

## Nobel Laureate Public Lecture Series

### “Applications of Olefin Metathesis Catalysts: Fundamental Research to Commercial Products” by Professor Robert Grubbs

**Professor Robert Howard Grubbs**, Nobel Laureate in Chemistry, 2005, Victor and Elizabeth Atkins Professor of Chemistry Division of Chemistry and Chemical Engineering California Institute of Technology, gave a public lecture at SBS Classroom 1, NTU on 1 February 2007.



Metathesis is a scientific jargon for “changing places”. In olefin metathesis, the “catalyst pair” (a dancing pair consisting of metals) and the “alkene pair” (a dancing pair

consisting of two alkylides) dance around each other and change partner with one another. The catalyst pair holds hands and when they meet the “alkene pair”, the two pairs unite in a ring dance. After sometime, they let go and leave their former partners and dance with their new ones. This fascinating mechanism is now known as the Chauvin’s mechanism.

In many chemical reactions, bonds between different atoms are often broken and new ones are formed. In olefin metathesis, the double bonding groups change places with one another forming butane and ethane. The catalyst is not consumed in the reaction but it is required for the reaction to occur.

In the early 1950s, a number of patents described the catalysation of olefin polymerization. H. S. Eleuterio at DuPont, USA, in a report described the formation of carbon chains with double bonds, that is, unsaturated polymers (olefins). In the same year another patent showed that propene could be converted into butene and ethene when treated with a mixture of tri-isobutyl aluminium and molybdenum oxide on aluminium oxide.

It was much later that N. Calderon at the Goodyear Tire and Rubber Company, USA made the connection between these two discoveries. Essentially, Calderon showed that olefin metathesis takes place in both processes. However, the question regarding the presence of the catalyst at molecular level, and how it worked, remains largely unresolved.

In 1970, Yves Chauvin and his student Jean-Louis Hérrison proposed that the catalyst was a metal carbene (a compound in which the metal is bound to the carbon with a double bond). In subsequent literature the metal carbene became known as metal alkylide. Chauvin presented an entirely new mechanism for how the metal compound functions as a catalyst in the reaction. The new experimental results were consistent with this new mechanism although it could not be explained by any previously proposed mechanisms.

With strong experimental support from investigations by Robert H. Grubbs, Thomas J. Katz and Richard R. Schrock, it was soon realized that metathesis could be very important for organic synthesis if suitable, reliable and effective catalysts could be found. Other than being stable and well-defined, the catalysts are required to have reactivity that could be adjusted depending on the purpose. In addition, they had to be selective — only react with double bonds and leave other parts of the molecules intact. Moreover, Chauvin showed how metal alkylidenes can act as catalysts in olefin metathesis.

In the early 70s, Richard Schrock started research on new alkylidene complexes. He showed that molybdenum and tungsten were suitable metals as catalyst with the discovery of a group of very active molybdenum catalyst in the 90s. In 1992, Robert Grubbs and his team discovered that the metal ruthenium can act as catalyst in olefin metathesis. Ruthenium has higher selectivity than molybdenum. Moreover it was stable in air. The new catalyst also had the ability to initiate metathesis in the presence of alcohols, water and carboxyl acids.

Grubbs' catalysts eventually became the benchmark for laboratory preparation of new catalysts.

In the final part of his talk, Professor Grubbs spoke on commercial potential of metathesis in pharmaceuticals, biotechnical and food industry. One intriguing application is the synthesis of insect pheromones. Metathesis is also an important tool for the search for new pharmaceuticals products for



the treatment of bacterial infections, hepatitis C, cancer, Alzheimer's disease and other diseases.

Leong-Chuan Kwek

## Nobel Laureate Public Lecture Series

# "Why Our Proteins Have to Die So We Shall Live: An Overview of the Ubiquitin Proteolytic System" by Professor Aaron Ciechanover



**Professor Aaron Ciechanover**, Nobel Laureate in Chemistry, 2004, Technion-Israel Institute of Technology, was invited to give a public lecture at Lecture Theatre 29, SS2-B1-15, NTU on 5 February 2007.

Translation of the genetic code to proteins was a main focus of biological research before the 1980s. How proteins are removed had remained a neglected area of research. With the discovery of the lysosome, it was suggested that cellular proteins are degraded within this organelle. Yet, a growing body of experimental evidence had strongly suggested that intracellular proteolysis is largely non-lysosomal. However, the mechanism(s) involved had remained obscure.

The discovery of the modification of protein substrates by ubiquitin as a degradation signal by Prof. Ciechanover, Hershko and Rose, has resolved the enigma. It leads to the important understanding that regulated proteolysis is a major pathway involved in controlling a broad array of cellular processes such as cell cycle and division, apoptosis, transcription, antigen presentation, signal transduction, receptor-mediated endocytosis, quality control, and modulation of diverse metabolic pathways. This development transformed intracellular proteolysis from a neglected process and research area into a major player in modern biology. The scope of the ubiquitin system has since been broadened beyond proteolysis, and we now know that modification by ubiquitin and ubiquitin-like proteins serve many non-proteolytic functions as well. Not surprisingly, aberrations in the system have been implicated in the pathogenesis of many diseases, including certain malignancies, neurodegenerative

disorders, and pathologies of the inflammatory and immune response among them.

In the ubiquitin system, the various target substrates are modified by ubiquitin or a ubiquitin-like protein. This modification remodels their surface, affecting, among other properties, their stability, interactions with other proteins, activity, and subcellular localization. At least ten different modifiers have been described in mammalian cells and conjugation of each of them to its target may result in a different biological effect. In many cases proteins are modified by multiple moieties of ubiquitin that generate a branched polyubiquitin chain. For most proteins, this modification leads to their degradation by the 26S proteasome. Yet, dependent on the character of the internal linkage between the ubiquitin moieties, it can also lead to other effects, such as activation of transcriptional regulators.

Modification by a single moiety of ubiquitin can target proteins for degradation in the lysosome/vacuole.



Conjugation of ubiquitin or ubiquitin-like proteins can serve a variety of non-proteolytic functions, such as modulation of

membrane dynamics, or routing of the tagged proteins to their sub-cellular destination. Ubiquitination is a highly complex, temporally controlled, and tightly regulated process that targets numerous cellular proteins in a specific manner. It is carried out by a modular cascade of enzymes with high specificity towards defined structural motifs in the target proteins. Further understanding of the mechanisms of ubiquitination and degradation is important for the development of highly specific mechanism-based drugs.

Shuyan Xu

## International Workshop on New Trends in Biomolecular Modeling: from Protein Folding to DNA Compaction



**Professor Kerson Huang**, Emeritus Professor of Physics, Massachusetts Institute of Technology, conducted a workshop titled “New Trends in Biomolecular Modeling: from Protein Folding to DNA Compaction” on 15 and 16 March 2007 at NEC Lecture Room 1. Several other researchers working in related fields from China and Singapore were also invited to speak during the workshop. They included Zhongcan Ouyang (Chinese Academy of Science, Institute of Theoretical Physics, China), Pik-Yin Lai (National Central University, Taiwan), Jin-Zhi Lei and Wei-Tao Sun (Tsinghua University, China), Lock-Yue Chew (NTU), Yuguang Mu (NTU), Lars Nordenskiöld (NTU), Jagath C. Rajapakse (NTU), Yuan-Ping Feng (NUS), Xiang-Yang Liu (NUS), Jianxing Song (NUS), and Neil Clarke (Genome Institute of Singapore).

There were energetic discussions on a wide range of recent developments in protein folding and DNA properties, such as dynamics of protein folding, DNA compaction, and objective assessment of protein structure prediction. A round-table discussion was held at the end of the workshop, where regional collaboration between China, Taiwan, Singapore and other countries

are proposed. Topics on encouraging physics and engineering students into biophysics research are also discussed. This workshop received more than 40 registrations, mainly from NTU and NUS, including a large proportion of graduate students.

Ricky Ang L. K.

## 1<sup>st</sup> International Workshop on “Plasma Applications in Nanofabrication and Photovoltaic Solar Cells” - PANPSC2007

**A two-day international workshop** titled “Plasma Applications In Nanofabrication And Photovoltaic Solar Cells” (PANPSC2007) was held at the Nanyang Executive Centre from 5 - 6 July 2007.

PANPSC2007 was jointly organized by the Institute of Advanced Studies and National Institute of Education, Nanyang Technological University, Singapore, and The University of Sydney, Australia. About 60 local and overseas researchers and academics attended this workshop. The guest speaker of the workshop was Professor Claude Cohen-Tannoudji, Nobel Laureate in Physics, 1997. He delivered a talk on “Measuring Time – Atomic Clocks and Ultracold Atoms”.

Professor Claude Cohen-Tannoudji,  
Nobel Laureate in Physics, 1997.



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PANPSC2007 focused on the major aspects of plasma applications in nanofabrication. In particular, the physics and applications of plasma systems for the fabrication and processing of nanostructured materials and high-efficiency thin-film photovoltaic solar cells were discussed. PANPSC2007 was an effort to demonstrate the major advance in plasma applications in the area of renewable photovoltaic energy generation. It described the current methods used and the plasma-based tools that are used to achieve the as-yet-elusive goal of deterministic nanoassembly in nanoscale manufacturing.

The keynote lecture for this event was delivered by Professor A. Aberle, School of Photovoltaic and Renewable Energy Engineering University of New South Wales, Australia. Professor Aberle is also a renowned

expert in thin film solar cell. The workshop was concluded with a special round table discussion involving distinguished speakers, academics and staff from NUS, NTU, NIE, A\*STAR and EDB.



Professor A. Aberle,  
University of New  
South Wales,  
Australia

## IAS Publications

Q. J. Cheng, S. Xu\*, J. D. Long, K. K. Ostrikov  
*Deterministic plasma-aided synthesis of high-quality nanoislanded nc-SiC films.* Applied Physics Letters 2007, **90**, 173112

Q. J. Cheng, J. D. Long, and S. Xu\*  
*Growth dynamics and characterization of SiC quantum dots synthesized by low-frequency inductively coupled plasma assisted rf magnetron sputtering.* Journal Of Applied Physics 2007, **101**, 094304

Y. P. Ren, J. D. Long, S. Xu\*  
*Transition radiation energy loss in inductively coupled argon plasma.* Physics of Plasmas 2007, **14**, 073301

E. S. Ong, M. Y. Heng, S. N. Tan, Jean W. H. Yong\*, H. J. Koh, C. C. Teo, C. S. Hew\*  
*Determination of gastrodin and vanillyl alcohol in Gastrodia elata Blume by pressurized liquid extraction at room temperature.* Journal of Separation Science 2007, **30**, 2130 – 2137

B. C. Low†  
*Dense Formation of Electric Current Sheets.* Journal of Physics of Plasmas (in press)

\* IAS Fellow / Staff

† IAS Visiting Scientist

## IAS Staff & Fellows

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National University of Singapore

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NTU

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Assistant Professor Jean, Wan-Hong Yong  
National Institute of Education, NTU

**Kerson Huang (MIT)**

**Professor Kerson Huang**, Professor of Physics Emeritus, Massachusetts Institute of Technology, visited IAS from 8 March 2007 to 7 May 2007.

Other than conducting the workshop on “New Trends in Biomolecular Modeling: from Protein Folding to DNA Compaction” and interacting with the CN Yang scholars, he also visited several other secondary schools and junior college to interact with teachers and students, and

to give talks on “How to learn Science” and “Science and Civilization”. These schools include Hwa Chong Institution, River Valley High School, Pioneer Junior College and Foon Yew High School at Johor Bahru, Malaysia. During his 2 month long visit, Professor Huang also collaborated with Dr Lock-Yue Chew in research relating to protein folding.

**Da-Hsuan Feng (UT-Dallas)**

**Professor Da-Hsuan Feng**, Vice President of The University of Texas at Dallas, came to Singapore as IAS visitor from 1-4 April. Other than giving a talk at River Valley High School, he also visited Confucius Institute, NTU at one-north for possible collaborations with Confucius at Institute-UT Dallas. He also met with NTU President, Professor Guaning Su, and NIE Director, Professor



Sing-Kong Lee. There exist the possible exchange collaboration between C. N.

Yang Scholars Program at NTU and Eugene McDermott Scholars Program at UT Dallas.

**Philip Hall (Imperial College)**

**Professor Philip Hall**, Founding Director of the Institute for Mathematical Sciences (IMS) at Imperial College London, visited the Institute of Advanced Studies at NTU on April 24 and 25, 2007. The IMS, founded in 2003, aims to bring together mathematicians and other scientists and engineers who tackle problems requiring significant mathematical input. It runs several research programs covering topics such as: turbulence, multiscale dynamics of biosystems, mathematics of banking and finance, etc. Each program comprises a team leader, academics from Imperial College as well as visiting academics from other institutions, and some post-doctoral fellows and PhD students.

Professor Hall previously served as the Head of the Department of Mathematics at Imperial College. After

obtaining his PhD from Imperial College in 1973, he was a faculty member at Imperial till 1985, when he became Professor at Exeter University. In 1990, he assumed the Beyer Chair at Manchester University, before returning to Imperial College in 1996 as Professor.

During his visit, Professor Hall met with Professor Phua, Director of IAS, together with some other members of the IAS, to explore future collaborations between the two institutes. An accomplished applied mathematician, Professor Hall also delivered a lecture, titled “Hydrodynamics Instability Theory and River Dynamics”, during his visit. The talk was followed by an enthusiastic discussion with some members of the audience.

### C. N. Yang Scholars meet eminent scientists

**The C. N. Yang Scholars Program** is a premier undergraduate program at Nanyang Technological University for exceptional science and engineering students. The program is named in honour of Professor CN Yang, Nobel Laureate in Physics (1957) who is often regarded as one of the greatest scientist in the world. One of the objectives of the program is to empower students to delve deeper into any discipline in science, technology, engineering and mathematics, and to develop a keen interest in forefront research. The Institute of Advanced Studies organizes regular interaction sessions for the C. N. Yang Scholars to meet eminent visiting scientists and other renowned people in various industries. The reports in this section are written by scholars who attended these meetings.

#### Professor Boon-Chye Low on “Science and Scientific Methods as I have come to know”



What could draw a crowd of more than thirty students from Nanyang Technological University (NTU) to Lecture Room 6 in Nanyang Executive Centre on a late Wednesday afternoon? It was no ordinary lecture or tutorial class. These students with a passion for science were attracted to attend an inspiring seminar given by Professor B. C. Low on 21 March 2007.

Professor Low is a senior scientist from the High Altitude Observatory of the National Center for Atmospheric Research, Boulder Colorado, USA. His expertise is in extra-terrestrial and atmospheric physical phenomena. Armed with a wealth of experience in research and scientific reading, Professor Low was in NTU at the invitation by the Institute of Advanced Studies to give a talk on science and scientific methods. His audience was a group of students majoring in Physics and Applied Physics as well as scholars under the C. N. Yang Scholars Programme.

The seminar literally opened with a bang, as a short video on solar flares was screened. Through interesting and mind-stimulating questions about the fundamental concept of nature, Professor Low proceeded to share his personal views on the philosophy of science. Drawing examples from the historic milestones of physics, biology and mathematics, he gave fresh and alternative perspectives to the basis for science and scientific research. Professor Low also shared with the audience his personal experience of being an aspiring researcher in his younger days. In doing so, he stressed the beauty and importance of language in the scientific arena.

The engaging and interactive style of the seminar captivated the audience and refueled their passion for research. The audience was so excited that even our professors from NTU, who took the opportunity to sit in the hour-long seminar, joined in the sharing of research experiences. Each view point raised by students and professors was unique, and every experience shared was valuable.

“Professor Low’s talk was a real eye-opener and it gave us useful insight into the life of a researcher,” commented Cheryl Seow, a first-year student majoring in Physics. Jillian Pakiam, a first-year student majoring in Biological Sciences, also added, “He (Professor Low) did not just talk about developments in science, but he went into the very fundamentals that can be applied across all scientific disciplines.”

The seminar was indeed a fruitful one. The mind-stimulating perspectives on the philosophy of science have broadened the horizons for the young audience. The real-life research experiences shared will continue to inspire them and boost their passion for science.



Chee-Yuen Wan  
Chemical and Biomolecular Engineering  
C. N. Yang Scholars Program

## Professor Kerson Huang on “Science and Civilization”

**Professor Kerson Huang**, Emeritus Professor of Physics, recently visited NTU’s Nanyang Executive Centre to deliver a seminar on science and culture, and how the two were inter-related.

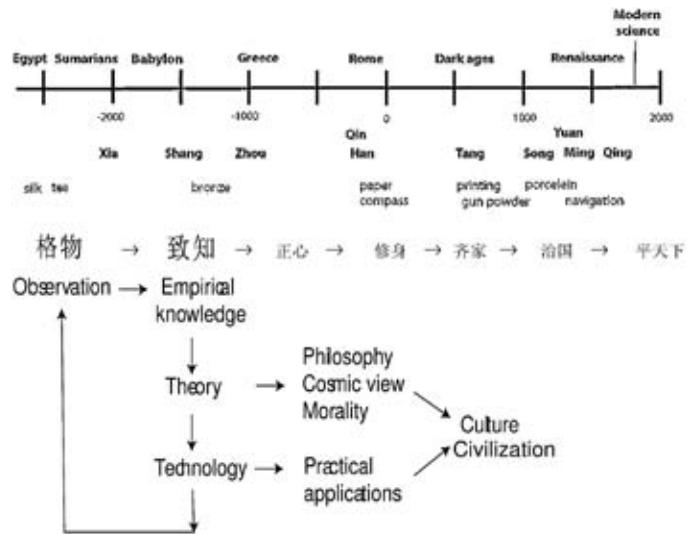
Professor Huang retired from active teaching in 1999. He is a Fellow of the American Physical Society and the American Academy of Arts and Sciences. His notable works include an English translation of the I Ching and a translation of the Rubaiyat of Omar Khayyam into Chinese classical quantrains.



All who attended the interaction seminar were captivated as Professor Huang’s presentation shed light on the cultural thinking of the Westerners and Chinese, how they were different, and how this led to the technological gap between these two civilisations.

His interesting insights, no doubt gleaned from his experiences on mainland China and in the United States, piqued much interest from his avid listeners as he richly coloured his presentation with examples. For instance, he highlighted the story of Zheng He’s worldly travels, and how he returned only with gifts from the lands he explored. In comparison, comparable Western trips such as that of Christopher Columbus resulted in discoveries of and expansion into new lands. The Chinese interest in spreading their cultural influence and learning about other cultures contrasts starkly with the Western interest in colonization and conquering of newly discovered lands.

He went on to elaborate on how the Chinese, invaded by various foreign powers after her unification, managed to continually integrate their thinking and practices



into its own culture, and hence felt no urgent need for technological development. In contrast, Western history was rife with lots of conflict and civil fighting, spurred by an intolerance for alternative ways of thinking. This created a continual need for more power and hence, better technology in order to suppress opposition. This need, together with the influence of the Renaissance age, spurred rapid scientific and technological development in the West.

He also compared Chinese and Western ways of thinking; while the Chinese explained observed occurrences with mythology and tales, the Westerners sought scientific and factual explanations to these occurrences, thus spurring the development of science and technology. This was summed up with a tongue-in-cheek example: the Chinese dragon is always seen with its feet and claws hidden in clouds; its mode of flight is unknown. The Western dragon, on the other hand, is always pictured with wings as an attempt to explain its flight.

There is no doubt that the seminar has been a very interesting and thought-provoking one, and all who have attended will walk away with a greater awareness of how a civilisation’s culture and thinking affects its pursuit and advancement of science.

Jun-Siang Ng  
Aerospace Engineering  
C. N. Yang Scholars Program

### Short Course

“Quantum Physics in Modern Technology” (EEE9009)  
Professor Ngee-Pong Chang  
Nanyang Professor, NTU and  
Professor of Physics, City  
College of New York, CUNY

### Visiting Scientists

Professor Kostya Ostrikov  
Professor of Physics  
University of Sydney, Australia

Professor Lay-Nam Chang  
Dean, College of Science  
Virginia Polytechnic, Institute  
and State University

Professor David Kiang  
Professor of Physics  
The Chinese University of  
Hong Kong

As a tribute to Professor C. N. Yang on the occasion of his 85<sup>th</sup> birthday and to celebrate his pioneering contributions in Physics, a conference covering a wide range of topics will be held in Singapore from 31<sup>st</sup> October to 3<sup>rd</sup> November 2007. Distinguished scientists from around the world, including several Nobel Laureates will join Professor Yang to celebrate his birthday with a festival of lectures.

CONFERENCE IN HONOR OF  
CN YANG'S 85<sup>TH</sup> BIRTHDAY  
庆祝杨振宁教授八十五华诞学术会议

31 October – 3 November 2007, Swissotel Merchant Court, Singapore

**Invited Speakers include:**

**Paul CHU**  
Hong Kong University of Science and Technology, Hong Kong

**Ignacio CIRAC**  
Max-Planck-Institute of Quantum Optics, Garching

**Claude COHEN-TANNOUDJI**  
Nobel Laureate in Physics, 1997

**Tohru EGUCHI**  
Kyoto University, Kyoto

**Ludwig FADDEEV**  
Russian Academy of Sciences, St Petersburg

**Michael E. FISHER**  
University of Maryland, College Park

**Martin L. PERL**  
Nobel Laureate in Physics, 1995

**David THOULESS**  
University of Washington, Seattle

**Samuel C. C. TING**  
Nobel Laureate in Physics, 1976 (attendance to be confirmed)

**YANG Chen Ning**  
Nobel Laureate in Physics, 1957

**Andrew YAO**  
Princeton University, Princeton and Tsinghua University, Beijing

**Anthony ZEE**  
University of California, Santa Barbara

**ZHANG Soucheng**  
Stanford University, Stanford  
and Others

**Statistical Physics,  
High Energy,  
Condensed Matter and  
Mathematical Physics**

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