JAN 2012

Physics Matters

First Light – Launch of a Teaching Telescope

As twilight settled over the University Hall on 17 Aug 2011, something astonishing was about to unfold. This was one significant milestone to put on record – in the 106th year of its existence, the National University of Singapore was about to unravel its first-ever, state-of-the-art telescope in a brand new teaching observatory. Built at a cost of $400,000, the NUS Telescope and Teaching Observatory houses the largest-aperture telescope in Singapore, with a primary mirror of 17.5 inch.

⇧ The team : From left: A/P Phil Chan (Particle Physics), A/P Edward Teo (Black Holes), Mr Tan Peng Kian (Research Assistant), Dr Ng Wei Khim (Neutrinos), Dr Cindy Ng (Cosmology), A/P Osipowicz Thomas (Nuclear Astrophysics), Mr Lim Teck Seng (Technologist), A/P Chung Keng Yeow (Astronomy, not in picture), Dr Colla Massimiliano (Solar System, not in picture) and Mr Leek Meng Lee (Research Scholar, not in picture)

To mark this historic moment, at 7:30 pm sharp, the guest of honour Prof Andrew Wee, Dean of the Faculty of Science, was invited to slew the telescope southwest to the planet Saturn. The event also coincided with the Dean's welcome for all the Science scholarship holders. More than 50 amateur astronomers from the local astronomy fraternity were also invited to join in the occasion for a time of relaxed, enjoyable exchange.

⇧ Prof Andrew Wee (right) and faculty from Science were present to mark the special occasion

Situated at the rooftop of two Physics blocks, this roll-off-roof teaching observatory houses a new

⇦ Students looking forward to trying out the new telescope

⇧ Pioneering group of physics undergraduates who will be using the new telescope

American-made 17 inch (0.43 m), f/6.8 Corrected Dall-Kirkham Astrograph telescope (CDK17) with a dual carbon-fiber truss design and a well-known Japanese computerised Showa mount. The observatory is large enough to accommodate a tutorial class of about 15 to 20 students.

The observatory complements the Physics Department's BSc programme with an astrophysics specialization, and also two other highly popular physics astro-GEK modules, Understanding the Universe as well as Einstein's Universe and Quantum Weirdness. Also, the observatory will be shared with faculty and students in the Geography Department, as part of their 3rd year geo-science module.

The observatory is currently used for UROPS instrumentation projects. Already, two separate groups of students are using the observatory, in preparation for the 2012 Venus Transit, which will be the final transit of the planet Venus across the Sun, in our generation.

Acknowledgements:

We like to thank Prof Feng Yuan Ping (Head of Physics) and Prof Kuok Meng Hau (former Dy Head (Resource)) for their constant encouragement and support for mounting this facility for our physics students.

With contributions from Dr Cindy Ng and A/P Phil Chan

Inside this issue:

The Editorial Committee wishes all staff and students a rewarding and cheerful 2012 ahead!

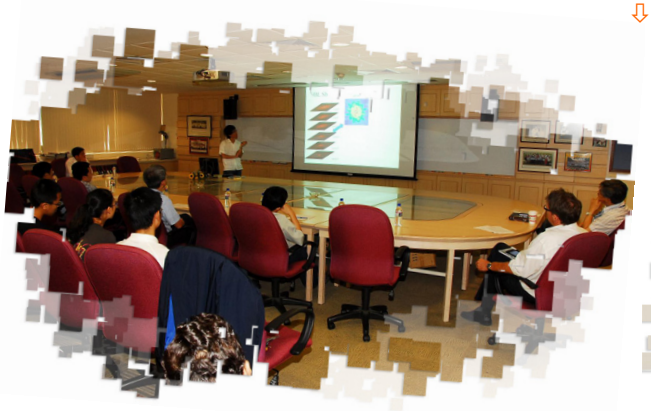
Department of Physics

NUS National University of Singapore

Calendar of Events

The second half of 2011 promised to be an eventful term for the Physics Department. Let's journey back memory lane as we recapture those moments in pictures.

3rd Physics Graduates Symposium, 3 August



⇧A total of 13 oral and 3 poster presentations were made.

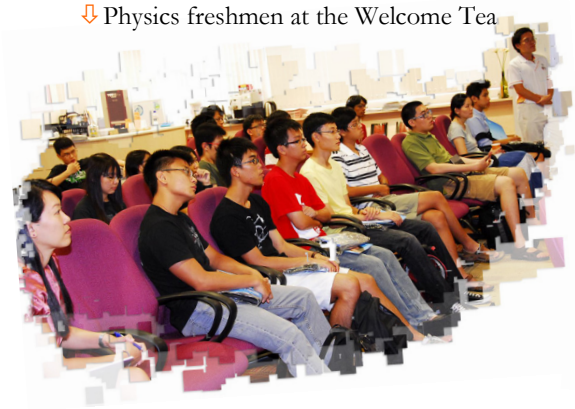
⇩Mr Yan Yuanjun, one of the best presenters, receiving an award from Prof Feng Yuan Ping

⇧New graduates received a warm reception orientation at the symposium.

⇩Interaction time for juniors and seniors

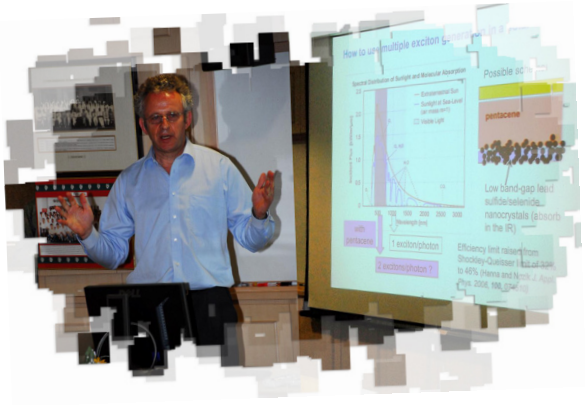
Freshmen Welcome Tea cum Career Talk, 17 August

⇩Physics freshmen at the Welcome Tea



⇦Official from the Meteorological Service Singapore (MSS) giving a career talk

Professor Richard Friend Centennial Professorship Lecture, 19 August



⇧Prof Richard Friend spearheads the field of polymer organic semiconductor devices and his works are internationally acclaimed.

⇩The Tan Chin Tuan Centennial Professor delivered a lecture in the department to an attentive audience.

Physics Safety Day, 2 September

⇩It was a day that over 100 participants had been anticipating!

⇧The health and safety talks were well received by everyone.

⇩Lucky draw - A lucky winner is a happy winner.

6th Conference of the Asian Consortium on Computational Materials Science (ACCMS-6), 6 – 9 September, Biopolis

⇩Two pre-conference short courses were held in the department to address challenging issues in computational materials science.

⇧The biennial conference drew 180 participants and provides a platform for experts to share their findings in advanced computational methodologies and their applications.

12th Frontier Science Symposium, 14 – 16 Novovember

⇨The Faculty of Science hosted the 12th Frontier Science Symposium, in collaboration with Nanjing University, National Central University and National Taiwan University. The Physics department played host to the Physical Sciences group.

Departmental Outing, 12 December

⇧Staff enjoying a game of bingo

⇩Let the ball roll ...

⇧One of the best bowling teams

Physics in Action! Patent Protection of Intellectual-Industrial Property

Imagine: your competitor monitors your R&D investments, commercializes your inventions and pockets the profit, while your company goes bankrupt! Innovation cannot coexist with unprotected inventions. A patent is a state-granted monopoly (earliest patent law: "Statute of Monopolies" in England, 1628). It is an exclusive right held against the rest of the world (in contrast to a contractual right held only against a contractual partner). It is an intellectual, non-physical, property right. Just like physical property, it is a financial asset, so it can be sold, leased or pawned. Patent licensing is a source of revenue.

Innovation cannot coexist with unprotected inventions.

An invention qualifies for patent protection if it satisfies: (a) novelty, i.e. it is not found in the "prior art", that is the body of disclosed information made available to the public anywhere in the world; (b) inventive step or non-obviousness, i.e. in the judgement of a person "skilled in the art" (not necessarily an expert) it is not a trivial modification of disclosed material; (c) industrial application in the broadest sense of the word.

An invention is a novel product by a known method, or a known product by a novel method, or both, or a novel use of a known product (the last often in medicine). The "unity of invention" is a legal requirement for a single patent. Patentable matter is severely restricted and important litigation exists on that topic.

To file for a patent you need a postage stamp and a legally prescribed address. An "international patent" does not exist; the PCT (Patent Cooperation Treaty) only provides for an *international application*, resulting in a group of national patents. In case of litigation for alleged infringement, you may end up losing your patent in one country while keeping it in another.

Whether the patent holder or the alleged infringer wins the case is on a razor's edge: very much depends on the judge's philosophy. For some judges (like my professor of patent law at the University of Amsterdam, who was also a judge in the regional court in the Hague designated for patent litigation) the freedom of information is a natural right, having priority above a state-granted monopoly that is merely a legal privilege. For other judges, protecting *any* property – whether physical or intellectual – is a matter of legal dignity approaching the dimensions of a human right; therefore intellectual property merits legal protection from a copyist just as, e.g. a purse or jewelry merit legal protection from a thief. That is why patent litigation almost always ends up in appeals and is costly.

Patents, trademarks and models form the class of "industrial property" within the cluster of intellectual property rights. A patent lasts 20 years (25 for medicines – 5 extra years for clinical testing). A trademark is a more durable right lasting forever. Why that difference? Society wants information to be freely available for exploitation after a certain period, whereas a trademark is a matter of public order: if, e.g. Coca Cola loses its trademark, you don't know *what* you are drinking! Aspirin is both a Bayer patent long expired, and a Bayer trademark that continues interminably. Copyright is another important category of intellectual property.

Society wants information to be freely available…

If in a spree of magnanimity your boss tells you that in a patent application, the company is going to name *you* – and not the company itself - as the "inventor", he is either kidding you or he should know better. The law demands an inventor to be a *natural* person. A company is a *legal* person that does not qualify as inventor, but it is entitled to own patents generated by its employees' inventions. If the patent application does not mention the owner's name, the inventor is presumed to be the owner. The employee-inventor's rights lie in a legal collision triangle between patent law, employment law and collective trade union contracts (this was incidentally the topic of my LLB thesis).

The object of *any* ownership must be exactly defined. (Your house has an exact address, your scientific article has an exact title and journal citation. Your bank account is only a claim you have against the bank, you do not "own" the money in it. But you do own the specific money notes with exact serial numbers in your pocket or in a safe deposit box.)

The object of *any* ownership must be exactly defined.

How is an invention defined legally exactly, so as to qualify for a patent? It is done by distinguishing between the "embodiment" and the "scope" of the invention. I will illustrate this by two inventions of the Biophysics & Micro-nanostructures Lab, whose patent applications I drafted:

(A) Prediction method of protein crystallization conditions. The surface tension of a solution of protein and salt is measured. Concentrations, pH and temperature are varied freely pair wise. When the surface tension reaches a critical value, it signifies a tendency of protein to assembly, allowing determination of the desired result.

(B) Method of producing enhanced silk fibers by applying an electric field to silk worms and enhanced silk product.

If your patent covers only the actual experimental procedures and results, e.g., the actual range of pH values in (A), or the actual electric field values in (B), it is a *free gift* to competitors! The Patent Office publishes eventually the patent, your competitor reads it, makes a trivial modification, e.g., in the pH or electric field, crystallizes protein rapidly at low cost, or produces and sells silk of superior strength, while pretending that he is not copying any inventions!

The actual experimental procedures and results constitute one possible "embodiment" of the invention. The "scope" of the invention is an umbrella covering all other thinkable embodiments that you may not have performed, but are sufficiently closely related with your actual embodiment so

continued on page 7…

Discovering Physics - Gold Clusters as Nanocatalysts

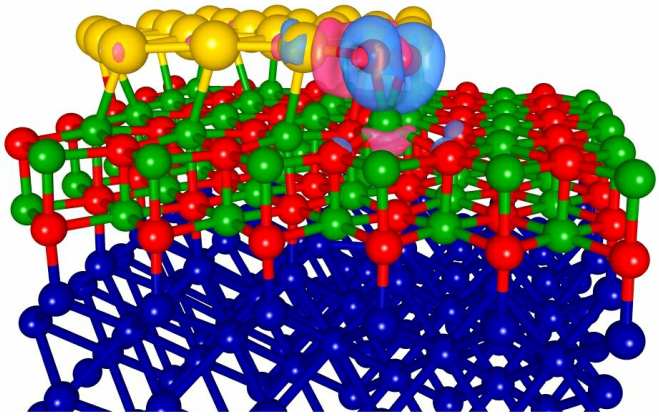
Catalysis lies in the heart of Chemistry and Chemical Physics. For 'conventional' catalysts, the catalytic performance often scales with the surface-to-volume ratio of the catalytic agent. When the size of the catalytic center decreases to nanoscale, quantum effects start to dominate and the surface-to-volume ratio no longer plays a key role in catalytic performance: We come to a new research field, nanocatalysis.

Nanocatalysis is one of the most exciting subfields in nanoscience presently. Due to the quantum effects originating from the highly reduced dimensions, the properties of nanocatalysts are often strongly size dependent, which are related to but cannot be deduced from their larger-scale counterparts. Nanocatalysts' unique properties provide many new opportunities in the design and control of novel catalysts.

Gold clusters are excellent examples of nanocatalysts. In bulk form, gold is the noblest metal. It is so inert that it has never been considered as catalysts till 1987 when Haruta and his collaborators reported an unexpected catalytic activity of small gold nanoparticles [1]. Since then, there was an explosion of interests in gold nanocatalysis which some chemists called the 21st-century catalytic gold rush.

Till now, gold nanoclusters have been found to be excellent catalysts for a large number of important chemical reactions such as CO oxidation, selective oxidation of alcohols, synthesis of hydrogen peroxide, C-C bond formation and water splitting. The origin of the catalytic activity or activation of gold clusters is a central issue in research. Among the various kinds of activation mechanisms, the so-called support-induced catalytic activity of gold clusters is particularly interesting in the context of heterogeneous catalysis.

For heterogeneous gold catalysts, gold clusters are chemically adsorbed on a substrate that is often a metal-oxide (MO) surface. The substrate-cluster interaction plays a key role in the activation of gold catalysts. Consequently, the tuning/ control of the chemical bonding between the gold clusters and substrate provides an effective way to tune/control the performance of gold nanocatalysts, which has great implications in real applications. Next, we show in one of our recent studies how the catalytic activity of gold clusters can be tuned through modifying the charge transfer between the underlying substrate and supported clusters.



⇧ **Figure 1. A Au_{20} cluster (yellow) adsorbed on a MgO surface (O atoms in red and Mg in green) that itself is supported on a Mo (100) substrate (blue) with a co-adsorbed O_2 molecule. An isosurface of the excess electronic charge (light blue) is also shown.**

The example is for Au_{20} clusters supported on MgO substrate [2]. MgO surface is a common substrate for Au nanocatalysts. It is well accepted that the defects in MgO surface are essential for the catalytic activity of gold clusters. In this study, we showed that without the need for defects, gold clusters can still be activated by tuning the thickness of the MgO substrate.

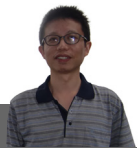
Figure 1 shows a Au_{20} cluster adsorbed on a thin MgO layer that is supported on a Mo substrate. The chemical reaction of CO oxidation is used to probe the catalytic activity of the gold cluster. When the MgO layer is thick (>3 nm), our calculatons showed that the gold cluster is not active, and the reaction barrier of the CO oxidation is around 3 eV. When the MgO layer is ultra thin (~ 1nm), significant amount of charges can transfer from the underlying Mo support to the gold cluster, activating it. When the O_2 molecule is adsorbed on the gold cluster, the 'extra' charge on the gold cluster will then be transferred to the O_2 molecule (see figure), leading to the greatly elongated O-O bond. As a result, the reaction barrier of the CO oxidation decreases to less than 0.2 eV. This study is quite meaningful since it provides a novel and effective way to greatly enhance the catalytic performance of metal nanocatalysts.

Recent studies of heterogeneous gold catalysis have been mainly focused on controlling the performance of gold clusters through tuning the substrate-cluster interaction by modifying the size, morphology, charging state of gold clusters, and/or the defect states, thickness, strain, chemical composition of the underlying support. It is worth mentioning that graphene as a support for gold nanocatalysts has attracted notable interests recently. Due to its excellent mechanical and electronic properties, graphene is believed to be an ideal support for metal nanocatalysts, which opens many new opportunities for future research.

References

[1] Haruta M etal, "Novel gold catalysts for the oxidation of carbon monoxide at a temperature far below 0 °C", *Chem Lett* **2**, 405-408 (1987)

[2] Zhang C, Bokwon Y and Landman U, "Predicted oxidation of CO catalyzed by Au nanoclusters on a thin defect-free MgO film supported on a Mo(100) surface", *J Am Chem Soc* **129**, 2228



Contributed by Dr Zhang Chun

Dr Zhang Chun received his PhD from the University of Florida in 2004. After working in the School of Physics, Georgia Institute of Technology as a postdoc fellow for 3 years, he joined NUS as an assistant professor in 2008. Dr Zhang's research focuses on the theoretical modeling and computational simulation of materials at the nanoscale which currently includes nanoscale electronics, spintronics and nanocatalysis.

Nobel Laureate, my coach

Prof Brian P Schmidt, an astronomer at the Research School of Astronomy and Astrophysics at the Australian National University (ANU), was one of three recipients of the Nobel Prize in Physics 2011. The award was given "*for the discovery of the accelerating expansion of the Universe through observations of distant supernovae*" (http://www.nobelprize.org/nobel_prizes/physics/laureates/2011/press.html). Honours-year graduate Loh Lerh Feng met Prof Schdmit while on an exchange programme in ANU. Prof Schmidt also co-supervised Lerh Feng in his honours-year project. Lerh Feng shared with *Physics Matters* his impressions of Prof Schmidt:

⇧ Mr Loh Lerh Feng, Physics Honours graduate

"Brian was an interesting lecturer, but above all he was very approachable. Once he actually helped my friend and I with an assignment question for a different course. We'd gone to the original lecturer's office (which is adjacent to his) and he wasn't in, so we asked Brian. He hadn't seen the question before, but was still confident to point us the way that turned out to be correct! Brian had also given me good suggestions and advice on what to do with my life after graduating."

⇧ Prof Brian Schmidt portrait by Berlinda Pratten

Hear what our award recipients have to say about what their award meant to them. More on page 8.

"Although this is an individual award, it's definitely not of my individual effort. I would like to think of it as an affirmation to the work on wellness done by the Welfare Committee, Safety Committee and department as a whole. My sincere thanks to the department for this privilege to serve and be rewarded for it."

Samuel Wu, NUS Wellness Ambassador Award & Faculty Outstanding Service Award

"I'm thankful to receive this award and would like to express my gratitude to all my colleagues who in one way or another have contributed to this recognition. I'm also glad that I could contribute not just in the department but the faculty as well."

Tong Hoe, Faculty Outstanding Service Award & NUS Quality Service Award

A Day in the Life of ...

Operations associate Mr Muthusamy s/o Annanvy still talked excitedly about the field trips he made to map the flow of underwater current in Seletar Reservoir years ago. Photos of the trips he kept have turned somewhat yellow but they brought back fond memories of interesting tasks he undertook in the good old days in the department.

Mr Muthusamy, or Muthu as he's called, enjoys cycling to and from work every day which is good exercise for him. A typical day for him starts and ends with safety and cleanliness in mind. Early in the morning he would faithfully dispose of all unwanted materials and chemicals in his labs. Being a safety warden, he has a keen eye for displaced chemicals or equipment. He would tirelessly remind staff and students to dispose of harmful chemicals properly and is available to offer his advice on storage matters. Muthu also assists in transporting liquid nitrogen and gas cylinders and checks that the vacuum pumps in the labs work optimally.

In recent years, Muthu finds himself in a more diverse workplace as the labs engage more foreign staff and students. When asked about his work environment, Muthu was quick to respond that he would not be in the department for over 40 years if not for the close work relationships he enjoys here. Staff and students are friendly and co-operative so any cultural or language difference is no barrier to him.

Muthu was sad when news broke that a colleague has taken ill. He does not hesitate to cover his duties whenever his service is needed. The proud grandfather of three indeed values good relationships especially with his family. Providing for them has always been his priority and he treasures the occasional trips he makes overseas with his family.

Physics in Action! Patent Protection of Intellectual-Industrial Property

...continued from page 4

as to preserve the legal requirement of "unity of invention". Intellectual ownership is established: first by proving the invention, and then by "claiming" it.

At the first stage, the novelty and inventive step are proven in the "Detailed Description" section and figures. The embodiments of the invention in your actual experiment are "taught" in extensive detail. It is not necessary to carry out the actual experiment, as long as you enable a reader "skilled in the art" to reproduce it. For reasons of legal logic, you are forbidden to *add* material to the detailed description after filing, you are only allowed to *subtract* material.

At the second stage, the patent monopoly right is claimed by constructing the scope of the invention. The "Claims" section comprises independent and dependent claims obtained by a process of abstraction. Again for reasons of legal logic, the claims *can* be modified endlessly after filing, and occasionally after grant.

Whereas the detailed description proves novelty and inventive step, the claims safeguard against infringement by a copyist – commonly known as theft.

…claims safeguard against infringement by a copyist…

In searching for the broadest possible scope in claims drafting, I think mathematically of a deductive system based on simple set theory expressed in words, presented here heuristically. By a step-by-step generalization of important key words, I arrive at a conceptual progression of nested subsets, while discarding along the way any subsets overlapping with prior art. A couple of simplistic deductive routes follow.

Some key words from invention A: *protein*, *salt*, *pH*, *concentration, temperature, surface tension.*

$\{protein\} \subset \{biomacromolecule\}$; $\{solution\ with\ a\ surface\} \subset \{solution\}$; $\{salt\} \subset \{additive\}$;

$\{pH,\ concentration,\ temperature\} \subset \{variable\ quantity\}$; $\{tendency\ to\ assembly\} \subset \{critical\ response\}$;

$\{surface\ tension/pressure\} \subset \{response\ quantity\}$; $\{surface\ tension/pressure\} \subset \{assembly\ parameter\}$.

Some key words from invention B: *silk worm, direct electric field.*

$\{silk\ worm\} \subset \{silk\ extruding\ animal\} \subset \{animal\ of\ invertebrate\ species\}$;

$\{silk\} \subset \{protein\ fiber\} \subset \{protein\ material\}$; $\{applied\ stimulus\ prior\ to\ extrusion\} \subset \{applied\ stimulus\}$;

$\{direct\ electric\ field\} \subset \{electric\ field\} \subset \{electromagnetic\ radiation\} \subset \{stimulus\}$

The present heuristic description of constructing nested subsets proceeds by conjunction of subsets at each step. Such a procedure ends spontaneously when any further generalization inevitably leads to a complete overlap with elements of the prior art. The maximal sets are optimal in the sense of having minimal distance from, or maximal approach to, the prior art, without overlapping it. Therefore they encompass the full scope of the invention, offering maximal protection. They are expressed in single sentences called "independent claims".

The complete set of possible embodiments associated with a resulting maximal set is deduced by finding those subsets that are compatible with the "detailed description". Such subsets are expressed in single sentences as "dependent claims"; they belong to a family generated by the corresponding independent claim. Frequently, several independent claims are drafted together with their respective families of dependent claims.

Clearly the actual embodiment of the experiment coincides with one of the generated subsets; the claim associated with the actual experiment is called a "picture claim". Ending up with only a picture claim in the patent application signifies a death certificate for the patent. Then it is worth refraining from filing for a patent, or withdrawing the application before publication, and exploiting the invention in a regime of trade secrets.

In conclusion, the broader the scope, the higher the level of claim abstraction, and the more resilient the patent. Protecting an invention involves an intense effort to *re-understand* it in an abstract deductive way that is different and deeper than the inventor's understanding. There can be no protection without abstraction!

Contributed by Dr Christina Strom

Dr Christina Strom holds a PhD in Physics, an LLB with specialization in intellectual property (patent and trademarks law, and copyright, with a strong background in international private law) and a patent drafting certificate issued by the FICPI (Fédération Internationale de Conseils en Propriété Industrielle). She has worked as researcher and associate professor in departments of crystal growth and solid state chemistry of the Universities of Leiden, Utrecht and Nijmegen in the Netherlands, as copyright advisor in the scientific publishing industry, as researcher and visiting associate professor in NUS, and as patent associate in Singapore.

Her research has covered development of graph-theoretic methods and algorithms to predict crystal growth and morphology, protein-crystal surface interaction and network architectures in biofunctional materials. More recently she has taught a general module on "Physics in Life Sciences" in the Physics Department of NUS. She has drafted patent applications with special attention to – and enjoyment of – claims drafting, for which she developed the method briefly outlined in this article. She is now working part time as a self-employed technology and legal advisor, including out-of-court settlements of related disputes.

Christina is happy to answer any questions or provide more information on the broad subject of intellectual property, including patents, copyright, licenses, trade secrets, intellectual rights in relation to employment vs work contracts, etc. She can be contacted at office.strom@gmail.com.

Awards - Congratulations to all winners!

Singapore National Academy of Science (SNAS) Fellowship
Prof Bernard Tan Tiong Gie
Prof Andrew Wee Thye Shen

National Day Awards 2011
Prof Belal E Baaquie (The Long Service Medal)
Prof Kuok Meng Hau (The Long Service Medal)
Mr Teo Hoon Hwee (The Efficiency Medal)

SMP Outstanding Mentor Award
Dr Massimiliano Colla
A/Prof Sow Chorng Haur
A/Prof Tay Seng Chuan
Dr M V Venkatashamy Reddy

Faculty Teaching Excellence Award AY2010/2011
A/Prof Chung Keng Yeow
A/Prof Gong Jiangbin
A/Prof Tay Seng Chuan
A/Prof Teo Ho Khoon, Edward
Dr Wang Qinghai
Prof Frank Watt

Faculty Honour Roll AY2010/2011
Dr Yeo Ye

Faculty Teaching Assistant Award AY2010/2011
Mr Chong Fu-Zhi, Jeremy
Mr Lim Yen Kheng
Mr Ng Wei Khim
Mr Qiu Leiju
Mr Setiawan

Faculty Outstanding Service Award 2011
Ms Foo Eng Tin
Mrs Lee Soo Mien
Mr Lim Geok Quee
Mr Ng Tong Hoe
Mrs Phua Swee Wah
Mr Seah Chong Huat Dicky
Ms Teo Hwee Sim
Mr Teo Hoon Hwee
Mr Wu Tong Meng Samuel

Faculty Commendation Award 2011
Ms Achuthan Prasanna

NUS Quality Service Award 2011: Service Advocate
Mr Lim Hwa Ngee
Mr Ng Tong Hoe
Mr Seah Chong Huat, Dicky
Mr Suradi Bin Sukri
Ms Teo Hwee Sim
Mdm Wong Siaw Khiaw, Rosalind

NUS Wellness Ambassador Award
Mr Wu Tong Meng Samuel

NUS Wellness Supportive Supervisor Award
Ms Tay Bee Hwee

Outstanding Undergraduate Researcher Prize AY2010/11
Mr Le Phuc Thinh

"I'm honoured to receive this award which recognises my service rendered in the department. The time and effort I have invested to make the workshop a safe and sound environment to work in have not gone to waste!"

Suradi, NUS Quality Service Award

"I truly appreciate the award. But at the same time, I do recognize the expectation on award recipients to keep up our good performance and continue to give of our best."

Soo Mien, Faculty Outstanding Service Award

"This is my first teaching award. It is a recognition of the effort I have put into teaching. I'm very excited about it!"

Qinghai, Teaching Excellence Award

"This award is a wonderful honour. I thank and share the credit with my fellow TAs and lecturers whom I work with, and also thanks go to my professors who taught me valuable lessons in physics."

Yen Kheng, Teaching Assistant Award

Announcements

India-Singapore Joint Physics Symposium
20-22 February
Indian Institute of Technology (IIT), New Delhi, India
Contact: Prof B V R Chowdari, phychowd@nus.edu.sg

IPS Meeting 2012
23-24 February
Faculty of Science, NUS, Singapore
More info at: http://ipsmeeting.org/

China Immersion Programme
Contact: Prof Liu Xiang Yang, phyliuxy@nus.edu.sg

Germany Immersion Programme
3-24 June (tentative)
Contact: A/P Thomas Osipowicz, phyto@nus.edu.sg

If you have any feedback or suggestion for Physics Matters, please feel free to contact any of us:

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Ng Wei Khim (phynwk@nus.edu.sg)

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