Message from the Vice-Chancellor,
University of Malaya

Assalammualaikum Warahmatullahi Wabarakatuh and Greetings.

With great delight, I welcome everyone especially our international participants to the 5th International Meeting on Frontiers of Physics. I would like to wish you all "Selamat Datang ke Malaysia". My heartiest congratulations to the Malaysian Institute of Physics (IFM), the Department of Physics, University of Malaya and the Organizing Committee for making the 5th International Meeting on Frontiers of Physics 2017 (IMFP2017) a reality. I understand it has been nearly 20 years since the first IMFP was organized in 1998 by the Malaysian Institute of Physics and Department of Physics, University of Malaya.

It is well-know that the Department of Physics, University of Malaya has always aimed to help promote the highest quality of physics research and learning at University of Malaya and Malaysia. The conference will bring together a mixture of leading experts (international and local) that will lead to discussion on the development of frontiers in physics between physicists in this region. I understand that besides the Plenary Speakers Sessions, the scientific programme of the IMFP2017, incorporates the unique feature of Special Sessions, each with a specific interest. These topics were chosen to reflect forefront research areas.

In the last three decades, we have seen the great development in science and technology in Asian countries like Japan, Korea, Taiwan, China and India. These nations were able to take advantage of the scientific knowledge acquired through basic science research to propel the nations into strong economic powers in Asia. In Malaysia, we must also strive in this direction, developing basic scientific research to achieve sustainable economic progress. Thus, the building up of a strong pool of expertise with strengths in basic sciences such as physics should be a major priority. Of course the most important quantum leap for Malaysian physicists is to go forward in innovation and lead Malaysia beyond 2050!

Recently, University of Malaya and other research universities were given a significant amount of funding in 2018 by the Government of Malaysia to provide the most needed impetus in scientific and technological research. Thus I hope some positive intellectual interactions and mutually beneficial collaborations will emerge from this meeting that will facilitate the materialization of these goals.

I would like to thank all of you for your invaluable contributions and participation in this conference. I am certain with the overwhelming support shown by all physicists in Malaysia, and our friends and colleagues from overseas, the IMFP2017 will be a major success in all fronts.

Thank you.

DATUK IR (DR) ABDUL RAHIM HASHIM
Vice-Chancellor

Message from IMFP2017 Chairman,
University of Malaya


On behalf of the Institut Fizik Malaysia (IFM), we extend our warmest welcome to all participants, ***"Selamat Datang".***

The International Meeting on Frontiers of Physics 2017 (IMFP2017) is a major milestone for IFM and the Department of Physics as it has been just over two decades since we organised the 1st IMFP in 1998. It has been a wonderful strategic relationship between IFM and UM and other universities in Malaysia.

Your presence here today marks and signifies the success of the IMFP series as well as celebrate this milestone for the Institute. It is always good to see some familiar faces among the participants. It reflects the long network relationship that IMFP series has nurtured.

It has been a tough year in organising the IMFP2017 under the gloomy scenario of economic challenges worldwide and in Malaysia. But the IFM Council unanimously agreed that the IMFP series must be continued in 2017 amidst the financial situation.

In that respect, we thank the Asia-Pacific Centre for Theoretical Physics for their generous grant, the Academy of Sciences Malaysia and K. I. S. M. Sdn Bhd for their continuous financial support.

We are delighted that about 110 participants from Malaysia as well as from more than 10 countries such as Australia, China, India, Japan, Korea, Morocco, Nepal, Philippines, Taiwan, Thailand and United Kingdom are present. In that respect, we are grateful to the endorsement of IMFP2017 by the Association of Asia-Pacific Physical Societies (AAPPS) and its Divisions- Division of Astrophysics, Cosmology, Gravity (DACG), Division of Nuclear Physics (ANPhA) and the Division of Plasma Physics (DPP).

The IMFP2017 was organised to bring in a mix of physicists from various branches of physics and highlight the frontiers of physics to Malaysian physicists. Our introduction of Special Parallel Sessions during the IMFP2017 has attracted leading physicists in Astronomy & Astrophysics, Biological & Medical Physics, Condensed Matter & Material Physics, Exotic Atomic, Molecular & Optical Physics, Complex Systems & Multidisciplinary Physics, Nuclear Physics & Radiation, Particle Physics & Fields, Plasma Physics, and Statistical Physics. There are more than 90 contributed papers and challenging 3 days of conference ahead for all of us! We hope there will be more interaction and networking among the physicists from this conference.

Finally, we thank the Vice-Chancellor, Datuk Ir (Dr) Abdul Rahim Hashim for gracing the opening ceremony during the conference dinner. The support of University of Malaya must be acknowledged as well as the various advertisers.

Thank you.

Prof Dr. Kurunathan Ratnavelu Prof. Dr. Hasan Abu Kassim

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Acknowledgement

The Local Organizing Committee thank the following for their kind support:
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IMFP2017 Scientific Programme Summary

	3th December 2017
14.30-17.30	IMFP2017 REGISTRATION @ Pullman Kuala Lumpur Bangsar

DAY 1	**4th December 2017**		
	PLENARY SESSION		
8.45-9.00	Welcoming Address		
9.00-9.40	**PLENARY 1:** Seungwan Kim		
9.40-10.20	**PLENARY 2:** Takaya Ohashi		
10.20-10.40	**PHOTO SESSION & TEA-BREAK**		
10.40-11.20	**PLENARY 3:** Aimin Song		
11.20-12.00	**PLENARY 4:** Kazuhiro Tanaka		
12.00-12.30	**KEYNOTE:** Woo-Sung Jung		
12.30-14.00	**LUNCH**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS1 Nuclear Physics & Radiation A (NR-A)	SS2 Plasma Physics A (PP-A)	SS3 Condensed Matter & Material Physics A (CM-A)
14.00-14.20	**NR-A1:** W. P. Liu	**PP-A1:** Rattachat Mongkolnavin	**CM-A1:** Masaaki Tanaka
14.20-14.40	**NR-A2:** Tohru Motobayashi	**PP-A2:** Mehdi Nasri Nasrabadi	**CM-A2:** Ahmad Nazrul Rosli
14.40-15.00	**NR-A3:** Leo Kwee Wah	**PP-A3:** Lim Mook Tzeng	**CM-A3:** Eduardo C. Cuansing
15.00-15.20	**NR-A4:** Nurhafiza Mohamad Nor	**PP-A4:** Mohd Faiz Bin Mohd Zin	**CM-A4:** Tarika K. Patel
15.20-15.40	**NR-A5:** V. Dehghani	**PP-A5:** Lau Yen Theng	
15.40-16.00	**TEA-BREAK**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS4 Nuclear Physics & Radiation B (NR-B)	SS5 Exotic AMO Physics A (EA-A)	SS6 Biological & Medical Physics A (BM-A)
16.00-16.20	**NR-B1:** Li Hau-Bin	**EA-A1:** Darryl B. Jones	**BM-A1:** Kwan Hoong Ng
16.20-16.40	**NR-B2:** Ong Hooi Jin	**EA-A2:** Masahiko Takahashi	**BM-A2:** Marco Petasecca
16.40-17.00	**NR-B3:** Muhammad Husamuddin Abdul Khalil	**EA-A3:** M. Z. M. Kamali	**BM-A3:** Cheah Ying Ying
17.00-17.20	**NR-B4:** Susan Sipaun		**BM-A4:** Nazifah bt Abdullah

DAY 2	**5th December 2017**		
	PLENARY SESSION		
9.00-9.40	**PLENARY 5:** YoungPak Lee		
9.40-10.20	**PLENARY 6:** Jun'ichi Yokoyama		
10.20-10.40	**TEA-BREAK**		
10.40-11.20	**PLENARY 7:** Geoffrey Taylor		
11.20-12.00	**PLENARY 8:** Gui-Lu Long		
12.00-12.40	**PLENARY 9:** Rui-Qin Zhang		
12.40-14.00	**LUNCH**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS7 Statistical Physics A (SP-A)	SS8 Exotic AMO Physics B (EA-B)	SS9 Condensed Matter & Material Physics B (CM-B)
14.00-14.20	**SP-A1:** Tay Buang Ann	**EA-B1:** Arijit Ghoshal	**CM-B1:** Xing Zhu
14.20-14.40	**SP-A2:** Nasir	**EA-B2:** Isao Nakajima	**CM-B2:** Christopher G.

	Ganikhodjaev		Jesudason
14.40-15.00	**SP-A3:** Mark Nolan P Confesor	**EA-B3:** Kurunathan Ratnavelu	**CM-B3:** Bhagwati Prasad
15.00-15.20	**SP-A4:** Chew Wei Xiang	**EA-B4:** Sabyasachi Kar	**CM-B4:** Konstantin Zloshchastiev
15.20-15.40	**TEA-BREAK**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS10 Nuclear Physics & Radiation C (NR-C)	SS11 Particle Physics & Fields A (PF-A)	SS12 Biological & Medical Physics B (BM-B)
15.40-16.00	**NR-C1:** S. C. Jeong	**PF-A1:** Chia Swee Ping	**BM-B1:** Lim Siew Yong
16.00-16.20	**NR-C2:** Siti Aiasah Hashim	**PF-A2:** Parada T. P. Hutauruk	**BM-B2:** Mohd Hafiz Mohd Zin
16.20-16.40	**NR-C3:** Nor Anita Rezle	**PF-A3:** Mohammed Abdulmalek Abdulraheem Ahmed	**BM-B3:** Wong Yin How
16.40-17.00	**NR-C4:** S. A. Alavi	**PF-A4:** Zhu Dan	
17.00-19.30	**Free time**		
19.30-22.30	**OPENING CEREMONY & CONFERENCE DINNER**		

DAY 3	**6th December 2017**		
	PLENARY SESSION		
8.30-9.10	**PLENARY 10:** Pak Ming Hui		
9.10-9.50	**PLENARY 11:** James Sullivan		
9.50-10.30	**PLENARY 12:** Fu-Jen Kao		
10.30-11.10	**TEA-BREAK**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS13 Statistical Physics B (SP-B)	SS14 Condensed Matter & Material Physics (CM-C)	SS15 Complex Systems & Multidisciplinary A (CS-A)
11.10-11.30	**SP-B1:** Satya N. V. Arjunan	**CM-C1:** Shuping Huang	**CS-A1:** Zuo-Bing Wu
11.30-11.50	**SP-B2:** Pik-Yin Lai	**CM-C2:** Nurul Najla Binti Samsun Baharun	**CS-A2:** Sugendran Palanisamy
11.50-12.10	**SP-B3:** Charlene Sue P Caumeran	**CM-C3:** Noor Syuhada Binti Zakuan	**CS-A3:** Zurita Ismail
12.10-12.30	**SP-B4:** Rosario L. Reserva	**CM-C4:** Yap Chi Chin	**CS-A4:** M. Kalpana
12.30-14.00	**LUNCH**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	**ROOM 3**
	SS16 Particle Physics & Fields B (PF-B)	SS17 Condensed Matter & Material Physics D (CM-D)	SS18 Complex Systems & Multidisciplinary B (CS-B)
14.00-14.20	**PF-B1:** Mohd Faudzi Umar	**CM-D1:** Tan Winie	**CS-B1:** Editha P. Jacosalem
14.20-14.40	**PF-B2:** Timothy Tie Dong Bing	**CM-D2:** Khadijah Hilmun Kamarudin	**CS-B2:** Ezzaeri Kabira
14.40-15.00	**PF-B3:** Ganesh A/L Subramaniam	**CM-D3:** Ngai Koh Sing	**CS-B3:** Jegenathan Krishnasamy
15.00-15.20		**CM-D4:** Zarina Aspanut	**CS-B4:** Sheila Gueroben-Gonzales
15.20-15.40	**TEA-BREAK**		
	PARALLEL SPECIAL SESSIONS		
	ROOM 1	**ROOM 2**	
	SS19 Plasma Physics B (PP-B)	SS20 Astronomy & Astrophysics (AA)	
15.40-16.00	**PP-B1:** C.S. Wong	**AA-1**: Hasan Abu Kassim	

16.00-16.20	**PP-B2:** Siddhartha Sankar Kausik	**AA-2:** Muhamad Akram Zaki Bin Roslan	
16.20-16.40	**PP-B3:** Deepak Subedi	**AA-3:** Muhamad Syazwan Faid	
16.40-17.00		**AA-4:** Adlyka Annuar	
17.00-17.20	**Closing Remarks**		

Day 4	**7th December 2017**
8.30 -12.00	FREE DAY / DEPARTURE FROM Pullman Kuala Lumpur Bangsar

IMFP2017 Scientific Programme Schedule

3th December 2017

14.30-17.30 REGISTRATION@Pullman Bangsar Kuala Lumpur

DAY 1 4th December 2017

8.45-9.00 **Welcoming Address**

PLENARY SESSION

9.00-9.40	**PLENARY 1: Seungwan Kim** (Pohang University of Science and Technology) *Quest for Neural Correlates of Consciousness*
9.40-10.20	**PLENARY 2: Takaya Ohashi** (Tokyo Metropolitan University) *X-Ray Study of Cosmic Plasmas: Present and Future*
10.20-10.40	**PHOTO SESSION & TEA-BREAK**
10.40-11.20	**PLENARY 3: Aimin Song** (University of Manchester) *Ultra-Fast Electron Transport in Graphene*
11.20-12.00	**PLENARY 4: Kazuhiro Tanaka** (KEK & Asian Nuclear Physics Association) *Major Accelerator Facilities for Nuclear Physics in Asia Pacific*
12.00-12.30	**KEYNOTE: Woo-Sung Jung** (Pohang University of Science and Technology) *New Horizons in Asia Pacific Physics Community*
12.30-14.00	**LUNCH**

PARALLEL SPECIAL SESSIONS

14.00-15.50	**SS1 Nuclear Physics & Radiation A (NR-A)**	**ROOM 1**
14.00-14.20	**W. P. Liu** (China Institute of Atomic Energy) *Progress of nuclear astrophysics project in China and underground project JUNA*	Invited NR-A1
14.20-14.40	**Tohru Motobayashi** (RIKEN Nishina Center) *Riken RI beam factory (RIBF)*	Invited NR-A2
14.40-15.00	**Leo Kwee Wah** (Malaysian Nuclear Agency) *Next generation of hadron driver for cancer therapy*	Contributed NR-A3
15.00-15.20	**Nurhafiza Mohamad Nor** (Universiti Teknologi Malaysia) *Band-head spectra of rare-earth nuclei within a self-consistent blocking approach*	Contributed NR-A4
15.20-15.40	**V. Dehghani** (University of Sistan and Baluchestan) *Thermal properties of superheavy nuclei with temperature-dependent pairing energy*	Contributed NR-A5

14.00-15.40	**SS2 Plasma Physics A (PP-A)**	**ROOM 2**
14.00-14.20	**Rattachat Mongkolnavin** (Chulalongkorn University) *Electric field effect on electric probe operating in plasma focus device*	Invited PP-A1
14.20-14.40	**Mehdi Nasri Nasrabadi** (University of Isfahan) *Effect of various parameters on reflection, transmission, and absorption coefficients in an inhomogeneous plasma slab*	Invited PP-A2
14.40-15.00	**Lim Mook Tzeng** (TNB Research Sdn. Bhd) *Non-thermal plasma research areas in TNB Research Sdn. Bhd*	Invited PP-A3

15.00-15.20	**Mohd Faiz Bin Mohd Zin** (Malaysian Nuclear Agency) *Variations of the neutron yield in Malaysian Nuclear Agency plasma focus (MNA-PF) operating in deuterium-argon mixture*	Contributed PP-A4
15.20-15.40	**Lau Yen Theng** (University of Malaya) *50 Hz argon plasma treatment on polystyrene surface*	Contributed PP-A5

14.00-15.40	**SS3 Condensed Matter & Material Physics A (CM-A)**	**ROOM 3**
14.00-14.20	**Masaaki Tanaka** (University of Tokyo) *Recent progress and topics in semiconductor spintronics and ferromagnetic semiconductors*	Invited CM-A1
14.20-14.40	**Ahmad Nazrul Rosli** (Universiti Sains Islam Malaysia) *Determination of the structural and electronic properties of Si_nGe_m (n=1,2,3 & m=1,2,3) clusters by first principle approach*	Contributed CM-A2
14.40-15.00	**Eduardo C. Cuansing** (University of the Philippines) *Quantum transport in nanojunctions with time-varying components*	Contributed CM-A3
15.00-15.20	**Tarika K. Patel** (Gujarat University) *Effect of thickness of filler layer in thermal transport through 1D sandwich structure*	Contributed CM-A4

15.40-16.00	**TEA-BREAK**

PARALLEL SPECIAL SESSIONS

16.00-17.20	**SS4 Nuclear Physics & Radiation B (NR-B)**	**ROOM 1**
16.00-16.20	**Li Hau-Bin** (Academia Sinica) *Neutrino physics with the TEXONO Program at the Kuo-Sheng Reactor Neutrino Laboratory*	Invited NR-B1
16.20-16.40	**Ong Hooi Jin** (Osaka University) *Probing structure of light atomic nuclei*	Invited NR-B2
16.40-17.00	**Muhammad Husamuddin Abdul Khalil** (Malaysian Nuclear Agency) *Measurement of fission products gamma spectra of reactor TRIGA PUSPATI's fuels*	Contributed NR-B3
17.00-17.20	**Susan Sipaun** (Malaysian Nuclear Agency) *Nuclear fuel rod simulator*	Contributed NR-B4

16.00-17.00	**SS5 Exotic Atomic, Molecular and Optical Physics A (EA-A)**	**ROOM 2**
16.00-16.20	**Darryl B. Jones** (Flinders University) *Electron scattering from technologically important molecules*	Invited EA-A1
16.20-16.40	**Masahiko Takahashi** (Tohoku University) *Towards vi4ualizing the driving principle of a chemical reaction by time-resolved high-energy impact spectroscopies*	Invited EA-A2
16.40-17.00	**MZM Kamali** (University of Malaya) *Rydberg transitions for positron-hydrogen collisions in Lorentzian astrophysical plasmas*	Contributed EA-A3

16.00-17.20	**SS6 Biological & Medical Physics A (BM-A)**	**ROOM 3**
16.00-16.20	**Kwan Hoong Ng** (University of Malaya) *From quantitative imaging to radiogenomics*	Invited BM-A1
16.20-16.40	**Marco Petasecca** (University of Wollongong) *Advanced dosimetry techniques: the experience at Centre for Medical Radiation Physics*	Invited BM-A2
16.40-17.00	**Cheah Ying Ying** (Asia Lab (Malaysia) Sdn. Bhd) *Characterisation of Al_2O_3:C optically stimulated luminescence dosimeter (OSLD) in low dose kilovoltage photon beams*	Contributed BM-A3
17.00-17.20	**Nazifah bt Abdullah** (Universiti Sultan Zainal Abidin) *Reducing scatter in Tc-99m myocardial spect imaging using physical filter*	Contributed BM-A4

DAY 2 — 5th December 2017

PLENARY SESSION

9.00-9.40	**PLENARY 5: YoungPak Lee** (Hanyang University) *Perfect Absorption and Electromagnetically-induced Transparency of Metamaterials*
9.40-10.20	**PLENARY 6: Jun'ichi Yokoyama** (University of Tokyo) *Approaches to Inflationary Cosmology*
10.20-10.40	**TEA-BREAK**
10.40-11.20	**PLENARY 7: Geoffrey Taylor** (University of Melbourne) *Future High Energy Particle Accelerators – Will The Asia Century Preside?*
11.20-12.00	**PLENARY 8: Gui-Lu Long** (Tsinghua University) *Quantum Secure Direct Communication*
12.00-12.40	**PLENARY 9: Rui-Qin Zhang** (City University of Hong Kong) *Electron Tunneling Lifetime in Atomic Systems, A Projected Green's Function Method*

12.40-14.00 LUNCH

PARALLEL SPECIAL SESSIONS

14.00-15.20	**SS7 Statistical Physics A (SP-A)**	**ROOM 1**
14.00-14.20	**Tay Buang Ann** (University of Nottingham Malaysia) *Generic Markovian master equation for a quantum oscillator and Its solutions*	Invited SP-A1
14.20-14.40	**Nasir Ganikhodjaev** (International Islamic University Malaysia) *Lattice models on Cayley tree with competing interaction*	Invited SP-A2
14.40-15.00	**Mark Nolan P Confesor** (MSU-Iligan Institute of Technology) *Active matter driven actuators: across length scales*	Invited SP-A3
15.00-15.20	**Chew Wei Xiang** (University of Malaya) *Simulating intracellular excluded volume effects at single molecule resolution with lattice-based approach*	Contributed SP-A4

14.00-15.20	**SS8 Exotic Atomic, Molecular and Optical Physics B (EA-B)**	**ROOM 2**
14.00-14.20	**Arijit Ghoshal** (Burdwan University) *Resonance in positronic lithium in plasmas*	Invited EA-B1
14.20-14.40	**Isao Nakajima** (Tohoku University) *On the range of validity of the plane wave impulse approximation picture for electron momentum spectroscopy*	Contributed EA-B2
14.40-15.00	**Kuru Ratnavelu** (University of Malaya) *Charge transfer in proton-hydrogen collisions under astrophysical plasmas*	Contributed EA-B3
15.00-15.20	**Sabyasachi Kar** (Harbin Institute of Technology) *Polarizability of exotic molecular ions in model plasma environments*	Invited EA-B4

14.00-15.20	**SS9 Condensed Matter & Material Physics B (CM-B)**	**ROOM 3**
14.00-14.20	**Xing Zhu** (Peking University) *Plasmonic nanostructure and devices*	Invited CM-B1
14.20-14.40	**Christopher G. Jesudason** (University of Malaya) *Steady state NEMD investigation of the energetics and temperature distribution of a 1-D lattice chain subjected to a temperature gradient*	Invited CM-B2

14.40-15.00	**Bhagwati Prasad** (Sardar Vallabhbhai National Institute of Technology) *Investigation of electronic and optical properties of GaSe monolayer using ab initio method*	Contributed CM-B3
15.00-15.20	**Konstantin Zloshchastiev** (Durban University of Technology) *Quantum-statistical phenomenon of sustainability and its manifestations in dissipative photonic systems*	Contributed CM-B4

15.20-15.40 **TEA-BREAK**

PARALLEL SPECIAL SESSIONS

15.40-17.00	**SS10 Nuclear Physics & Radiation C (NR-C)**	**ROOM 1**
15.40-16.00	**S. C. Jeong** (Institute of Basic Science, Korea) *Progress of rare isotope science project in Korea*	Invited NR-C1
16.00-16.20	**Siti Aiasah Hashim** (Malaysian Nuclear Agency) *Irradiation facilities at Nuclear Malaysia for industrial product development*	Invited NR-C2
16.20-16.40	**Nor Anita Rezle** (Universiti Teknologi Malaysia) *Effect of pairing correlations on band-head spectra of rare-earth nuclei within highly truncated diagonalization approach*	Contributed NR-C3
16.40-17.00	**S. A. Alavi** (University of Sistan and Baluchestan) *Effect of deformed surface diffuseness on fusion and alpha decay*	Contributed NR-C4

15.40-17.00	**SS11 Particle Physics & Fields A (PF-A)**	**ROOM 2**
15.40-16.00	**Chia Swee Ping** (University of Malaya) *Vertex function of gluon-photon penguin*	Invited PF-A1
16.00-16.20	**Parada T. P. Hutauruk** (Asia Pacific Center for Theoretical Physics) *Kaon structure in the chiral effective quark model*	Contributed PF-A2
16.20-16.40	**Mohammed Abdulmalek Abdulraheem Ahmed** (Universiti Putra Malaysia) *Effect of colour singlet on phase transition from hadronic gas to partonic plasma*	Contributed PF-A3
16.40-17.00	**Zhu Dan** (Universiti Sains Malaysia) *Bifurcation and transition of multiple charged one-plus-half monopole solutions of the SU(2) Yang-Mills-Higgs theory*	Contributed PF-A4

15.20-16.40	**SS12 Biological & Medical Physics B (BM-B)**	**ROOM 3**
15.40-16.00	**Lim Siew Yong** (Universiti Sains Malaysia) *Characterisation of fast time-of-flight cameras for optical surface tracking in advanced radiotherapy*	Contributed BM-B1
16.00-16.20	**Mohd Hafiz Mohd Zin** (Universiti Sains Malaysia) *Reduction of tumour target uncertainties using Image Guided Radiotherapy (IGRT): a review*	Contributed BM-B2
16.20-16.40	**Wong Yin How** (University of Malaya) *Computed Tomography-based thermometry for temperature mapping during percutaneous radiofrequency ablation: ex-vivo investigation*	Contributed BM-B3

19.30-22.30 **OPENING CEREMONY & CONFERENCE DINNER**

DAY 3 — 6th December 2017

PLENARY SESSION

8.30-9.10	**PLENARY 10: Pak Ming Hui** (Chinese University of Hong Kong) *Evolutionary Games and The Ising Model – When Two Fields Meet*
9.10-9.50	**PLENARY 11: James Sullivan** (Australian National University) *Fundamental and Applied Studies of Low Energy Positron Scattering*
9.50-10.30	**PLENARY 12: Fu-Jen Kao** (National Yang-Ming University) *Pump-Probe Microscopy With Stimulated Emission Modulation*

10.30-11.10 TEA-BREAK

PARALLEL SPECIAL SESSIONS

11.10-12.30	**SS13 Statistical Physics B (SP-B)**	**ROOM 1**
11.10-11.30	**Satya N. V. Arjunan** (RIKEN Quantitative Biology Center) *Biophysical modelling and simulation of complex molecular systems*	Invited SP-B1
11.30-11.50	**Pik-Yin Lai** (National Central University) *Irreversibility and entropy production in non-equilibrium systems*	Invited SP-B2
11.50-12.10	**Charlene Sue P Caumeran** (MSU-Iligan Institute of Technology) *Dynamics of Physarum Polycephalum powered mm-sized gear*	Contributed SP-B3
12.10-12.30	**Rosario L. Reserva** (MSU-Iligan Institute of Technology) *Electrotaxis of the Physarum polycephalum cells probed by traction force microscopy*	Contributed SP-B4

11.10-12.30	**SS14 Condensed Matter & Material Physics C (CM-C)**	**ROOM 2**
11.10-11.30	**Shuping Huang** (Fuzhou University) *Li_8MO_6: A cathode material for lithium ion batteries*	Invited CM-C1
11.30-11.50	**Nurul Najla Binti Samsun Baharun** (University of Malaya) *Preparation and studies of sodium-carboxymethylcellulose (CMC-Na) thin film polymer electrolyte*	Contributed CM-C2
11.50-12.10	**Noor Syuhada Binti Zakuan** (University of Malaya) *Tin-based Metal Oxide Li_2SnO_3 as an Anode Material for Lithium-Ion Batteries Synthesized via Hydrothermal Route*	Contributed CM-C3
12.10-12.30	**Yap Chi Chin** (Universiti Kebangsaan Malaysia) *Spin-coated Bi_2S_3 electron selective layer for inverted organic solar cell application*	Contributed CM-C4

11.10-12.30	**SS15 Complex Systems & Multidisciplinary Physics A (CS-A)**	**ROOM 3**
11.10-11.30	**Zuo-Bing Wu** (Chinese Academy of Science) *Recurrence distance distributions in the Synechocystis PCC6803 genome*	Invited CS-A1
11.30-11.50	**Sugendran Palanisamy** (University of Malaya) *Subthreshold Fluctuation Analysis of Excitatory and Inhibitory (E-I) Neural signals for pre-seizure prediction using 1D Wilson-Cowan formalism*	Contributed CS-A2
11.50-12.10	**Zurita Ismail** (Universiti Putra Malaysia) *Structure and evolution of UPM co-authorship network in journal publication from 2007-2010*	Contributed CS-A3
12.10-12.30	**M. Kalpana** (University of Malaya) *Audio encryption based on chaotic fuzzy cellular neural networks*	Contributed CS-A4

12.30-14.00 LUNCH

PARALLEL SPECIAL SESSIONS

14.00-15.00	**SS16 Particle Physics & Fields B (PF-B)**	**ROOM 1**
14.00-14.20	**Mohd Faudzi Umar** (Universiti Pendidikan Sultan Idris) *Two dimensional plane, modified symplectic structure and quantization*	Contributed PF-B1
14.20-14.40	**Timothy Tie Dong Bing** (Universiti Sains Malaysia) *Branching behavior of dyonic multi-monopole with multi-half monopole*	Contributed PF-B2
14.40-15.00	**Ganesh A/L Subramaniam** (University Putra Malaysia) *Killing tensor of five dimensional Melvin's spacetime*	Contributed PF-B3

14.00-15.20	**SS17 Condensed Matter & Material Physics D (CM-D)**	**ROOM 2**
14.00-14.20	**Tan Winie** (Universiti Teknologi MARA) *Chitosan for new generation energy device*	Invited CM-D1
14.20-14.40	**Khadijah Hilmun Kamarudin** (Universiti Malaysia Terengganu) *Enhanced ionic conductivity of CMC-Based solid polymer electrolytes by varying ethylene gycol concentration*	Contributed CM-D2
14.40-15.00	**Ngai Koh Sing** (University of Malaya) *Composite polymer electrolyte based on PAA and $LiBF_4$ doped with $BaTiO_3$: a novel material for energy devices*	Contributed CM-D3
15.00-15.20	**Zarina Aspanut** (University of Malaya) *Effect of substrate temperature on the growth of nickel silicide nanowires for electrochemical supercapacitor application*	Contributed CM-D4

14.00-15.20	**SS18 Complex Systems & Multidisciplinary Physics B (CS-B)**	**ROOM 3**
14.00-14.20	**Editha P. Jacosalem** (MSU-Iligan Institute of Technology) *Dynamics of the probe particle in flowing soap thin film*	Contributed CS-B1
14.20-14.40	**Ezzaeri Kabira** (Ibn Zohr University) *Experimental study of climate inside the greenhouse equipped with the photovoltaic panels*	Contributed CS-B2
14.40-15.00	**Jegenathan Krishnasamy** (University of Malaya) *Nucleic acid based back to back Schotty diode*	Contributed CS-B3
15.00-15.20	**Sheila Gueroben-Gonzales** (MSU-Iligan Institute of Technology) *Demonstration of anomalous diffusion of compressed gas through a semi-permeable membrane*	Contributed CS-B4

15.20-15.40 **TEA-BREAK**

PARALLEL SPECIAL SESSIONS

15.40-17.00	**SS19 Plasma Physics B (PP-B)**	**ROOM 3**
15.40-16.00	**C.S. Wong** (University of Malaya) *Cost effective non-thermal plasma devices*	Invited PP-B1
16.00-16.20	**Siddhartha Sankar Kausik** (Institute for Plasma Research Assam) *Cesiated tungsten dust in plasma volume: a new source of negative ion*	Invited PP-B2
16.20-16.40	**Deepak Subedi** (Kathmandu University) *Surface treatment of PET and PP by atmospheric pressure dielectric barrier discharge for improvement in hydrophilicity*	Invited PP-B3

15.40-16.40	**SS20 Astronomy & Astrophysics (AA)**	**ROOM 2**
15.40-16.00	**Hasan Abu Kassim** (University of Malaya) *Very massive stars and pair instability supernovae explosion*	Invited AA-1
16.00-16.20	**Muhamad Akram Zaki Bin Roslan** (Universiti Sains Malaysia) *Observation study of major solar flares*	Contributed AA-2
16.20-16.40	**Muhamad Syazwan Faid** (Universiti Teknologi Mara) *Semi empirical modelling of light polluted twilight sky brightness*	Contributed AA-3

16.40-17.00	**Adlyka Anuuar** (Durham University) *Towards a complete census of the hidden supermassive black hole population in our local universe*	Contributed AA-4

17.00-17.20	**Closing Remarks**

Day 4	**7th December 2017**
8.30 -12.00	FREE DAY / DEPARTURE FROM Pullman Bangsar Kuala Lumpur

KEYNOTE TALK

NEW HORIZONS IN ASIA PACIFIC PHYSICS COMMUNITY

Woo-Sung Jung
APCTP and Department of Physics, Pohang University of Science and Technology, Republic of Korea

Asia-Pacific Center for Theoretical Physics (APCTP), which was established in 1996 to be a leader in world physics research, to facilitate international collaboration, and to train young scientists in the Asia-Pacific region. The Center was relocated to the POSTECH campus in 2001. We celebrated the Center's 21st anniversary with 16 member countries this year. The Center now runs numerous research programs: Junior Research Group (JRG), which promotes young scientists in leadership roles; Young Scientist Training, which provides post-doctoral positions; and the Visitors Program, which allows short and long-term visits of researchers from across the Asia-Pacific region. AAPPS (Association of Asia Pacific Physical Societies) was officially established in 1989. The principal aim of AAPPS is to promote the advancement of knowledge in physics in the Asia Pacific region, through means including research, application and teaching, and especially through international collaboration in these activities in this region. APCTP plays a role as the administrative headquarters of AAPPS from 2016. It strengthens the APCTP-AAPPS cooperation and enriches our community's scientific activities.

PLENARY TALKS

QUEST FOR NEURAL CORRELATES OF CONSCIOUSNESS

Seunghwan Kim
Pohang University of Science and Technology,
Republic of Korea

People have long sought for answers to the perennial questions: How do I think? What is this "I" that seems to be doing the thinking? Where do I go when I fall asleep, dream and anesthetised? What is the consciousness? Until the 20th century, the question of consciousness laid outside the boundary of "normal" science, a fuzzy, ill-defined domain with the puzzling subjectivity outside the reach of scientific experimentation. Then in the late 80th, everything has changed. Now the scientific study of consciousness has emerged as a burgeoning interdisciplinary field in brain science, encompassing physics, cognitive science, neuroscience, psychology, philosophy, AI, and so on. The consciousness was selected as one of the top 25 questions by the science magazine on the occasion of its 125th Anniversary. It is also one of the top 10 unsolved problems chosen by physicists around the world according to the millennium survey by IOP. The study of the consciousness is now regarded by some as the holy grail of neuroscience, the search for the neural correlates of the consciousness in two pillars of research; the visual awareness and the general anesthesia. The key scientific questions here are how to specify and measure the contents of consciousness and how to understand the loss and emergence of the consciousness, which have both clinical and neuroscientific implications. In this lecture, we introduce the scientific study of the consciousness. In particular, we focus on the search for the neural correlates of the consciousness in general anesthesia, which we have been investigating for the last 10 years. The brain is considered to be one of the most complex systems in universe with a hierarchy of nodal units and a complex network structure with massive interconnections. Recent studies suggest that the consciousness does not reside in any one part of the complex brain and synthesis and integration of information among many different parts of the brain are essential for the formation and maintenance of consciousness. Therefore, we take the complex system approach to find the neural correlates to consciousness, in particular, the ability of the brain to integrate information as processed by multiple functional brain regions. The information biding capacity can be modelled and quantified using measures of nonlinear dynamics and complex systems. The application of the nonlinear method for measuring and monitoring intra-brain communication and integration is crucial for preventing operating-table awareness.

X-RAY STUDY OF COSMIC PLASMAS: PRESENT AND FUTURE

Takaya Ohashi
Department of Physics,
Tokyo Metropolitan University, Japan

X-ray spectroscopy is a powerful method to study cosmic plasmas. It has been recognized that a wide range of cosmic objects exhibit high-temperature plasmas with temperatures of one million to 100 million degrees, including galaxies and clusters of galaxies, supernova remnants, and surrounding regions of neutron stars and black holes. Spectral structures such as emission and absorption lines and edge features give us key information in characterizing the plasma properties: such as temperature, density, metallicity, and atomic processes in the system. The spectral information enables us to infer geometry and dynamics, and to estimate the evolution history of the plasma regions. Therefore, good energy resolution is crucial in advancing the sensitivity for such science. Technologies for spectral studies have been improving steadily, and energy resolution of X-ray instruments has improved from a few keV to a few eV (FWHM for a 6 keV line) in the past 30 years. Microcalorimeter technique is very promising for the X-ray spectroscopy, in which detectors operate at a very low temperature around 50 mK and give an energy resolution of 5 eV or better. The microcalorimeters can detect X-rays from extended objects, for which grating spectrometers have a problem because of the requirement of parallel beam incidence. Improvement in the energy resolution by a factor of 25 over conventional CCD instruments reveals new views of the Universe. Japan launched Hitomi satellite in February 2016 in collaboration with US, Europe and Canada. This mission carried microcalorimeters as the main instrument. The spacecraft lost its observing capability after about a month in the orbit, but very interesting data were obtained from the Perseus cluster of galaxies and a few other objects. I will describe Hitomi results and their implications. To recover the spectroscopy science of Hitomi, a recovery mission (XARM: X-ray Astronomy Recovery Mission) is under preparation with the expected launch year around 2021.

ULTRA-FAST ELECTRON TRANSPORT IN GRAPHENE

Gregory Auton[1,3], Jiawei Zhang[1], Hanbin Wang[2], Arun K. Singh[1], Ernie Hill[3], Aimin Song [1,2]
[1]*School of Electrical and Electronic Engineering, University of Manchester, Manchester, M13 9PL, United Kingdom*
[2] *Center of Nanoelectronics and School of Physics, Shandong University, Jinan, 250100, China*
[3]*Manchester Centre for Mesoscience and Nanotechnology, University of Manchester, Manchester, M13 9PL, United Kingdom*

Most effort on graphene electronic devices has so far focused on transistors by, e.g., generating a suitable bandgap in order to achieve a reasonable on/off ratio while preserving the carrier mobility. In contrast to transistors, the functionality of some diodes does not necessarily require a large bandgap. In particular, a nano-rectifier known as the ballistic rectifier can greatly benefit from the extremely long carrier mean-free-path in graphene. Here, we fabricate ballistic rectifier structures by creating an asymmetric cross-junction in a single-layer graphene sandwiched between two boron nitride flakes. A mobility of around 200,000 cm^2/Vs is achieved, ensuring a mean-free-path well beyond that required for the device to operate in the ballistic regime. This enables a very high intrinsic responsivity at room temperature. Taking advantage of the four-terminal device architecture in which the output channels are orthogonal to the input channels, we show that the device noise is hardly influenced by the input and is mainly limited by thermal noise, and this enables an exceptional noise-equivalent power in the order of $pW/Hz^{1/2}$. High-frequency characterisation and imaging experiments have also been carried out up to 640 GHz.

References

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MAJOR ACCELERATOR FACILITIES FOR NUCLEAR PHYSICS IN ASIA PACIFIC

Kazuhiro Tanaka
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Asian Nuclear Physics Association (ANPhA) is preparing a list of accelerators applicable for nuclear physics experiments in Asia Pacific region. Among them, characteristics of world class "Major" accelerator facilities will briefly be summarized in my talk in IMFP2017, in comparing to similar facilities in Europe and North America. Major facilities in Asia Pacific region are mainly locating in China (Heavy Ion Research Facility in Lanzhou (HIRFL), Beijing Tandem Accelerator National Laboratory (BTANL)), India (K500 Superconducting Cyclotron at Variable Energy Cyclotron Centre (VECC)), Korea (RISP/RAON), and Japan (RIBF at Riken, J-PARC, and ELPH/LIPS). Most of them (HIRFL, BTANL, VECC, RISP/RAON and RIBF) are medium energy heavy-ion accelerator facilities and are competing to European and American Facilities such as SPIRAL2, HIE-ISOLDE and ARIEL-II. In addition, future extension plans of these Asian facilities are really aiming far beyond the wave front of the research of this field of nuclear physics. In this meaning, Asian research facilities are keeping world best positions in medium energy heavy-ion physics. Hadron physics facility in Asia (J-PARC) is also world leading facility in the world. ELPH/LIPS facilities can provide world competitive photon beams. However, there are no high energy heavy-ion accelerators and colliders (such as ALICE in LHC, RHIC in USA, and NICA in Russia) in Asia Pacific region. In other word, we concentrated our research resources to medium energy heavy ion physics and chosen to promote high energy heavy-ion physics at abroad (outside Asia). This strategy seems successful at present. However, we have to check our strategy of this field of Nuclear Physics for our future research activities in Asia Pacific. For example, too much concentration may be happening in medium energy heavy-ion accelerator facilities in Asia Pacific region.

PERFECT ABSORPTION AND ELECTROMAGNETICALLY-INDUCED TRANSPARENCY OF METAMATERIALS

YoungPak Lee
Hanyang University, Seoul, Korea

Electromagnetically-induced-transparency (EIT) phenomena, perfect absorption and super-lensing of electromagnetic (EM) microwaves using metamaterials (MMs) have been studied vigorously recently for the possible applications in sensor, EM-wave cautery, hyper-transmitter, super-lens, EM compatibility, solar energy, bolometer, etc. These days, the coherent processes, leading to EIT, have been observed in MMs. This can relax dramatically the difficulty in the experimental realization because of the room-temperature operation and of no need for external activation by pumping lasers. The MM structures reveal the EIT-like phenomena which are the result of Fano-type linear destructive interference among the artificial resonant elements. The phenomena are obtained by the broken structural symmetry or by the near-field subwavelength-scale coupling. The latter origin of EIT can be interpreted by the near-field coupling between a radiative bright resonator that couples strongly with the incident light, and a dark resonator that couples weakly with light. However, the EIT-like behavior also occurs without the dark-mode excitation, which is described by the interference between bright modes. In addition, the EIT-like effect, based on the phase coupling, can be switched by adjusting the incident angle. Perfect absorption of EM microwaves using MMs is a flourishing research field in expecting the potential applications as above. By minimizing the reflectance and eliminating the transmittance, the design and the fabrication of perfect absorbers could be realized in various frequency bands, including the GHz and the MHz bands. The problem of EM noise comes to be more serious according to the advent of ubiquitous society. Extended dissemination of high-speed and high-f digital products and smart equipments has made special EM-wave materials used in various fields. We are investigating advanced meta-structures/materials and MMs for EM-wave absorption, MM technology for EM-wave absorption over 99% and ultrawide-band absorption, and MMs for EM-wave absorption independent of incident angle and polarization. This work was supported by the ICT R&D program of MSIP/IITP, Korea (2013-0-00375), and by the NRF fund by MSIP, Korea (No. 2017R1A2B4003916).

APPROACHES TO INFLATIONARY COSMOLOGY

Jun'ichi YOKOYAMA
Research Center for the Early Universe(RESCEU),
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Inflation in the early universe is an indispensable ingredient of modern cosmology which not only solves long standing problems such as horizon, flatness, and monopole/unwanted relics problems but also provides the origin of tiny density fluctuations which have evolved to the observed large-scale structures. Now the standard paradigm of inflation is that the accelerated expansion is realized when a scalar field, dubbed as the inflaton, slowly rolls over its potential down to a global minimum in a time scale longer than the cosmic expansion time. The remarkable feature of the slow-roll inflation is that it cannot only explain the global properties of the observed Universe, but also provide seeds of density and curvature fluctuations out of the quantum fluctuations of the inflaton field in exponentially expanding space. In fact, the slow-roll inflation driven by a potential is not the only inflation scenario prevailing today, and there are two alternatives. One is models realizing inflation without introducing any inflaton field but modifying gravity from the Einstein's general relativity. Starobinsky was the first to show that quasi-exponential expansion and graceful exit therefrom could be realized by incorporating higher-order curvature terms in the action based on quantum corrections. Nowadays its simpler version including square scalar curvature term besides the Einstein action is referred to as the Starobinsky model. The other alternative is models which make use of a scalar field with a higher-order kinetic function. If we can realize a state with a constant canonical kinetic function its energy density can have the same equation of state as the cosmological constant to drive exponential inflation. Such models are referred to as k-inflation. All these models can be regarded as a subclass of the generalized G-inflation model which is the most general theory of single-field inflation with its field equations given by second-order differential equations as with most of the other theories of fundamental physics. Turning back to the potential-driven models, in order to realize inflation with proper amplitude of fluctuations, we must have a sufficiently flat potential. The conventional way to protect this flatness against quantum correction has been to make use of supersymmetry. Recently, however, we have shown that higher-order derivative interactions typical in generalized G-inflation can also make the potential effectively flat even though they contain much larger values of parameters than usually assumed. This provides another arena for model building of realistic inflation. I will introduce these new trends in inflationary cosmology.

FUTURE HIGH ENERGY PARTICLE ACCELERATORS – WILL THE ASIA CENTURY PRESIDE?

Geoffrey Taylor
The University of Melbourne, Australia

The talk will give an overview of current high energy physics facilities and their capabilities, and an outline of the facilities planned or in progress. High energy particle accelerators have been pivotal for the understanding of the fundamental constituents of nature and their interactions. An overview of recent major achievements will be presented. Asian high energy accelerator facilities such as in KEK, Japan, and IHEP, China, have carried out important measurements in this recent past. Japan and China continue to develop technical capacity at the forefront of high energy physics and are expected to pursue multi-billion investments in the next wave of high energy accelerators in the future. The talk will also cover some technical and industrial aspects of accelerator developments in which developing countries can also benefit.

QUANTUM SECURE DIRECT COMMUNICATION

Gui-Lu Long
Department of Physics, Tsinghua University, Tsinghua National Laboratory of Information Science and Technology, Beijing 100084, China

In this talk, I will briefly introduce the basic ideas of QSDC, some typical QSDC protocols, QSDC in a noisy and lossy environment, experimental development of QSDC. In particular, I will emphasize that contrary to common misunderstanding, QSDC is well within the current technology, with the same order of magnitude as QKD in parameters, such as communication distance, bits per second and so on. Future perspective is also given toward the end of the talk. Quantum secure direct communication (QSDC) is one the major branches of quantum cryptography. Since the first QSDC protocol proposed in 2000 [ArXiv preprint quant-ph/0012056, PRA65, 032302,2002], it has been developed steadily. In QSDC, secret message is sent directly over a quantum channel, due to te use of block data transmission technique. QSDC offers higher security in transmission in three aspects: 1) it can detect Eve; 2) it eliminates the leakage of information transmitted before Eve is detected; 3) it has no ciphertext hence has perpetual security. In fact, QSDC has changed the infrastructure of secure communication. QSDC is also a powerful basic quantum communication primitive to build other quantum communication protocols such as quantum bidding, quantum signature and quantum dialogue and so on.

ELECTRON TUNNELING LIFETIME IN ATOMIC SYSTEMS, A PROJECTED GREEN'S FUNCTION METHOD

Rui-Qin Zhang
Department of Physics and Materials Science,
City University of Hong Kong

Atoms exposed to strong laser field can lose electrons via the process of tunnelling or multi-photon ionization. Recent progress in attosecond technology allows detailed measurement of these processes. Complementary theoretical calculations of model systems are necessary to help reveal the mechanism of an electron to tunnel through a barrier. In this work, we adopt a projected Green's function (PGF) method for the calculation of the tunnelling lifetime of an electron escaping from some small atoms. The method has been used in the past to calculate the tunnelling lifetime of an electron in quantum wells. This method allows us to evaluate the tunnelling lifetime for a specific barrier width in a very straightforward way. Results of calculated electron tunnelling lifetime in model systems such as quantum dot (QD) are shown to be comparable with other theoretical studies. Based on this, we have been able to obtain the tunnelling lifetime of the electron escaping from hydrogen, helium, neon, argon atoms under electric field

PLENARY 10

EVOLUTIONARY GAMES AND THE ISING MODEL – WHEN TWO FIELDS MEET

Pak Ming Hui
Department of Physics, Chinese University of Hong Kong

Evolutionary games are useful for studying the emergence of cooperation in a competing population. They typically deal with a system of many agents competing via pairwise two-person games, with every agent aiming at achieving a better payoff by continually adapting the choice of actions during the game to one's competing environment. A class of evolutionary games using a self-questioning adaptive mechanism for strategy switching played in a population of connected agents is shown to be describable by an Ising model Hamiltonian of spins that are connected in the same way. Combinations of the payoff parameters in the game give the coupling between neighbouring spins and an external magnetic field. Depending on the payoff parameters, the mapping between the two problems covers the prisoner's dilemma, snowdrift games, and stag hunt games, played in spatial structures of a uniform degree. The equivalence is illustrated in a well-mixed system in which both the games and the Ising model allow exact solutions. For a chain of agents/spins, the known result of the Ising model leads to an exact closed-form solution to the games without any effort. This connection also allows the accuracy of standard dynamical approaches previously developed for the games to be tested and quantified. The site approximation is found to show varied accuracies in different regions of the parameter space, and the link approximation turns out to give the exact result for a chain of agents but not in a closed-form. The established equivalence connects two research areas, with each having much to offer to the other. This work was done in collaboration with Ms. Jie Liu of the Chinese University of Hong Kong and Prof. Chen Xu of Soochow University, China.

FUNDAMENTAL AND APPLIED STUDIES OF LOW ENERGY POSITRON SCATTERING

James Sullivan
Australian National University, Australia

Low energy positron interactions provide particular challenges for atomic and molecular scattering theory. Until recently, theoretical predictions were rarely tested with the precision and accuracy of their counterparts in electron scattering, mainly due to the reduced intensity and relatively poorer energy distribution of positron beams [1]. In the last two decades, the field of low energy positron scattering has taken a leap forward, thanks to the development of the Surko trap and beam system [2,3], which has made available a source of low energy, high resolution positrons which can be used for a variety of experiments [4]. At the Australian National University, we have developed two positron beams, which are used for these studies [5]. In this talk, I will outline their operation, and describe a range of different experiments we have undertaken of fundamental scattering processes – providing an overview of the variety of different measurements available and a demonstration of the ability to make high accuracy comparison to the best available theoretical calculations. In addition to these fundamental studies, part of our experimental program is geared towards a broader collaboration to investigate the processes underpinning Positron Emission Tomography (PET), a now common medical imaging technique. This is a contribution towards a broader program including theoreticians and modellers to develop better models of PET, for use in calculation of relevant quantities, such as received radiation dose. The talk will present relevant data, with a description of where it fits in to the overall research program. Finally, I will present progress on a new experimental endeavour currently being undertaken in our laboratory, to make a Ps beam for scattering studies. This is a particularly challenging experiment, but previous results have shown some very interesting possibilities and areas of investigation for such a system. The state of our current progress will be presented, along with an outline of the future research program.

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PUMP-PROBE MICROSCOPY WITH STIMULATED EMISSION MODULATION

Fu-Jen Kao
Institute of Biophotonics, National Yang-Ming University, Taiwan

Pump-probe microscopy has become a common platform for imaging based on nonlinear optical processes, such as stimulated emission (SE), ground state depletion (GSD), and excited state depletion (ESD). The capacity includes molecular specificity, improved (or super-) resolution, and enhanced penetration depth [1]. In the past years, stimulated emission based pump-probe microscopy has also demonstrated dark chromophore detection [2] and fluorescence lifetime imaging [3]. For stimulated gain detection, the pump beam is modulated at a frequency, f_1, and the probe beam is demodulated accordingly to extract the signal in the transmission direction with a photodiode as the detector (PDA 36A, Thorlabs). For spontaneous loss, the probe beam is modulated at frequency, f_2, the spontaneous loss signal is then demodulated from the fluorescence detected in the reflection mode by a PMT. In all cases, a high performance lock-in amplifier (HF2LI, Zurich Instruments) is used. By demodulating fluorescence signal, the fluorescence lifetime and optical section images can be obtained with greatly reduced background that is attributed to shot noise. Additionally, this technique improves signal-to-noise ratio and enhances penetration depth like multiphoton microscopy without expansive femtosecond lasers. Importantly, the remarkable features about pump-probe microscopy include contrast enhancement, molecular specificity, and a broad range of modality.

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INVITED & CONTRIBUTED TALKS

PARALLEL SPECIAL SESSIONS

AA – ASTRONOMY & ASTROPHYSICS

BM – BIOLOGICAL & MEDICAL PHYSICS

CM – CONDENSED MATTER & MATERIAL PHYSICS

CS – COMPLEX SYSTEMS & MULTIDISCIPLINARY PHYSICS

EA – EXOTIC ATOMIC, MOLECULAR & ATOMIC PHYSICS

NR – NUCLEAR PHYSICS & RADIATION

PF – PARTICLE PHYSICS & FIELDS

PP – PLASMA PHYSICS

SP – STATISTICAL PHYSICS

ASTRONOMY & ASTROPHYSICS

INVITED TALK

AA-1

VERY MASSIVE STARS AND PAIR INSTABILITY SUPERNOVAE EXPLOSION

Hasan Abu Kassim and Norhasliza Yusof
Department of Physics, University of Malaya, 50603 Kuala Lumpur, Malaysia

In this work, we are going to discuss the evolution of very massive stars (VMS) with low metallicity. This includes general properties, impact of the chemical abundances due to the rotation and mass loss. We are also going to discuss the fate of the VMS, which are thought to end as pair instability supernovae. We shall present the explosion models and their light curve from our progenitor models.

CONTRIBUTED TALKS

AA-2

OBSERVATION STUDY OF MAJOR SOLAR FLARES

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11800 Penang Malaysia

Solar Flare is one of the solar activity and the most dramatic forms of transient activity occurring in the solar atmosphere and it gives big impact on the earth in term of space weather. In this paper, we study the process before, during and after of major solar flares by using EIT 195 and Magnetogram images from SOHO data set. We choose Active Region (AR) 10486 and AR 10720 because in these AR have a series of major solar flares. The data was analysed and interpreted by using ImageJ and Helio Viewer software to calculate solar flares features. Based on our observation, we found that most of the Major Flares have the same pattern which are the emergence of Magnetic Sigmoidal Shape or S and reverse S shape before the flares and reconnection field lied just above the magnetic flux rope after the flares.

AA-3

SEMI EMPIRICAL MODELLING OF LIGHT POLLUTED TWILIGHT SKY BRIGHTNESS

MS Faid[a], NNM Shariff[a], ZS Hamidi[b], N. Kadir[c]
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[c]*Academy of Islamic Studies, University of Malaya*
50603 Kuala Lumpur

The phenomenon of twilight been stipulated as naturally dependent on the variables of solar depression, aerosol concentration and ozone composition. The unique color spectrum of twilight is attributed by the ozone layer and aerosol, whereas its brightness is heavily relying on the altitude of the sun below horizon. While all the natural dependent is being researched extensively, the impact of light pollution on the brightness of the twilight is not being explored thoroughly. Most of the models of twilight sky brightness, such as Kastner, Schaefer and Patat only consider the factor of solar depression, aerosol concentration and ozone composition, while light pollution variable is not yet considered in the models. The objective of this study is to construct a model of light-polluted twilight sky brightness by understanding the alteration of light

pollution towards the natural behavior of twilight sky brightness. The model is constructed using Kastner expression of twilight sky brightness as a base, with the combination of data from Garstang, Berry and our own data, utilized by TableCurve 3D and SigmaPlot. The model is then compared with a total of 84 data of twilight brightness from various location profiles to assess its reliability on real condition. The model is found to have an acceptable accuracy in representing the actual light-polluted twilight sky brightness. It is among the first attempt to accurately express the light-polluted twilight sky brightness in mathematical formulation. The model however, need further refinement particularly on the atmospheric variables of light polluted twilight sky brightness.

AA-4

TOWARDS A COMPLETE CENSUS OF THE HIDDEN SUPERMASSIVE BLACK HOLE POPULATION IN OUR LOCAL UNIVERSE

Adlyka Anuar [1,2] and the Nu*STAR* Science Team
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Many studies have shown that the majority of acceration onto supermassive black hole; i.e active galactic nuclei (AGN) are hidden from our view by obscuring "torus" of gas and dust with column densities of $N_H \geq 10^{22}$ cm^{-2}. Arguably, the most efficient method of identifying AGM is in the X-Ray waveband, where even heavily obscured AGN have been detected. However, a significant fraction of the AGN population have remained hidden X-rays due to their extreme torus column densities along our line of sight, NH $\geq 1.5 \times 10^{24}$ cm^{-2}, i.e, Compton-thick (CT). These CT AGN are predicted abundant but their census is far from complete, even in our local universe, due to the challenge in identifying them because of their faint fluxes. Having a complete census of their population is important in our understanding of the cosmic X-ray background radiation and the growth of supermassive black holes. In my talk, I will present an updated census of the CT AGN population within a volume of D = 15 Mpc. The telescopes, primarily *NUSTAR* in combination with *Chandra* and *XMM-Newton*. For cases in which this is not possible, we use indirect multiwavelength techniques to identify potential CT AGN within volume. The CT AGN fraction we found; i.e $\geq 30\%$ is significantly higher than that directly intrinsically low luminosity CT AGN that are missed by previous generation of high X-ray telescope, and provide case studies of two newly identified bona-fide CT AGN in our local universe (i.e., NGC 1448 and NGC 5643). This work provides a well-defined local benchmark for AGN obscuration studies.

BIOLOGICAL AND MEDICAL PHYSICS

INVITED TALKS

BM-A1

FROM QUANTITATIVE IMAGING TO RADIOGENOMICS

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Traditionally radiology or medical imaging provides a diagnosis based on pattern recognition of medical images. Quantitative methods have been developed, integrating radiology with pathology, molecular biology, and artificial intelligence leading to the birth of radiomics. Human cancers exhibit high intra and inter patient heterogeneity, which occurs at different levels: genes, proteins, cells, tissues and organs. This limits the use of, for instance, biopsy-based molecular assays but in contrast, provides huge potential for non-invasive imaging techniques.
Radiomics enables the high-throughput extraction of a lot of quantitative features from various medical images such as CT, MRI or PET, in providing a comprehensive quantification of the tumour phenotype, and application within clinical decision support systems to improve diagnostic, prognostic and predictive accuracy. It can also provide complementary information compared to other sources (e.g. demographics, pathology, biomarkers or genomics), thus improving individualized treatment selection and subsequent monitoring.
In addition to visual-based reporting and diagnosis, a large percentage (above 90%) of available imaging data is currently left unused. With the big data currently available to us, we could achieve an *in-vivo* phenotyping of disease patterns. In future, the scope of radiology will include selecting heterogeneous patient populations and accurately determining suitable patients for a particular treatment. The basis of this will be a combination of image data and genomic data. By extracting 'radionomics' data, classifiers can be established and correlated with genomic classifiers. This research focus on the relationship between imaging phenotypes and genomics is known as radiogenomics or imaging genomics. However, one major obstacle is that current data often lack complete characterization of the patients and poor integration of individual datasets. Radiogenomics offers a practical way to leverage limited and incomplete data to generate knowledge that might lead to improved decision making, and as a result, improved patient outcomes. Radiogenomics is expected to have a large clinical impact, since imaging is routinely used in clinical practice worldwide, playing an increasingly significant role in clinical decision-making and hasten the realiasation of personalized medicine.

BM-A2

ADVANCED DOSIMETRY TECHNIQUES: THE EXPERIENCE AT CENTRE FOR MEDICAL RADIATION PHYSICS

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Cancer is rapidly becoming the largest cause of mortality in this century. Better technologies for diagnosis and treatment of cancer are required to address this problem and save more lives. During the last decade, due to the continuing development of innovative radiation therapy techniques, very conformal delivery of radiation has been achieved, improving the treatment of the cancer. A review of major radiation therapy modalities related instrumentation developed at the Centre for Medical Radiation Physics will be presented and in particular for real-time, pre-treatment dosimetry for Adaptive Motion (ART), robotic-based radiotherapy such as Cyberknife and skin dosimetry. Such highly conformal modern radiation therapy modalities allow dose enhancement in a target while sparing normal tissue, and they are always associated with steep dose gradients. Safe application of these radiotherapy modalities requires sophisticated tools for quality assurance often with a patient specific approach. Semiconductor electronic dosimetry is one option for such QA tools due to the small size of the radiation detectors, the ability to

produce pixelated detectors for 2D dosimetry with high spatial resolution and large area, and reproducible response thanks to the stability of the manufacturing by microelectronics foundries. A family of new semiconductor dosimeters was developed at Centre for Medical Radiation Physics (CMRP): (i) Edgeless Angular independent single diode is first used for dose verification in non-coplanar radiotherapy modalities for pre-treatment dose verification. (Ii) The technology of silicon strips and pixelated detectors allow dose mapping in IMRT phantom with spatial resolution down to 0.2 mm. The so named Dose Magnifying Glass, was developed at CMRP and used for QA of steep dose fall off at the target and organ-at-risk interfaces in both EBRT and Hadron therapy modalities. MagicPlate and MagicPlate512 will be also presented as dosimetry system for SBRT/SRS modalities, respectively. (iii) The Skin diode detector technology is for real time dosimetry of the skin at water equivalent depth (WED) of 0.07mm (basal layer), as recommended by ICRU. As direct spin-off of the technology used to develop the MOSkin detectors, the Skin Diode technology has been characterised and tested in EBRT applications. All this instrumentation has been develop with the intent to provide effective tools for medical physicists and design with the “customer” needs as priority specifications.

CONTRIBUTED TALKS

BM-A3

CHARACTERISATION OF AL2O3:C OPTICALLY STIMULATED LUMINESCENCE DOSEMETER (OSLD) IN LOW DOSE KILOVOLTAGE PHOTON BEAMS

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General radiography delivers low radiation dose to patient and it is often difficult to measure patient dose. Radiation dosimetry in kilovoltage photon beams are usually done using large ion chamber and phantom. This project is to characterise Al2O3:C optically stimulated luminescence dosemeter (OSLD) using radiography system and investigate its application for clinical dosimetry for general radiography. The assessment was done using nanoDot OSLDs. NanoDots were exposed to kilovoltage (kV) beams ranging from 60 to 140 kVp (30-43 keV). The characterisation of nanoDots includes batch homogeneity, energy dependence, dose linearity, reader reproducibility, temperature dependence, and percentage depth dose (PDD). The use of nanoDot in kV beam dosimetry was investigated. Measurements of air kerma (AK), entrance surface air kerma (ESAK), organ dose and exit dose were carried out using nanoDots. Dose linearity for nanoDots were found to have a coefficient of variation (CV) of ± 12.8% and were temperature independence. Within the commonly used tube potentials in clinics (60-140 kVp), there is a slight energy dependence (CV ± 6.1%). There appears to be a large batch inhomogeneity (CV ± 8.3%) due to a mixture of “screened” and “unscreened” nanoDots. The microStar reader has a good reproducibility with CV ± 0.94%. The percentage depth dose (PDD) measured using nanoDots has a CV of ± 6.4%. The total uncertainties of nanoDots were found to be ± 16.5%. The application of nanoDots for AK and ESAK in kilovoltage dosimetry were found to have standard deviation (SD) of ± 6%. Whereas, the application of nanoDots for ESAK, organ dose and exit doses using anthropomorphic phantom were found to have precise readings. NanoDots were applicable for clinical dosimetry in radiography with dose range not less than 0.1 mGy.

BM-A4

REDUCING SCATTER IN TC-99 CM MYOCARDIAL SPECT IMAGING USING PHYSICAL FILTER

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Myocardial SPECT is one of the techniques that provide high diagnostic accuracy for the assessment of coronary artery disease. However, in general, the presence of Compton scattered photons in the resulting image data will reduce the diagnostic accuracy. This undesirable effect is even more significant in heart thorax-linked analysis compared to other regions with a more homogenous volume. In this study, the use of physical filter was proposed to reduce the undesirable scattered gamma photons. In Myocardial SPECT imaging procedure, an anthropomorphic torso (heart/thorax) phantom was used. The image reconstruction procedure was based on filtered back projection. Chang's attenuation correction method was used. The image quality was analyzed qualitatively and quantitatively. In Tc-99m spectra test, a decrease in the ratio of scattered to non-scattered photon for the whole spectra was observed for all types of the physical filters examined. However, the reduction in photopeak region was only recorded by Zn 0.2 mm filters. The physical filters were also found to improve system's spatial resolution, but the uniformity of tomographic image was unchanged, and the system volume sensitivity was reduced to 16% for Cu and 4% for Zn filter. It was found that Zn 0.2 mm reduced the scatter in Myocardial SPECT imaging where a clear separation between the liver and heart was observed. A significant improvement in contrast (10.98%) and signal-to-noise ratio of myocardial wall to defect areas (12.68%) was achieved with the use of Zn 0.2 mm material filter has the potential to enhance the image quality in clinical SPECT imaging. However, clinical trials of this technique are required prior to its use in patient studies.

BM-B1

CHARACTERISATION OF FAST TIME-OF-FLIGHT CAMERAS FOR OPTICAL SURFACE TRACKING IN ADVANCED RADIOTHERAPY

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Fast time-of-flight (ToF) camera is an optical 3D imaging sensor that provides the depth information of a scene at high frame rate. The technology is useful in advanced radiotherapy treatment that requires patient setup information to ensure accurate radiation dose delivery. Optical surface tracking provides real-time information of the patient setup during treatment. The objective of this study is to evaluate the depth measurement accuracy of two commercial ToF cameras of different specifications: Argos^{3D} P320 (low image resolution camera with LED illumination source) and Argos^{3D} P330 (high image resolution camera with laser diode illumination source). ToF cameras may suffer from systematic error that affect the accuracy of depth measurement. Experiments such as dark current test, temporal noise test and wiggling test were performed for each camera and the results obtained were analysed using MatLab. Overall, both cameras have high depth measurement accuracy above 99% with a low temporal noise of 0.06%. In term of warm-up time, Argos^{3D} P330 camera has a shorter warm-up time of 20 minutes. The results provide the performance characteristics of the sensors and the factors that influence the depth measurement accuracy. The results can also be used as a reference in selecting the ToF camera design for radiotherapy application.

BM-B2

REDUCTION OF TUMOUR TARGET UNCERTAINTIES USING IMAGE GUIDED RADIOTHERAPY (IGRT): A REVIEW

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Modern radiotherapy uses linear accelerator and complex beam shaping system to shape the high dose x-ray accurately to the tumour while sparing the normal tissues. The beam is delivered to the tumour target daily, fraction-by-fraction, over several weeks. Irradiation is guided with imaging modalities in the treatment room known as image guided radiotherapy (IGRT) to ensure the accuracy of treatment delivery. This work review IGRT modalities used widely in the clinical setting and recent research development in IGRT technologies and techniques. The uncertainties of the tumour target using a cone beam CT system that is available in most modern radiotherapy departments will be presented. Typically, cone beam CT images are acquired before radiotherapy treatment and compared with the intended treatment setup acquired during simulation. The position differences are corrected if the margin exceeded a threshold defined during treatment planning. The difference should be less than the volumetric target margins delineated on the CT images. This safety margin will be sufficient provided that daily imaging and setup correction are performed. However, busy radiotherapy centres have high patient workload and unable to perform daily cone beam CT. Treatment often requires larger margin to ensure sufficient radiation delivery to the tumour target. This work will also review current technological advancement in IGRT that may efficiently reduce the uncertainties in radiotherapy delivery and improve the accuracy of modern radiotherapy treatment.

BM-B3

COMPUTED TOMOGRAPHY-BASED THERMOMETRY FOR TEMPERATURE MAPPING DURING PERCUTANEOUS RADIOFREQUENCY ABLATION: EX-VIVO INVESTIGATION

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Radiofrequency ablation (RFA) is commonly used for hyperthermia ablation of small primary or metastatic liver tumours. The current post-ablative evaluation relies on visual inspection of the non-enhancing tissues on the computed tomography (CT) images. The objective of this study was to investigate the correlation between CT number shift (dHU) and tissue temperature change (dT) in order to produce CT thermal maps for more objective assessment of ablation adequacy. RFA was performed on ex-vivo bovine liver samples (n=15) using single RFA electrode (Covidien, Massachusetts, USA). Standard 3 cm liver ablation protocol (impedance-controlled mode, 12 min ablation followed by 15 min cooling) was used. Fiber Bragg Grating (FBG) optical laser sensors were placed inside the liver samples at 10, 20, 30 and 40 mm away from the RFA electrode. A sequential CT scan was performed at 3 min interval throughout the ablation and cooling process. The CT numbers adjacent to the FBG sensors were measured and correlated to the tissue temperature measured by the sensors.
A notable decrease in the CT number during heating phase and subsequent recovery in CT number as temperature decreased during the cool-down period was observed in all bovine liver samples. A negative linear relationship ($y = –1.6347x – 3.1135$, $R^2=0.780$) between dHU and dT was observed. Spearman's rho correlation analysis suggested that there was high negative correlation ($r=–0.820$, $p=0.001$) between dHU and dT, with average 1.6 HU change per degree Celsius. The strong correlation between dHU and dT during RFA could be used to estimate tissue temperature based on the CT number measured during real-time CT-guided RFA. This approach would help the interventionalist in determining the ablation efficacy hence improving treatment outcomes.

CONDENSED MATTER & MATERIAL PHYSICS

INVITED TALKS

CM-A1

RECENT PROGRESS AND TOPICS IN SEMICONDUCTOR SPINTRONICS AND FERROMAGNETIC SEMICONDUCTORS

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Ferromagnetic semiconductors (FMSs) have been intensively studied for decades as they have novel functionalities that cannot be achieved with conventional metallic materials, such as the ability to control magnetism by electrical gating or light irradiation [1-3]. Prototype FMSs such as (Ga,Mn)As, however, are always p-type, making it difficult to be used in real spin devices. Here, we demonstrate that by introducing Fe into InAs, it is possible to fabricate a new n-type electron-induced FMS with the ability to control ferromagnetism by both Fe and independent carrier doping. The studied $(In_{1-x},Fe_x)As$ layers were grown by low-temperature molecular beam epitaxy on semi-insulating GaAs substrates. Electron carriers in these layers are generated by independent chemical doping of donors. The ferromagnetism was investigated by magnetic circular dichroism (MCD), superconducting quantum interference device (SQUID), and anomalous Hall effect (AHE) measurements. With increasing the electron concentration (n = 1.8×10^{18} cm^{-3} to 2.7×10^{19} cm^{-3}) and Fe concentration (x = 5 - 8%), the MCD intensity shows strong enhancement at optical critical-point energies of InAs, indicating that the band structure of (In,Fe)As is spin-split due to *sp-d* exchange interaction between the localized *d* states of Fe and the electron sea. SQUID and AHE measurements are also consistent with the MCD results. The Hall and Seebeck effects confirm the n-type conductivity of our (In,Fe)As samples. The electron effective mass is estimated to be as small as 0.03-0.175m_0, depending on the electron concentration. These results reveal that the electrons are in the InAs conduction band rather than in the impurity band, allowing us to use the conventional mean-field Zener model of carrier-induced ferromagnetism [4]. This band picture is different from that of (Ga,Mn)As [5][6]. Our results open the way to implement novel spin-devices such as spin light-emitting diodes or spin field-effect transistors, as well as help understand the mechanism of carrier-mediated ferromagnetism in FMSs [7-14]. Furthermore, we have found new phenomena in (In,Fe)As and its quantum heterostructures: Novel crystalline anisotropic magnetoresistance with two fold and eight fold symmetry [7], and control of ferromagnetism by strain, quantum confinement, gate electric field and wave-function engineering in quantum heterostructures with a (In,Fe)As quantum well [10-12]. Very recently, we have found very intriguing phenomena; sudden restoration of the band ordering associated with the ferromagnetic phase transition in the prototypical ferromagnetic semiconductor (Ga,Mn)As [15], and control of the bias-voltage dependence of tunneling anisotropic magneto-resistance using quantization in (Ga,Mn)As quantum wells [16]. Also, we have successfully grown another narrow-gap p-type III-V-based FMS (Ga,Fe)Sb with high Curie temperature (T_C > 300K) [17]. Combining different n-type and p-type FMSs with high T_C will lead to new spin-related functionalities and devices. This work was carried out in collaboration with Drs. S. Ohya, P.N. Hai, I. Muneta, L. D. Anh, M. Kobayashi, S. Sakamoto, and A. Fujimori. This work was partly supported by Grants-in-Aid for Scientific Research and Spintronics Research Network of Japan (Spin-RNJ).

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CM-B1

PLASMONIC NANOSTRUCTURE AND DEVICES

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Surface plasmon polaritons (SPPs) have shorter wavelengths and stronger field enhancement, confined to the dielectric-metal interface, in comparison with light and have been widely used in nano-optics, resonance sensing and imaging, including surface plasmon focusing. However, the low conversion efficiency and high propagation loss of SPPs limit its use. Controlling the propagation direction of SPPs by using nanostructures on metal surfaces is important. The manipulating of the focusing and polarization in plasmonic nanostructures is the key problems. In this lecture, we will introduce the principle and experimental of Near-field Optics, and then report the recent progress in the following aspects at Plasmonic-SNOM group, Peking University:

- ✧ **Surface Plasmons in Metal**

  Magnetic Fano Resonance; Toroidal Dipolar Resonance; Active Control of Graphene-Based Unidirectional Surface Plasmon Launcher

- ✧ **Surface Plasmons in 2D materials**

  Plasmonic hot electron induced structural phase transition in MoS_2 monolayer; Graphene quantum dots doping of monolayer MoS_2; Active Plasmonic Tuning of MoS_2 Absorption and Luminescence

- ✧ **Plasmonic circular polarization** and Focusing surface plasmon polaritons in Archimedes' nanostructure

CM-B2

STEADY STATE NEMD INVESTIGATION OF THE ENERGETICS AND TEMPERATURE DISTRIBUTION OF A 1-D LATTICE CHAIN SUBJECTED TO A TEMPERATURE GRADIENT

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Two aspects of conductive heat are reviewed here, (i) its basic definitions and (ii) the results of nonequilibrium molecular dynamics (NEMD) simulation for a 1-D lattice chain for the harmonic and non-harmonic FPU-β standard model potentials subjected to a temperature gradient that results in both thermal energy flow and a distinct temperature profile at the steady state. Ever since the publication of the RLL theory [1] half a century ago, it has been taken as axiomatic [2] by the global Physics community that their rationalization and prediction of a near flat

temperature profile along the central region of the harmonic lattice is unique and the only one possible for the ballistic trajectory that ensues for such intermolecular potentials. We note that the RLL theory is replete with assumptions concerning the nature of how the particles interact with the potential field which was mathematically convenient in providing the boundary conditions that allows one to derive exact solutions to the matrix differential equations. Using non-synthetic NEMD algorithms that conserves energy and momentum, we observe that other solutions to the steady state problem exists, where the temperature profile varies sinusoidally, which also obtains for non- harmonic potentials depending on the strength of the potential coefficients for the harmonic part of the potential. This investigation will describe some of the potentials used and the ensuing results. Apart from the obvious theoretical implications of these results, we surmise that systems exhibiting a near harmonic potential could be used for the construction of thermal PN junctions in regulating heat flows in applications.

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CM-C1

Li_8MO_6: A CATHODE MATERIAL FOR LITHIUM ION BATTERIES

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Computational simulations provide a supplementary tool to understand lithium-ion battery properties at the atomic level, and they can be used to design and to optimize new materials for lithium batteries. We used Kohn-Sham density functional theory to study the feasibility of using Li_8MO_6 as a cathode material for Li-ion batteries. Several properties were calculated, including the stable delithiated configurations, the delithiation energy, the charge flow during delithiation, and the stability of the delithiated materials. Experimentally, lithiation and delithiation cycles were demonstrated in nanocomposites of doped Li_8ZrO_6 with carbon.

CM-D1

CHITOSAN FOR NEW GENERATION ENERGY DEVICES

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Most of the reports on energy devices such as batteries, supercapacitors and solar cells are based on liquid electrolytes. However, problems associated with liquid electrolytes are leakage, flammability, corrosion and other electrochemical stability issues. Replacing liquid electrolyte with a film of polymer electrolyte will overcome these drawbacks. Biopolymers have attracted great interest in studies on polymer electrolytes. We focused on chitosan. Chitosan is a polymer of β-(1-4)-linked D-glucosamine, which can be derived from the chitin components of the shells of crustacean, insect exoskeletons and fungal cell walls. Presence of lone pair electrons in the structure of chitosan allows it to serve as an ion conductor. Conductivities in the range of 10^{-4} to 10^{-3} S cm^{-1} are achieved in chitosan-based electrolytes. The application and performance of chitosan in batteries, supercapacitors and solar cells will be presented.

CM-A2

DETERMINATION OF THE STRUCTURAL AND ELECTRONIC PROPERTIES OF SI_NGE_M (N=1,2,3 & M=1,2,3) CLUSTERS BY FIRST PRINCIPLE APPROACH

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Silicon-germanium (SiGe) is an alloy of silicon and germanium and mainly used in integrated circuits as a semiconductor. The immersing of nanotechnology research opens a branch of physics which lead to the different structural and electronics properties of the same element which undergo reduction of it size due to quantum confinement effect. Thus, this research is proposed to study the structural and electronics properties of where Si_nGe_m clusters (n=1,2,3) and (m=1,2,3). Determination of the structural and electronic properties of SiGe throughout this research is using Density Functional Theory as the most versatile and accurate quantum mechanical algorithm to approximately solve the wave-function of many-body problem. This research does give an impact on the exploration of SiGe nanoscale regime which is totally different from its bulk properties. The software used throughout the calculation is Octopus under Fortran code. We are implementing the LDA exchange-correlation functional for the electron behaviour in order to calculate the band gap and density of states for every structure of SiGe clusters. The possibility of finding electron from $|\varphi^2|$ of highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) for each structure were also reported. This visualization leads us to understand the location and role of electron and hole on the nature of bonding of the particular system.

CM-A3

QUANTUM TRANSPORT IN NANOJUNCTIONS WITH TIME-VARYING COMPONENTS

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We study the transport of electrons and the resulting electron current in nanojunctions where time-varying components are present. In the first device, we allow the gate potential to vary in time. The second device is attached to heat baths and we incorporate electron-phonon interactions. In the third device, a photon beam is incident on the channel. We usethe nonequilibrium Green's functions technique to calculate the electroncurrent flowing across the devices. In the nonequilibrium Green'sfunctions technique, we are able to express the Green's functions, via aperturbative expansion, in terms of integrals of steady-state Green'sfunctions. In turn, these steady-state Green's functions can be expressedin terms of integrals of equilibrium Green's functions. EquilibriumGreen's functions are calculated from the equations of motion of theparticles. Nonequilibrum and steady-state Green's functions are then calculated using numerical integration. We find that in all three devicesthe current takes time to react whenever there is a sudden, non-adiabatic,change. The current then overshoots, oscillates, and eventually settlesdown to a steady value. In the device where there is a changing gatepotential, the current is either amplified or attenuated depending on thesign of the gate potential. In the device that is coupled to heat baths,the electron-phonon interaction in the channel is switched on suddenly.We find that the averaged current across the device is less than thenon-interacting case, indicating that the interaction acts as a drag tothe electron flow. In the device where a photon beam is impinging on thechannel, the current can be attenuated or amplified depending on thefrequency of the impinging photon.

CM-A4

EFFECT OF THICKNESS OF FILLER LAYER IN THERMAL TRANSPORT THROUGH 1D SANDWICH STRUCTURE

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In present paper we proposed 1D sandwich model to investigate heat transport. Basically, sandwich model consists of three regions in which the middle region is filled with different material than that of two outer regions. We simulated temperature profile, heat flux and thermal conductivity of one dimensional sandwich structure as a function of thickness of filling part of the model. The interface thermal resistance and temperature gradient are also computed. FPU-β potential is used as intermolecular potential. The outer layers (left and right) of the sandwich structure are kept at constant temperature T_L=0.9 and T_R=1.1 using Langevin heat baths. The mass of each outer layer is taken as M=1.0 while that for the filler layer is M_s=0.5. It is noticed that as the thickness of sandwiched layer increases, the thermal conductivity and heat flux are increased. The phonon propagation from left layer to middle layer (from higher mass to lower mass) and again from middle layer to right layer (from lower mass to higher mass) is found less thermal resistive. In this case, the distance between two interfaces plays very important role in overall performance of the sandwich model. The model can be used to design good thermal conductor or insulator by varying width of the filler layer.

CM-B3

INVESTIGATION OF ELECTRONIC AND OPTICAL PROPERTIES OF GASE MONOLAYER USING AB INITIO METHOD

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GaSe is a layered semiconductor and can be easily separated the single layer from its bulk solid. In this paper, we study the geometrical structure, electronic and optical properties of GaSe monolayer from first principle calculations within generalized gradient approximation. Our results indicate that GaSe monolayer is an indirect bandgap semiconductor with bandgap of 1.98 eV. In addition, the substantial enhancement of the absorption coefficient in the ultraviolet (UV) region suggest that GaSe monolayer can be used as UV-detector.

CM-B4

QUANTUM-STATISTICAL PHENOMENON OF SUSTAINABILITY AND ITS MANIFESTATIONS IN DISSIPATIVE PHOTONIC SYSTEMS

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It is shown that sustainability is a universal quantum-statistical phenomenon, which emerges during propagation of photons inside different dissipative media, such as waveguides, metamaterials or biological tissues. These quantum effects occur due to the interaction of electromagnetic (EM) waves or photons with their environment, which can be described by means of the reduced density operator and effective non-Hermitian Hamiltonian (NH) approach. We illustrate them using two seemingly entirely different kinds of photonic systems: (1) we start by considering EM wave propagation in dielectric linear media, for which we derive the effective Hamiltonian operator, which describes such propagation. This operator turns out to be essentially non-Hermitian. Using the density operator approach for general non-Hermitian Hamiltonians, we derive a master equation that takes into account statistical ensembles of EM wave modes. The method describes dissipative processes which happen during the wave's propagation, and, among other things, it reveals the conditions that are necessary to control the energy and information loss inside the above-mentioned materials. (2) In case of photobiological complexes (PBCs), such as photosynthetic reaction centers and centers of melanogenesis inside living organisms or organelles, we derive a simple effective model of excitonic energy transfer. We demonstrate that photobiological systems must be both quantum and sustainable for them to simultaneously endure continuous energy transfer and keep their internal structure from destruction or critical instability. We show that in sustainable PBCs, quantum effects survive on a much larger time scale than the energy relaxation of an exciton. Besides, sustainable evolution significantly lowers the entropy of PBCs and improves the speed and capacity of energy transfer therein.

CM-C2

PREPARATION AND STUDIES OF SODIUM-CARBOXYMETHYLCELLULOSE (CMC-NA) THIN FILM POLYMER ELECTROLYTE

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Sodium-Carboxymethylcellulose (CMC-Na) thin film polymer electrolytes have been prepared by forming CMC-Na thin films by solution cast technique and followed by soaking the prepared thin film in the optimized polysulphide solution at various times. Optimized polysulphide solution has the composition of 4 M sodium sulphide (Na_2S) and 1 M Sulphur (S) with ionic conductivity

of 0.31 S cm^{-1}. From electrochemical impedance spectroscopy (EIS) data, has been found that CMC-Na thin film polymer electrolyte prepared by soaking time of 68 seconds possesses the best performance with ionic conductivity of 1.21 x 10^{-5} S cm^{-1}. The temperature dependence of conductivity of CMC-Na based polysulfide thin film seems to obey the Arrhenius rule and exhibit activation energy of 0.34 eV. The dielectric behavior is analyzed using dielectric permittivity (ε' and ε''), loss tangent (tan δ) and electric modulus (M' and M'') of the samples.

CM-C3

TIN-BASED METAL OXIDE LI_2SNO_3 AS AN ANODE MATERIAL FOR LITHIUM-ION BATTERIES SYNTHESIZED VIA HYDROTHERMAL ROUTE

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Tin-based oxide Li_2SnO_3 has been synthesized as a potential lithium-storage material which can replace the conventional carbon-based material as the negative electrode (anode) in lithium-ion rechargeable batteries (LIB). Owing to its environmental acceptability, tin-based oxide Li_2SnO_3 is one of the most promising anode materials for LIB. Sn is cheaper than Co and disposal cause minimal harm. In this work, lithium tin oxide, Li_2SnO_3 has been synthesized using the hydrothermal route. Stoichiometry amount of tin (IV) oxide, SnO_2 and lithium hydroxide monohydrate, $LiOH.H_2O$ as starting materials. X-Ray Diffraction (XRD) analysis confirmed high purity of monoclinic Li_2SnO_3. The half-cell employing Li_2SnO_3 as active material has been characterized using Electrochemical Impedance Spectroscopy (EIS), Cyclic Voltammetry (CV) and Galvanostatic charge/discharge studies. Cyclic voltammetric results illustrate that there are oxidation peaks at 0.6 V and 1.3 V and reduction peaks at 0.5 V and 0.9 V indicating that the intercalation/deintercalataion of Li^+ has taken place. Preliminary results of charge discharge at the 2nd cycle show that the charge specific capacity obtained was ~616 mAh/g while the discharge specific capacity was ~746 mAh/g. This revealed that the reversible lithium adsorption is 20% higher than those of the carbon family's anode materials.

CM-C4

SPIN-COATED BI_2S_3 ELECTRON SELECTIVE LAYER FOR INVERTED ORGANIC SOLAR CELL APPLICATION

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The present work reports spin-coated bismuth sulphide (Bi_2S_3) electron selective layer for inverted organic solar cell application. The devices were fabricated on top of Bi_2S_3-coated FTO substrate that acts as a cathode, followed by deposition of P3HT:PCBM blend films via spin-coating method. Finally silver electrode was thermal evaporated onto the sample with an effective area of 0.07 cm^2 to act as an anode. The morphology, optical and electrical properties of the devices were investigated and characterized in detailed. It was found that device at the optimum thickness exhibited the highest power conversion efficiency under 100 mW/cm^2 simulated AM 1.5 G sunlight. The obtained results indicate spin-coated Bi_2S_3 can be used as electron selective layer for inverted organic solar cells based on P3HT:PCBM.

CM-D2

ENHANCED IONIC CONDUCTIVITY OF CMC-BASED SOLID POLYMER ELECTROLYTES BY VARYING ETHYLENE GLYCOL CONCENTRATION

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Solid polymer electrolyte (SPE) incorporated cellulose derivatives offer a vast potential application in electrochemical devices. Plasticization is one of the most effective approaches to enhance SPE properties by improving the ionic mobility and/or the interfacial interaction among ionic and polar groups in polymer chains. In this work, the effect of ethylene glycol (EG) in CMC (carboxymethyl cellulose)-based SPEs were studied. Nyquist plots reveal capacitive behaviour of SPEs with the addition of EG. Impedance results show ionic conductivity was optimized at $(3.80 \pm 0.06) \times 10^{-2}$ S/cm (20 wt.% EG). X-ray diffraction analysis shows the increase of amorphocity as the EG added into SPE. Linear sweep voltammetry analysis at different scan rates reveals the potential of SPE to be applied in electrochemical devices application.

CM-D3

COMPOSITE POLYMER ELECTROLYTE BASED ON PAA AND $LIBF_4$DOPED WITH $BATIO_3$: A NOVEL MATERIAL FOR ENERGY DEVICES

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In the past few decades, the demand for high energy and power storage devices has increased worldwide. Renewable energy sources, such as rechargeable lithium-ion/polymer batteries and supercapacitors are among the important energy converting/storing devices. The adoption of polymer electrolytes as ionic conductor, as well as separator in electrochemical devices has become an important focus of material scientists and physicists throughout the world. This exploration has further strengthened as approaches of composite polymer electrolyte have been recognized and assembled in the design of batteries. In this perspective, our research direction is focused on advanced materials and electrolyte design, which should nourish the development of new energy devices. The electrical, dielectrical and electrochemical properties of PAA-$LiBF_4$-$BaTiO_3$ were investigated. The doping of nano-$BaTiO_3$has decreased the crystallinity of the composite polymer electrolyte. This enhances the ionic conduction which reaches 9×10^{-4} S cm^{-1} at ambient temperature. Concentration and temperature studies were examined via AC-impedance spectroscopy. The calculated activation energy value shows that this result is in agreement with the Arrhenius equation. The frequency dependent of dielectric permittivity and dielectric loss were studied at ambient temperature. The dielectric permittivity decreases with the increase of frequency, which is attributed to electrode polarization. From dielectric modulus studies, a distinctive increase at high frequency implies that the presence of plurality of relaxation mechanism. A long tail is observed at low frequency, which is associated with the large capacitance of the electrodes. A wide electrochemical stability window is obtained indicates the applicability of this composite polymer electrolyte in rechargeable energy devices. Various characterization studies demonstrated that PAA-$LiBF_4$-$BaTiO_3$ composite polymer electrolyte appears to be a promising material for high energy devices. The insights emerging from this new material could be associate with a broad range of diverse applications, such as electrochromic, electronic, and electrochemical devices.

EFFECT OF SUBSTRATE TEMPERATURE ON THE GROWTH OF NICKEL SILICIDE NANOWIRES FOR ELECTROCHEMICAL SUPERCAPACITOR APPLICATION

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This report refers to our study on the dependence of substrate temperature on formation and growth of nickel-silicide nanowires (NiSiNWs) by a solid-phase diffusion-control growth mechanism. A tungsten filament with a purity of 99.95% was employed as a hot-wire for evaporation of Ni nanoparticles on the Ni foil substrates. The Ni film with thickness 140 ± 5 nm was used as catalyst to induce the growth of NiSiNWs. The samples were varied from 350°C to 500°C in order to investigate the growth of nanowires. FESEM results show that the morphologies of the NWs were strongly substrate temperature-dependent. The increase in substrate temperature also resulted in the growth of high densities of NiSi NWs. At low temperatures 350°C Ni atoms diffused into the Si layer to form NiSi nanoparticles. High density nanowires were clearly demonstrated when the substrate temperatures increased above 400°C. A single wire was structured from single-crystalline Ni_3Si_2 phase with a preferred orientation in the (100) plane by HRTEM image. The electrochemical galvanostatic charge-discharge demonstrated sample with high density of Ni_3Si_2 NWs exhibited an enhancement of the specific capacity at maximum of 300.12 Cg-1 by a current density of 1 Ag-1 as compared to the other sample. These results suggested that Ni_3Si_2 nanowires plays an important role in increasing the accessible specific surface area of the electrode/electrolyte interface. The effects of substrate temperatures on the growth, structural and electrochemical properties of the nanowires for supercapacitor were presented and discussed.

COMPLEX SYSTEMS & MULTIDISCIPLINARY PHYSICS

INVITED TALKS

CS-A1

RECURRENCE DISTANCE DISTRIBUTIONS IN THE SYNECHOCYSTIS PCC6803 GENOME

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Transfer of nucleotide strings in the Synechocystis sp. PCC6803 genome is investigated to exhibit periodic and non-periodic correlation structures by using the recurrence plot method and the phase space reconstruction technique. The periodic correlation structures are generated by periodic transfer of several substrings in long periodic or non-periodic nucleotide strings embedded in the coding regions of genes. The non-periodic correlation structures are generated by non-periodic transfer of several substrings covering or overlapping with the coding regions of genes. In the periodic and non-periodic transfer, some gaps divide the long nucleotide strings into the substrings and prevent their global transfer. Most of the gaps are either the replacement of one base or the insertion/reduction of one base. In the reconstructed phase space, the points generated from two or three steps for the continuous iterative transfer via the second maximal distance can be fitted by two lines. It partly reveals an intrinsic dynamics in the transfer of nucleotide strings. Due to the comparison of the relative positions and lengths, the substrings concerned with the non-periodic correlation structures are almost identical to the mobile elements annotated in the genome. The mobile elements are thus endowed with the basic results on the correlation structures. This research is supported by the National Science Foundation through the Grants No. 11172310 and No. 11472284.

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CONTRIBUTED TALKS

CS-A2

SUBTHRESHOLD FLUCTUATION ANALYSIS OF EXCITATORY AND INHIBITORY (E-I) NEURAL SIGNALS FOR PRE-SEIZURE PREDICTION USING 1D WILSON-COWAN FORMALISM

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Neuronal signals which are measured during seizures and epileptic activities advocate that the individual nerve cells experience an activity depolarization block when they saturate. The effect of such saturation is studied using the Wilson-Cowan neural field equations by describing the dynamical behavior of a one-dimensional continuum of excitatory $E(x,t)$ and inhibitory $I(x, t)$ written as a pair of coupled integro-differential equations. The Turing-Hopf instability method is adopted to analyze the neurodynamical subthreshold fluctuation using the Ornstein-Uhlenbeck linearization with respect to different amplitudes of spatio-temporal white noise. The effects of noise on neurobiological significance are characterized using the spectral analysis and the wavelet scalogram to detect early indication of changes in the neocortical states. The model simulation is then corroborated with the observation of spiking activities before or during seizures.

CS-A3

STRUCTURE AND EVOLUTION OF UPM CO-AUTHORSHIP NETWORK IN JOURNAL PUBLICATION FROM 2007-2010

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Co-authorship is one of the most tangible forms of research collaboration. A coauthorship network is a social network in which the authors through participation in one or more joint publications are linked (undirectedly) to each other. The present work used social network analysis to study coauthorship network of UPM journal publications database for the first four years Research University (2007-2010) with the aid of Mathematica 11. The structure and evolution of the coauthorship network of publications between 2007 till 2010 was analyzed using the micro-level indicators such as degree centrality, closeness centrality, betweenness centrality and assortativity to observe changes of structure in the network over the early research university years. The study also determines the most connected authors and their influence among coauthors.

CS-A4

AUDIO ENCRYPTION BASED ON CHAOTIC FUZZY CELLULAR NEURAL NETWORKS

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In this work, the audio encryption method based on fuzzy cellular neural networks (FCNNs) is proposed. In order to improve the security in the process of audio files in Internet communication, first we identify the values of the parameters of FCNNs to generate chaotic signals, which are in turn utilized to encrypt the audio files. Using chaotic characteristics of dynamic system is a capable direction to play an essential role in audio encryption, i.e., information assertion and security.

CS-B1

DYNAMICS OF THE PROBE PARTICLE IN A FLOWING SOAP THIN FILM

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We successfully demonstrated an experiment on hydrodynamics by utilizing locally available materials consisting of a constrained probe particle in a vertically flowing soap film. In the experimental set-up, the end point of a nylon thread which serves as the probe particle is tied to another thread at the top of the flowing soap film. The position of the probe particle is recorded every 1/30 second and its movement is tracked using the home-based IDL particle tracker software. The fluctuations of the probe's position are characterized via the Mean Square Displacement (MSD) for different flow rates and lengths of the nylon thread. The dynamics of the probe particle is also investigated at an optimum length of the thread and flow rate with varying glycerin concentrations. Results have revealed that 11.0cm^3/min is the optimum flow rate and the probe particle at some point undergoes anomalous diffusion. For different flow rates, the MSD were found to have a complex dynamic with three scaling exponents needed to characterize the MSD, MSD ~ τ^{α}. Typically, for $\tau < \tau_{c1}$ (τ_{c1} ~ 0.04s), we found exponent to be α~1 thereby suggesting pure diffusion process. For $\tau_{c1} < \tau < \tau_{c2}$ (τ_{c2} ~ 0.30s), we observed that $\alpha > 1$, i.e. super-diffusion. At longer time scales, $\tau > \tau_{c2}$, we measured the exponent of τ to be α~1.

CS-B2

EXPERIMENTAL STUDY OF CLIMATE INSIDE THE GREENHOUSE EQUIPPED WITH THE PHOTOVOLTAIC PANELS

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Photovoltaic solar energy is an advantageous and competitive alternative to other traditional sources for both farmers and the development of the country. In a policy of solar integration in agricultural greenhouses, the objective of our study is to design and study the performance of a greenhouse equipped with photovoltaic panels on its roof so as to combine on the same surface the production of electricity and plant production. The first phase of this study consists of studying the influence of the presence of panels on the climate of the greenhouse. The results of the climate comparison in two greenhouses (photovoltaic and control) show that an occupancy rate of 10% of the roof of a greenhouse by flexible photovoltaic panels does not have a significant effect on the internal climate of the greenhouse.

CS-B3

NUCLEIC ACID BASED BACK TO BACK SCHOTTY DIODE

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A back-to-back Schottky diode configuration employing nucleic acid has been assessed for bio-sensing applications in disease detection. In this study, we demonstrate a novel identification method for nucleic acid using the electronic properties which offer simple, rapid, high sensitivity and low-cost. Current-voltage (I-V) characteristics for selected nucleic acid were obtained and its corresponding diode parameters: ideality factor, reverse saturation current, barrier height, turn-on voltage, shunt and series resistance, knee voltage, breakdown voltage as well as breakdown current, were then calculated and compared. These electronic properties may therefore offer a better method of detecting or identifying nucleic acids as each sequence may contribute to specific characteristic electronic signal. Therefore, we believe this novel technique will benefit mankind in future in terms of medical technology in pathology and diagnostics.

CS-B4

DEMONSTRATION OF ANOMALOUS DIFFUSION OF COMPRESSED GAS THROUGH A SEMI-PERMEABLE MEMBRANE

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We performed an experiment to demonstrate and determine the diffusive behavior of compressed air impacting a semi-permeable membrane. The air is pumped into an empty air tank resulting to a dense-gas system with recorded pressure of 5 psi. A valve is connected in between the air tank and the cylindrical gas chamber equipped with a semi-permeable

membrane. We observed surface area fluctuations of the circular probe on the membrane. Single particle tracking software reveals a damped oscillation behavior of the probe. We analyzed the fluctuations via the Mean Square Displacement (MSD). Our analysis of the Mean Square Displacements (MSD) of the surface area of the semi-permeable membrane showed anomalous diffusion with slope, $\alpha = 1.4$.

EXOTIC ATOMIC, MOLECULAR AND OPTICAL PHYSICS

INVITED TALKS

EA-A1

ELECTRON SCATTERING FROM TECHNOLOGICALLY IMPORTANT MOLECULES

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Knowledge of how electron collisions can excite or ionize molecular species is particularly important for understanding phenomena within plasmas and plasma-like environments. With improved descriptions of these collisional interactions that drive chemical processes, we can develop and refine plasma technologies to realise innovation, such as employing plasmas to overcome the natural recalcitrance of biomass in its conversion into functional materials. At Flinders, we have performed a range of electron scattering experiments to study excitation and ionization phenomena from molecules that are some of the prototypical structures found in biomass. In this presentation, results from our electron energy loss spectroscopy and dynamical (e,2e) instigations of phenol [1], furfural [2] and para-benzoquinone [3] will be discussed. In order to assess the limitations of describing complex systems through molecular subunits, we pay particular attention to the role of molecular structure in electron scattering phenomena. We also discuss our progress in performing new electron scattering experiments from molecular radicals.

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EA-A2

TOWARDS VISUALIZING THE DRIVING PRINCIPLE OF A CHEMICAL REACTION BY TIME-RESOLVED HIGH-ENERGY ELECTRON IMPACT SPECTROSCOPIES

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One of the goals in the field of chemical reaction dynamics may be to watch reactions in real time. Indeed, for instance, the time-resolved electron and X-ray diffraction technique has made it possible to visualize structural dynamics during chemical reaction. Nevertheless, there still remains the challenge, that is, to explore why the atoms are dancing in such a way. Our strategy for this one of future issues is along a simple view of chemistry; in a field-free environment, it is electrons that bind atoms into molecules and chemical reactions are all about rearrangements of these electrons. This is the material reason why we are developing a real-time spectroscopic complex using high-energy electron scattering. One of the constituents is a time-resolved version of (e,2e) electron momentum spectroscopy, whose target goal is to measure in real time the momentum distribution of each electron with different ionization energies in a decaying system [1-3]. The observed change in electron motion represents the driving force behind chemical reaction. The other is a time-resolved version of atomic momentum spectroscopy, which aims to measure in real time the momentum distribution of each atom with different mass numbers involved in a decaying system [4]. The measurement tells one about how and how much the change in atomic motions are brought about by the change in electron motion. In this contribution, we will report on the present status and future prospect of this new spectroscopic complex that may provide a completely new, momentum-space approach to studying chemical reaction dynamics.

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EA-B1

RESONANCES IN POSITRONIC LITHIUM IN PLASMAS

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Low-lying S-wave resonances in positronic lithium (e^+Li) embedded in plasma environments have been investigated within the framework of the stabilization method. Two types of plasma environments have been considered – classical weakly coupled plasma (WCP) and dense quantum plasma (DQP). Screened interactions in WCP and DQP have been taken care of by Debye-Huckel potential and exponential cosine screened Coulomb potential respectively. Two resonances have been found to exist lying below the Ps(n=2) excitation threshold. It has been found that the position of the resonances is pushed towards the Ps(2s) with increasing plasma screening strength for both plasmas. For the free atomic system, our reported results are in agreement with the results of other reliable calculations.

EA-B4

POLARIZABILITY OF EXOTIC MOLECULAR IONS IN MODEL PLASMA ENVIRONMENTS

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The study of atomic structure and spectra in dense plasma environments is one of the interesting and hot topics of current research [1]. In this talk, we intend to present our recent work on the polarizability of exotic molecular ions immersed in various model plasma environments. The computational scheme to estimate the polarizability for the proposed molecular three-body ions which contain positively charged muons and the selection of plasma backgrounds will be discussed at the meeting. The importance of our study will also be elucidated [2].
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CONTRIBUTED TALKS

EA-A3

RYDBERG TRANSITIONS FOR POSITRON-HYDROGEN COLLISIONS IN LORENTZIAN ASTROPHYSICAL PLASMAS

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The excitations of hydrogen atom to the highly excited states in positron-hydrogen collisions have been investigated in Lorentzian astrophysical plasma environments by applying a distorted

wave theory in the momentum space. Excitation cross sections are calculated as functions of the spectral index and plasma parameter for various incident positron energies in the range 20-300eV. It is found that the nonthermal effects of plasma significantly modify the excitation cross sections.

EA-B2

ON THE RANGE OF VALIDITY OF THE PLANE WAVE IMPULSE APPROXIMATION PICTURE FOR ELCTRON MOMENTUM SPECTROSCOPY

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Electron momentum spectroscopy (EMS) is a kinematically complete electron-impact ionization experiment under the high-energy Bethe ridge conditions [1,2]. Of particular note is that within the framework of the plane-wave impulse approximation (PWIA), the EMS cross section is directly connected to the electron momentum distributions of individual molecular orbitals (MOs).In other words, validity of PWIA is the key for promoting molecular spectroscopy with EMS. Nevertheless, many of previous EMS studies have routinely employed an incident electron energy (E_0) around 1.2 keV, and hence their arguments have been limited in an electron momentum range up to about 1.5 a.u. One of the illustrative examples of this is bond oscillation that gives modulations to EMS cross sections due to interference between the constituent atomic orbitals [3]; observation of EMS cross sections in a wide electron momentum range, where PWIA is valid, is required for a complete understanding of this phenomenon particular to momentum-space MOs. Under these circumstances, one may desire to identify and extend the range of validity of PWIA. To this end, we have started the challenge both experimentally and instrumentally. Experimentally, we have performed a series of EMS experiments on Ne and Xe atoms to identify how the range of validity of PWIA depends upon the E_0 value employed by using one of our symmetric-noncoplanar EMS spectrometers [4].It is found from comparisons between the experiment and theory that PWIA reproduces the experimental momentum distribution more closely in terms of not only shape but also intensity at a higher E_0 value. Instrumentally, we have tested various ideas in trajectory simulations and eventually found a completely new experimental technique that enables one to achieve a high energy resolution even at a much higher E_0 value [5]. In this contribution, we will focus our discussions on the experimental findings.

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EA-B3

CHARGE TRANSFER IN PROTON-HYDROGEN COLLISIONS UNDER ASTROPHYSICAL PLASMAS

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The charge transfer process in proton-hydrogen collisions under Lorentzian astrophysical plasma environments has been investigated within the framework of a distorted wave theory. Charge transfer cross section is reported as a function of the spectral index and plasma parameter for various incident positron energies in the range 20-1000keV. It is found that cross sections are modified significantly due to the effects of background plasma.

NUCLEAR PHYSICS AND RADIATION

INVITED TALKS

NR-A1

PROGRESS OF NUCLEAR ASTOPHYSICS PROJECT IN CHINA AND UNDERGROUND PROJECT JUNA

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Progress of nuclear astrophysics in China will be given, some of the recent lights below. β decay data are important input to the network calculation of astophysical rp-process. The β decay of ^{53,54}Ni, ^{52,53}Co, ^{51}Fe, and ^{50}Mn was investigated. The proton-γ coincidences of ^{53}Ni β-delayed proton emission were observed. The half-lives were evaluated and used in nucleosynthesis calculations of rp-process in an x-ray burst [1]. In addition, the IAS isospin mixing and their implications will be discussed [2]. Jinping Underground laboratory for Nuclear Astrophysics (JUNA) [3] will take the advantage of the ultra-low background of China Jinping Laboratory (CJPL) (rock depth 2400 m) and high current accelerator based on an ECR source and a highly sensitive detector to directly study for the first time a number of crucial reactions occurring at their relevant stellar energies during the evolution of hydrostatic stars. In its first phase, JUNA aims at the direct measurements of ^{25}Mg(p,γ)^{26}Al, ^{19}F(p,α)^{16}O [4], ^{13}C(α,n)^{16}O and ^{12}C(α,γ)^{16}O reactions.

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NR-A2

RIKEN RI BEAM FACTORY (RIBF)

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The RIKEN RI Beam Factory (RIBF) provides beams of nuclei very far from the nuclear stability valley, or radioactive isotope (RI) beams. Since 2007, when the new cyclotron complex started to operate, various fast (100-300 MeV/nucleon) RI beams using projectile fragmentation and/or in-flight fission have been used for a variety of experiments. Unique research opportunities for structure of exotic (neutron- or proton-rich) nuclei and roles of short-lived nuclei in astrophysical processes, especially for explosive nucleosynthesis attract world researches. Capability of RI beam production is highest in the world. An overview of the facility and recent research highlights will be presented.

NR-B1

NEUTRINO PHYSICS WITH THE TEXONO PROGRAM AT THE KUO-SHENG REACTOR NEUTRINO LABORATORY

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Germanium detectors with sub-keV sensitivities [1] offer a unique opportunity to study neutrino interactions and properties [2] as well as to search for light WIMP Dark Matter and axion-like particles [3]. The TEXONO Collaboration has been pursuing this research program at the Kuo Sheng Neutrino Laboratory (KSNL) in Taiwan. We will highlight our results on neutrino electromagnetic properties, search of sterile neutrinos, as well as studies towards observation of neutrino-nucleus coherent scattering. The detector R&D programs which allow us to experimentally probe this new energy window will be discussed. The efforts set the stage and complement the CDEX dark matter experiment and beyond at the new China Jinping Underground Laboratory (CJPL) in China.

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NR-B2

PROBING STRUCTURE OF LIGHT ATOMIC NUCLEI

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Atomic nuclei are finite quantum many-body systems consisting of protons and neutrons (known collectively as nucleons). Their structures are governed by the strong interactions. Extensive experimental and theoretical studies over the past decades have yielded sophisticated phenomenological realistic nucleon-nucleon, as well as (semiphenomenological) chiral two- and three-nucleon, interactions. However, it is still not possible to understand even the nuclear structures of relatively light nuclei such as carbon and oxygen isotopes. In this talk, I will introduce two recent experimental studies at RCNP. In the first work, we determined the proton distribution radii of neutron-rich carbon isotopes using radio-isotope beams, and obtained evidence for a proton subshell closure, which was partially predicted in 1963 [1]. The second work is related to the observation [2] of the effect of the tensor interaction, which is an important but largely unknown component of the realistic nucleon-nucleon interactions, in ^{16}O.

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NR-C1

PROGRESS OF RARE ISOTOPE SCIENCE PROJECT IN KOREA

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The use of rare isotopes existing in the world only at a very short moment (radioactivity with short lifetime) is increasing nowadays in various research fields, not only for basic researches in nuclear physics investigating origin of matter, synthesis of new atomic elements, and exotic nuclear structure of rare isotopes but also for applied researches in medical-bio-life science, materials and nuclear sciences.*In Korea, a new heavy-ion (HI) accelerator complex, RAON* (Rare isotope Accelerator complex for ON-line experiments)*, is under construction at Daejeon.* Fully utilizing the conventional diversity of HI beams, in addition to the new availability of rare isotope (RI) beams, RAON is intended to become one of the world-leading HI beam facilities. RAON could provide new research opportunities in rare isotope science, which is recently attracting many interdisciplinary scientists, manifesting itself in the form of a second renaissance in heavy ion science. Powered by a 400-kW superconducting heavy ion linear accelerator, RAON is intended to establish the In-flight Fragment (IF) and Isotope Separation On-Line (ISOL) facilities. Prototyping major accelerator components is almost complete, and the fabrication of major components will start soon. Following a brief overview of the project and facility RAON, the progress on the development of some components, especially important for an accelerator system to be integrated at an off-site test facility for demonstrating the successful operation of the front-end of the RAON, is presented.

NR-C2

IRRADIATION FACILITIES AT NUCLEAR MALAYSIA FOR INDUSTRIAL PRODUCT DEVELOPMENT

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The Malaysian Nuclear Agency owns several facilities that provide irradiations services for various purposes. Gamma irradiation has been used mainly for chemical free sterilization and decontamination of local produces. The facility had serviced many local SMEs to further add value to their products such as rubber gloves, medical devices, herbs & spices and local produce. Crosslinking of polymers by electron beam irradiation is the greener alternative to chemical loaded conventional methods. Manufacturers of wire & cable, heat shrinkable tubing and superconductors have benefited from the service provided by Nuclear Malaysia. The research reactor TRIGA MARK II, now in its 35^{th} year of criticality, is the main source of irradiation for isotope production as well as other neutron based experimental activities such as neutron radiography and Small Angle Neutron Scattering.

NR-A3

NEXT GENERATION OF HADRON DRIVER FOR CANCER THERAPY

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A next generation cancer therapy driver by using the fast-cycling and inductionsynchrotron is given. Therequirement of the lattice parameterswith the zero momentum-dipersion and high-flat momentum-dipersion region , continuos enegy sweep scanning technique and extraction system are discussed here with the computer simulation results.

NR-A4

BAND-HEAD SPECTRA OF RARE-EARTH NUCLEI WITHIN A SELF-CONSISTENT BLOCKING APPROACH

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Description of nuclear properties of odd-mass nuclei using mean-field method in general diverges into two main approaches with respect to the treatment of time-reversal symmetry. As a consequence of an unpaired nucleon in odd-mass nucleus, the time-reversal symmetry is not conserved at the mean-field level. One simple approach is to neglect the time-reversal symmetry breaking along the so-called equal-filling approximation. A proper manner, however, is to include extra terms in the Hamiltonian density as a consequence of this symmetry breaking. The latter has been applied for e.g. in the calculations of fission-barrier heights, band heads energies and magnetic moments of some odd-mass nuclei. However, the application of such approach around rare-earth region is still lacking. We will present the application of the Hartree-Fock-plus-Bardeen-Cooper-Schrieffer (HF-BCS) method with a self-consistent blocking procedure to describe the band-head spectra of some selected rare-earth nuclei. The effective nucleon-nucleon and pairing interactions are approximated by the SIII Skyrme parameters set and seniority force, respectively. The pairing strengths were determined through a fit to experimental odd-even staggering of a wide range of rare-earth nuclei. In our calculations, we consider only axially symmetrical nuclear shape while the intrinsic parity symmetry is conserved. Comparison of our calculated band-head energies to experimental data will also be presented.

NR-A5

THERMAL PROPERTIES OF SUPERHEAVY NUCLEI WITH TEMPERATURE-DEPENDENT PAIRING ENERGY

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The influence of using a temperature-dependent pairing term on the back-shifted Fermi gas (BSFG) model of nuclear level density of some superheavy nuclei has been investigated. The exact Ginzburg-Landau (EGL) theory was used to determine the temperature-dependent pairing

energy as back-shifted parameter of the BSFG model. Thermal properties of some Superheavy nuclei with temperature-dependent pairing energy have been represented.

NR-B3

MEASUREMENT OF FISSION PRODUCTS GAMMA SPECTRA OF REACTOR TRIGA PUSPATI'S FUELS

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The fission product gamma spectra of Reactor TRIGA PUSPATI's fuel have been measured at several cooling times following 30000-s exposure time in-situ and underwater of the reactor. The signature fission product gamma energies i.e. Cs-137 & Am-241 were identified and the total gamma energies were obtained by integrating over the energy spectra. They were also compared in a series of figures.

NR-B4

NUCLEAR FUEL ROD SIMULATOR

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Physical simulation of nuclear fuel rod was performed using a specially designed electrical heated test section. This study investigates heat flow behaviour through design and fabrication of one educational unit lab-scale reactor tank. The heat transfer properties of the vertical heat tube within an assembly of mechanical traysare measured systematically via an array of thermocouples. Experimental results reveal both axial and radial profiles of heat transfer coefficient.

NR-C3

EFFECT OF PAIRING CORRELATIONS ON BAND-HEAD SPECTRA OF RARE-EARTH NUCLEI WITHIN HIGHLY TRUNCATED DIAGONALIZATION APPROACH

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Pairing correlations play an important role in the description of nuclear properties such as binding energy, odd even effect and even more so when going towards extremely deformed nuclear shapes. It is therefore important that pairing is treated in the best way possible within any theoretical framework. We are interested in exploring effect of pairing correlations within the Highly Truncated Diagonalization Approach (HTDA) framework which conserves the particle number symmetry. Calculations within the Hartree-Fock-plus-Bardeen-Cooper-Schrieffer (HF-BCS) framework were first performed by blocking a single-particle state corresponding to the experimental nuclear spin and parity quantum numbers. The effective nucleon-nucleon and pairing interactions are approximated by the SIII Skyrme parameter set and density-dependent delta interaction, respectively. The intrinsic HF-BCS solutions were then used for the HTDA calculations. The pairing strengths in the HTDA framework were determined by reproducing the experimental moment of inertia for a set of rare-earth nuclei. In this presentation, we will present the band-head energies of some odd-mass rare earth nuclei within both the HF-BCS and HTDA approaches.

EFFECT OF DEFORMED SURFACE DIFFUSENESS ON FUSION AND ALPHA DECAY

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The mean-field nuclear potential is an essential quantity in both nuclear structure and nuclear reaction. The surface diffuseness parameter of Woods-Saxon type potentials plays an important role in alpha-decay and heavy-ion reactions calculations. By using new form of deformed surface diffuseness and considering Woods-Saxon potential the alpha decay half lives of some deformed lanthanide and actinide nuclei have been calculated. The barrier characteristics and fusion-cross section of alpha-induced reactions and 16O-induced reactions on some deformed lanthanide and actinide target nuclei have been studied by using Wong formula of fusion cross section and taking into account Broglia-Winther nuclear interaction potential. Significant differences between theoretical calculations with deformed and constant surface diffuseness were observed. It may be concluded that deformed surface diffuseness plays a significant role in alpha decay and heavy-ion fusion studies.

PARTICLE PHYSICS AND FIELDS

INVITED TALKS

PF-A1

VERTEX FUNCTION OF GLUON-PHOTON PENGUIN

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The Standard Model is highly successful in describing the interactions of leptons and quarks. There are, however, rare processes that involve higher order effects in electroweak interactions. One specific class of processes is the penguin-like diagram. Such class of diagrams involves the neutral change of quark flavours accompanied by the emission of a gauge boson such as a gluon (gluon penguin), a photon (photon penguin), a Z-boson (Z penguin), or a Higgs-boson (Higgs penguin). There are also diagrams that involve the emission of two gauge bosons, such as two gluons (double gluon penguin), two photons (double photon penguin), and a gluon and a photon (gluon-photon penguin). These diagrams do not occur at the tree level in the Standard Model. They are, however, induced by one-loop effects. In this paper, we present an exact calculation of the vertex function of the double photon penguin. We perform the calculation in the 'tHooft-Feynman gauge. Renormalization of the vertex is affected by a prescription by Chia and Chong which gives an expression for the counter term identical to that obtained by employing Ward-Takahashi identity. The on-shell vertex functions are obtained.

CONTRIBUTED TALKS

PF-A2

KAON STRUCTURE IN THE CHIRAL EFFECTIVE QUARK MODEL

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It is widely known that the kaon consist of a quark-antiquark pair. This shows the structure of the kaon simpler than the nucleon and hence the dynamics of quarks inside the kaon may be easier to study than inside the nucleon. This gives us a great opportunity to gain useful information of the dynamics of quark inside the kaon, which may eventually be applied to study the dynamics of quarks inside the nucleon and to understand the QCD as the underlying theory. In this work the kaon structure will be studied by means of the parton distribution functions (PDFs) within the chiral effective quark model. From the Lagrangian of the model, the dynamics mass of quark or antiquark are generated by interaction with the vacuum state and the chiral spontaneously symmetry breaking is realized. However the chiral effective quark model has a divergent in the loop integral, therefore a specific regularization will be chosen to cure the divergence. In this study the proper time regularization (PTR) scheme is applied. In this regularization the infrared cutoff removes the imaginary part of the loop integral to eliminate the unphysical domain for hadron decay into quarks and simulates confinement. Thus these dynamical features of the kaon in the chiral effective quark model are used as an input into PDFs to describe the kaon structure. In the near future the new data for kaon are expected from CLAS, JPARC and COMPASS experiment at CERN as well as the future EIC (Electron Ion Collider) experiment. The result of this work will be tested using those new experimental data. On the other hand, the comparison between our model predicted and experimental data will lead us to new understanding of the kaon structure and QCD as underlying theory.

PF-A3

EFFECT OF COLOUR SINGLET ON PHASE TRANSITION FROM HADRONIC GAS TO PARTONIC PLASMA

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Phase transition is among the most important phenomena in physics. In Thermal Quantum ChromoDynamics (QCD), Deconfinement Phase Transition (DPT) provides one such example. Due to the confinement of colour charge, all hadrons are colourless and consequently, the whole partonic plasma fireball needs to be in a colour singlet state called colourless QGP (cQGP). From the different behaviour of thermodynamic quantities of the system such as the energy density and the pressure, which are obtained in the context of our model, we try to analyze the DPT phenomenon in a finite system, without/with the colour singlet condition.

PF-A4

BIFURCATION AND TRANSITION OF MULTIPLE CHARGED ONE-PLUS-HALF MONOPOLE SOLUTIONS OF THE SU(2) YANG-MILLS-HIGGS THEORY

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In this paper, we report on the electrically neutral one-plus-half monopole configuration of the SU(2) Yang-Mills-Higgs Theory when the φ-winding number, n, runs from 2 to 6 and for a range of Higgs coupling constant, $\lambda_b \leq \lambda \leq 40$, where λ_b is the lower bound, below which no solution can be found. Bifurcation and transition are observed when $n > 2$ and when the Higgs coupling constant is larger than some critical value, λ_c and λ_t, respectively. It is found that there are two different bifurcatory families of solution above the fundamental solution with higher energies for the case where $n = 3$, and for $n > 3$, the bifurcation is found to have different structures. All solutions possess finite energy and magnetic moment. The magnetic field and the Higgs modulus of the solutions are plotted and analyzed.

PF-B1

TWO DIMENSIONAL PLANE, MODIFIED SYMPLECTIC STRUCTURE AND QUANTIZATION

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Non-commutative quantum mechanics on the plane has been widely studied in the literature. Here, we consider the problem using Isham's canonical group quantization scheme for which the primary object is the symmetry group that underlies the phase space. The noncommutativity of the configuration space coordinates require us to introduce the 'noncommutative term' in the symplectic structure of the system. This un-natural symplectic structure will modify the group acting on the configuration space from abelian $\mathbb{R}2$ to a nonabelian one. In result, the canonical group obtained is a deformed Heisenberg group and the "canonical" commutation relation (CCR) corresponds to what is usually found in noncommutative quantum mechanics.

PF-B2

BRANCHING BEHAVIOR OF DYONIC MULTI-MONOPOLE WITH MULTI-HALF MONOPOLE

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It is known that dyonic multi-monopole solutions are found in SU(2) Yang-Mills-Higgs theory, such as MAP and MAC dyons. There have finite energy and electrically charged. When the φ-winding number, $n > 2$, branching started to happen at a critical Higgs coupling constant, $\lambda \geq \lambda c$ at each branch of solution. It is found that branching occurred in dyonic multi-monopole with multi-half-monopole solutions too. In this paper, we study on their branching behaviors for $2 \leq n \leq 6$ across $\lambda_b \leq \lambda \leq 25$ at some finite electric charge parameter η, where λ_b is the bottom limit of λ. There is only one fundamental solution when $n = 2$, which is known as 2-dyon plus 2-half-dyon. When $n \geq 3$, each of them possesses a bifurcating new solution besides the fundamental one. These branching solutions possess different structures and energy. At some transitional lambda, $\lambda \geq \lambda_t$, these solutions turn into vortex rings with half monopoles. We investigate on the total energy, pole-separation, magnetic moment and electric charge for different λ.

PF-B3

KILLING TENSOR OF FIVE DIMENSIONAL MELVIN'S SPACETIME

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Killing tensors are generalizations of Killing vectors as objects that reflect the symmetries of spacetime. With recent interest in higher-dimensional spacetimes, construction of Killing tensors from lower dimensional ones may be useful. Our focus lies in the (4+1) dimensional Melvin's spacetime which describes a magnetic universe with a cylindrical symmetry. We constructed the Killing vectors and Killing tensors in 5-dimensional Melvin's spacetime. The Killing tensors are linear combination of a scalar times a metric and respective symmetric products of Killing vectors similar to those found by Garfinkle and Glass for the 4-dimensional ones.

PLASMA PHYSICS

INVITED TALKS

PP-A1

ELECTRIC FIELD EFFECT ON ELECTRIC PROBE OPERATING IN PLASMA FOCUS DEVICE

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Plasma Focus Device (PFD) has been investigated by many researchers because it can be used as a source of radiation includingions in many applications. However, the investigation and characterization of plasma, ions and radiation are difficult and challenging due to the short duration pulse and harsh electrical environment during the operation of the device. Many researchers used electric probe to measure ions generated by the device and found that high energy ions can be generated by PFD. This work investigates the sensitivity of electric probe to variation of strong electric field produced by a 2.3 kJ PFD. The results obtainedby simulation is compared with actual experimental results. The results show that, the electric field can severely affect the signal of the electric probe operated without proper grounding around the probe as it can induce sufficient current within the probe. This can lead to misinterpretation of ions signal or photoelectric signal detected from PFD especially during the focusing phase.

PP-A2

EFFECT OF VARIOUS PARAMETERS ON REFLECTION, TRANSMISSION, AND ABSORPTION COEFFICIENTS IN AN INHOMOGENEOUS PLASMA SLAB

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This research deals with how to calculate the absorption coefficient, transmission and reflected in inhomogeneous magnetized cold plasma slab, it then examines the impact of various factors on the coefficients. Here, each plasma slab consists of some parallel slabs that each slab has a constant density; but, on the whole the slabs follow a specific function. Plasma density is taken as parabolic function with maximum density in center and minimum density on edges. The absorption, reflection and transmission coefficients are affected by internal and external magnetic fields, plasma density, frequency, thickness of plasma and etc. This study examines how these parameters affect the absorption, reflection and transmission coefficients.

PP-A3

NON-THERMAL PLASMA RESEARCH AREAS IN TNB RESEARCH SDN. BHD.

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Non-thermal plasma (NTP) at low bulk temperature with low power consumption makes it a flexible technology that can be applied in various processes. We present the results of applying NTP in the combustion facility at the TNB Research Sdn. Bhd. (TNBR), a research institute wholly owned by Malaysia's largest power generation company, Tenaga Nasional Berhad. A dimensionless correlation has been developed to characterize the energy characteristics of NTPs of various configurations. The correlation can be used to differentiate and group the NTPs according to their discharge power relative to the capactive energy in the dielectric gap. A separate planar-to-planar (DBD) has been used to investigate the effects of NTP treatment on biomass surface properties in terms of its chemical scavenging activity and functional group compositions.

PP-B1

COST EFFECTIVE NON THERMAL PLASMA DEVICES

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In recent years, there have been much effort by researchers from developing countries to explore the feasibility of using a range of small non thermal plasma devices to test processes that may be useful in industry. The small non thermal plasma devices that are most widely studied are those operated at atmospheric pressure. The operation of a device at atmospheric pressure will help to reduce the setting up cost of the device as well as simplifying the operation procedure.
Another cost factor in the setting up of small plasma device is the power supply required to power the discharge. The cheapest option is to use the household alternating electricity supply (AC). For low current at mA range as required by non thermal plasma generation, the 230 V voltage level can be stepped up by using an adjustable transformer (a variac). In this talk, we are going to share our experience on working with several cost effective plasma devices. These include the glow discharge, the dielectric barrier discharge and the non thermal plasma torch.

PP-B2

CESIATED TUNGSTEN DUST IN PLASMA VOLUME: A NEW SOURCE OF NEGATIVE ION

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The novelty of generation of negative hydrogen ions using cesium coated tungsten dust grains suspended in the plasma volume is to increase the low work-function surface area with respect to the plasma volume significantly. This efficient surface production mechanism thereby increases the negative ion yield. Recently, it has been proved at Centre of Plasma Physics, Institute for Plasma Research (CPP-IPR) [1,2]. The generation of negative hydrogen ions and its subsequent effort to investigate the possibility of extraction of these ions are being pursued due to the possibility of its wide variety of significant applications in fusion plasma devices,

particle accelerators, surface modifications and biomedical fields. For this purpose, a negative ion extraction experimental system has been developed at CPP-IPR. The surface assisted volume negative ion source has an advantage that negative ions are produced isotropically around the dust grains in the plasma volume and thus it is not required to reverse the direction of the negative hydrogen ions for extraction. The ion source is floated negatively with respect to the extraction chamber with a potential difference of 30 kV DC total. The first phase of experiment related to the production of hydrogen plasma by filament discharge method at low pressure (~10^{-4} mbar) and its characterization at different system parameters in the new experimental system of floating configuration is being initiated. A hydrogen plasma of density ~10^{18} m^{-3} and electron temperature 1-2 eV is produced in the ion source with full line cusp magnetic cage made of samarium cobalt magnets having surface field strength~3.5 kGauss. Different diagnostics have been used for measurement of negative ion density in the ion source. The ion source is expected to deliver a hydrogen negative ion beam of 300 mA at 12 kV with three numbers of extraction apertures of the three grid extractor system in the initial phase of operation. The ion beam current will be measured by an array of Faraday cup assemblies. The possibility of increasing the negative ion conversion yield by enhancing the cesium monolayer on tungsten dust grains, dust number density and plasma density, and also the role of reduction of electron temperature will be emphasized. The performance of the extracted beam will also be discussed. The presentation will highlight the current status, initial experimental results and the proposed experimental plan of the negative ion extraction experiment.

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PP-B3

SURFACE TREATMENT OF PET AND PP BY ATMOSPHERIC PRESSURE DIELECTRIC BARRIER DISCHARGE FOR IMPROVEMENT IN HYDROPHILICITY

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Recently, much attention has been paid to the use of low temperature plasmas under atmospheric pressure for surface treatment of materials due to their many advantages over conventional methods of treatment. Among various plasma sources, atmospheric pressure dielectric barrier discharge (DBD) using line frequency (50 Hz) is attractive for industrial applications. This paper reports the study of surface modification of Polyethylene Terephthalate (PET) and polypropylene (PP) by DBD to improve the hydrophilicity of the polymers. The discharge was generated by using a high voltage power supply (V_{pp}=50 kV) operating at line frequency. The samples before and after the treatment were studied using contact angle measurements, surface free energy calculations, Scanning electron microscopy (SEM) and atomic force microscopy (AFM). Contact angles of three test liquids: distilled water, glycerol and diiodomethane with the polymer sample were used to determine total surface free energy and its polar and non-polar components. The results showed a remarkable decrease in contact angle with plasma treated samples indicating an improvement in hydrophilicity after the treatment. SEM and AFM analysis revealed that plasma treatment introduces greater roughness on the surface leading to the increased surface free energy. Furthermore, it was found that introducing a small quantity of argon to produce the discharge can enhance the surface treatment remarkably.

PP-A4

VARIATIONS OF THE NEUTRON YIELD IN MALAYSIAN NUCLEAR AGENCY PLASMA FOCUS (MNA-PF) OPERATING IN DEUTERIUM-ARGON MIXTURE

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In pure deuterium environment, the optimized MNA-PF device can emit 7500 neutrons per shot. Previous studies have shown differences on neutron yield when using noble-gas doping. Therefore, the percentage variation of deuterium-argon mixture as filling gas on the neutron yield in slow focus mode MNA-PF are studied.MNA-PF is driven by 30 μF capacitor and charged at 15 kV with peak discharge current of 85 kA. Neutron yields on pure deuterium and deuterium-argon mixture are shown. Lee Model Code is used forcurrent fitting to the experimental parameter and the numericalresults based on the fitting are obtained. The differences between pure deuterium and deuterium-argon mixture in their breakdown voltage, time-varying inductance, and speed factor are presented.

PP-A5

50 HZ ARGON PLASMA TREATMENT ON POLYSTYRENE SURFACE

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Plasma treatment can be used to modify the morphology, characteristics and structure of surfaces of materials such as glasses and polymers. When treated using plasma, functional groups such as the hydroxyl, carboxyl and amino groups, can be incorporated to the surface of polymers, leading to increased wettability and enhanced adhesion properties of the surface. Hence, these unique properties can allow improved and expanded applications of polymers in food packaging and biotechnology. In this paper, we present a 50 Hz Argon plasma that was used to modify the surface of polystyrene (PS). The optimum treatment duration to enhance the wettability of PS surface was 3 min, whereby the water contact angle (WCA) of the untreated PS of (91 ± 7)° was reduced to (21 ± 3)° after treatment by the plasma that was sustained with inter-electrode voltage of (515 ± 6) kV and current (2.45 ± 0.06) mA in Argon gas flow of (36 ± 1) sccm at (0.274 ± 0.007) mbar. Increasing the inter-electrode voltage was found to enhance the wettability of the PS surface. The wettability of the plasma-treated PS surface tended to revert to its pre-treatment state rapidly within the initial one-day period, and maintained at a stable level after that.

STATISTICAL PHYSICS

INVITED TALKS

SP-A1

GENERIC MARKOVIAN MASTER EQUATION FOR A QUANTUM OSCILLATOR AND ITS SOLUTIONS

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We construct the most general Markovian Master equation for a quantum oscillator that conserves probability and preserves the hermiticity of density operators. We then derive the Baker-Campbell-Hausdorff formula of its time evolution operator, and obtain the analytic solutions to the generic master equation. By requiring the stationary states of the solutions to satisfy a factorized condition, various master equations can be divided into a few types. They include the well-known ones, which are used in the studies of quantum information, quantum Brownian motion, quantum optics and etc., as well as their generalizations. While we require the time-dependent density operators be positive, we obtain conditions on the parameters of the master equations that ensure a positive time evolution of the system.

SP-A2

LATTICE MODELS ON CAYLEY TREE WITH COMPETING INTERACTIONS

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The existence of competing interactions lies at the heart of a variety of original phenomena in magnetic systems, ranging from the spin-glass transitions found in many disordered materials to the modulated phases with an infinite number of commensurate regions, that are observed in certain models with periodic interactions. The similarity of results obtained for models defined on Cayley trees and on crystal lattices is a strong motivation for the study of models on trees, since the statistical mechanics on trees presents many simplifying aspects that are absent in models defined on crystal lattices. This suggests that more complicated models should be studied on trees first, with the hope to discover new phases or unusual types of behaviour. The important point is that statistical mechanics on trees involve nonlinear recursion equationsand are naturally connected to the rich world of dynamical systems, a world presently under intense investigation. We consider the following kinds of bonds on the Cayley tree: the first-, second- and third nearest neighbors, where spins for second- and third nearest neighbors can belong to the same branch of the tree as well as different branches. In our talk we review well-known results about models on Cayley tree with competing interactions on the first-, second- and third nearest neighbors, and present some new results.

SP-A3

ACTIVE MATTER DRIVEN ACTUATORS: ACROSS LENGTH SCALES

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Active matter refers to a bath composed of self-propelling particles. The non-equilibrium nature of the bath results to possible extraction of work from the bath itself. In this talk, I will discuss universality of this energy extraction principle at different length scales. First, I will discuss experiments done to power and control sub-mm sized channels using the tactic behavior of the slime mold, *Physarum polycephalum*. I will also report on the rotational dynamics of an asymmetric gear (50 mm diameter) powered by a bath of active granular chains.

SP-B1

BIOPHYSICAL MODELLING AND SIMULATION OF COMPLEX MOLECULAR SYSTEMS

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Patterns and complex behavior observed in biological cells can arise from basic reaction-diffusion interactions at the molecular scale. Cell division, polarisation and migration are some of the systems strongly coupled with the diffusion and spatiotemporal localisation of signalling protein molecules. In addition to noisy reactions from low reactant numbers, the stochastic nature of the molecular interactions can also induce oscillations and excite systems in space and time. Molecular mechanisms driving these systems can be uncovered using realistic biophysical models and simulations employing parameters measured experimentally. We can verify the model by comparing simulation outcomes with wild-type and mutant phenotypes of the system. We have developed a stochastic reaction-diffusion method, called Spatiocyte to realistically model and simulate complex biomolecular systems at single molecule resolution. Here, I will talk about the Spatiocyte method and its application in building realistic models of bacterial cell division, amoeba migration and neuronal polarization systems. The simulation models have revealed some of the basic molecular mechanisms driving the systems. I will also talk about our recent progress in improving the performance of the simulator and the application of machine learning techniques to predict system parameters.

SP-B2

IRREVERSIBILITY AND ENTROPY PRODUCTION IN NON-EQUILIBRIUM SYSTEMS

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The thermodynamics associated with the irreversibility in stochastic trajectories of a probe particle is examined both theoretically and experimentally in colloidal transport[1-3] and electric RC circuits[4,5]. Entropy production in non-equilibrium steady-states can be calculated and verified in experiments, detailed balanced are observed to be violated to different extend as the system is driven further away from equilibrium. Non-Boltzmann steady-state distributions, forward and reverse transition probabilities are examined theoretically for these NESS state and the results are verified in experiments.

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SP-A4

SIMULATING INTRACELLULAR EXCLUDED VOLUME EFFECTS AT SINGLE MOLECULE RESOLUTION WITH A LATTICE-BASED APPROACH

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Intracellular environment is spatially inhomogeneous and crowded with macromolecules. Volume exclusion arising from molecular crowding can alter protein diffusion behavior and reaction kinetics. The effects of crowding in reaction networks can first be studied with a simple bimolecular reaction system. Particle-based simulation approaches such as Brownian dynamics and Green's Function Reaction Dynamics, although accurate, are computationally expensive to study crowding, which involves many interacting molecules. Typical time- and length-scales covered by particle-based methods are much smaller than the scales where emergent behavior can be observed in cells. Other methods based on the Reaction Diffusion Master Equation have much lower computational cost but cannot realistically recapitulate the effects of crowding because molecules are not represented explicitly in space. Here, we adopt a lattice-based approach that represents each molecule explicitly in space and can thus incorporate the effects of crowding. The approach is accurate and computationally efficient in solving bimolecular reaction and diffusion at dilute conditions. However, as the fraction of excluded volume increases, the diffusion behavior deviates from the continuum counterpart due to the spatial discretization artifacts. We study the auto-crowding diffusion behavior in lattice, in comparison to the continuous space. We then develop a new scheme to overcome the lattice artifacts. Finally, we study the influence of excluded volume on bimolecular reaction rates and discuss its implication in reaction networks

SP-B3

DYNAMICS OF *PHYSARUM POLYCEPHALUM* POWERED MM-SIZED GEAR

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We have designed an mm-sized asymmetric gear and studied its dynamics in a bath of *Physarum polycephalum* under laser illumination (λ = 450 nm). Using video microscopy and single particle tracking, we were able to measure the rotation as well as the angular frequency of the gear. Our results reveal oscillatory component of the angular rotation of the gear with frequencies within the range of the measured shuttle streaming of *P. polycephalum*. Furthermore, using Fluctuation Theorem the torque generated by the *P. polycephalum* was measured at about N=6510 pN·nm. Our results constitute an initial study of making use of the *P. polycephalum*to power actuators for microfluidic applications.

ELECTROTAXIS OF THE *PHYSARUM POLYCEPHALUM* CELLS PROBED BY TRACTION FORCE MICROSCOPY

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Cell movement on the underlying substrate is a complex phenomenon which is essentially driven by the actin-myosin network. In this paper, we show the dynamics of the Physarum polycephalum cells as they respond to an electrostatic environment. The directional hint of physarum cells streaming towards the cathode is provided by the DC electric field. Using traction force video microscopy, we tracked the movement of the micro-sized polystyrene beads embedded on a polyacrylamide (PA) gel substrate coated with collagen. The movement of the physarum cells displace the microscopic beads. Our results showed a fluctuating trajectory of the beads. The probability distributions of the beads' displacement follow a Gaussian distribution at different time scales. Furthermore, we show that the traction force generated by the migrating plasmodia cells are calculated from the measurement of deformations of PA gel by using particle image velocimetry.