Press Release

Sept. 20 2024
Association of Asia-Pacific Physical Societies (AAPPS)
Division of Plasma Physics (AAPPS-DPP)

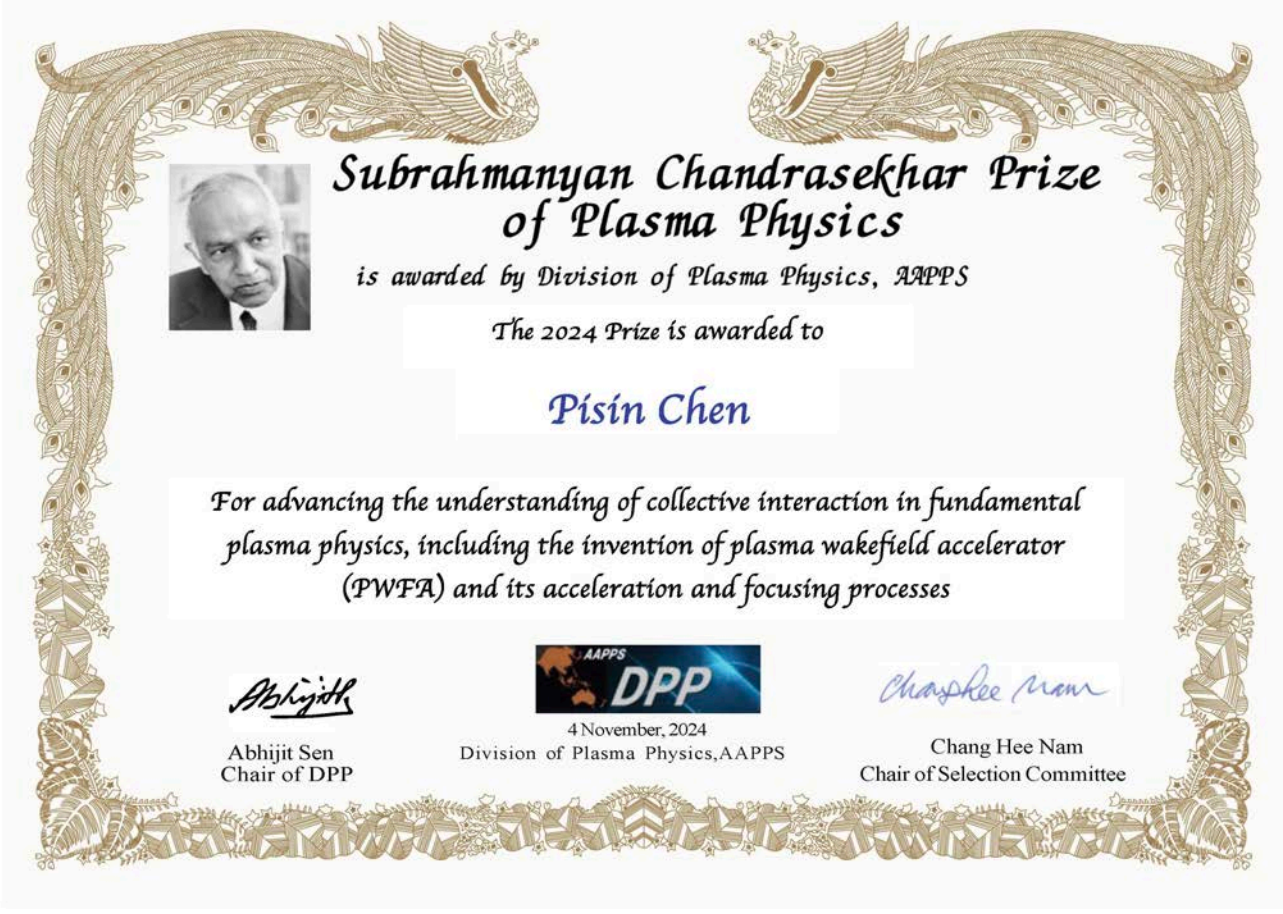
Subrahmanyan Chandrasekhar Prize of Plasma Physics

– Professor Pisin Chen is selected as 11th (2024) Laureate –

The Division of Plasma Physics (CEO: Mitsuru Kikuchi, Chair: Abhijit Sen) under the Association of Asia Pacific Physical Societies (President: Hyoung Joon Choi) has selected Professor Pisin Chen of the National Taiwan University as the 11th (2024) Laureate of S. Chandrasekhar Prize of Plasma Physics, which is awarded to scientist who have made seminal / pioneering contributions in the field of plasma physics.

Citation:

Pisin Chen: For *advancing the understanding of collective interaction in fundamental plasma physics, including the invention of plasma wakefield accelerator (PWFA) and its acceleration and focusing processes.*



Certificates of 2024 S. Chandrasekhar Prize of Plasma Physics

Certificate, medal and cash prize will be given at the 8th Asia-Pacific Conference on Plasma Physics (AAPPS-DPP2024) Nov. 3-8, 2024 at Grand Swiss-BelHotel, Malacca.

Contact points：

AAPPS-DPP Association Inc. : Representative Director and CEO, Mitsuru Kikuchi, TEL: +81-80-1115-3482
AAPPS-DPP Homepage Address：http://aappsdpp.org/AAPPSDPPF/index.html

Press Release

On the achievements of Professor Pisin Chen

Prof. Pisin Chen

Professor Pisin Chen is internationally recognized as the inventor of the plasma wakefield accelerator (PWFA) concept in 1985. In this paper, he and coauthors demonstrated that a relativistic charged particle beam traversing a plasma can be equally effective in exciting plasma waves as that by a laser pulse (LWFA), which was proposed by Tajima and Dawson in 1979. By now LWFA and PWFA have become the two major plasma accelerator schemes under active pursuit worldwide. Historically, the term *plasma wakefield* was born because of the PWFA invention. The concept of PWFA, and its first demonstration, was achieved in the 1980s, explored in the decades since, and today, a vibrant community drives forward their development and exploitation at numerous smaller, medium-sized and large laboratories, including CERN.

In the following two years since this seminal paper, Prof. Chen published two more seminal papers that have further developed the theoretical foundation of PWFA. In his 1986 paper, he demonstrated mathematically that the energy gain restricted by the Fundamental Theorem of Beam Loading can be ameliorated through the breaking of the head-tail symmetry of the driving beam density profile. He further introduced a new theorem that provides the optimum beam density profile for the maximum *transformer ratio* (the ratio of the maximum accelerating wakefield behind the driving beam to the maximum retarding field experienced by the driving beam). He further contributed to the understanding of critical beam dynamics issues in plasma wakefield accelerators, including beam loading, dephasing, phase slippage, pump depletion, etc. Then in 1987, he discovered the relativistic particle beam self-induced plasma focusing effect, and, based on that, proposed a plasma lens for the final focus in future high energy linear colliders. These three papers completed the trilogy of the PWFA principle.

He extended himself from a pure theorist to an experimentalist in the 1990s to lead the SLAC-E150 Plasma Lens Experiment. In 2000, his experiment observed for the first time the plasma lensing of not only high energy electron beams, but also positron beams with a focusing strength more than a thousand times stronger than that of the conventional magnets, as he predicted in 1987. The invention of PWFA was pathbreaking in the energy frontier, while the discovery and application of plasma self-focusing was pathbreaking in the luminosity frontier. Both are equally essential to future high energy physics.

Concurrent with and independent of Prof. Tajima's publication, Prof. Chen proposed in 1987 the use of conduction-band electrons in solid state material such as metals to excite plasma wakefields by x-rays to accelerate particles along crystal channels. Such nano-scale plasma wakefield accelerators promise to offer an acceleration gradient that is two-to-three orders of magnitude even higher than that in LWFA and PWFA based on gaseous plasmas.

Trained as a theoretical particle physicist, Professor Chen has made prolific contributions across many fields of physics, including particle astrophysics, cosmology, and gravity, in particular classical and quantum black hole physics. While pursuing these fields, he always connected them with the plasma wakefield principle. In astrophysics, he, together with Prof. Toshiki Tajima, proposed in 2002 plasma wakefield acceleration as the origin of the observed ultra-high energy cosmic rays. In 2017, he proposed, with Prof. Gerard Mourou, the 2018 Nobel Laureate, to accelerate laser-induced relativistic flying plasma mirror by tailoring the target density, which acts as an analog black hole to investigate the celebrated black hole Hawking radiation and its associated *information loss paradox* in the laboratory setting. Currently, he leads the international AnaBHEL (Analog Black Hole Evaporation via Lasers) Collaboration that includes research teams from Taiwan, France, and Japan, to carry out such an experiment. These efforts have helped to extend the role of plasma physics in tackling critical issues in other frontier fields of physics.

Fig. 1: The particle beam driven Plasma Wakefield Accelerator (PWFA) is analogous to what happens in this photo. The mother duck exerts her energy to pump the water wakes, while the ducklings enjoy the free ride by sitting on the crest of the wake. In PWFA, a higher current charged particle beam injected into a plasma would excite the plasma wakefields, while a lower current beam trailing with a proper distance would pick up the energy and be accelerated.

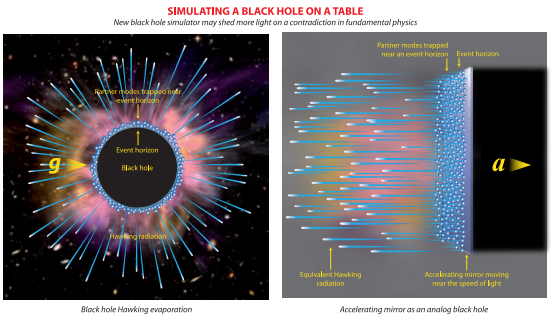


Fig. 2: Accelerating mirror as an analog black hole. Left: Black hole Hawking evaporation and the trapping of the partner modes near the horizon. Right: An accelerating mirror also has a horizon and can also emit Hawking particles and trap their partner modes. The analogy between these two systems may be appreciated via Einstein's equivalence principle.

Professor Pisin Chen is the Chee-Chun Leung Distinguished Chair Professor of Cosmology at National Taiwan University. He received his BS degree from NTU and PhD in theoretical particle physics from UCLA under Prof. J. J. Sakurai. He was a postdoc of Prof. John Dawson in 1984-1986. He then worked at SLAC National Accelerator Center from 1986 to 2007. In 2000, he initiated and successfully raised private endowment to establish the Chen Institute for Particle Astrophysics and Cosmology (later renamed the Kavli Institute for Particle Astrophysics and Cosmology) at Stanford University. He joined the faculty of his alma mater NTU in 2007, and again successfully raised private endowment to found the Leung Center for Cosmology and Particle Physics (LeCosPA) and served as its director since 2007. He is the LeCosPA Founding Director Emeritus since 2024. He is the laureate of the 2018 Blaise Pascal Chair bestowed by the government of Ile de France, and the recipient of the 2023 EPS-DPP Hannes Alfven Prize. Total citation of his paper is 8083 with H-index of 43 according to Web of Science, and 15003 with H-index of 58 according to Google Scholar.

Appendix:

1. Subrahmanyan Chandrasekhar

Astrophysicist born in India. He received the Nobel Prize in Physics in 1983 *for his theoretical studies of the physical processes of importance to the structure and evolution of stars,* including the Chandrasekhar limit on the mass of white dwarf stars. His research covered several broad areas, as seen from his texts, which included *Principles of Stellar Dynamics* (1942), *Hydrodynamic and Hydromagnetic Stability* (1961), and an influential book based on his lecture notes in *Plasma Physics* (1960).

2. AAPPS: Association of Asia-Pacific Physical Societies
（HP: http://www.aapps.org/main/index.php）

The Association of physical societies in the Asia Pacific region founded by the Nobel Laureate in Physics C.N. Yang, and Professor Akito Arima in 1983. The AAPPS held the 12th Asia Pacific Physics Conference under the president (at that time) Shoji Nagamiya in Makuhari, Japan. The current president is Professor Hyoung Joon Choi, Yonsei University, Korea.

3. AAPPS-DPP: Division of Plasma Physics, AAPPS
（HP : http://aappsdpp.org/AAPPSDPPF/index.html ）

The first division under the AAPPS based on the success of the plasma physics program in the APPC-12. This division was formed in January 2014 based on the recommendation of Professor Nagamiya at the AAPPS council. From Nov 28, 2018, AAPPS-DPP becomes legal entity http://aappsdpp.org/DPPhoujin/index.html .

4. Subrahmanyan Chandrasekhar Prize of Plasma Physics

Subrahmanyan Chandrasekhar Prize of Plasma Physics is a top plasma physics prize founded by the AAPPS-DPP in July 2014 and is endorsed by AAPPS. This prize is given to a plasma physicist annually for pioneering and/or seminal contribution to plasma physics. The prize recipients were Professor S. Ichimaru (2014), Professor P. Kaw (2015), Professor D. Melrose (2016), Professors C.Z. Cheng and Lou C. Lee (2017), Professor Toshiki Tajima (2018), Professors Liu Chen and Kazunari Shibata (2019), Professor Hyeon Park (2020), Professor Taik Soo Hahm (2021), Professor Arnab Rai Choudhuri (2022), Professor Katsumi Ida (2023) (http://aappsdpp.org/AAPPSDPPF/prizetable.html).

The 2024 Selection Committee composed of leading plasma physicists in Asia-Pacific region.
Chairman : Professor Chang Hee Nam (GIST)
Members : Professor Yutong Li (Institute of Physics, CAS)
Professor Baonian Wan (Institute of Plasma Physics, CAS)
Professor Yasushi Todo (NIFS)
Professor Shinsuke Fujioka (Osaka University)
Professor Abraham Chian (University of Adelaide)
Professor Michael Wheatland (University of Sydney)
Professor Hyyong Suk (GIST)
Professor Yongkyun In (UNIST)
Professor Rajaraman Ganesh (Institute for Plasma Research)
Professor Ravindra G Kumar (TIFR)
Professor Shih-Hung Chen (National Central University)
Professor Lin I (National Central University)