nichrome wire was controlled by a computer to maintain a constant crucible temperature. The sensor readings for one evaporation are shown in Fig. 3.

RESULTS

The temperature profile during heat-up of the evaporation source was as expected and the crucible reached and maintained 200°C with fluctuations of less than 2°C.

The measured thicknesses for each evaporation, shown in Fig. 4, indicate an overall uniformity within the design

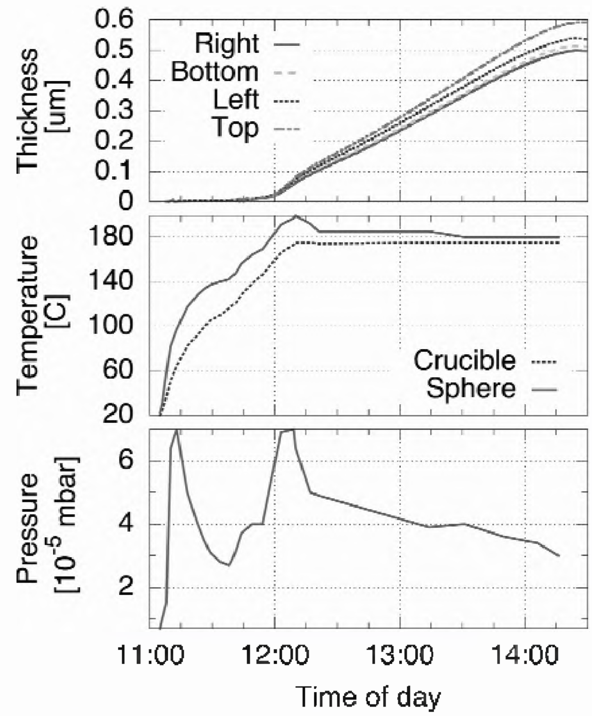

Fig. 3 Sensor readings during an evaporation. Top: Thickness readings from the four quartz crystal deposition monitors. Middle: Temperature sensor readings on the deposition source. Bottom: Pressure in the vacuum test system as measured at the right arm. The Pressure spikes each time the power to the heating wire is increased.

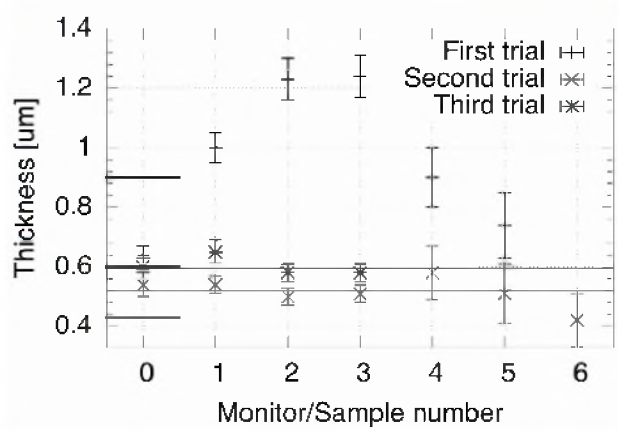

Fig. 4 Distribution of thicknesses at 85 cm radius from the source. Numbers 0 to 3 are the readings from the deposition monitors. Numbers 4 through 6 are the thicknesses glass and acrylic samples. The expected thickness is indicated by the short thick bars. The averaged thickness is indicated by the long thin lines.

specifications, with trial two and three several times better than the specification. The first sensor was shaded during the first trial and therefore did not give an accurate reading. All sensor readings were elevated for the first and second trial because they were taken before the system had cooled down. The third trial with accurate sensor readings indicates excellent uniformity and an averaged thickness matching the expectation.

The coatings on the glass samples were uniform with thickness variations less than 0.2 μm. Glass samples not in good thermal contact with the vacuum system were not reliably coated, probably because of the radiative heat load from the crucible. All acrylic samples had good coatings.

DISCUSSION

We have designed and tested an evaporative deposition source to coat the 9 m^2 of the DEAP-3600 acrylic vessel with the wavelength shifter TPB. The requirements of large scale and small scale uniformity were achieved. Even the trials where the deposition monitor readings were unreliable had a uniform enough TPB thickness distribution for the final experiment. The true uniformity, as seen in the last trial, is better than 5%. One drawback of this system is that the distribution of thicknesses could only be tested at four angles. The source was not kept at the same rotation angle for each evaporation, remedying this shortcoming to some extent. In future work, an evaporation test is planned on a small scale mock up of the detector vessel, before deploying the source in the actual detector.

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QUANTUM PHASES OF DIPOLAR BOSONS IN BILAYER GEOMETRY

BY ARGHAVAN SAFAVI-NAINI, SEBNEM G. SÕYLER, GUIDO PUPILLO, HOSSEIN R. SADEGHPOUR, AND BARBARA CAPOGROSSO-SANSONE

Models describing strongly correlated lattice quantum systems have been the focus of intense theoretical studies in the past decade. The Fermi-Hubbard hamiltonian, potentially being the minimal model explaining high Tc superconductivity [2], and the Bose-Hubbard hamiltonian exhibiting the superfluid (SF)-Mott-insulator (MI) phase transition [3], are two paradigmatic examples. These models, although simple, are highly non-trivial as they reveal the important many-body physics of strongly correlated systems. Moreover, they can be experimentally realized using atomic and molecular quantum gases trapped in optical lattices [4,5].

More recently, due to experimental progress in trapping ground state polar molecules with strong electric dipole moments [7], and atoms with large permanent magnetic moments [6], quantum models with tunable, long-range and anisotropic interactions are within reach. Hence theoretical understanding of such systems is timely and compelling.

In the following letter we study a system consisting of dipolar particles confined in a pair of two-dimensional (2D) optical lattice layers, and with dipole moments polarized perpendicular to the planes. As a result of the anisotropic and long-range nature of the dipolar interaction between the particles, exotic quantum phases such as the pair-supersolid (PSS) and pair-superfluid (PSF) [among others] can be stabilized and survive up to temperatures of the order of nK. The schematic of this setup is shown in the top right panel of Figure 1(b). The 2D confinement is achieved by using a strong transverse trapping field, *e.g.* a 1D optical lattice with harmonic oscillator frequency $\omega_\perp$ and lattice spacing d_z. A large

SUMMARY

We present the zero temperature phase diagram of a system of ultra-cold bosons in a bilayer optical lattice as well as the finite temperature behavior of these phases using Quantum Monte Carlo (QMC) simulations by the Worm Algorithm (WA) [1].

enough confinement provides the collisional stability of the setup [8] and creates a large potential barrier between the two layers which suppresses tunneling, thus preventing inter-layer hopping. The particles are further confined in plane by a 2D optical lattice with harmonic frequency ω and lattice spacing a. When $\hbar\omega > d^2/a^3$, $k_B T$ (where d is the induced dipole moment and T the temperature), tunneling to an already occupied site is strongly suppressed [9], and particles can be treated in the hard-core limit.

The system is described by the extended Bose-Hubbard model:

$$(1) \qquad H = -J \sum_{<i,j>,\alpha} a_{i\alpha} a_{j\alpha} - \frac{1}{2} \sum_{i\alpha;j\beta} V_{i\alpha;j\beta} n_{i,\alpha} n_{j,\beta} - \sum_{i,\alpha} \mu n_{i,\alpha}$$

where i, j refer to the lattice sites, α, β refer to the layers and $a_{i,\alpha}$ and $a^\dagger_{i,\alpha}$ are the bosonic creation and annihilation operators respectively, with $(a^\dagger_{i,\alpha})^2 = 0$, $n_{i,\alpha} = a^\dagger_{i,\alpha} a_{i,\alpha}$. $< >$ denotes summation over nearest neighbors only. The first term in the Hamiltonian describes the kinetic energy with in-plane hopping rate J. The second term is the dipole-dipole interaction given by

$$V_{i,\alpha;j\beta} = C_{dd}/4\pi[(1 - 3\cos 2\theta)/|r_{i,\alpha} - r_{j,\beta}|^3]$$

where $C_{dd} = d^2/\varepsilon_0(\mu_0 d^2)$ for electric (magnetic) dipoles. Lastly μ is the chemical potential which sets N, the number of particles present in the system.

In this setup the in-plane dipolar interaction, V_{dd}, is repulsive and isotropic while the interlayer interaction is anisotropic. We denote the repulsive nearest neighbor intralayer interaction by $V_{dd} = C_{dd}/4\pi a^3$ and the attractive interlayer dipole-dipole interaction between dipoles sitting on top of each other by $V_{dd}^\perp = 2C_{dd}/4\pi d_z^3$. We can tune the relative strength $V_{dd}/V_{dd}^\perp$ over a wide range of values by changing d_z. In what follows we consider same type and number of particles on each layer, and choose $d_z = 0.36a$ so that $V_{dd}^\perp/J < 10$ at half filling factor [10]. This choice allows us to access a parameter regime where particles on the same lattice site but on different layers can pair up to form a composite object. For

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a gas of RbCs molecules with d ≈1.25 D the above conditions will be satisfied for a < 500nm and dz < 200 nm at J < 120hHz.

We present results based on path integral Quantum Monte Carlo simulations by a two-worm algorithm [11] which allows for efficient sampling of paired phases. We have performed simulations of L × L = N_{sites} square lattices with L = 8,12,16, 20 and 24. We have set the dipole-dipole interaction cutoff to the third nearest neighbor. We found that, while using a larger cutoff did not change the simulation results (within error bars), super-solid phases (see below) cannot be stabilized at lower cutoff values.

The zero temperature phase diagram of model (1) is shown in Figure 1(a). The latter is symmetric about n = 0.5 due to the particle-hole symmetry (a consequence of the hard-core constraint). The observed phases are sketched in Figure 1(b).

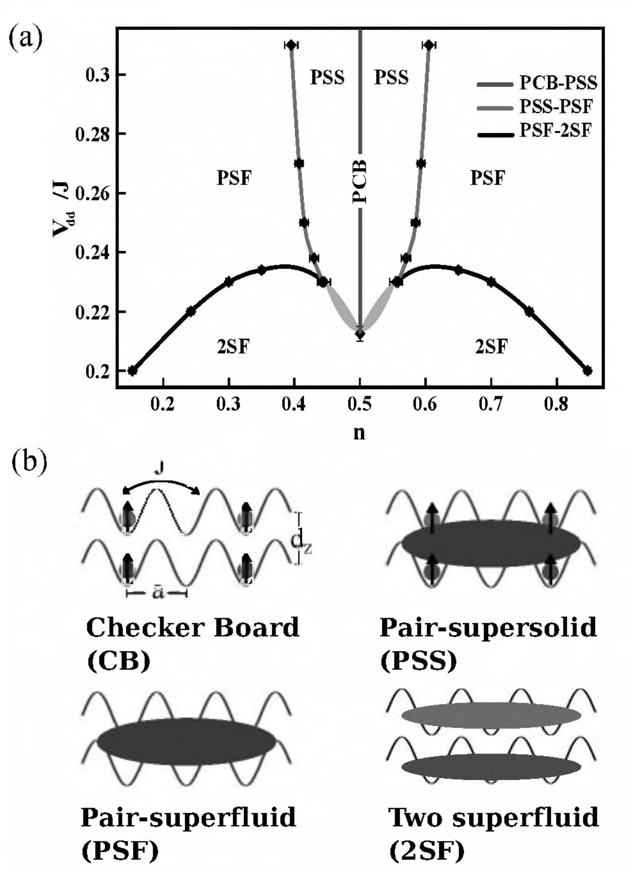

Fig. 1 (a) The zero temperature phase diagram of (1) as a function of the in-plane dipole-dipole interaction V_{dd}/J and the filling factor n. The diamonds show the QMC simulation results. In cases where the error bars are not visible, the error is within the symbol size. We were not able to resolve the phase boundaries in the shaded region. (b) A schematic representation of the phases. Each cloud represents an independent superfluid in the 2SF phase while the cloud in the PSS and PSF phases is a superfluid of the pairs.

At half-filling, n = N/N_{sites} = 0.5, when the in-plane repulsion is strong enough, *i.e.* $V_{dd}/J \geq 0.21 \pm 0.05$, a checkerboard (CB) solid of pairs (with every other site in each layer occupied) is stabilized. At this filling factor, the most energetically favorable configuration is a perfect CB crystal. The CB solid order is characterized by zero superfluidity and finite structure factor for each layer:

$$S(k)=\frac{1}{N}\sum_{r,r'}\exp\left[ik\left(r-r'\right)\right]\left\langle n_r n_{r'}\right\rangle \qquad (2)$$

at reciprocal lattice vector **k** = (π,π). In this phase $\psi_{i\alpha} = \psi_{i\beta} = \Psi = 0$ where $\psi_{i\alpha} = \langle a_{i\alpha}\rangle$ is the single-particle order parameter and $\Psi = \langle a_{i\alpha}\, a_{i\beta}\rangle$ is the pair order parameter. In the paired CB phase atoms across the layers are strongly paired due to attractive interlayer interactions. Hence the particles sit on top of each other and the system can be envisioned as a solid of pairs [12,13].

Upon doping the CB solid with particles or holes we enter the PSS phase. The latter displays both, broken translational symmetry, S(π,π) ≠ 0, *i.e.* diagonal long range order, and non-vanishing pair order parameter Ψ, *i.e.* off-diagonal long range order, while $\psi_{i\alpha} = \psi_{i\beta} = 0$. Figure 2(a) shows S(π,π) (left y-axis) and the superfluid stiffness of pairs ρ_{PSS} (right y-axis) as a function of n, at $V_{dd}/J = 0.238$ for different system sizes. Both quantities are non-zero for a finite range of densities

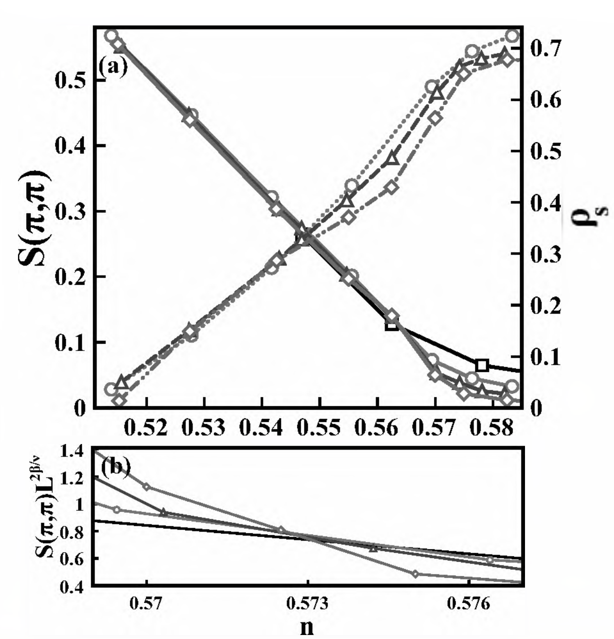

Fig. 2 (a) The structure factor S(π,π) (solid lines, left y-axis) and superfluid density ρs (dashed lines, right y-axis) for the PSS-PSF transition at V_{dd} = 0.238J for L = 8,12,16,20 and 24 and at T/J = 1/(1.5L). The arrow indicates the phase boundary. (b) The scaled structure factor S(π,π)$L^{2\beta/\nu}$ vs. n using the critical exponents of the Ising universality class in (2+1) dimensions, 2β/ν = 1.0366.

implying a stable PSS phase. The off-diagonal order present in the PSS phase is a result of extra particle or hole pairs (quasi-particles) which delocalize on top of the CB solid. Upon further doping, the system can no longer sustain the solid order and PSS disappears in favor of PSF via an Ising transition in (2+1)-dimensions. In the PSF phase only the off-diagonal long range order of PSS survives. The critical point (indicated by an arrow in Fig. 2(a)) is determined using finite size scaling with scaling coefficients $2\beta/\nu = 1.0366$ [14]. Figure 2(b) shows the scaled quantity $S(\pi,\pi)L^{1.0366}$ as a function of n. The crossing of the curves corresponds to the quantum critical point where the finite size effects disappear.

Finally, the system forms two independent superfluids (2SF) as V_{dd}/J is lowered at constant n. In this phase $\psi_{i\alpha} = \psi_{i\beta} \neq 0$ and the pair order parameter is trivially non-zero, $\Psi \neq 0$. Unlike the zero density limit, where a bound state is always formed [15], at finite density, many body effects favor 2SF, resulting in a finite threshold for stabilization of pairing.

We have also studied the finite temperature behavior of the system and determined critical temperatures at which the above described quantum phases disappear. The SF-normal transition is of Kosterlitz-Thouless (KT) type [16]. We determine its critical temperature $T_{KT} = \pi\hbar^2\rho_s(T_{KT})/2$ by finite size scaling as described in [17].

Figure 3 shows a plot of ρ_s vs. T/J at $V_{dd}/J = 0.20$ and n = 0.3 (corresponding to 2SF) for different system sizes. The finite size scaling procedure used to determine the critical temperature is shown in the inset. We find $T_{KT,2SF} \approx 0.255 \pm 0.005J$. For the PSF phase we find $T_{KT,PSF} \approx 0.08 \pm 0.01J$ at n = 0.3 and $V_{dd}/J = 0.25$. The lower critical temperature is due to a larger effective mass of the pairs which results in a lower effective hopping, a suppression of particle delocalization and consequently lower ρ_s.

The disappearance of the PSS phase proceeds in two successive stages. At n=0.38, $V_{dd}/J = 0.25$ and $T_{KT,PSS} \approx 0.060 \pm 0.005J$, first the superfluidity of excess particle (hole) pairs disappear leaving a normal liquid phase on top of the CB solid, reminiscent of a liquid crystal with $\rho_s = 0$ and $S(\pi,\pi) \neq 0$. Upon further increasing the temperature $S(\pi,\pi)$ becomes zero at $T_c \approx 0.3J$ through an Ising-type transition ($2\beta/\nu = 1/4$ in 2D). We estimate $T_{KT,PSS}$ < nK for a typical experimental setup with RbCs.

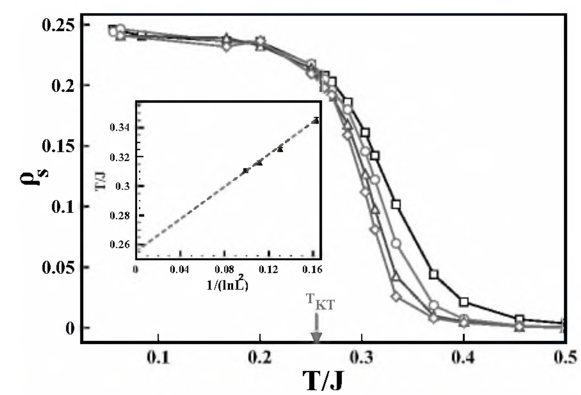

Fig. 3 Superfluid stiffness, ρs, as a function of temperature, T/J, at V_{dd}=0.20J and n=0.30 in the 2SF phase at L = 12,16,20 and 24. As temperature is increased the 2SF phase undergoes BKT phase transition at critical temperature T_{KT}. The error bars are within symbol size. The inset shows $T_{KT}(L)$ vs. $1/(\ln L)^2$. The dashed line is the linear fit to the simulation results (points). The y-intersect is the T_{KT} for an infinite size system.

In conclusion we have studied the quantum phases of dipolar bosons in a bilayer lattice geometry described by model (1) in the regime where pairing can be stabilized. We have observed a rich ground state phase diagram featuring pair-superfluidity, pair-supersolidity, independent superfluids and checkerboard solid phases. These phases are experimentally observable at temperatures of the order of nK.

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BRAIN FUNCTIONAL CONNECTIVITY IN CEREBRAL AMYLOID ANGIOPATHY, AN AGE-RELATED CEREBROVASCULAR DISEASE

BY STEFANO PECA, CHERYL R. MCCREARY, ERIC E. SMITH, AND BRADLEY G. GOODYEAR

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BRAIN CONNECTIVITY AND AGING

There is growing evidence that in the aging process both the neural and the vascular aspects of brain function are affected. On the neural side, aging is associated with damage to the myelin sheaths and reduction in the total number of nerve fibers, resulting in a reduction in structural connectivity [1]. But connections in the brain are not only structural (*i.e.* synapses, axons, etc.); equally important are blood flow related (vascular) connections. This hypothesis arose after the first observation that blood flow increased and decreased simultaneously in the two motor regions in opposite brain hemispheres. We call regions such as these *functionally connected*. As we get older, so does our brain's vascular system: the elasticity of small blood vessels in the brain diminishes in some persons [2] and white matter lesions of presumed vascular origin increase [3]. These vascular changes affect blood flow to neurons and thus may reduce functional connectivity. The extent to which these vascular-related phenomena contribute to age-related reductions in structural or functional connectivity (and perhaps to cognitive decline) is not yet clear.

Cerebral Amyloid Angiopathy (CAA) is a common age-related disease characterized by deposition of amyloid beta protein in the small arteries of the brain. It affects in some form between 10% to 40% of elderly people and 80% or more of patients with Alzheimer's disease [4]. Amyloid beta is toxic to smooth muscle cells and causes degeneration of the vessel walls resulting in asymptomatic microbleeds (Fig.1a) and a greatly increased risk of hemorrhagic stroke. Recent human and animal studies suggest that CAA also decreases vascular reactivity to neuronal metabolic demands [5], and that CAA is associated with cognitive dysfunction, independent of the presence of hemorrhagic strokes or any coexisting Alzheimer pathology. It remains unproven if cognitive deficits in CAA are a direct consequence of the vascular dysfunction, or if it develops by other pathways.

SUMMARY

We set out to investigate the difference in brain functional connectivity between healthy aging and persons with the age-related vascular disease cerebral amyloid angiopathy.

FUNCTIONAL CONNECTIVITY MRI

We used seed-based **functional connectivity magnetic resonance imaging** (fc-MRI) to assess the functional connection level of brains affected by CAA, to investigate the relationship between known vascular dysfunction and a hypothetical 'disconnection syndrome' which may be responsible for the associated cognitive impairments. We chose this approach because CAA is related to structural connectivity impairment in the form of white matter lesions (Fig.1b), which may affect functional networks, *i.e.* separate brain regions that work together to process information or perform a task [6].

Functional connectivity MRI is a promising new application of functional MRI (fMRI). In standard fMRI, active regions of the brain are identified by the so-called Blood Oxygenation Level-Dependent (BOLD) contrast. As a group of neurons increase their workload (for example your visual processing areas as you are reading this!), they use more oxygen. The small brain vessels then dilate and allow more fresh (oxygenated) blood to replace it. This increase in oxygenated blood causes changes in the MRI signal intensity, because the magnetic field properties of iron atoms in hemoglobin molecules are

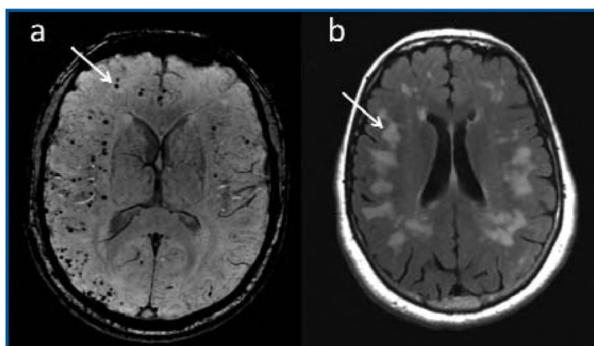

Fig 1. Cerebral Amyloid Angiopathy (CAA) is manifested on MRI images as microbleeds (a) or white matter lesions (b). Because structural white matter integrity - which is essential for connectivity - is known to be affected by CAA, we hypothesized that patients with CAA would also exhibit reduced functional connectivity.

dependent on whether the iron atom is bound to oxygen or not. In fc-MRI, spontaneous BOLD fluctuations at rest are mapped in the whole brain. Interestingly, there are separate regions in which the BOLD signal fluctuates in coherence, *i.e.* are functionally connected. Conserved functional networks have been identified by fc-MRI both during mental activity and during the resting state in normal individuals [7, 8].

Because posterior brain regions are most strongly affected by CAA [9], we chose the primary visual cortex (V1) as the 'seed' region, located in the occipital lobe, and mapped all brain regions that are functionally connected to it. To ensure precise functional location of V1, we ran a visual stimulus fMRI sequence before the fc-MRI sequence. We hypothesized that patients with CAA would exhibit reduced functional connectivity with V1 compared to similar-aged control subjects.

METHODS

Nine CAA patients (age 72.4±9.4 y) and eleven age-matched healthy controls underwent fMRI during a visual stimulus and during a rest condition. Patients were free of hemorrhagic stroke in the occipital poles, and had normal or corrected-to-normal visual acuity and no visual field deficits. CAA patients had higher volumes of MRI white matter hyperintensities (median 40.9 mL, interquartile range 35.5-54.0 mL) compared to healthy controls (4.8 mL, 3.7-5.7 mL), $p=0.002$. Participants were recruited and gave informed consent in accordance with the guidelines of the Conjoint Health Research Ethics Board.

Visual stimulus fMRI consisted of four blocks of an 8-Hz contrast-reversing black/white checkerboard for 40 s alternating with 40 s of black cross fixation on a gray screen. To obtain the fc-MRI data, a separate resting-state fMRI sequence was acquired with subjects awake, eyes open, and continuous black cross fixation. Echo-planar images were acquired with standard parameters (TR/TE/FA = 2000ms 30ms/70°, 64x64 matrix, 24 cm FOV, 4 mm contiguous slices, 220 s in duration), and inversion-prepared, 3D gradient echo high-resolution images were also acquired for anatomical registration (TR/TE/TI/FA = 6.0 ms/2.4 ms/650 ms/8°, 256x256 matrix, 24 cm FOV, 1 mm slice thickness). All MRI data were acquired on a 3.0 T scanner using an 8-channel head coil (Signa VH/i, GE Healthcare, Waukesha, WI).

Data analysis was carried out using FSL (http://www.fmrib.ox.ac.uk/fsl). A mask was obtained for each subject's 50 most active voxels (2.8 cm^3) within the primary visual cortex. This masked region is schematically represented by the green volume in Fig.2. Whole-brain maps of the functional connectivity with this region were generated for each subject using the resting-state fMRI data. This was done by extracting the average time course of all voxels in the mask and using it in a whole-brain general linear model (GLM) analysis. Finally, a between-group connectivity analysis was performed using a mixed-effects GLM. Clusters corrected to $p<0.05$ were considered significant.

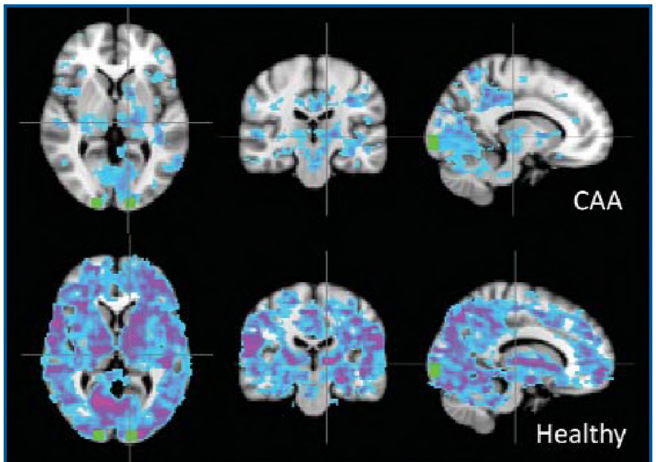

Fig 2. Functional connectivity with primary visual cortex (in green), for CAA patients (top) and controls (bottom). Color scale represents the strength of functional connectivity, expressed as statistical Z-scores ranging from 3.1 (cyan) to 5.0 (purple). Connectivity is weaker in CAA.

RESULTS: BRAINS ARE 'DISCONNECTED'

Qualitatively, **whole-brain functional connectivity with V1 is weaker in CAA patients** (Fig.2, top) compared to healthy controls (Fig.2, bottom), particularly in regions farther from the seed.

Significant differences in functional connectivity were identified between the two groups in four brain regions (Fig. 3). Connectivity was significantly **reduced** in CAA patients bilaterally in the anterior section of the superior temporal cortices (Brodmann's areas 21 and 22), which are involved in language processing, and in the right putamen, which is associated with motor and executive function (Fig.3, top). Interestingly, connectivity was significantly **greater** in

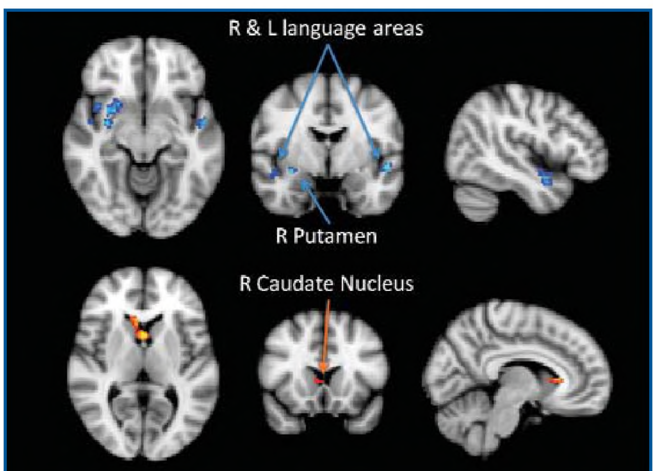

Fig 3 Regions where functional connectivity is significantly reduced (blue) or increased (red) in CAA patients compared to controls. Color scales represent Z-scores ranging from 2.3 to 3.0 (blue-to-light blue) and 2.3 to 2.6 (red-to-yellow).

CAA patients in the body of the right caudate nucleus (Fig.3, bottom), a region involved in learning, working memory, and language comprehension.

CONCLUSIONS AND FUTURE DIRECTION

Our results suggest that functional connectivity with the primary visual cortex is affected by the presence of vascular amyloid in the brain. The connectivity differences with the right putamen and the right caudate may indicate that these structures are secondarily affected by CAA-related neurodegeneration, as suggested by previous studies that have shown that the basal ganglia may atrophy in neurodegenerative diseases, including Alzheimer's disease [11, 12]. Although it is possible that atrophy brings about functional disconnection, it does not explain our unexpected result of increased connectivity with the right caudate. One potential explanation for this increase is that the caudate nucleus could have been recruited as part of a compensatory network, thus increasing functional connectivity, as has been recently observed in cognitively impaired multiple sclerosis patients [13].

We speculate that the observed reduced connection between the primary visual cortex and the higher-level language processing areas may be a consequence of structural disconnection due to CAA-related white matter disease [6]. However, increased heterogeneity in vascular reactivity, due to CAA-related vascular dysfunction, could also potentially explain some of the observed disconnection in correlated fMRI signal fluctuations because the fMRI signal is dependent on local changes in blood flow. Functional disconnection may underlie some of the cognitive dysfunction that affects CAA patients; however, future larger studies will be needed to address this question. Future studies should also address the question of whether functional connectivity declines with aging, and whether cerebrovascular disease or altered cerebrovascular activity is a component of age-related decline. Further study of the impact of CAA and other age-related cerebrovascular syndromes on brain functional networks is warranted, and functional connectivity MRI will certainly prove to be a valuable tool to investigate these relationships.

FUNDING

This study was funded by the Canadian Stroke Network.

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Prize Winners / Gagnants des prix

University Prize Exam Results 2012
Résultats de l'examen du prix universitaire 2012

88 students from 23 post-secondary institutions competed this year. The exam was run by representatives from the University of Alberta and was held on February 7th, 2012. The examining committee included Ian Blokland (Augustana campus), Andrzej Czarnecki, Richard Marchand, Helmy Sherif (retired) and Frank Weichman(retired). / *88 étudiants de 23 universités ont écrit l'examen cette année. Le concours universitaire 2012 de l'ACP a eu lieu 7 février, 2012. Cet examen fut administré par l'Université de l'Alberta. Le comité d'examen comprenaient Ian Blokland (Augustana campus), Andrzej Czarnecki, Richard Marchand, Helmy Sherif (retraité) et Frank Weichman (retraité).*

Junjiajia Long	**First Prize / Premier Prix**	Univ. of Toronto / Univ. de Toronto
Mohammadreza Mohammadi	**Second Prize / Deuxième Prix**	Univ. of Toronto / Univ. de Toronto
Keith Ng	**Third Prize / Troisième Prix**	Univ. of Calgary / Univ. de Calgary

4.	Rhys Anderson	U. of Waterloo
5.	Wilkie Choi	Queen's U.
6.	Alexander James	U. of Calgary
7.	Michael Grudich	Memorial U. of Nfld.
8.	Chris Read	UBC
8.	Deshin Finlay	UBC
10.	Kyle Boone	UBC

The first prize winner received an all-expense paid trip to the CAP Congress to receive his cash award during the banquet. / *Le gagnant du premier prix a été invité à participer au congrès annuel de l'ACP, toutes dépenses payées, pour recevoir son prix au banquet.*

CAP High School Prize Exam - l'examen du secondaire ou collégial de l'ACP -- 2012 National Winners gagnants 2012 à l'échelle nationale --

1st Prize	Henry Wu	University of Toronto Schools, Ontario
2nd Prize	Yun Jia (Melody) Guan	University of Toronto Schools, Ontario
3rd Prize (tie)	Jiajun Wang	Vanier College, Québec
3rd Prize (tie)	Run Ze Cao	Martingrove Collegiate Institute, Ontario

2012 Canada-Wide Science Fair

Anna O'Grady, Gr.12
Bishops College, Newfoundland

The 52nd Annual Canada-Wide Science Fair, held from May 15-23, 2012 in Charlottetown, PEI, was a resounding success. The CAP sponsored an award for the best physics project in the senior category. The prize included of a cash award of $1,000. The winner of the 2012 CAP prize was:

Unveiling Dark Matter: A Study of Dark Matter and its Effects on Galaxy Clusters

For my science project, I studied the various physical properties of a galaxy cluster, and through my observations, I was able to infer the existence of dark matter. In my project I retrieved data from an astronomical database, transformed the observed values into physical data, and finally calculated the kinetic and gravitational energies of the galaxy cluster.

Biography : *I have an interest in good music and movies, and a strong interest in anything science. My main field of science is astronomy and astrophysics, something that I hope to see myself doing as a career. Last year at the CWSF, I received a Silver Medal, the Canadian Association of Physicists Award, and I had the distinct honor of attending the International Summer School for Young Physicists - an experience I will never forget. At the regional science fair this year in Newfoundland, I was the Best in Fair, and I also received an award from the Royal Astronomical Society of Canada. Outside of school, I volunteer at my church every Sunday, and I've been taking piano lessons for twelve years.*

REPORT ON CANADA'S PARTICIPATION IN THE 43RD INTERNATIONAL PHYSICS OLYMPIAD, TALLINN, ESTONIA

BY JEAN-FRANÇOIS CARON AND ANDRZEJ KOTLICKI

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Dr. Andrzej Kotlicki <kotlicki@phas.ubc.ca> is from the Department of Physics and Astronomy at the University of British Columbia

The 43rd International Physics Olympiad (IPhO) was held from 15 to 24 July in Tallinn and Tartu, Estonia. A total of 378 students from 80 countries took part in the competition, with 45 receiving gold medals, 71 receiving silver medals and 92 receiving bronze medals. A further 63 students completed the Olympiad with honorary mentions. For the first time in the history of the Olympiad the International Committee and most of the organizers were staying in Tallinn and were separated by 200 km from the students who were in the old Estonian University Town Tartu.

The members of the Canadian team this year (Figure 1) were: Tristan Downing from Semiahmoo High School (BC), Sepher Ebadi from Langstaff Secondary School (ON), Yun Jia (Melody) Guan from University of Toronto Schools (ON), Henry Wu from University of Toronto Schools (ON), and Simon Blouin from Collège Bois-de-Boulogne (QC). The leaders were Dr Andrzej Kotlicki (UBC) and Jean-Francois Caron (UBC)

Again for the first time the Estonian Olympiad was preceded by an on line theoretical problem competition open on line for all students. Interestingly the winner of this competition was also an absolute winner of the Olympiad. The organization of the Olympiad was very good with some new features like leaders submitting the translated problems on line (problems are prepared and discussed in English and the team leaders translate then for their teams in their native languages) rather than printing them and submitting all the marks on line. Some of these were the result of the separation of students and leaders.

SUMMARY

The 43rd International Physics Olympiad (IPhO) was held from 15 to 24 July in Tallinn and Tartu, Estonia. A total of 378 students from 80 countries took part in the competition, with 45 receiving gold medals, 71 receiving silver medals and 92 receiving bronze medals. A further 63 students completed the Olympiad with honorary mentions.

Fig. 1 Members of the Canadian team.

The problems comprising the competition challenged the students' knowledge of physics at a level exceeding most introductory physics courses in universities. As usual, there were three theoretical problems, while the experimental part of the competition consisted of two separate experiments. These were the most difficult problems in the history of the Olympiad. They were very well prepared and most challenging. The absolute winner of the Olympiad got 46 point out of 50 and one needed only 24 points for silver medal and 17 for bronze!

The first theoretical problem consisted of three independent parts. Part one was an optimization of a ball trajectory to reach a top of a spherical building, the second part was a flow around a wing problem and in the third part student were expected to find a magnetic field around the superconducting tubes with the trapped flux and the interaction between two tubes like it. The interaction is equivalent to the interaction of four magnetic monopoles and it seems that finding this equivalence far exceeds what one can expect from a best high school student.

The second theoretical problem was about the Kelvin water dropper – an electrostatic voltage generator.

The third theoretical problem asked the students for number of (mainly thermodynamical) calculations modeling a Protostar formation.

Fig. 2 Our team did well in the competition: Henry Wu got a silver medal and all the other team members received bronze medals.

In the first experimental problem students were expected to measure the magnetic permeability of water. It was a beautifully designed experiment, which allowed to obtain the value μ -1 = -7.8 × 10^{-6} to within 30%.

The second experimental problem was an electrical black box problem with the tunnel diode inside a “black box.

As indicated by the IPhO Statutes, a moderation of the grading was held where the local markers and the delegation leaders discussed the students’ scores to ensure fairness and consistency in the marking. The moderation went very smoothly, with disagreements resolved in a friendly and speedy manner.

Our team did well in the competition: Henry Wu got a silver medal and all the other bronze medals.

When the students were not busy solving problems, they experienced the rich social and scientific program. They visited Tartu Adventure Park and were able to try various obstacle courses and Zip Line rides, visited the Rakvere medieval Castle, listened to the lecture by Sir Harold Kroto (the 1996 Nobel Prize in Chemistry), participated in a soccer tournament… Direct interaction with students from all over the world, sharing the passion for physics and science is probably the most valuable experience for the students.

Next year, the IPhO will be held in Copenhagen, Denmark from 7th to 15th of July 2013. The chair of the organizing committee, Dr. Niels Hartling, invited all countries present to participate in next year’s competition.

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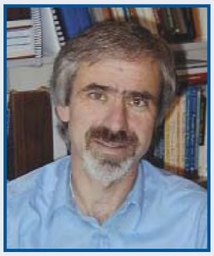

PRESIDENT

Gabor Kunstatter obtained both his B.A.Sc. in Engineering Science (Physics) and his PhD in general relativity at the University of Toronto. He then spent two years at Imperial College (London) as a NATO Postdoctoral Fellow before returning to the University of Toronto for four years as an NSERC University Research Fellow. Dr. Kunstatter took up his current position at the University of Winnipeg in 1985, becoming a Full Professor of Physics in 1992. He served as Chair of the Physics Department from 2000-2002 and spent the next six years completing a five year term as Dean of Science. He has been a visiting scientist at M.I.T., Université de Paris (Orsay), UNAM (Mexico), University of Nottingham and CECS (Chile).

Dr. Kunstatter's research interests include a variety of topics in theoretical physics. He has worked on relativity, gauge theory quantization, finite temperature quantum field theory, quantum computing and quantum gravity. Most recently, his work focuses on the semi-classical effects of quantum gravity on black holes and black hole formation. Having taught a full spectrum of courses over the years, Dr. Kunstatter remains fully committed to undergraduate teaching and particularly to the involvement of undergraduates in research. In addition to supervising the summer research of a large number of outstanding undergraduates at the University of Winnipeg, Dr. Kunstatter has supervised several excellent graduate students via an adjunct professorship at the University of Manitoba.

He is a founding member, serving as Director during 1991-92 and 2010-2012, of the Winnipeg Institute for Theoretical Physics ,which is a joint research institute of Brandon University, the University of Manitoba and the University of Winnipeg. Dr. Kunstatter has been a member of the CAP for close to twenty-five years, having joined in 1986. He toured as CAP Lecturer three times (1987, 1994 and 2005, with the next apparently scheduled for 2018 if the sequence of prime numbers continues). Dr. Kunstatter served as CAP Councillor for Manitoba and Saskatchewan from 1986-88 and chaired the Theory Division in 1991/92. He also served on the Editorial Advisory Board of the CJP from 1995-98. Dr. Kunstatter completed two terms on NSERC GSC's, the first from 1992-95 on GSC 29 and the second from 2006-09 on GSC 17, which he chaired in the last year.

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VICE-PRESIDENT

Ken Ragan graduated with a B.Sc. in Honours Physics from the University of Alberta in 1980, and obtained his D.Sc. in Particle Physics from the University of Geneva in 1986. He then spent three years as a post-doc at the University of Pennsylvania in Philadelphia prior to moving to McGill University in 1990 as a faculty member. He is currently a Professor and William C. MacDonald Chair in the Department of Physics at McGill. He has been a visiting scholar at the University of Bordeaux, at the University of Paris VI, and at the University of California, Santa Cruz.

For many years his research interests centred around particle colliders, and specifically the CDF experiment studying proton-antiproton collisions at Fermilab, where the top quark was discovered in 1995. More recently his interests have moved towards the area of particle astrophysics, and centred around the STACEE and VERITAS ground-based high-energy gamma-ray observatories.

He has taught a wide range of undergraduate and graduate courses, most recently large freshman introductory physics classes, where he has been involved in introducing technology and techniques designed to enhance student participation and learning.

He has been a CAP member for more than 20 years, has served as a CAP Councillor and as the Chair of the CAP-NSERC Liaison Committee. He served on NSERC's GSC 19 (Sub-atomic Physics) from 1999 to 2002 (including chairing the committee in 2002), and chaired the NSERC 2006 Long Range Planning Committee on sub-atomic physics.

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VICE-PRESIDENT ELECT

Robert Fedosejevs graduated with a B.Sc. in Honours Physics from the University of Toronto in 1973. He obtained his Ph.D in Physics from the University of Toronto in 1979 in high power laser-plasma interactions, having carried out his research work at the National Research Council of Canada in Ottawa. He spent the following year as a Post-Doctoral Fellow and two subsequent sabbaticals (1988-89 and 1996-96) at the Max-Planck Institute for Quantum Optics in Garching, Germany. In the Fall of 1980 he started as a Research Associate at the University of Alberta becoming an Associate Professor in 1982 and a full Professor in 1988 in the Department of Electrical and Computer Engineering. In 1986, he became Director of the Engineering Physics Program at the University of Alberta for a period of ten years. In 1998 he served as Associate Chair of the Department for one year and then from 1999 to 2011 he held the position of MPBT/ NSERC/UofA Senior Industrial Research Chair in lasers sensor applications. He has also been a visiting professor at the University of Bordeaux, University of California San Diego and the Polytechnical University of Madrid. His research interests centre on high powered lasers, laser produced plasmas and applications ranging from laser sensors to laser fusion energy. He has taught courses on circuit theory, plasma physics, mathematical methods for science and engineering, lasers and nonlinear optics.

He has been a CAP member for more than 35 years, has served as Chair of the CAP Division of Plasma Physics twice, and served three years on the CAP-NSERC Liaison Committee. He served as member and Chair on NSERC's GSC 29 (General Physics) from 1996 to 1999. From 2003 until 2012, he served as the Scientific Director of a Network of Centers of Excellence, the Canadian Institute for Photonic Innovations.

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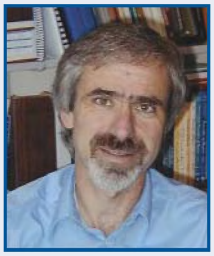

PRÉSIDENT

Après avoir obtenu ses deux diplômes de l'Université de Toronto, soient un B.A. Sc. en génie physique et un Ph. D. en relativité générale, Gabor Kunstatter a passé deux ans à l'Imperial College (London) comme boursier postdoctoral de l'OTAN, avant de retourner à l'Université de Toronto à titre de chercheur universitaire du CRSNG pendant quatre ans. Le Dr Kunstatter a été nommé à son poste actuel à l'Université de Winnipeg en 1985, devenant professeur titulaire de physique en 1992. Il a été directeur de département de 2000 à 2002 et il a passé les six années suivantes à remplir un mandat comme doyen des sciences. Il a été scientifique invité au MIT, à l'Université de Paris (Orsay), à l'UNAM (Mexique), à l'University of Nottingham et au CECS (Chili). Les intérêts de recherche du Dr Kunstatter comprennent une variété de sujets en physique théorique. Il a travaillé sur la relativité, sur la quantification des théories de jauge, sur la théorie du champ quantique à des températures finies, sur l'informatique quantique et sur la gravité quantique. Plus récemment, son travail s'est concentré sur les effets semi-quantiques de la gravité quantique, sur les trous noirs et sur la formation des trous noirs. Ayant enseigné une grande variété de cours à travers les années, le Dr Kunstatter reste complètement engagé dans l'enseignement au niveau du premier cycle et particulièrement dans la participation des étudiants du premier cycle à la recherche. Cet engagement vient du fait qu'il croit fermement qu'enseignement et recherche constituent les deux côtés de la même médaille. En plus de diriger la recherche d'un grand nombre d'étudiants d'été de premier cycle à l'Université de Winnipeg, le Dr Kunstatter a aussi supervisé plusieurs excellents étudiants des cycles supérieurs, grâce à sa nomination comme professeur associé à l'Université du Manitoba.

Il est un membre fondateur (directeur - 1991-92 et 2010-12), de l'Institut de physique théorique de Winnipeg, qui est un institut de recherche conjoint de l'Université Brandon, de l'Université du Manitoba et de l'Université de Winnipeg. Le Dr Kunstatter a été membre de l'ACP pendant près de vingt-cinq ans, ayant adhéré à l'association en 1986. Il a été conférencier de l'ACP trois fois. Le Dr Kunstatter a servi comme conseiller pour le Manitoba et la Saskatchewan de 1986 à 1988 et il a présidé la Division théorique, en 1991-1992. Il a également siégé au comité éditorial consultatif de la RCP de 1995 à 1998. Le Dr Kunstatter a rempli deux mandats au CSS (Comité de sélection des subventions) du CRSNG, le premier, de 1992 à 1995 (CSS 29), et le deuxième, de 2006 à 2009 (CSS 17), comité qu'il a présidé l'année dernière..

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VICE-PRÉSIDENT

Ken Ragan a obtenu un baccalauréat en sciences avec spécialisation en physique de l'Université de l'Alberta en 1980 ainsi qu'un doctorat en sciences en physique des particules de l'Université de Genève en 1986. Il a ensuite entrepris au cours des trois années suivantes son postdoctorat à l'Université de Pennsylvanie à Philadelphie avant de s'établir en 1990 comme professeur à l'Université McGill. Il est actuellement professeur et titulaire de la Chaire William C. MacDonald au département de physique de l'Université McGill. Il a été chercheur invité à l'Université de Bordeaux, à l'Université de Paris VIe ainsi qu'à l'Université de la Californie à Santa Cruz.

Pendant plusieurs années, ses recherches se sont concentrées autour des collisionneurs de particules, et il a plus précisément étudié le domaine des collisions proton-antiproton à Fermilab, où l'on a découvert le quark t en 1995. Récemment, ses intérêts l'ont amené dans le domaine de l'astrophysique des particules et vers les observatoires terrestres de rayonnement gamma à haute énergie STACEE et VERITAS.

Il a donné un grand nombre de cours à des étudiants de premier cycle ainsi qu'à des étudiants diplômés. Dernièrement, il a donné un cours d'introduction à la physique à des étudiants de première année universitaire à qui il propose des notions technologiques et techniques conçues pour améliorer l'apprentissage et la participation.

M. Ragan est membre de l'ACP depuis plus de 20 ans; il a été conseiller pour l'Association et a aussi dirigé le Comité de liaison ACP-CRSNG. Il a fait partie du CSS 19 du CRSNG (Physique subatomique) de 1999 à 2002 (en tant que président du comité en 2002) et a présidé le Comité de planification à long terme de la physique subatomique de 2006 au CRSNG.

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VICE-PRÉSIDENT ÉLU

Robert Fedosejevs obtient un B.Sc. avec spécialisation en physique de l'University of Toronto en 1973. En 1979, à la suite de travaux de recherche menés au Conseil national de recherches du Canada à Ottawa, cette même université lui décerne un Ph. D. en physique des interactions laser-plasma de forte puissance. L'année suivante, il est boursier de recherches postdoctorales et, par la suite, il passe deux années sabbatiques (1988-1989 et 1996-1996) au Max-Planck Institute for Quantum Optics de Garching, en Allemagne. À l'automne 1980, il entre comme attaché de recherches à l'University of Alberta où il devient professeur agrégé en 1982 et professeur titulaire en 1988 au Département de génie électrique et informatique. À partir de 1986, il sera directeur du Programme de génie physique à l'University of Alberta pendant dix ans. En 1998, il est directeur associé du Département, puis de 1999 à 2011, il détient le poste de MPBT/CRSNG/professeur-chercheur industriel principal à l'UofA en applications de capteurs laser. Il sera aussi professeur invité à l'Université de Bordeaux, à l'University of California de San Diego et à l'Université polytechnique de Madrid. Ses intérêts en recherches gravitent autour des lasers de forte puissance, des plasmas créés par laser et d'applications allant des capteurs laser à la production d'énergie par fusion-laser. Il donnera des cours sur la théorie des circuits, la physique des plasmas, les méthodes mathématiques en sciences et en génie, les lasers et l'optique non linéaire.

Membre de l'ACP pendant plus de 35 ans, le Dr Fedosejevs présidera pendant deux périodes la Division de la physique des plasmas de l'ACP, puis pendant trois ans, il siégera au Comité de Liaison de l'ACP et du CRSNG. Il sera membre et président du Comité de sélection des subventions 29 du CRSNG (physique générale) de 1996 à 1999. De 2003 à 2012, il a été aussi directeur scientifique d'un réseau de centres d'excellence : l'Institut canadien pour les innovations en photonique.

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BUREAU DE L'ACP

REPORT ON CAP ACTIVITIES RELATED TO SCIENCE POLICY ISSUES

BY DANIEL BANKS, DIR. OF SCIENCE POLICY AND BARBARA FRISKEN, DIR. OF ACADEMIC AFFAIRS

One of the Canadian Association of Physicists (CAP) most important (and successful) roles has been to advocate for physicists, and for scientists generally, in the corridors of power. The following report contains a summary of recent activities pursued by CAP on behalf of members related to this role. It includes a summary of the results of the recent survey of members on NSERC programs, an update on negotiations with the Professional Engineers of Ontario, CAP's response to the Jenkins report, and recent consultations with federal politicians. More detail on most of these issues can be found on the CAP website, www.cap.ca.

In May 2012, CAP launched a survey of its members regarding recent changes to Natural Science and Engineering Research Council (NSERC) programs. This survey was initiated in order to enable CAP to respond on behalf of members to an anticipated review of the significant changes made to the Discovery Grant (DG) program since 2010. Following cancellation of the Research Tools and Instrumentation (RTI) and Major Research Support (MRS) programs in April 2012, feedback on these programs was also requested.

A summary of results is presented here; details have been posted on the CAP website www.cap.ca. The survey consisted of 21 multiple choice questions and 5 free form questions, which allowed for detailed comments. During the six weeks that the survey was available, responses were recorded for 366 participants. Of these, 90% were associated with a university or college and 80% were eligible to hold an NSERC grant.

In the section of the survey that focused on changes to the DG program, respondents expressed dissatisfaction with two significant aspects of the program: the equal weighting of excellence of researcher, proposal and training of highly qualified personnel (HQP), and the role of the expert panel. Of the respondents who stated an opinion, 51% felt the changes to the DG program have had a negative impact, while only 19% have found the changes to be positive. When asked for specific comments, respondents agreed that a fundamental problem is that funding for the DG program is too low, and suggested that the following concerns should be addressed when the impact of the changes are assessed:

- It is important to emphasize quality and impact, not only output.
- Are small to medium universities being hit disproportionally?
- Are some regions of the country being hit disproportionally?
- What is the impact of concentrating funding on a few large groups? Does more funding mean higher research impact?
- What is the impact of the Discovery Accelerator Supplement (DAS) and is it worthwhile?
- What is the impact on new researchers?

Specific suggestions for measuring the impact of the changes were extensive, and addressed the following aspects: impact on HQP, research output, our position in the global research community, and faculty attraction and retention; changes to distribution of funding between large and small universities, different regions of the country, career stage of faculty, number of researchers supported and sub-disciplines. Respondents also suggested that NSERC examine whether the funding levels assigned are sufficient to achieve the goals of the research program, the impact of a researcher receiving substandard funding, and the non-linearity of the funding distribution by bin, and stressed that the emphasis on evaluation should always be on quality and not quantity (of HQP, publications etc).

The section that addressed the RTI and MRS programs focused on determining the importance of these programs and on whether respondents felt that they could be replaced by other programs, as was suggested by NSERC representatives. Comparing the RTI, MRS and DAS, respondents felt that RTI had the most impact on their research programs and DAS the least, with 73% feeling that the loss of the RTI program would have a negative impact on their research programs and 61% feeling that the loss of the MRS program would have a negative impact. The primary example of how to replace the RTI and MRS programs has been programs of the Canadian Foundation for Innovation (CFI). 78% of respondents agreed that it would be difficult to maintain and/or grow their research infrastructure with only the existing CFI programs, with the major impediment being that participation in CFI projects requires development of large scale multidisciplinary projects that can be significantly different from their primary research focus. The survey also asked whether the CAP/NSERC Liaison committee should explore the possibility of having the funding panel for physics manage a suitably-sized funding envelope which supports the DG, RTI and MRS programs – 73% of respondents were in favour of this option.

The Executive of the CAP and the CAP/NSERC Liaison Committee would like to sincerely thank all those who participated in the survey.

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Working with the wider science community, CAP has taken the lead role in two years of negotiations with the Professional Engineers of Ontario (PEO) to determine how to formally distinguish between the practices of natural science and of engineering. This is important due to recent removal of the exemption for natural scientists from the definition of professional engineering in the Ontario *Professional Engineers Act,* which created significant risk that scientists could be found in violation of the Act for practicing science. After many meetings with CAP and its allies, PEO agreed, in October 2011, to post the following permanent disclaimer on its website:

"PEO has no jurisdiction over the practice of natural science. Under the Professional Engineers Act, it regulates the practice of professional engineering. Where PEO is concerned a person not licensed by PEO might be practising professional engineering in addition to natural science, the Overlapping Practices Committee will be consulted."

The newly-established Overlapping Practices Committee has now met twice. The committee, which includes two CAP representatives, is balanced with both natural scientists and professional engineers in order to help PEO resolve disputes quickly where the boundary between engineering and natural science is in question. Henry van Driel, past-president of CAP, is currently Vice-Chair.

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In March, CAP wrote to the Prime Minister in response to the report of the Expert Review Panel on Research and Development, informally known as the Jenkins Report [1]. CAP's response, which is available on the CAP website [2], was the culmination of a lot of thought and discussion within the Science Policy Committee (SPC). In this letter, CAP argues that the transformation of the National Research Council (NRC) recommended in the Jenkins report would be "much more likely to preserve the very valuable, hard-won expertise of the NRC Institutes, and to assist them to continue to make major long-term contributions from which industry and all Canadians will benefit," than the current plans for reorganization of NRC. CAP also suggests a reduced reliance on tax credits in favor of more support for later-stage industrial research through the Industrial Research Assistance Program and recommends extending one of the report's ideas, vouchers for industry for commercialization activities, to vouchers for R&D collaborations with academia to lower the barrier to such cooperation. Finally, while the Jenkins report calls for a Minister of Innovation to oversee all changes to federal support for R&D, CAP argues that such a Minister should be responsible for all of science, technology, and innovation, because technological innovation cannot be separated from the basic and applied research that makes it possible.

In April, CAP submitted ideas regarding the future mission and governance of AECL's Chalk River Laboratories (CRL) to Natural Resources Canada on behalf of members, many of whom are employees, users or potential users of the NRC Canadian Neutron Beam Centre and other CRL facilities. CAP argued that CRL should be governed and funded as a major scientific resource; that to maintain Canada's expertise in nuclear R&D and neutron beams, the NRU reactor needs to operate beyond 2016 until a new facility can be built to supersede its capabilities; and that a new reactor is urgent and is an extensive project that requires careful planning, whether for a multipurpose reactor at CRL or for a neutron-beam reactor elsewhere.

Most recently, in July 2012, CAP submitted recommendations to the House of Commons Finance Committee as part of its annual pre-budget consultation. [3] This year, respondents were asked to provide recommendations on federal measures to address key challenges such as economic growth and demographic change. In its submission, CAP argued that Canada's research capabilities, whether at universities, government, or industry, have important roles in meeting Canada's challenges, and provided specific ideas for federal actions. These specific actions included better coordination of research funds for universities and large-scale science infrastructure, further encouragement of industry-academic collaboration through more funding for NCE networks and creation of vouchers for small and medium-sized businesses for collaborative R&D funding, use of federal procurement to stimulate business innovation, better support for students and post docs, and support for Canada's basic and public-good research capabilities currently housed in federal research agencies and science-based departments.

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CAP seeks to engage federal politicians of any party and public servants as appropriate to advocate for science funding and to better understand their concerns in order to communicate effectively with them. This year, CAP has been pleased to work with Ted Hsu, a new Member of Parliament who is a former theoretical physicist and is now the Liberal Critic for Science and Technology. Dr. Hsu was interviewed by CAP in Physics in Canada [4], and was the banquet speaker at the 2012 CAP Congress regarding his experience making the transition to a Member of Parliament. Representatives of CAP have been able to engage him on specific issues over the year such as the cancellation of the RTI and moratorium on the MRS program.

CAP continues to play a leadership role in the Canadian Consortium for Research (CCR) and has also been involved for many years in the Partnership Action Group for Science and Engineering (PAGSE). These groups perform complementary activities that promote awareness of the importance of Canadian research with federal policy makers. Over the past two years, Paul Vincett, a past President of CAP and immediate past-chair of the CAP science policy committee, has been chair of the CCR. During his tenure, CCR has testified to the House of Commons Finance Committee, secured meetings with Finance Minister Jim Flaherty and with key public servants at Industry Canada that oversee science funding in Canada, led two major e-mail campaigns to support research in the 2011 and 2012 federal Budgets, and undertaken many other lobbying activities on behalf of the research community.

Finally, CAP maintains an archive of articles that help members remain current on science policy-related issues. [5] Mike Morrow leads this effort. CAP members are invited to submit policy-related articles that would be of interest to others to Mike Morrow at mmorrow@mun.ca.

1. Expert Review Panel on Research and Development. Innovation Canada: A Call to Action. 2011 http://rd-review.ca/eic/site/033.nsf/eng/00288.html.
2. http://www.cap.ca/en/news/2012-03-31/cap-writes-prime-minister-re-nrc-and-other-matters-jenkins-report
3. http://www.cap.ca/en/news/2012-07-29/cap-submission-house-commons-finance-committee.
4. *Physics in Canada* **67**, 216 (2011).
5. http://www.cap.ca/en/about-cap/committees/science-policy-committee/links-and-articles.

RAPPORT SUR LES ACTIVITÉS DE POLITIQUE SCIENTIFIQUE DE L'ACP

PAR DANIEL BANKS, DIRECTEUR DE LA POLITIQUE SCIENTIFIQUE ET
BARBARA FRISKEN, DIRECTRICE DES AFFAIRES ACADÉMIQUES

L'un des rôles les plus importants (et fructueux) de l'Association canadienne des physiciens et physiciennes (ACP) a été de préconiser la présence de physiciens, et de scientifiques en général, dans les coulisses du pouvoir. Le présent rapport résume les activités récentes de l'ACP par rapport à ce rôle, au nom de ses membres. Il résume les résultats d'un sondage tenu récemment auprès des membres sur les programmes du Conseil de recherches en sciences naturelles et en génie (CRSNG), la réponse de l'ACP au rapport Jenkins et les consultations récentes auprès des politiciens fédéraux, et il fait le point sur les négociations avec l'Ordre des ingénieurs de l'Ontario. Le site Web de l'ACP (www.cap.ca) fournit plus de détails sur la plupart de ces questions.

En mai 2012, l'ACP a tenu un sondage auprès de ses membres au sujet des changements récents aux programmes du CRSNG. Ce sondage visait à permettre à l'ACP de répondre, au nom de ses membres, à l'examen prévu des changements importants qui avaient été apportés au programme Subventions à la découverte (SD) depuis 2010. Par suite de l'annulation des programmes Outils et instruments de recherche (OIR) et Grandes subventions de recherche (GSR), en avril 2012, on invitait également les répondants à réagir à ce sujet.

Voici en résumé les résultats qui sont affichés en détail sur le site Web de l'ACP (www.cap.ca). Le sondage comportait 21 questions à choix multiple et 5 de forme libre qui laissaient place à des commentaires détaillés. Au cours des six semaines allouées pour répondre au sondage, 366 participants ont fait parvenir leurs réponses. De ce nombre, 90 % étaient associés à une université ou à un collège et 80 %, admissibles à une subvention du CRSNG.

Dans la section du sondage portant sur les changements au programme de SD, les répondants se sont dits insatisfaits de deux aspects importants du programme : la pondération égale du chercheur, de la proposition et de la formation de personnel hautement qualifié (PHQ) et le rôle du groupe d'experts. Parmi les répondants qui ont exprimé une opinion, 51 % estimaient que les changements au programme SD avaient eu un effet négatif, tandis que seulement 19 % estimaient les changements positifs. Invités à préciser leurs commentaires, les répondants ont admis que le niveau trop bas du financement du programme SD est un problème fondamental et ils ont proposé qu'on examine les points suivants au moment d'évaluer les effets des changements :

- Il importe de mettre en valeur la qualité et les incidences, et pas seulement les résultats.
- Les universités de taille petite à grande sont-elles touchées de façon disproportionnée?
- Y a-t-il des régions du pays qui sont touchées de façon disproportionnée?
- Quelles sont les incidences de la concentration du financement sur certains groupes importants? Un financement accru de ces groupes signifie-t-il des incidences plus grandes?
- Quelles sont les incidences des Suppléments d'accélération à la découverte (SAD) et est-ce que cela en vaut la peine?
- Quelles sont les incidences sur les chercheurs en début de carrière?

Les propositions précises concernant l'évaluation des incidences des changements étaient vastes et portaient sur les aspects suivants : l'impact sur le PHQ, les résultats de la recherche, notre position dans la collectivité mondiale de la recherche et la capacité à attirer et à retenir des enseignants; les changements à la répartition des fonds entre les grandes et les petites universités et entre les différentes régions du pays, les étapes de la carrière des chercheurs, le nombre de chercheurs financés et de sous-disciplines. Des répondants ont aussi proposé que le CRSNG examine si les niveaux de financement attribués sont suffisants pour permettre d'atteindre les objectifs du programme de recherche, les incidences de l'attribution d'un financement insuffisant à un chercheur et la non-linéarité de la répartition des fonds par catégorie, et ils ont souligné qu'il faut toujours mettre l'accent sur la qualité plutôt que sur la quantité (du PHQ, publications, etc.).

La section qui portait sur les programmes OIR et GSR visait à déterminer l'importance de ceux-ci et si les répondants estimaient possible de les remplacer par d'autres programmes, selon la proposition des représentants du CRSNG. Comparant les programmes OIR, GSR et SAD, les répondants estimaient que c'est le programme OIR qui avait le plus d'incidences sur leurs programmes de recherche et le SAD qui en avait le moins, 73 % estimant que la perte du programme OIR aurait un effet négatif sur leurs programmes de recherche et 61 %, que c'est la perte du programme GSR qui aurait cet effet. Pour illustrer la manière de remplacer les programmes OIR et GSR, on a surtout évoqué les programmes de la Fondation canadienne pour l'innovation (FCI). Selon 78 % des répondants, il serait difficile de maintenir et/ou d'accroître leur infrastructure de recherche avec les seuls programmes de la FCI, le principal obstacle étant que la participation aux projets de la FCI oblige à mettre sur pied des projets multidisciplinaires de grande envergure qui s'écartent sensiblement de l'objectif principal de leur recherche. Dans le sondage, on demandait aussi si le Comité de liaison de l'ACP/CRSNG devrait examiner la possibilité que le groupe de financement de la physique gère une enveloppe suffisante pour financer les programmes SD, OIR et GSR, option que 73 % des répondants favorisaient.

L'exécutif de l'ACP et le Comité de liaison de l'ACP/CRSNG tiennent à remercier sincèrement tous ceux qui ont participé au sondage.

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De concert avec la vaste collectivité de la science, l'ACP a joué un rôle de premier plan pendant les deux années de négociation avec l'Ordre des ingénieurs de l'Ontario (OIO) afin de déterminer la façon de distinguer officiellement l'exercice en sciences naturelles et en génie. C'est important du fait que, dans la Loi sur les ingénieurs de l'Ontario, l'exemption des experts en sciences naturelles a été supprimée récemment de la définition d'ingénieur professionnel, ce qui a suscité un fort risque que des scientifiques puissent être taxés de violer la Loi parce qu'ils exercent en science. À la suite de nombreuses réunions avec l'ACP et ses alliés, l'OIO a accepté, en octobre 2011, d'afficher en permanence sur son site Web l'avertissement suivant :

> « *PEO has no jurisdiction over the practice of natural science. Under the Professional Engineers Act, it regulates the practice of professional engineering. Where PEO is concerned a person not licensed by PEO might be practising professional engineering in addition to natural science, the Overlapping Practices Committee will be consulted.* » (L'OIO n'a pas compétence sur l'exercice en sciences naturelles. Selon la Loi sur les ingénieurs, il réglemente l'exercice en génie. S'il craint qu'une personne non accréditée par l'OIO puisse exercer en génie ainsi qu'en sciences naturelles, il doit en référer au Comité sur les chevauchements en matière d'exercice.)

Le Comité sur les chevauchements en matière d'exercice, nouvellement créé, s'est maintenant réuni à deux reprises. Il compte deux représentants de l'ACP et sa composition équilibrée (experts en sciences naturelles et en génie) aide l'OIO à résoudre rapidement les différends lorsque la distinction entre le génie et les sciences naturelles est en cause. Henry van Driel, président sortant de l'ACP, est actuellement vice-président.

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En mars, l'ACP a adressé une lettre au premier ministre en réponse au rapport du Groupe d'experts sur l'examen du soutien de la recherche-développement, couramment appelé rapport Jenkins [1]. La réponse de l'ACP, qui est affichée sur son site Web [2], est le fruit d'une foule d'échanges et de discussions du Comité de la politique scientifique (SPC). Dans cette lettre, l'ACP affirme que la transformation du Conseil national de recherches (CNRC), recommandée dans le rapport Jenkins, permettrait fort probablement mieux « que les plans actuels de réorganisation du CNRC, de préserver l'expertise des Instituts du CNRC, très précieuse et difficilement acquise, et de les aider à maintenir leur important apport à long terme dont profiteront l'industrie et tous les Canadiens ». L'ACP propose aussi qu'on mise moins sur les crédits d'impôt et qu'on favorise davantage le soutien de la recherche industrielle à un stade ultérieur, grâce au Programme d'aide à la recherche industrielle, et elle recommande qu'on élargisse une des idées énoncées dans le rapport, soit les justificatifs d'activités de commercialisation de l'industrie, de manière à englober les justificatifs de la collaboration au titre de la R-D avec le milieu universitaire afin d'abaisser les barrières à cette coopération. Enfin, le rapport Jenkins préconise la nomination d'un ministre de l'Innovation qui superviserait tous les changements au soutien fédéral de la R-D, mais l'ACP affirme que ce ministre devrait être chargé de l'ensemble des sciences, de la technologie et de l'innovation, l'innovation technologique ne pouvant être dissociée de la recherche fondamentale et appliquée qui la rend possible.

En avril, l'ACP a soumis à Ressources naturelles Canada des idées quant à la mission future et à la gouvernance des Laboratoires d'EACL à Chalk River (LCR). Elle l'a fait au nom de ses membres dont beaucoup sont des employés ou des utilisateurs actuels ou éventuels du Centre canadien de faisceaux de neutrons du CNRC et d'autres installations des LCR. L'ACP affirme que les LCR devraient être régis et financés à titre de ressource scientifique majeure; que, pour maintenir l'expertise du Canada en matière de R-D nucléaire et de faisceaux de neutrons, l'exploitation du réacteur NRU devra se poursuivre au-delà de 2016 jusqu'à ce que de nouvelles installations puissent être construites pour remplacer cette capacité; et que le projet d'envergure de construire un nouveau réacteur est urgent et doit être planifié avec soin, qu'il s'agisse d'un réacteur polyvalent aux LCR ou d'un réacteur à faisceaux de neutrons ailleurs.

Tout récemment, en juillet 2012, l'ACP a présenté des recommandations au Comité des finances de la Chambre des communes à l'occasion des consultations prébudgétaires annuelles [3]. Cette année, les répondants étaient invités à formuler des recommandations à propos des mesures fédérales requises face aux importants défis que représentent des questions comme la croissance économique et le changement démographique. Dans son mémoire, l'ACP a affirmé que la capacité de recherche du Canada, tant dans les universités que dans les installations de l'État ou de l'industrie, joue un rôle important pour permettre au pays de relever les défis auxquels il doit faire face et elle a proposé des actions fédérales précises. Voici quelques-unes de ces actions : mieux coordonner les fonds de recherche pour les universités et les infrastructures scientifiques à grande échelle, encourager davantage la collaboration entre l'industrie et les milieux universitaires par un financement accru des Réseaux de centres d'excellence et par la création de justificatifs pour les petites et moyennes entreprises au titre du financement de la R.-D. coopérative, miser sur les achats de l'État fédéral pour stimuler l'innovation dans l'entreprise, mieux soutenir étudiants et postdoctorants et soutenir les capacités du Canada en recherche fondamentale et d'intérêt public dont sont actuellement dotés les organismes fédéraux de recherche et les ministères à vocation scientifique.

1. Groupe d'experts sur l'examen du soutien de la recherche-développement. Innovation Canada : le pouvoir d'agir, 2011, http://examen-rd.ca/eic/site/033.nsf/fra/00288.html.
2. http://www.cap.ca/fr/nouvelles/2012-03-31/cap-writes-prime-minister-re-jenkins-report-and-nrc.
3. http://www.cap.ca/fr/nouvelles/2012-07-29/soumission-lacp-au-comite-des-finances-chambre-des-communes.

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L'ACP s'emploie à inciter les politiciens fédéraux de tous les partis et les fonctionnaires, au besoin, afin qu'ils militent en faveur du financement de la science et à mieux comprendre leurs préoccupations afin de communiquer efficacement avec eux. Cette année, l'ACP a eu le plaisir de travailler avec le nouveau député fédéral et ancien physicien théoricien Ted Hsu, maintenant porte-parole du Parti libéral en matière de sciences et de technologie. L'ACP a interviewé le Dr Hsu dans La Physique au Canada [4] et l'a invité, au banquet de son congrès 2012, à entretenir les convives de son expérience de la transition au poste de député. Les représentants de l'ACP ont réussi cette année à l'engager envers des questions particulières telles que l'annulation du programme OIR et un moratoire à l'égard du programme GSR.

L'ACP continue de jouer un rôle de premier plan au sein du Consortium canadien pour la recherche (CCR) et participe aussi depuis de nombreuses années au Partenariat en faveur des sciences et de la technologie. Ces groupes exercent des activités complémentaires qui visent à sensibiliser les décideurs fédéraux à l'importance de la recherche au Canada. Depuis deux ans, l'ancien président de l'ACP et président sortant du comité de la politique scientifique de l'ACP, Paul Vincett, est président du CCR. Au cours de son mandat, le CCR a comparu devant le Comité des finances de la Chambre des communes et rencontré à quelques reprises le ministre des Finances Jim Flaherty et des fonctionnaires clés qui, à Industrie Canada, supervisent le financement de la science au pays. Le CCR a aussi tenu deux importantes campagnes courriel pour appuyer la recherche dans les budgets fédéraux de 2011 et 2012, et il a mené nombre d'autres activités de lobbying au nom de la collectivité de la recherche.

Enfin, sous la direction de Mike Morrow, l'ACP archive les articles susceptibles d'aider ses membres à se tenir au fait des questions liées à la politique scientifique [5]. Les membres sont invités à envoyer à Mike Morrow des articles traitant de la politique scientifique et susceptibles d'intéresser d'autres personnes, à l'adresse suivante : mmorrow@mun.ca

4. La Physique au Canada 67, 216 (2011).
5. http://www.cap.ca/fr/propos-lacp/comites/comite-politique-scientifique/liens-articles.

CAP COUNCIL / CONSEIL DE L'ACP

Are you interested in having a voice in the management of the CAP? Do you want to help define the priorities of your association? Volunteers for the following Council positions starting in 2013-2014 are now being sought:

*Vice-President Elect (Presidential line)
*Director of Student Affairs
*Director of Communications
*Secretary-Treasurer (preferably local to Ottawa)
Regional Councillors (2-year term)

A brief call for suggestions and a description of the roles and responsibilties of CAP Council members, can be found on the CAP's website at http://www.cap.ca or by contacting the CAP office at 613-562-5614 or by email at cap@uottawa.ca.

Deadline for the submission of expressions of interest is **2012 December 15.**

*** Executive Committee position**

Vous voulez avoir voix au chapitre dans la direction de l'ACP? Vous désirez définir les priorités de votre association? Nous sommes présentement à la recherche de personnes voulant se proposer comme candidat(e)s aux postes suivants à combler au Conseil commencant en 2013-2014:

*Vice-Président Élu (ligne présidentielle)
*Directeur/Directrice des affaires étudiant(e)s
*Directeur/Directrice des communications
*Secrétaire-trésorier (environ Ottawa préférable)
Conseillers régionaux (2-années)

Si vous voulez voir un formulaire d'appel de candidatures et une description du rôle et des responsabilités des membres du Conseil de l'ACP, veuillez consulter les pages internet de l'ACP à l'URL www.cap.ca ou contacter le bureau de l'ACP à 613-562-5614 ou par courriel à CAP@uottawa.ca.

L'échéance pour la présentation des candidatures a été fixée au **15 décembre 2012.**

*** Position sur le Comité exécutif**

2012 HIGH SCHOOL TEACHING AWARD WINNERS
RÉCIPIENDAIRES DES PRIX ACP EN ENSEIGNEMENT AU SECONDAIRE 2012

British Columbia and Yukon / Colombie-Britannique et Yukon

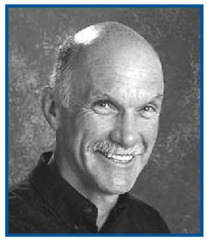
Mr. Mike Hengeveld,
Templeton Secondary School,
Vancouver, BC

Ontario

Mrs. Olga Michalopoulos
Georgetown District High School,
Halton Hills, ON

Prairies and Northwest Territories / Prairies et Territoires du Nord-Ouest

Mr. Brian Dentry
Kildonan-East Collegiate,
Winnipeg, MB



Atlantic / Atlantique

Mr. Brendan Kelly
Kinkora Regional High School,
Kinkora, PE

2012 Award winner, Brian Dentry, has an opportunity to meet Dr. Peter Higgs during his trip to CERN for the 2012 CERN Teachers' Workshop held during July.

NOTE: A report on Mr. Dentry's participation in the 2012 CERN Teachers' Workshop will appear in the 2012 Oct-Dec issue of *Physics in Canada* (Vol. 68, No. 4).

2013 AWARD / BOURSE 2013

Nominations for the 2013 award close February 14, 2013. Full details are available online at www.cap.ca

The award includes an educational grant that can be used to support professional development for the teacher or to purchase computer software, equipment or books for the classroom. One teacher will also be given the opportunity to participate in a 3-week physics teachers' symposium at CERN.

Les candidatures pour le prix de 2013 sont acceptées jusqu'au 14 février 2013. Tous les détails sont disponibles en ligne à l'adresse www.cap.ca

Le prix comprend une subvention qui peut être utilisée pour le développement professionnel de l'enseignant(e), ou pour acheter des logiciels, du matériel ou des livres pour la salle de classe ou le laboratoire. A un(e) enseignant(e) sera également donné(e) la possibilité de participer à un symposium de trois semaines pour des enseignant(e)s en physique, tenu à CERN.

CAP-INO Medal for Outstanding Achievement in Applied Photonics

La médaille de l'ACP-INO pour contributions exceptionnelles en photonique appliquée

Dr. Andreas Mandelis is one of the most remarkable and accomplished researchers in Canada. His 305 publications are an imposing record of achievement. He is a Fellow of the Royal Society of Canada, a Fellow of the American Physical Society, and a fellow of the S.P.I.E (the international society for optics and photonics. He is renowned in the areas of applied photonics, imaging, applications of lasers in optoelectronics, materials science and biophotonics; in particular, he is a pioneer in the development and shaping of diffusion-wave, photothermal and photoacoustic sciences and associated technologies.

The 2012 CAP-INO Medal for Outstanding Achievement in Applied Photonics is awarded to Dr. Andreas Mandelis, University of Toronto, for his seminal contributions to the field of photothermal and photoacoustic science and applications.

La Médaille de l'ACP-INO pour contributions exceptionnelles en photonique appliquée 2012 sera décernée au Dr. Andreas Mandelis, University of Toronto, pour ses contributions originales dans le domaine de la science photothermique et photoacoustique ainsi que pour ses applications.

His work has ranged from the eminently practical, as in the examination of dental cavities, to the profoundly theoretical. As one of the supporters of this nomination writes, "Perhaps the work I have found to be the most creative and which impresses me the most with its depth is his *J. Math Phys*. paper [*J. Math. Phys*. **26**, 2676 (1985)], where he formulated theory for the fundamental character of thermal waves. In this paper he gave elegant derivations of a Hamilton-Jacobi formulation of thermal wave physics, a thermal wave equivalent of Planck's constant, a thermal wave Schrödinger equation, an uncertainty principle for thermal waves, and the thermal wave equivalent of Ehrenfest's theorems. The concepts embodied in these thermal wave properties are analogues of what every physicist has studied in their graduate course work, except that the fields where these ideas were originally applied are classical mechanics and quantum mechanics."

An exemplary entrepreneur, Dr. Mandelis has founded several companies, basing their products on patents resulting from his research.

Michael O. Steinitz
St. Francis Xavier University

Interview with Andreas Mandelis, June 2012 (by Béla Joós)

BJ— I looked into your CV and there's a lot of information but very little about your personal background. You started in physics, but quickly moved onto applied research.

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. Andreas Mandelis

AM— Right. I was in mechanical and aerospace engineering but I was still working in applied physics and materials science. There was a joint program between the physics department and mechanical and aerospace departments so the courses were in physics but the thesis was in mechanical and aerospace.

BJ— Going further back, can you tell me where you were born and raised?

AM— I was born in the island of Corfu (Kerkyra), in Greece. And I was raised in Athens and then I went to the States with a full scholarship at Yale. After I finished high school, I went immediately over to the U.S. as a Fullbright scholar.

BJ— What is your connection to Canada?

AM— The connection to Canada was that at the end of my PhD I was looking for a position in the States. I was a foreign student in the U.S. and Canada appeared to me as a good employment prospect because I was married to a Canadian and I also got a research job at Bell Northern Research in Ottawa at the same time. So, it took exactly three weeks to get permanent residency in Canada. That's how I ended up in Canada.

BJ— You seemed to have had an early interest in applied and experimental type of science.

AM— Yeah but I always enjoy doing theory. The point is I've read the standard theoretical books in my physics courses as a student, I really love doing theory but I always liked to connect that to something that is going to be useful not only for my C.V. but also potentially for somebody else. I think that's the mentality of the Faculty of Engineering so I've always been an odd ball, a scientist in engineering but understanding the engineering philosophy.

"It is a great honor for me to be awarded the 2012 CAP-INO Medal for Outstanding Achievement in Applied Photonics. As a researcher in the photoacoustic and photothermal sciences, and an entrepreneur in technologies based on these sciences, this Medal is testimony of the power of applied photonics to lead to successful industrial ventures that benefit Canadian society and strengthen Canada's international competitiveness in advanced technologies."

"C'est un grand honneur pour moi de recevoir la Médaille pour réalisations exceptionnelles en photonique appliquée 2012 de l'ACP-INO. En tant que chercheur en sciences de la photo-acoustique et photothermique, ainsi qu'entrepreneur dans les technologies basées sur ces sciences, cette médaille est un témoignage de la puissance de la photonique appliquée à mener au succès des entreprises industrielles qui bénéficient à la société canadienne et renforcent la concurrence internationale du Canada dans les technologies de pointe."

BJ— You contributed to many different subjects. It would take too long to go through the list. Usually for people who do that, there is a common theme, a technique or a scientific method or something that is transferable from one subject to the other. Is this the case or are you moving from one unrelated subject to the other?

AM— It's a very good question. It's both. Basically I've always been fascinated by energy conversion processes, which is really the essence of the physics of materials, and spectroscopy. I felt that there was important physics to do and one major interest of my early work was in non-radiative physics. How do I actually get optical energy converted into thermal energy? What are the physical processes of generation of thermal and ultrasonic energy from photonic sources in condensed and gaseous matter? At the same time I decided that while I'm doing this I can really see my way to introduce novel matter interrogation techniques which could far outdo today's diagnostic methodologies because energy conversion means that we look only at the energy that is being converted. So if you look at optical processes without energy conversion we can put light into a system and measure light out. The physical process induced by light may produce a minute change in the incident energy measured by the difference between two large optical fields (input-output). This is going to be inherently insensitive compared to, let's say, conversion from light to heat or ultrasound where a signal is obtained from a zero baseline: unless there's optical absorption converting the light, there is no signal. These physical principles naturally led me to make the linkage to concepts of instrumentation and measurement science. If I can achieve detection of a physical process with one or two orders of magnitude higher sensitivity than other methods, that is where I want to be. So there is a common element to the methods I work on: normally I try to start where others leave off. I want to be able to do better than what is currently available by using methodologies that almost always are related to physical and instrumental combinations involving energy conversion.

BJ— And your book, it was on what?

AM— It was on Green functions and mathematical methods in diffusive wave physics.

BJ— That's what I'm coming to, the theoretical technique that seemed to underly everything was diffusive waves.

AM— Yes, my motto is "diffusive waves go where no light has gone before". That has been the case with my students and my own research through the years: for example, because of energy conversion, light incident on normally opaque regions does not stop at or near the surface but, converted to heat, ultrasound electrons, or simply photons of different energy, can effectively penetrate much deeper, so one can "see" phenomena well beyond the optical reach. To do that it is necessary to develop and combine instrumentation and measurement principles along with the physics. So what are these diffusive waves? They are oscillating counterparts of conventional diffusion. Why are they useful? Because they are damped in space, so we can study depth profiles of material properties; and they are everywhere! There are thermal diffusers, everybody knows that. But when thermal sources are modulated harmonically they generate thermal waves. There are electronic diffusers: optoelectronic devices involve free carriers (free carriers are diffusive entities which, upon modulation, become carrier diffusion waves). Then we also have optical scattering and diffusion in turbid media which can be modulated to produce diffuse photon waves which are extremely useful in today's biophotonic diagnostic technologies. As an example, all these diffusion-wave fields represent opportunities to take some fundamental physical ideas, and, upon energy conversion, apply them as powerful diagnostic tools to a very wide range of applications.

BJ— So what drove you from one project to another? Opportunities or one technology giving you the seeds for another one?

AM— Escalating opportunities are a challenge going from simple problems such as monitoring defects in a material, which raises the question of "how do we study this defect problem quantitatively?". So we started looking at inverse problems in diffusion waves. People have been studying inverse problems in ultrasonics, optics and other propagating wave fields, but the diffusive field is a big mathematical issue because it is ill defined and ill posed. You can get an infinity of solutions giving you the same results as the experiment does, but which solution is the right one? That's the kind of challenge that I mean, and I started building some of the mathematical tools for inverse problems in diffusion waves. You look back when some Russian mathematicians started thinking about it 50-60 years ago but they did not move away from the basic mathematics.

So my approach, which has been successful so far, has been to pair up with people in different fields where I felt I could actually move some of my techniques and have impact in their areas.

BJ— I don't have to ask you whether you're self-driven.

AM— Well yeah, I felt those directions were very satisfying to me because I saw the challenge in fields that bridge, and are relevant to, both science and engineering.

BJ— Research is increasingly of a collaborative nature, subject matters cross-discipline and technology requires an interplay of things. Are you very much a group person or are you more individually driven?

AM— I was very much driven individually maybe because that's how I felt I had full control on my research, until I discovered how much more I can do in collaboration with others and how many more opportunities arise. Because I was a techniques-based person, I could move across a spectrum of disciplines and judge where I want to see these techniques being applied. So my approach, which has been successful so far, has been to pair up with people in different fields where I felt I could actually move some of my techniques and have impact in their areas. For instance, in dentistry: I started talking to dentists, specifically to Dr. Stephen Abrams, in my own dentist's clinic, about Planck radiation and luminescence diffuse emissions from teeth, and the result of that is that we now have a company (Quantum Dental Technologies) and an international dental caries diagnostic product line ("The Canary System"), 9 or 10 years later. Then I started looking at people in the field of biosensors and their search for a noninvasive way to monitor blood glucose. Why? Because at some point I had a blood glucose test at Mount Sinai Hospital in Toronto and the key diabetes person there made me aware of the problems with measuring glucose noninvasively. This is a measurement science "Holy Grail" to this day: after thousands and thousands of papers, nobody has really been able to measure blood glucose reliably noninvasively. To me, that was a challenge. So we paired up and put forward a proposal, I got a research grant and now I'm at the end of this research with successful results.

BJ— Isn't glucose measured routinely?

AM— They do measure it but it's not easy to measure it noninvasively. The key is the noninvasive measurement of glucose so as to avoid pricking the finger time after time. There's a thick book that has been written – Optical Techniques on Glucose Diagnostics – and a business history report by John L. Smith that is available on the internet – The Pursuit of Noninvasive Glucose: "Hunting the Deceitful Turkey". This is a Holy Grail because to this day billions have been spent and companies have gone bankrupt thinking that they're going to produce an instrument but they didn't. Just about anything that can go wrong will go wrong and will interfere with the measurement of glucose! So I started looking at it from a different point of view. Now, I think I have a mid-infrared biosensor methodology based on only one vibrational band of the glucose molecule; importantly, I have my original collaborating clinical doctor and his clinic to support me.

What I'm saying is, there is this pattern. I wanted to do something about metals and cracks in fatigued metals. So there is a Canadian company that makes automotive parts. I talked to their engineer, they liked what I had to say, suddenly we found out we have a project together so that allows me to move forward in that direction. Now there are solar cell coverings.

BJ— What is the connection of metal fatigue with solar cell coverings?

AM— Oh, because we start looking at stress and all sorts of defects and cracks, at what changes the properties of a crack. You want to prevent electronic carrier diffusion from going the natural way, interacting with mechanical defects and compromising quality. So there is a link.

BJ— You did a lot of theory.

AM— I did. But that also guides the kind of work I want my students to do. I want to do the applied science, which means to me that they have to do the science at the same time as they do the engineering, that is, they have to be able to understand physically and quantitatively what they do. Just to do the experiment is not good enough.

BJ— You know that people are very concerned about research funding and the government's emphasis on transfer of knowledge to industry. You are in a strong position but are you concerned about the changes in the funding priorities? Do you see the emphasis moving towards more applied as being the right direction?

The goal has to be right, but how you get there is very important because, unless we do the fundamental work, we're only going to be very incremental and the rest of the world will be able to do much better than we can in Canada.

AM— No. I don't really think that should be the case. I think that there must be room for fundamental research that could lead to applied. That is, the goal has to be right but how you get there is very important because, unless we do the fundamental work, we're only going to be very incremental and the rest of the world will be able to do much better than we can in Canada. As an example, beyond the methods I discussed today, some of our other work is in taking concepts from radar science and importing them into imaging science. This is something other people have not done, so as a result it is non-incremental and I can see the competitive advantages. But this is basic instrumentation science combined with the physics of materials: signal generation, signal processing, instrumentation that is going to optimize your signals in different pathways. To do this, one must understand the fundamental properties of the materials under excitation, so as to be able to generate effective and sophisticated enough instruments that are needed in order to compete with the rest of the world. It is pointless to work with existing instrumentation systems, because other people have done it already. Besides, if it is simple, they have done it. We want our research outcomes to be taken up by a sophisticated industry. Sometimes, this is an issue in Canada: the lack of an industry in a particular area which can take up and commercialize the fruits of sophisticated instrumentation research. For example, we've had problems with the area of biomedical photoacoustics, because there isn't a Canadian company there to readily exploit our photoacoustic radar and our thermophotonic radar imager research. Perversely, this is because they are the products of fundamental work and several notches removed from today's market products. So it seems there are natural initial market barriers to the products of fundamental research, but this can be overcome and Canada can be competitive with government help. You've got to do the basic science; this is the only way to non-incremental international competitiveness and rise in the standards of living of Canadians.

BJ— You're at the university. Universities have their strengths and their weaknesses. Being in a university environment, are there limitations in your style of investigation?

AM— No there are none. Because being in a university, I was given the opportunity to work in areas that I wanted to. Getting the Canada Research Chair, getting the Ontario Premier's Award and the CFI – all these gave me the freedom to move in areas that otherwise I would have had to justify several times and maybe not being successful in getting them funded the first or second time around, or not at all. These acts of government "largesse" and foresight allowed me and my group to be the first to work on critical problems, so we could patent technologies and eventually end up with something along the lines I mentioned above that's beyond only just the research papers and could be good for the country. So yes, being at the university has been a great advantage.

BJ— How do you view the role of an academic in technology transfer? More and more the government is saying that we should be able to literally provide industry with almost ready to implement or manufacture or commercialize technologies. Is that a correct approach?

AM— "Ready to implement" cannot be feasible under the present conditions in Canada or elsewhere. All significant academic research is rooted in novelty. If the outcome is something incremental, it is not going to be very worthwhile because somebody has probably already commercialized it. On the other hand, for technology transfer you need to address the particular problems of an industry. In order to do that, you need to develop sound technology with the science behind the particular problem and an eventual goal to transfer it to industry. To be useful, the transfer product has to be something that the industry partner wants, and the partner has to be wise enough to know that it's not going to be ready to implement. My technology transfer experience has taught me that maybe a year or two from now, three years if things go right and the funding is there, then there is going to be a prototype and that's what industry wants. At least the industry I am working with are really looking forward to that state-of-the-art because their scientists and engineers can now go to the CEO or the VP Research and ask for support to take the technology and put it in the production line. They also appreciate the fact that this is novel and is going to be helping them compete against the world because something like that does not exist in the hands of their competition.

As an example, the imaging of cracks in green automotive parts is not feasible before you sinter them, whereas after sintering there are methods to inspect cracks. Before sintering, there really aren't any inspection tools because the scattering of conventional wave fields (optical, ultrasonic) is too much. But unless you can catch the cracks before you sinter you can waste a great deal of dollars worth of material because the parts forming machine could be faulty. If you can catch faults ahead of time saves a lot of money and effort. This is not a trivial problem. An effective solution rests with photothermal waves and involves the physics of their interaction with subsurface inhomogeneities, the scattering of diffusive fields, the inverse problem, axial resolution and the creation and capture of depth resolved images beyond the limits of depth-integrated diffusion. It's going to take three years or so to develop the sophisticated technology, so industry must work intimately with the academic in technology transfer as there is no "ready to implement" solution. We need an educated industrial establishment that understands what it takes. They need to work two-three years together, they need to help by putting cash and lots of in-kind expertise in their area; because they want the outcome. All levels of government have to offer financial support as well so as to make Canadian industry competitive. With the automotive parts project, when the technology emerges from our lab at the Center for Advanced Diffusion-Wave Technologies at the University of Toronto, the industrial partner and we, together, are going to have a quality control tool that other industries don't have and it's going to save them money while boosting their world competitiveness. This will be a fair return for the taxpayer funds that supported the research and development.

BJ— You deal with many companies, you created your own. Do you have lessons that you can derive that would be useful for policy makers to make Canadian companies invest more in technology and developments and have a more productive partnership between universities and industry?

AM— I think Canadian companies so far have been looking for the easy way out. That is, if there is something they can use now – "ready to implement" – they gravitate toward that. In many cases they come to the universities because they know they want something they don't have and they really do like to work with academics if something good for their operations is going to come out of that. They must realize, however, that many of their major problems require an intimate interaction with, and company support of, our very willing academics and a combination of the expertise of both partners toward resolving the issues within a realistic time frame. The point being though, Canadian industry has been trained to think that the government is going to put up the majority of the money. This is not realistic especially compared to the potential financial gains to be made as a result of a technology transfer.

Industry must realize that many of their major problems require an intimate interaction with, and company support of, our very willing academics and a combination of the expertise of both partners toward resolving the issues within a realistic time frame.

BJ— That's the Canadian way.

AM— That's the Canadian way. Industry has to learn that there's no such a thing as a free hamburger or "ready to implement" solutions. Academics also have to be active in pushing their agenda to get the technology out of the universities and into the hands of industry and the health sector. In fairness, governments have several arm's length organizations and programs, whether they're federal or provincial, to provide funds such as the Ontario Centres of Excellence, I2I (ideas to innovation) and CRD, for instance. These are the vehicles industries are using for much of the support they give to university research, however, they resist putting significant additional money into the project. It's hard to find good industrial partners who pay their fair share for what they get in terms of R&D from academia! But academics have to seek them out because you cannot get any serious research money in Canada unless you have an industrial partner. It is also true that industry cannot get robust solutions to science based technical problems unless it has an academic partner expert in the field. So, the need for each other is mutual and research funding dynamics should reflect this interdependence.

BJ— hat brings me to another big issue. The CAP is very much involved in lobbying the government to support basic science. They've been arguing that physics is very important for industry and technology. The government comes back to us and tells us "you know most large companies do not value academic research. We hear it from them Bombardier and others. They don't think universities are doing anything for them." What can we do to change that mentality?

AM— Here is the way I've approached this issue. Industry is basically oblivious to what research is being done in our universities and how it can help them with their very concrete issues. So, I have become basically a salesman for research and I make industrial contacts personally. To find contacts in the industrial sector I primarily contact their chief engineers because these are the people who make the technical decisions which influence their administrators. The funding people come a lot later. That's over on the other side of the gap. There's a big divide there between the technical side and the administrators. You have to convince the technical people first. In many cases, they don't really know what you're doing. So it is up to the university researcher to contact the people and make the relevance pitch, telling those engineers that "we have something that you want". But, he/she must first become aware of the company's R&D and production problems. Invariably, that "something" is going to be the result of fundamental research in an applied direction at the university. One thing academics should know is that industry demands that what is being offered, whether it's a methodology, a piece of software or hardware, it is based on solid scientific principles. My industrial partners have always relished the assurance that "the physics is sound" behind a developing technology – they won't have anything less than that. This assurance is a powerful tool working for university researchers in pure and applied sciences when teaming up with industry, as they can ensure that the scientific background is sound. This can be coupled quite intimately with engineering researchers who have appropriate technological backgrounds and the whole team can look very strong. As an example, I have been working in heat transfer as one of my disciplines within an applied photonics envelope. What does it mean? A mastery of conductive, radiative, convective heat transfer physics. Combining physics with engineering heat transfer one can see the foundations of the latter as quanta, as vibrations and phonons, as the continuum that it is between physics and engineering, a sine qua non. It takes a specific kind of individual to communicate that to the government because that individual can see the entire spectrum. So my answer to the question is, normally one sees a portion of the spectrum. I see engineers talking to industry but they may miss the arguments of soundness and the implications of the idea, the science behind it. I also see pure scientists not talking to industry because they don't have the linkages and they lack the relevance arguments to excite very applied industrial audiences. The government is the recipient of industrial reactions, so basically it doesn't see the connections to the science either that are there but are not always explicitly made.

My industrial partners have always relished the assurance that "the physics is sound" behind a developing technology – they won't have anything less than that. This assurance is a powerful tool when teaming up with industry.

BJ— OK, thank you. You are in academia. What was your prime attraction to academic life? Are you drawn to classroom teaching, or mainly research training?

AM— It's the freedom to choose what you want to do and to choose what you think is important and then you try your best. I get excited thinking "hey, I bet that what I'm doing could be important" and then I go out and work on it. A few years later I review the results as objectively as I can to see if I made the right decision to go in this direction. Also a very important aspect of academia is the freshness of continuously moving ideas that exists in the laboratory. New people, new young people with fresh minds come to me. I believe that I have learned more from my students than they may have learned from me because they come up with many fresh ideas. I don't think there's any other environment where you can talk to peers while they're your students. I think there is a lot to be said for that. In an industrial setting where I was working for a couple of years, the mind set is this: we have this task to carry out from A to Z, we have to do this within time limits and within budget. That is not very conducive to new pioneering insights, notions and things like that because there is just not enough freedom. So ultimately it is the numbers of degrees of freedom that I cherish in academia. Although classroom teaching is absolutely important because it sets the foundations of a subject, concept teaching within research training is what I enjoy the most as there are no rules there, no textbook to invoke as the final arbiter of an argument. All of our scientific knowledge and its boundaries, including the scientific literature we can cite by heart, are on the table – this is the ultimate dynamic teaching and learning platform!

BJ— One last question. You definitely must work very hard. So what do you do to relax and do you have any hobbies or your work is basically your hobby?

AM— I also work on the editorial board of about three journals over the evening and I prepare monthly "New Products" reports for "Physics Today" and the "Review of Scientific Instruments". What I do to relax is once in a while I take off to Greece. I also go on vacation elsewhere in Europe. You cannot relax while you're in Toronto, that's my feeling. You have to go elsewhere and that's exactly what I do. One of the things I do in the summertime is take off and sit at a café on the island of Corfu relaxing and working on my own research papers. I have published research papers that I conceived and wrote while sitting in a café drinking coffee. That is very relaxing to me because it's a non-pressured environment and it leads to intense intellectual activity. There's no deadline. I don't have to deliver anything to you by tomorrow and to me this is my relaxation, so every year I do this kind of thing and, yes, ultimately I don't go fishing because this is what I know how to do best and I enjoy doing it as long as I don't have to meet a deadline. It is all about changing one's environment, taking the time to think about some of the deeper aspects of the research that you want to do but you're not able to accomplish in the routine of life in Toronto because of so many other obligations and projects that must be on time and on budget. Acting on those other ideas and observing concrete outcomes is an ultimate reassurance of my individuality and self worth.

CAP-CRM Prize In Theoretical And Mathematical Physics

Le Prix ACP-CRM de physique théorique et mathématique

Luc Vinet is one of Canada's leading mathematical and theoretical physicists who has made outstanding contributions in numerous areas. The unifying feature of his research is the innovative use of group theoretical and algebraic methods, the emphasis on exact solutions of physical problems and the originality of his approach. He has made important contributions that have had great impact on both physics and mathematics.

The 2012 CAP-CRM Prize In Theoretical And Mathematical Physics is awarded to Luc Vinet, University of Montreal, for his outstanding and continued contributions to mathematical physics, mainly based on the study of symmetries, algebraic structures, and special functions.

Le Prix ACP-CRM de physique théorique et mathématique 2012 sera décerné à Luc Vinet, University of Montreal, pour ses contributions exceptionnelles et constantes à la physique mathématique, principalement sur l'étude des symétries, des structures algébriques et des fonctions spéciales.

His early remarkable work was on gauge field theories in particular on exact invariant solutions of Yang–Mills equations in Minkowski space.

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. Luc Vinet

Also early in his career he identified the symmetries and supersymmetries of magnetic monopole systems. He explored various algebraic structures appropriate to describe symmetries in different physical problems. These go well beyond standard Lie groups and algebras. They include polynomial, quantum, super- and parasuper- algebras.

He is very well known for his influential work on quantum many body problems and for his application of this work to a proof of the long outstanding Macdonald conjecture on properties of multivariate orthogonal polynomials. His contributions to the symmetry theory of difference and q-difference equations are truly pioneering. Remarkably, Vinet's scientific career was not interrupted by his heavy administrative duties as Director of the Centre de Recherches Mathematiques, then Provost of McGill University and finally Rector of the Universite de Montreal. He continued to publish highly innovative work during his administrative tenure and is now going through a new burst of creativity. Quite recently, in 2011, he has discovered new families of orthogonal polynomials, associated to reflections. These have already found many applications. In the context of quantum information theory, he has shown how spin chains can be used to design perfect quantum wires.

Pavel Winternitz
Centre de recherches mathématiques

REMARKS BY LUC VINET

SEIZED OPPORTUNITIES: A PERSONAL PRAISE OF THE CRM

I am tremendously pleased and honoured to receive the 2012 CAP-CRM medal in theoretical and mathematical physics. I would first like to thank the generous colleagues who have proposed and supported my nomination. Throughout my career I have had the good fortune of always working with friends from whom I have learned much. Let me therefore use the occasion to express to all of them, collaborators, postdocs and students, my profound gratefulness.

As it happens I had a role in the creation of the CAP-CRM medal in theoretical and mathematical physics. I received part of my training at the Centre de Recherches Mathématiques (CRM) and then had the privilege to become its director from 1993 to 1999. It gives me great pleasure to witness, especially in my field, that there is a preeminent and highly networked international community of researchers that has roots in the CRM. In 1995 it seemed a good idea to create a prize to celebrate and encourage theoretical and mathematical physics in Canada. CAP and CRM thus inaugurated jointly this award that has since been received by a number of outstanding scientists. It is an honour to now be included in their group knowing also of the many highly deserving people there are. One will understand that this prize brings together many threads in my career, is hence very special to me and that I much appreciate the « boomerang effect ».

"This award really means much to me and receiving it gives me great pleasure. I wish to thank CAP and CRM and the many who have a share in this most appreciated kudo. Cheers for mathematical physics at the CRM and in Canada!"

"Ce prix est particulièrement significatif pour moi et je suis très heureux de le recevoir. J'aimerais remercier l'ACP et le CRM ainsi que tous ceux qui ont une part dans cette marque de reconnaissance bien appréciée. Vive la physique mathématique au CRM et au Canada!"

The long marriage between physics and mathematics has had a long and fruitful history but it also had its pitfalls. In his famous Gibbs lecture entitled « Missed opportunities » (Bulletin of the American Mathematical Society, Volume 78, Number 5, September 1972), Freeman Dyson masterfully discusses « occasions on which mathematicians and physicists lost chances of making discoveries by neglecting to talk to each other ». The title I have given to this response obviously refers to this article, as I would like to briefly offer egocentric counterexamples where the CRM was directly responsible for creating the exchanges Dyson was wishing for.

My former PhD student Luc Lapointe and I are getting recognition for the proof of a version of the long-standing conjecture of Macdonald. In 1995, we were looking for exact solutions to the many-body Calogero model and had obtained raising operators for the multivariate polynomials arising in the wave functions. There was a workshop in Algebraic Combinatorics taking place at the CRM at the time. This gave us the opportunity to present our results to some participants in the meeting who quickly educated us on the conjecture and suggested that we might have a way to prove it. They were right of course. This example is a case where physics provided the tools to solve a mathematical problem.

In the summer of 2010, after much involvement in senior university management, I was making my first investigations in quantum information (QI) looking at the design of perfect quantum wires. The CRM again came to help with a QI theme semester in the following fall that brought to Montreal the experts with whom we could validate our findings.

Even in these days of interdisciplinarity, mathematical physics may find itself in an uncomfortable place being deemed « neither fish nor fowl ». Good science should not suffer from labels, fashions or cliques. Like Dyson I plea for more seized opportunities and I wish to commend the remarkable institutes like the CRM across Canada who really make them happen by judiciously bringing together scientists from various horizons.

As per the words of Wigner, exploring « the unreasonable effectiveness of mathematics in the natural sciences » is an always awe-inspiring activity and to be rewarded for it is really « icing on the cake ». My thanks again to my family, to my friends, to CAP and to the institutions that are supporting me.

CAP MEDAL FOR EXCELLENCE IN TEACHING UNDERGRADUATE PHYSICS

LA MÉDAILLE DE L'ACP POUR L'EXCELLENCE EN ENSEIGNEMENT DE LA PHYSIQUE AU PREMIER CYCLE

It is difficult to imagine a person more deserving of the Medal for Undergraduate Teaching. David is the linchpin of our large first year teaching efforts at Toronto. With over 1000 very demanding first year biology and pre-med students, our largest courses represent a significant challenge for any teacher. Over many years, and especially in the last decade, David has taken on a leadership role in bringing modern Physics pedagogical techniques to these courses. He has relentlessly scoured the world for the best in Physics Education Research and then done the hard work necessary to roll out sweeping changes to the way we teach Physics to these students. The benefits are enormous; greatly improved student satisfaction, and a new higher profile for the department as a place for teaching innovation are just two.

The 2012 CAP Medal for Excellence in Teaching Undergraduate Physics is awarded to Dr. David Harrison, Dept. of Physics, Univ. of Toronto, for his leadership and innovation in introducing research-based pedagogical techniques to his physics courses at the University of Toronto, and for his significant contributions to the on-line physics teaching community and the Ontario Association of Physics Teachers.

A major part of David's work has been the complete renovation and replacement of our old first year labs and tutorials with new Physics "Practicals". These combine all the best available ideas in hands-on, experiential Physics pedagogy with new purpose-built rooms and an entirely new set of activities and labs. These innovations took several years to implement and cost more than $1 million to realize. David tirelessly drove this project from start to finish, attending to every aspect. David is also central to the suite of "Physics for Humanities" courses that we offer.

La Médaille de l'ACP pour l'excellence en enseignement de la physique au premier cycle 2012 sera décernée au Dr. David Harrison, Dept. of Physics, Univ. of Toronto, pour son leadership et son esprit innovateur dans l'emploi de méthodes pédagogiques fondées sur la recherche lors de ses cours de physique à l'Université de Toronto ainsi que pour sa contribution marquante à la communauté enseignante de la physique en ligne et à l'Ontario Association of Physics Teachers.

David has taught thousands of non-Physics students to appreciate and delight in Physics, as well as extensively writing on this topic. He has made his notes for students at various stages available on the web for the last decade. This collection has grown to hundreds of pages of that amounts to an online free book called The Physics Virtual Bookshelf. These documents have been consulted millions of times. He is also the author of a very large and well-regarded collection of Flash demonstrations, again freely available online. These are particularly suited for use in the classroom and are downloaded at a rate of around one million times per year.

Stephen Morris
University of Toronto

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. David Harrison

REMARKS BY DAVID HARRISON

It is typical for award winners, both inside and outside academia, to deflect credit to colleagues, a deity, a grandmother, etc. Often this strikes me as being disingenuous, as I sometimes get the feeling that the recipient is secretly thinking "I deserve this because I really am great." However in my case I think deflecting credit really is appropriate. I really don't have great skill as an educator, but have been fortunate to have been surrounded by great teachers. I haven't really contributed to Physics Education Research either, but have been taught a great deal about pedagogy from those who have. Of course, I have also learned a great deal by watching the results of my students suffering through my many mistakes. If I have contributed anything worthy of this medal it is perhaps, as the citation stated, my "relentless pursuit of improved teaching using new, evidence-based teaching methodologies." Relentless in this case is a synonym for "stubborn".

"This award is, of course, thrilling for me, although I suspect that my very small number of successes is due to many students through the years suffering through my many many failures."

"Ce prix est, bien sûr, excitant pour moi, bien que je soupçonne que mon nombre limité de succès soit dû à de nombreux étudiants qui, au fil des années, ont souffert à travers mes nombreux échecs."

Churchill nicely summarized my feelings here when he said that "success is going from failure to failure without loss of enthusiasm." There is at least one very positive outcome of receiving this award. Once I (finally) converted to research-based instruction some years ago, I became an outspoken advocate for it and would talk about reformed pedagogy to anybody who would listen. So, for example, I was thrilled when I heard that some physics faculty were intending to implement research-based instruction after hearing my talk at the Plenary session in Calgary this summer. Further, the publicity surrounding the award has led to a number of invited talks on this subject in both other disciplines at my university, Toronto, and at other schools. So the pool of people willing to listen to me expound about the benefits of reformed pedagogy has grown appreciably as a direct result of this medal and the accompanying publicity.

I hope that I will not waste the pedagogical "capital" that has come my way due to this prize. I am deeply grateful to CAP and especially to my colleagues who worked very hard on nominating me for this award.

CAP/DCMMP BROCKHOUSE MEDAL

LA MÉDAILLE BROCKHOUSE

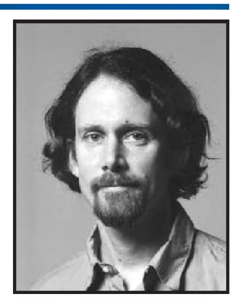
Douglas Bonn's research has focused primarily on high temperature superconductors since their discovery in 1987. Currently, this research on superconductors is equally divided between microwave and transport measurements, and sample development and preparation for a wide range of external collaborations. His work on microwave properties is in collaboration with Walter Hardy, while the work on sample preparation is performed in collaboration with Ruixing Liang. For many years Doug has been strongly involved in promoting collaborations as a means of enhancing the Canadian effort in high temperature superconductivity. The exchange of samples and ideas between the group at UBC and those at McMaster University, University of Toronto, McGill University, Université de Sherbrooke, Simon Fraser University, and many institutions outside of Canada have greatly enhanced the productivity and visibility of Canadian research in this field. In these collaborations, Doug has been intimately involved in the tailoring of samples to the particular measurement, including far-infrared, μSR, ARPES and scanning magnetic microscopy, and in the interpretation of the experimental results. He has published over 170 refereed papers, and presented many invited lectures around the world. Doug is a Fellow of the Royal Society of Canada, a Fellow of the American Physical Society, and an Associate of the Canadian Institute for Advanced Research. He has won a number of prizes including the an Alfred P. Sloan Fellowship in 1996, the CAP Herzberg Medal in 1997, an E.W.R. Steacie Fellowship and a UBC Killam Research Prize in 1999, and the UBC McDowell Medal in 2001. In 2006, the team of Bonn, Hardy and

The 2012 CAP/DCMMP Brockhouse Medal is awarded to Dr. Douglas Bonn, University of British Columbia, for his contributions to the field of high temperature superconductivity.

La Médaille Brockhouse 2012 sera décernée au Dr. Douglas Bonn, University of British Columbia, pour ses contributions dans le domaine de la supraconductivité à haute température.

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. Douglas Bonn



Liang was awarded the NSERC Brockhouse Canada Prize.

The purpose of CAP's Brockhouse Medal, which is sponsored jointly by the Division of Condensed Matter and Materials Physics (DCMMP) and the Canadian Association of Physicists (CAP), is to recognize and encourage outstanding experimental or theoretical contributions to condensed matter and materials physics. It is named in honour of Bertram Brockhouse, whose outstanding contributions to research in condensed matter physics in Canada were recognized by the 1994 Nobel Prize for Physics. The Brockhouse medal was first introduced in 1999 and has been awarded annually since.

Brian G. Turrell
University of British Columbia

REMARKS BY DOUGLAS BONN

It is an honour and a pleasure for me to be awarded this year's CAP Brockhouse medal. The name of this award brings vivid memories of the man it is named after. Bertram Brockhouse was still teaching when I was a student at McMaster. He had an early influence on me through his teaching in a second year laboratory, a memorable first exposure to real instrumentation used in research. My later upbringing as an experimentalist under Tom Timusk's supervision occurred in the materials institute that now bears Brockhouse's name. It is there that I learned two key things that continue to guide much of what I am involved in. First, the challenging problems that we work on require multiple experimental and theoretical approaches to get at the truth, so collaborations are essential to making progress. The second is that careful attention to the development of well-controlled materials is essential if one is to do good physics on those materials. This means working as closely as possible with chemists and materials scientists, preferably in an institute where they work alongside one another.

"This award is a welcome honour and one that I particularly treasure because I still have wonderful memories of my overlap with Bertram Brockhouse when I was a student at McMaster. He had an early influence on me through his teaching in a second year laboratory and my upbringing as an experimentalist occurred in the materials institute that now bears his name."

In many ways I feel that I am accepting this award on behalf of a great web of collaborators. At the heart of it is my many years spent working alongside Walter Hardy and Ruixing Liang, who have been pivotal in bringing Canada to its leadership role in this field, especially through their devotion to the painstaking development of high quality single crystals and novel microwave measurement techniques to study them. This group at UBC has grown and changed over the years and I have had the pleasure of working in a great pool of talent. More broadly, there is a remarkable community effort in this field, spurred on by a collective sense that Canadian researchers can chart a highly effective course in this field through work that is based on collaboration at least as much as it is driven by competition. This began early on for us with groups not only trading samples around but also freely passing data back and forth to shed light on one another's experiments. An early example is the web of far infrared, microwave, and muon spin relaxation measurements, at UBC, McMaster and TRIUMF, that put together the story of superfluid density in the cuprates. The recent wave of exciting new results on quantum oscillations in high temperature superconductors is similarly a product of this team effort, stretching from UBC, to the group of Louis Taillefer at Univ. de Sherbrooke, and on to our international collaborators at national magnet labs. This same approach will continue to serve us well as research in condensed matter increasingly relies on large teams bringing multiple approaches to bear on difficult materials problems.

"Ce prix est un grand honneur pour moi. Il m'est particulièrement cher, puisque j'ai encore de merveilleux souvenirs de Bertram Brockhouse en tant qu'étudiant à l'Université McMaster. Il a eu très tôt une influence sur moi par son enseignement au laboratoire lors de ma deuxième année d'université; d'ailleurs, mon apprentissage comme expérimentateur a eu lieu à l'institut des matériaux qui porte désormais son nom."

CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics

La Médaille Vogt de l'ACP-TRIUMF pour l'excellence en physique subatomique

Robert Myers is a pioneering theoretical physicist who has made extraordinarily broad and deep contributions to subatomic physics. His groundbreaking contributions span a broad range, from foundational aspects of string theory and gravitational physics to innovative advances in string cosmology, a testament to his deep physical insight and originality.

The 2012 CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics is awarded to Dr. Robert Myers, Perimeter Institute / University of Waterloo, for his outstanding contributions to advancing the frontiers of string theory and its application to theories of gravitation, black holes, and QCD.

Myers is among the most highly-cited particle physicists of all time, whose 140 papers have attracted more than 11,000 citations to date, and have opened completely new lines of inquiry. Several of his discoveries, including the widely known 'Myers effect', are regarded as modern classics. Working in the highest scientific tradition, Professor Myers has consistently sought ways to connect theory with experiment, and many of his results have implications for current experiments.

Myers has also strengthened the wider physics community in Canada. As a founding member of the Perimeter Institute for Theoretical Physics, he has played a key role in building the institute into an internationally recognized centre of research excellence, including serving as its Scientific Director from 2007-2008. He was a founding member on the scientific advisory committee of the Banff International Research Station and serves on various international advisory and editorial boards.

La Médaille Vogt de l'ACP-TRIUMF pour l'excellence dans le domaine de la recherche théorique ou expérimentale en physique subatomique 2012 sera décernée au Dr. Robert Myers, Perimeter Institute / University of Waterloo, pour ses contributions exceptionnelles à repousser les frontières de la théorie des cordes et de son application aux théories de la gravitation, des trous noirs et de la chromodynamique quantique.

Neil Turok
Perimeter Institute for Theoretical Physics

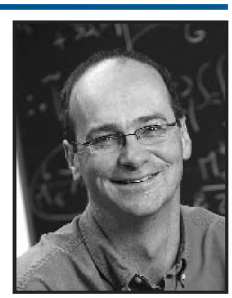
Remarks by Robert Myers

"Canada has a long tradition of research in subatomic physics and continues to be home to a vigorous community of world-class researchers in this field. Hence I am very honoured and grateful to be selected from amongst my colleagues as the recipient of the 2012 CAP-TRIUMF Vogt Medal."

"Le Canada a une longue tradition de recherche en physique subatomique et continue à rassembler une communauté vigoureuse de chercheurs de renommée mondiale dans ce domaine. C'est donc un grand honneur d'être sélectionné parmi mes collègues en tant que récipiendaire de la médaille Vogt de l'ACP-TRIUMF 2012, et j'en suis très reconnaissant."

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. Robert Myers



LAURÉATS ET GAGNANTS DE 2012

CAP HERZBERG MEDAL

LA MÉDAILLE HERZBERG

Dr. Freddy Cachazo is a theoretical physicist who has made outstanding contributions to the field of particle physics, many of which are widely characterized as breakthroughs.

With collaborators, Cachazo has creatively drawn upon a variety of elegant mathematical ideas, including twistor theory, Grassmanians and algebraic geometry, to develop entirely new methods of calculating scattering processes in gauge theories and gravity. Beyond providing deep new insights into the structure of quantum field theory, these new methods have had a major impact on high-energy physics. In particular, Cachazo's techniques have become essential in state-of-the-art calculations done to interpret the new data coming from experiments at the Large Hadron Collider at CERN, as well as the Tevatron at Fermilab.

The 2012 CAP Herzberg Medal is awarded to Dr. Freddy Cachazo, Perimeter Institute, for his deep new insights into the structure of quantum field theory, and the development of elegant mathematical techniques to simplify the analysis of high-energy particle scattering experiments.

His work has already been incorporated into a textbook on quantum field theory, and his work has continued to open up entirely new research directions now being investigated all over the world. Cachazo's contributions to quantum field theory range from applications of geometric engineering (in string theory) to understanding mysterious dualities relating theories in different dimensions to improved techniques to compute scattering amplitudes in Quantum Chromodynamics (and its generalizations). In a research career spanning less than a decade, Cachazo's 41 papers have attracted well over 4,000 citations, attesting to the rapid, far-reaching impact of his new insights. The principles underlying Cachazo's research are profound. Besides being of immediate utility to huge accelerator experiments, Cachazo's works will have enduring and far-reaching impact in the search for a simpler, unified description of nature's physical laws.

La Médaille Herzberg 2012 sera décernée au Dr. Freddy Cachazo, Perimeter Institute, pour ses idées nouvelles sur la structure de la théorie des champs quantiques, et pour l'élaboration de techniques mathématiques élégantes visant à simplifier l'analyse des expériences de diffusion de particules de haute énergie.

Neil Turok
Perimeter Institute for Theoretical Physics

REMARKS BY FREDDY CACHAZO

I am very honoured to be recognized by my colleagues in Canada with the 2012 Herzberg Medal. The subject of my work goes back to Wheeler, who introduced the Scattering or S-matrix in 1937. Soon after, Heisenberg proposed to use it as a way to describe particle physics in 1942. Since then the S-matrix has become our main tool in unearthing the structure of matter and forces at very short distances.

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Dr. Freddy Cachazo

In 1948, Feynman introduced beautiful techniques for computing S-matrix elements. Feynman diagrams are "a dream come true" as they can make manifest the two pillars of quantum field theory: unitarity and locality. However, in theories of massless particles, such as gluons, the nice properties of Feynman diagrams come with a price: a large amount of redundancy. This redundancy translates into a proliferation in the number of terms that have to be computed, so large in fact that even processes involving few number of particles can only be handled using powerful computers.

Anyone staring at a Feynman diagram might get the impression that it is telling a story of particles interacting. However, "internal lines" are very different from external particles in that they must be off the mass-shell. If the internal lines could only be made to lie on the mass-shell then the S-matrix elements could be computed using smaller S-matrix elements, thus leading to a recursion relation.

In 2004, Ruth Britto and Bo Feng, who at the time were postdoctoral fellows with me at the Institute for Advanced Study (IAS) in Princeton, joined my research in trying to use complex analysis techniques to compute scattering amplitudes. These adventures naturally led us to different space-times where internal lines can be promoted to particles, *i.e.*, can be made to lie on the mass shell! We then introduced what are now known as the BCF recursion relations.

"I am very honored to be awarded the 2012 Herzberg Medal. This medal, named after not only a brilliant scientist but also someone who had a great impact on Canada's physics community, is truly an inspiration."

Early in 2005, we developed a simple and elegant construction of the BCF recursion relations in collaboration with Edward Witten (Professor at the IAS) which is now known as the BCFW or on-shell technique. This is a good opportunity to thank Britto, Feng and Witten for a very enjoyable and exciting collaboration.

The formulas obtained using the BCF recursion relations are incredibly compact compared to those obtained using Feynman diagrams. How can it be that by allowing internal particles to wander off the space of real momenta while remaining on the mass-shell has such a dramatic impact on the form of the S-matrix?

Finding the answer to this question has motivated most of my research during recent years. In 2008, the depth of this question attracted the attention of Nima Arkani-Hamed (Professor at the IAS), one of the most influential and bright figures in particle physics. I have been very lucky to have established a very fruitful collaboration with Arkani-Hamed which has boosted this research line to a point impossible to foresee back in 2005.

"C'est un honneur de recevoir la Médaille Herzberg 2012. Cette médaille est nommée d'après non seulement un brillant scientifique, mais aussi quelqu'un qui a eu un grand impact sur le milieu canadien de la physique. Elle est vraiment une source d'inspiration."

Finally, I would like to mention that many young talented physicists have joined this research area. I have been very fortunate to collaborate with some of them and to enjoy the wonderful developments done by others. The young talents, together with pioneers of this field, who made foundational contributions in the 80's and 90's like Z. Bern, L. Dixon and D. Kosower, now compose a truly vibrant community of researchers. I would like to also dedicate this medal to the hard work and creativity of this community.

CAP Medal for Lifetime Achievement in Physics
La Médaille de l'ACP pour contributions exceptionnelles à la physique

Gordon Semenoff is a theoretical physicist with a long record of generating important ideas. He is internationally recognized for his 1984 pioneering work on the substance which became known as graphene. His highly cited paper, predating the fabrication of the material by 20 years, demonstrated that graphene electrons obey a Dirac equation, proposed a mechanism for giving the electron a mass, sometimes called "Semenoff mass" and applied index theorems to study the electron spectrum. These ideas were important for understanding graphene and its remarkable electronic properties once it was made in the lab. The later experimental discovery was awarded the 2010 Nobel Prize.

He is well known for contributions to quantum field theory, in particular for using mathematical index theorems to understand fractional charges and the discovery of the parity anomaly of odd-dimensional gauge theories. These ideas have had significant influence over the years and have recently come to the forefront in studies of topological insulators. His pioneering work on the real-time formulation of relativistic quantum field theories at non-zero temperature and density, including invention of the "Kobes-Semenoff rules", are considered cornerstones of that subject.

Recipient of the 2012 Medal / Lauréat de la médaille de 2012:

Prof. Gordon W. Semenoff

He has made important contributions to string theory. His computation of the Wilson loop in N = 4 Yang Mills theory is considered a classic and an important test of a duality between gauge fields and strings. His pioneering work in 2002 on string loop corrections to plane wave strings is considered seminal, not just for its results, but as the beginning of the integrability program of supersymmetric gauge theory and string theory which has been widely pursued over the ten years since.

The 2012 CAP Medal for Lifetime Achievement in Physics is awarded to Prof. Gordon W. Semenoff, University of British Columbia, for his seminal contributions to quantum field theory, statistical mechanics and condensed matter physics.

La Médaille de l'ACP pour contributions exceptionnelles à la physique 2012 sera décernée au Prof. Gordon W. Semenoff, Université de la Colombie-Britannique, pour ses contributions originales à la théorie des champs quantiques, à la mécanique statistique et à la physique de la matière condensée.

His research has earned him CAP medals in two disparate fields, the CAP/CRM Prize in Theoretical and Mathematical Physics (2000) and the Brockhouse Medal for condensed matter and material physics (2010).

Brian G. Turrell
UBC

INTERVIEW WITH GORDON SEMENOFF, JUNE 2012 (BY RICHARD MACKENZIE)

RM— Where are you born and raised, Gordon?

GWS— Pincher Creek, Alberta, about an hour from here.

RM— It makes Lethbridge look like a big city, I guess?

GWS— Yes, when I was a kid, I thought of Lethbridge as the big city.

RM— Can you describe your academic training, or in other words, your academic world line?

GWS— I studied at the University of Alberta where I got a bachelor's degree (honours physics) in 1976, and a PhD in 1981, in theoretical physics. It actually has "theoretical physics" written on the degree. I spent a little more time in Alberta; I taught a course there. After that, I was a post-doc at MIT – again in the theoretical physics group for one year. After that I moved to UBC as what was called an "NSERC University Research Fellow" which wasn't really a permanent job, but it became permanent after a few years, and I've been there ever since (since 1983 so almost 30 years).

"I am absolutely delighted to receive a CAP Lifetime Achievement Award. It is an extraordinary honour. My scientific work owes a great deal to my many co-workers, collaborators and students and I consider this award an equal acknowledgement of their talent and hard work."

RM— Who was your PhD supervisor?

GWS— My PhD was done under Hiroomi Umezawa.

RM— Over the course of your career, who influenced your choice to go into physics, your choice of area of physics, and so on? Do you have any mentors that were important to you?

"Je suis absolument ravi de recevoir la Médaille de l'ACP pour contributions exceptionnelles de carrière. C'est un honneur extraordinaire. Mon travail scientifique a été possible grâce à mes nombreux collègues de travail, collaborateurs et étudiants et je considère que ce prix constitue une reconnaissance égale de leur talent et de leur travail acharné."

GWS—I wouldn't say anybody influenced me in high school simply because there were very few people who even knew what that was. For example, I took high school calculus by correspondence since it wasn't offered at my high school; same with linear algebra.

RM— What about physics in high school?

GWS—We did have a physics course. Actually it wasn't my favourite course nor was it the one I was the best at. I was the best at chemistry with mathematics second and then physics third. But somehow physics just seemed more basic than the others. And I didn't really know what I wanted to do because I didn't know that much about these things. I just felt confident that I can do something challenging and physics and mathematics looked like the most challenging. I didn't go to chemistry. In fact, I never took another chemistry course after grade 12.

RM— Were your parents helpful in terms of your scholastic and career choices?

GWS— No. They of course wanted their kids to go to university but they discouraged areas which were less concrete and not obviously useful. They really wanted their kids to go to medicine, law or something that had an obvious place in the world.

RM— So they must have wondered where they went wrong with you!

GWS— They always worried about it, yes.

RM— Good for you for going into what you liked.

GWS— Well it was the sixties, right? I began university in 1971 so it was technically after the sixties but you still had that attitude of doing something a little bit outside the box, and going to study mathematics or physics in Alberta at the time certainly was outside the box.

My parents wanted their kids to go to university but they discouraged areas which were less concrete and not obviously useful. They really wanted their kids to go to medicine, law or something that had an obvious place in the world.

RM— Let's jump ahead a little bit to your time at MIT. I know from personal experience that you wrote a lot of papers with Antti Niemi. How did that collaboration work?

GWS— That's right. It started at MIT. You know, I don't remember how it started. Antti was there. He was a very active, brilliant guy and I just enjoyed talking to him. At the time he had a very heavy Finnish accent, and I was used to understanding accented English, partly from working with Prof. Umezawa. So I was perhaps one of the few around there who could understand what he was talking about so that made the collaboration somewhat natural.

RM— Okay. Jumping ahead again, you won the CAP-CRM Prize for Theoretical and Mathematical Physics in 2000, the CAP-DCMMP Brockhouse medal in 2010, and then this one – the CAP Medal for Lifetime Achievement in Physics. Can you remind us what you won the CAP-CRM prize for?

GWS— I think the citation was a fairly generic one for work in quantum field theory and something else I'm trying to remember.

RM— OK, it might have been string theory or something.

GWS— I wasn't very active in string theory yet at the time. The work I did in string theory that had any impact was just coming out at about that time.

RM— OK. And how about the Brockhouse medal?

GWS— That was for graphene.

RM— Graphene is an interesting story because you worked on it long before it sort of exploded internationally.

GWS— That's right. If I'd written my paper 20 years later it would have had more impact.

RM— So you wrote the paper and then it went largely unnoticed for a long time?

GWS— I would say the relatively small number of people working in the field found the paper interesting, so it was not exactly unnoticed. It was probably a fifty-citation paper until 2005-2006. Now it has near 1,000 citations according to Google Scholar.

RM— When you were doing that work did you realize that it was going to end up being so important?

GWS— Not really, at least not for a concrete reason. Theoretically the idea was very interesting, and I thought it should be important, but it only became important when a physical system it described, graphene, was discovered. There are several miracles in the case of graphene that imply that the model I used back then is basically the model that works. That didn't have to be so. The physics of graphene for electronics or even condensed matter physics is much more interesting than I anticipated it would be. It's simply because the Dirac equation in condensed matter physics gives electrons some extremely interesting properties.

RM— So in your work you studied fermions on a hexagonal lattice.

GWS— That's right, and it's a wonderful example of emergence. You get emergent special relativity and it isn't because of some complicated many-body effect which maybe wouldn't be solvable, but just single particle physics of an electron interacting with a hexagonal lattice.

RM— Amazing. Your work is very diverse. You've worked in string theory, in quantum field theory, fractional quantum numbers, condensed matter physics. The word "interdisciplinary" comes to mind.

GWS— Actually, I was always sceptical of interdisciplinarity, simply because it seemed like one spread oneself too thin in a way. To really have an impact, you have to solve a non-trivial problem. To do that you'd better concentrate on what that problem is. On the other hand, I was always taught to be broad. I think one of the first conversations I had with Umezawa when I became his graduate student had to do with this. He said something like "if you read the standard papers and do the standard calculations you'll just be a standard physicist" and that I should broaden my horizons. I think at that point I told him I was interested in quantum field theory and maybe quantum gravity, the implication being that I wasn't that interested in condensed matter physics. He was trying to convince me that I should be interested in condensed matter physics because there was really a lot of things to do there, a lot of different models and interesting physics that one could study that aren't really in the particle physics world. Particle physics really just has one model.

During one of the first conversations I had with Umezawa when I became his graduate student, he said something like "if you read the standard papers and do the standard calculations you'll just be a standard physicist". He encouraged me to broaden my horizons.

RM— But was he interested in condensed matter?

GWS— He was, yeah. In fact a lot of his program at the time was superconductivity, and some of my work with him was on superconductivity.

RM— We're now in 2012. What do you see as the big open questions in physics?

GWS— Well, this is the age of LHC. Some of these open questions could be answered just any day. Physics beyond the standard model. The hierarchy problem.

RM— Do you think we're going to find super symmetry?

GWS— You know, I think I actually signed on the positive side of a bet on that, which I regret doing because they certainly aren't seeing it right now. It looks less and less likely that they will find it at least in a way that is useful for explaining things in the standard model. That looks like it's been pushed off the map in that sense. I remain agnostic, but whatever happens there will be interesting, and I look forward to whatever that is. In fact, it could be announced this summer, at one of the big particle physics conferences.

RM— We can always take comfort in the fact that half of supersymmetry has been seen.

GWS— That's what my more skeptical colleagues in the coffee room at UBC used to say. It's a good theory. Half of the particles are already discovered.

RM— At a more pragmatic level, what's your opinion of funding in physics in particular in Canada these days?

GWS— I think compared to other jurisdictions Canada's done reasonably well even though I would say the funding is flat. One thing that has helped a lot is the private funding of the Perimeter Institute because that has injected a ton of money, both government and private money. The government money came from outside of our usual grant envelopes, so it took nothing away from us and the Institute funds quite a lot of research and does a lot of other things which has raised the profile of theoretical physics considerably in Canada. In fact, I think more has been written in newspapers about theoretical physics since Perimeter than all the integrated time before it that I can remember. So in some ways it's quite positive even though the actual funding that I would have access to has been relatively flat for quite a while.

RM— Do you see government funding being steered away from pure research towards applied research and technology and so on?

GWS— That is certainly happening. It is a directive that NSERC has gotten for example and it is one that they seem to be trying to follow through on. I wouldn't say that it's a new phenomenon entirely. I remember some pressure in that direction almost at any time in my living memory as a physicist.

RM— You've been a physics professor at UBC now for about 30 years. What do you like the most and what do you like the least about your job?

GWS— I would say the thing that I like the most is feeling I'm free to pursue whatever research seems the most promising to me. I wouldn't say I've been free to do nothing. There is pressure to produce something, but no one has ever really told me what direction I have to go in. And that freedom is invaluable. It's very difficult to make progress as it is, but if you take away the freedom to go in the most promising direction then it becomes really hopeless. So that's probably what I like the most. What I like the least? I'm drawing a blank here. When I first went to UBC it felt like a very isolated place, but it has really evolved into a major research university with almost 100% replacement of the faculty over that time. I went from being one of the youngest to one of the oldest in the space of about five years. So it was like a phase transition. So at the beginning I might have complained that I was isolated and that there wasn't a lot of help that would make myself less isolated but that seems to have gone away with time.

RM— Let's backtrack a little bit in your career. What was it like for a small town boy from Alberta to go to MIT? How did U of Alberta and MIT compare back then?

GWS— Total shock. That was the time before the Internet so there wasn't hep-th. People sent around paper preprints which had been typed on typewriters; things have really changed. At the time big groups had a big advantage in that they had all the information and they had it first, so there was quite a big difference between working in a small place and a big place. On a Canadian scale, the U of Alberta is not a small place, but on an international scale of course its particle theory group was much smaller than MIT, which had (and still has) breadth and depth. GIve a seminar at MIT and you don't really have to explain why you did what you did because the hundred people in the audience all know that already. You just have to tell them what you did.

It isn't actually learning what people did that has a permanent impact on you, it's learning how they did it just to see how people worked, the style of doing things, what the expectations were. That's the thing that has the most impact on a person.

RM— I guess there was a steady stream of famous people passing through.

GWS— Definitely. Everybody passes through at some time and it was a very big group of people more or less all interested in the frontiers of particle physics. It was actually quite a shock to be in that rather intense crowd, all very talented people. It's quite, quite different.

RM— From those days, whom do you still work with or keep in touch with regularly?

GWS— I wouldn't say I still work with anybody. I of course keep in touch with quite a few people. With some of my colleagues like Antti Niemi and Rohana Wijewardhana, with my supervisor at MIT, Roman Jackiw. In fact, he's maybe the most recent I've worked with. But I felt I learned there and as always it isn't actually learning what people did that has a permanent impact on you, it's learning how they did it just to see how people worked, the style of doing things, what the expectations were. That's the thing that has the most impact on a person.

CALL FOR NOMINATIONS / *APPEL DE CANDIDATURES*

CAP MEDALS / MÉDAILLES DE L'ACP

The following medals will be awarded in 2013:

- CAP MEDAL FOR LIFETIME ACHIEVEMENT IN PHYSICS
- CAP HERZBERG MEDAL
- CAP (UNDERGRADUATE) TEACHING MEDAL
- CAP BROCKHOUSE MEDAL (CONDENSED MATTER & MATERIALS PHYSICS)
- CAP/CRM PRIZE IN THEORETICAL AND MATHEMATICAL PHYSICS
- CAP MEDAL FOR OUTSTANDING ACHIEVEMENT IN INDUSTRIAL AND APPLIED PHYSICS
- CAP-TRIUMF VOGT MEDAL (SUBATOMIC PHYSICS)
- CAP-COMP PETER KIRKBY MEMORIAL MEDAL FOR OUTSTANDING SERVICE TO CANADIAN PHYSICS
- CAP AWARDS FOR HIGH SCHOOL PHYSICS TEACHERS (FEB.14 DEADLINE)

Information and nomination forms can be found on the CAP`s website - http://www.cap.ca
(Deadline: 14 January 2013)

Les médailles suivantes seront décernées en 2013 :

- MÉDAILLE DE L'ACP POUR CONTRIBUTIONS EXCEPTIONNELLES DE CARRIÈRE EN PHYSIQUE
- MÉDAILLE HERZBERG DE L'ACP
- MÉDAILLE POUR L'EXCELLENCE EN ENSEIGNEMENT DE LA PHYSIQUE
- MÉDAILLE BROCKHOUSE (MATIÈRE CONDENSÉE ET MATÉRIAUX)
- PRIX ACP/CRM DE PHYSIQUE THÉORIQUE ET MATHÉMATIQUE
- MÉDAILLE POUR DES RÉALISATIONS EXCEPTIONNELLES EN PHYSIQUE INDUSTRIELLE ET APPLIQUÉE
- MÉDAILLE VOGT DE L'ACP-TRIUMF (PHYSIQUE SUBATOMIQUE)
- MÉDAILLE COMMÉMORATIVE PETER KIRKBY DE L'ACP-OCPM POUR SERVICES EXCEPTIONNELS À LA PHYSIQUE AU CANADA
- BOURSES POUR ENSEIGNANTS EN PHYSIQUE AU NIVEAU SECONDAIRE*

Renseignements et formulaires de nominations pourront être trouvés au site internet de l'ACP -- http://www.cap.ca
Date d'echéance : 14 janvier 2013 (* 14 fév. 2013)

IUPAP SPONSORSHIP OF INTERNATIONAL CONFERENCES
PARRAINAGE DE CONFÉRENCES INTERNATIONALES PAR L'UIPPA

Each year IUPAP sponsors from 20 to 30 international conferences and awards grants to some of them. Conference organizers desiring IUPAP's sponsorship should communicate with the appropriate international Commission which will then make recommendations to the IUPAP Executive Council. ***April of the year preceding the proposed conference is the target date by which applications should be submitted to Commissions.*** Potential organizers of conferences to be held in Canada, during 2014 or early 2015 should obtain the support of the Canadian National IUPAP Liaison Committee (CNILC). In order for this to occur, the relevant information must be sent to the address below by **February 28, 2013**.

It should be noted that conditions for IUPAP sponsorship that the conference registration fee should not exceed the upper limit set by IUPAP each year (see IUPAP web site) and that circulars, other announcements, and the proceedings of the confrerence contain the following statement:

"To secure IUPAP sponsorship, the organizers have provided assurance that (Conference name) will be conducted in accordance with IUPAP principles as stated in the ICSU Document "Universality of Science" (sixth edition 1989) regarding the free circulation of scientists for international purposes. In particular, no bona fide scientist will be excluded from participation on the grounds of national origin, nationalitiy, or political considerations unrelated to science."

Application forms and additional information can be obtained from the IUPAP website: http://www.iupap.org or from the Secretary of the Canadian National IUPAP Liaison Committee :

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Chaque année, l'UIPPA parraine de vingt à trente conférences internationales et accorde des subventions à certaines d'entre elles. Les organisateurs de conférences qui souhaitent obtenir le parrainage de l'UIPPA doivent communiquer avec la Commission internationale appropriée, laquelle fera des recommendations au Conseil excutif de l'UIPPA. ***Les demandes de parrainage doivent être présentées aux commissions au plus tard le mois d'avril de l'année précédant la conférence proposée.*** Les éventuels organisateurs de conférences devant avoir lieu au Canada en 2014 ou au début de 2015 devraient obtenir l'appui du Comité national canadien de liaison avec l'UIPPA. Pour ce faire, ils doivent lui faire parvenir l'information nécessaire à l'adresse indiquée ci-dessous, d'ici **le 28 février 2013.**

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Pour obtenir des formules de demande et toute autre information, il suffit de visiter le site suivant : http://www.iupap.org ou de s'addresser au secrétaire du Comité national canadien de liaison avec l'UIPPA :

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PROFESSIONAL CERTIFICATION *PROFESSIONNELLE*

Details regarding the certification process, as well as all forms required to apply for certification, can be found in the "Professional Certification" section of http://www.cap.ca.

L'information relative au processus de certification, ainsi que les formulaires requis, sont disponibles sous la rubrique "Certification professionnelle" du site Internet de l'ACP qui se lit ainsi : http://www.cap.ca.

BOOK REVIEW POLICY

Books may be requested from the Book Review Editor, Richard Marchand, by using the online book request form at http://www.cap.ca.

CAP members are given the first opportunity to request books. For non-members, only those residing in Canada may request a book. Requests from non-members will only be considered one month after the distribution date of the issue of *Physics in Canada* in which the book was published as being available (e.g. a book listed in the January-March issue of *Physics in Canada* will be made available to non-members at the end of April).

The Book Review Editor reserves the right to limit the number of books provided to reviewers each year. He also reserves the right to modify any submitted review for style and clarity. When rewording is required, the Book Review Editor will endeavour to preserve the intended meaning and, in so doing, may find it necessary to consult the reviewer. Reviewers submit a 300-500 word review for publication in PiC and posting on the website; however, they can choose to submit a longer review for the website together with the shorter one for PiC.

LA POLITIQUE POUR LA CRITIQUE DE LIVRES

Si vous voulez faire l'évaluation critique d'un ouvrage, veuillez entrer en contact avec le responsable de la critique de livres, Richard Marchand, en utilisant le formulaire de demande électronique à http://www.cap.ca.

Les membres de l'ACP auront priorité pour les demandes de livres. Ceux qui ne sont pas membres et qui résident au Canada peuvent faire une demande de livres. Les demandes des non-membres ne seront examinées qu'un mois après la date de distribution du numéro de la Physique au Canada dans lequel le livre aura été déclaré disponible (p. ex., un livre figurant dans le numéro de janvier-mars de la Physique au Canada sera mis à la disposition des non-membres à la fin d'avril).

Le Directeur de la critique de livres se réserve le droit de limiter le nombre de livres confiés chaque année aux examinateurs. Il se réserve, en outre, le droit de modifier toute critique présentée afin d'en améliorer le style et la clarté. S'il lui faut reformuler une critique, il s'efforcera de conserver le sens voulu par l'auteur de la critique et, à cette fin, il pourra juger nécessaire de le consulter. Les critiques pour publication dans la PaC doivent être de 300 à 500 mots. Ces critiques seront aussi affichées sur le web ; s'ils le désirent les examinateurs peuvent soumettre une plus longue version pour le web.

BOOKS RECEIVED / *LIVRES REÇUS*

The following titles have recently been received for review. Readers are invited to write reviews, in English of French, of books of interest to them. Books may be requested from the book review editor, Richard Marchand, by using the online request form at www.cap.ca. Note that book titles followed by a [v] will be made available electronically; following the publication of a review, the reviewer will receive a hard copy directly from the publisher.

A list of all books available for review, books out for review and copies of book reviews published since 2000 are available on-line at www.cap.ca.

In addition to books listed here, readers are invited to consider writing comparative reviews on books in topics of interest to the physics community. This could include for example, books used for teaching and learning physics, or technical references aimed at professional researchers.

Les titres suivants ont été reçus aux fins de critique. Nous invitons nos lecteurs à nous soumettre une critique en anglais ou en français, sur les sujets de leur choix. Des copies des différents ouvrages peuvent être obtenues en en faisant la demande au responsable de la critique de livres, Richard Marchand, à www.cap.ca. Veuillez noter que les titres suivis de [v] seront accessibles électroniquement. Suite à la publication de sa critique, l'auteur pourra recevoir une copie papier directement de la maison d'édition.

Les listes de livres disponibles pour critique, ceux en voie de révision, ainsi que des exemples de critiques publiées depuis 2000 sont disponible sur: www.cap.ca.

En plus des livres mentionnés ci-dessous, les lecteurs sont invités à soumettre des revues thématiques comparées sur des sujets particuliers. Ces revues pourraient par exemple porter sur des ouvrages de nature pédagogique, ou des textes de référence destinés à des professionnels.

GENERAL INTEREST

NUMBER-CRUNCHING: TAMING UNRULY COMPUTATIONAL PROBLEMS FROM MATHEMATICAL PHYSICS TO SCIENCE FICTION [v], Paul J. Nahin, Princeton University Press, 2011; pp. 400; ISBN: 9780691144252; Price: 19.75.

COLLECTIVE ANIMAL BEHAVIOR [v], David J. T. Sumpter, Princeton University Press, 2010; pp. 312; ISBN: 9780691148434; Price: 27.62.

CONDENSED MATTER IN A NUTSHELL [v], Gerald D. Mahan, Princeton University Press, 2010; pp. 590; ISBN: 9780691140162; Price: 67.07.

ELEMENTARY PARTICLE PHYSICS IN A NUTSHELL [v], Christopher G. Tully, Princeton University Press, 2011; pp. 320; ISBN: 9780691131160; Price: 52.10.

PLASMA MEDICINE: APPLICATIONS OF LOW-TEMPERATURE GAS PLASMAS IN MEDICINE AND BIOLOGY, Edited by M. Laroussi, M.G. Kong, G. Morfill and W. Stolz, Cambridge University Press, 2012; pp. 346; ISBN: 9781107006430; Price: USD$121.95.

THE ATOM AND THE APPLE: TWELVE TALES FROM CONTEMPORARY PHYSICS [v], Sébastien Balibar, Princeton University Press, 2009; pp. 200; ISBN: 9780691131085; Price: 17.86.

UNDERGRADUATE TEXTS

AN INTRODUCTION TO ATMOSPHERIC PHYSICS (SECOND EDITION), David G. Andrews, Cambridge University Press, 2010; pp. 237; ISBN: 9780521693189; Price: USD$65.00.

AN INTRODUCTION TO CELESTIAL MECHANICS, Richard Fitzpatrick, Cambridge University Press, 2012; pp. 266; ISBN: 9781107023819; Price: USD$65.95.

ENGINEERING DYNAMICS: A COMPREHENSIVE INTRODUCTION [v], N. Jeremy Kasdin & Derek A. Paley, Princeton University Press, 2011; pp. 704; ISBN: 9780691135373; Price: 61.66.

FUNDAMENTALS OF CONDENSED MATTER AND CRYSTALLINE PHYSICS, David L. Sidebottom, Cambridge University Press, 2012; pp. 398; ISBN: 9781107017108; Price: USD$76.95.

INTRODUCTION TO STRINGS AND BRANES, Peter West, Cambridge University Press, 2012; pp. 709; ISBN: 9780521817479; Price: USD$ 81.95.

QUANTUM INFORMATION, COMPUTATION AND COMMUNICATION, Jonathan A. Jones & Dieter Jaksch, Cambridge University Press, 2012; pp. 200; ISBN: 9781107014466; Price: $USD 55.95.

GRADUATE TEXTS AND PROCEEDINGS

BIOPHYSICS: SEARCHING FOR PRINCIPLES [v], William Bialek, Princeton University Press, 2012; pp. 632; ISBN: 9780691138916; Price: 62.66.

CLASSICAL ELECTROMAGNETISM IN A NUTSHELL [v], Anupam Garg, Princeton University Press, 2012; pp. 712; ISBN: 9780691130187; Price: 61.28.

LIQUID SURFACES AND INTERFACES SYNCHROTRON X-RAY METHODS, Peter S. Pershan and Mark L. Schlossman, Cambridge University Press, 2012; pp. 311; ISBN: 9780521814010; Price: US $142.95.

UNDERSTANDING THE EARTH SYSTEM GLOBAL CHANGE SCIENCE FOR APPLICATION, Sarah E. Cornell, I, Colin Prentice, Joanna I. House, Catherine J. Downy, Cambridge University Press, 2012; pp. 267; ISBN: 9781107009363; Price: US$81.95.

BOOK REVIEWS / CRITIQUES DE LIVRES

Book reviews for the following books have been received and posted to the Physics in Canada section of the CAP's website : http://www.cap.ca. When available, the url to longer versions are listed with the book details.

Des revues critiques ont été reçues pour les livres suivants et ont été affichées dans la section "La Physique au Canada" de la page web de l'ACP : http://www.cap.ca. Quand disponible, un lien url à une critique plus longue est indiqué avec les détails du livre.

A STUDENT'S GUIDE TO FOURIER TRANSFORMS WITH APPLICATIONS IN PHYSICS AND ENGINEERING, J.F. James, Cambridge University Press, 2011; pp. 146; ISBN: 978-0-521-17683-5; Price: 29.99.

This small and relatively inexpensive book could be useful for physics students, with many of the worked examples taken from the field of optics. It provides a couple of fairly standard introductory chapters, and clarifies the varying definitions of the Fourier transform that can be confusing to students (in fact championing use of the frequency as opposed to angular frequency, in order to give clearer definitions). Of three chapters on applications, two are about optics and one about signal processing. Some diagrams have unlabeled or unclearly labeled axes, for example in the diffraction section where one would hope the several angles involved would be made the most clear. Aliasing is dealt with in a cursory fashion, and the simple analog means to prevent it are not discussed. There being one short chapter on signal processing, it seems like some important topics are left out, such as the practical (digital and analog) implementation of filters. Two and higher dimensional Fourier transforms are dealt with using interesting examples.

Discussion of the digital implementation of the Fourier transform, and the FFT, is minimal. A BASIC program is provided for doing FFTs: likely this is now of minimal utility, and updating to give references to modern programs for FFTs (fftw comes to mind) might have been a better use of space. The book is likely most suited as a supplement, and that could be envisaged in several courses, ranging from optics to mathematical methods for physics students. A useful bibliography points to some of the standard books such as those of Bracewell and Brigham.

Courses using those books could benefit from using the worked examples in this one, and again most particularly if the aim is to understand the use of the Fourier transform in optics.

Martin Connors
Athabasca University

INTRODUCTION TO EXPERIMENTAL BIOPHYSICS: BIOLOGICAL METHODS FOR PHYSICAL SCIENTISTS, Jay Nadeau, pp:641, CRC Press 2011, ISBN:9781439829530, $89.95 USD.

The stated intent of this book is to introduce physicists, chemists and engineers to experimental techniques commonly used in biology labs. The book is quite comprehensive and it provides a good, practical introduction to biological experimental techniques. I would highly recommend the book as a reference for any physicist whose research touches on biology and will certainly keep the book handy for students working in my research group.

One of the pitfalls of trying to write a book about biophysics is that the field is extremely broad. This book touches on many of the experimental techniques used to study biological systems, although it is focused on techniques for measuring properties of microscopic biological systems. More macroscopic techniques, such as the imaging modalities used in medical physics are noticeably absent. Even some common techniques for studying microscopic systems, like optical tweezers, are missing.

The book is intended to be a textbook for use in an experimental biophysics course, although it's not clear what students would be targeted for such a course. The assumed background knowledge for the textbook suggests that it should be used in a graduate-level course, but the wide variety of experimental techniques presented here is not particularly suited for graduate students who are trying to become experts in a specific field. Additionally, none of the techniques are discussed at the depth typically needed for a graduate level course.

While some of the experimental techniques are described in detail, many techniques included in the book are presented with just enough information to leave you with an understanding of how the experimental technique works and what information the experiment will give you. In order to accomplish this, however, the book assumes that the reader has some familiarity with both physics and biology. While biology terms are defined in the glossary at the end of the book, there are a few parts of the main text that are heavily biological and a reader completely unfamiliar with biology would be constantly flipping to the back of the book. Some of the more advanced biology is explained in the text and I found the figures and illustrations to be quite helpful in clarifying some of the biology.

The features that I think make this book unique and useful are some of the ``insider tips", hints and recipes. There are detailed step-by-step instructions for carrying out some of the experiments, including information on how to obtain the chemicals or biological samples necessary for the experiments as well as tips for avoiding common pitfalls. The appendices include recipes for gels, solutions and growth media used in biological and lists of fluorescent proteins, dyes and restriction enzymes along with their experimentally relevant properties. The end of each chapter lists books and journal articles for further reference, but also gives lists of online resources and software, both commercial and open source, that are used in analysis of the experimental data.

"Introduction to Experimental Biophysics" is a very useful reference book for physicists who do research, or have some interest in, biology. It provides an introduction to a wide variety of experimental biological techniques and gives practical information for setting up and performing the experiments.

Hana Dobrovolny
Assistant Professor of Biophysics
Texas Christian University

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You are invited to enter the competition (open or high school categories) by capturing in a photograph a beautiful or unusual physics phenomenon and explaining it in less than 200 words in terms that everyone can understand.

The emphasis of the contest is not so much on having a high level of physics compre-hension as it is on being able to explain the general principle behind the photograph submitted. Individual (open and high school) and high school class entries are invited up until April 30, 2013 (see http:// www.cap.ca/en/activities/art-physics for entry form/ rules). Please note that all entries must be original artwork produced by the participant.

Winning entries will form part of our Art of Physics exhibition which will be on display at the Canada Science and Technology Museum, and may appear as a cover on our publication, *Physics in Canada* (the cover of this issue is a winning entry for 2012). They will also be posted on our Art of Physics website at http://www.cap.ca.

We hope you will take advantage of this opportunity to explore the art of physics by submitting entries for the 2013 competition.

"The Diverging Glass"

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by Kirstyn Tourneur, Blessed Cardinal Newman Catholic High School Scarborough, ON

CONCOURS L'ART DE LA PHYSIQUE

Vous êtes invités (es) à par-ticiper (aux catégories ouvert ou école secondaire) en pho-tographiant un phénomène physique magnifique, ou particulier, et en rédigeant un court texte explicatif de moins de 200 mots, en termes simples et à la portée de tous.

L'accent de ce concours est de pouvoir expliquer le principe général de la photo soumise plutôt que de démontrer un niveau élevé de compréhension de la physique. L'échéance pour les inscriptions individuelles (ouvert et école secondaire) et scolaires (voir formulaire d'in-scription/règlements à http://www.cap.ca/fr/ activites/lart-de-physique) est fixée au 30 avril, 2013. Notez bien que toutes les inscriptions doivent être des oeuvres originales du participant ou de la participante.

Les soumissions gagnantes feront partie de notre exposition L'Art de la physique au Musée des sciences et de la technologie du Canada et auront une chance de paraître sur la couverture d'un numéro de *La Physique au Canada* (la couverture de ce numéro est une des soumissions gagnantes de 2012). Elles seront également affichées sous la rubrique L'Art de la physique du site web de l'ACP à l'adresse suivante: http://www.cap.ca.

Nous espérons que vous profiterez de cette occasion d'explorer l'art de la physique en soumettant une oeuvre pour la compétition de 2013.

Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Université de Montréal

Congrès de l'ACP-CAP Congress

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