Advanced Core for Energetics, Hiroshima University Vol. 85

HU-ACE NEWS LETTER

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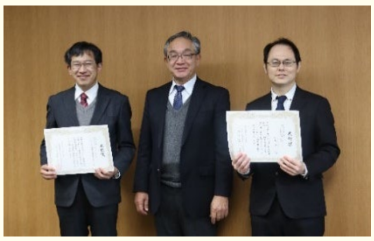
Activities of the Core

Jan. 5, 2024	Assist Prof. Mengli ZHANG gave the invited lecture The 6th International Symposium on Heat Transfer and Energy Conservation Conference（ISHTEC2024）
Jan. 11-Feb. 6, 2024	Prof. Matsumura Conducts JICA Seminar-Based Training "Biomass Utilization Technology"
Jan. 17, 2024	The 111th Hiroshima University Biomass Evening Seminar (co-organized by HU-ACE)
Jan. 22, 2024	The 87th HU-ACE Steering Committee Meeting
Jan. 27, 2024	The 8th Higashihiroshima-Ene/Eco Seminar (co-organized by HU-ACE)

HU-ACE Receivs the "Special Award of the Dean of the Graduate School of Advanced Science and Engineering"

The award ceremony for the Special Award of the Dean of the Graduate School of Advanced Science and Engineering was held on November 29, 2023. The aim of this award is to encourage new attempts and creativity in education and research activities at the Graduate School of Advanced Science and Engineering, Hiroshima University, and to revitalize, enhance, and develop education and research activities. The achievement that was to be honored for the Dean's Special Award was "Promotion of Energy Education for Society," and Yukihiko Matsumura, Head of the Research Center for Advanced Core for Energetics, Hiroshima University (HU-ACE), attended the award ceremony. We will continue to develop activities that look at the entire flow of energy from a broader perspective, and at the same time, we will develop research and education on the ultra-advanced use of energy by taking advantage of the strengths of a comprehensive university with a wide range of faculty members and researchers.



Related Events

The 8th International Symposium on Fuels and Energy (ISFE2024) is scheduled on July 1-2, 2024.
Details can be found here. https://symposium2024.isfe.hiroshima-u.ac.jp/

We have constructed a roadmap for the development of energy utilization technologies leading up to 2050 and an integration scenario called the "Hiroshima Scenario". Please feel free to share your thoughts with us.
https://hu-ace.hiroshima-u.ac.jp/wp/wp-content/uploads/2022/10/220921-brochure.pdf

Research consultation and joint research are welcome.

Issued by Advanced Core for Energetics, Hiroshima University
HU-ACE Secretariat, URA Division, Office of Research and Academia-Government-Community Collaboration, Hiroshima University 1-3-2 Kagamiyama, Higashi-Hiroshima, 739-8511 Japan
E-mail: hu-ace-info@ml.hiroshima-u.ac.jp, tel:+81-82-424-4425, URL: https://hu-ace.hiroshima-u.ac.jp/en/

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Research Topics No. 48

High heat flux reduction to materials using current filaments for shielding satellites and spacecraft

Yasuhiro Suzuki
Professor, Graduate School of Advanced Science and Engineering

Research fields: Plasma science
Keywords: Plasma, Magnetic confinement fusion, Magnetohydrodynamics

Abstract

Background

A magnetic confinement fusion reactor utilizes the nuclear fusion reaction generated when a high-temperature and high-density plasma is confined for a certain period of time by the force of a magnetic field. In the fusion reactor, the challenge is reducing and controlling the heat flux transported from the reactor core. One of the most promising methods is to apply a magnetic field to the fusion reactor to control and reduce the heat flux.

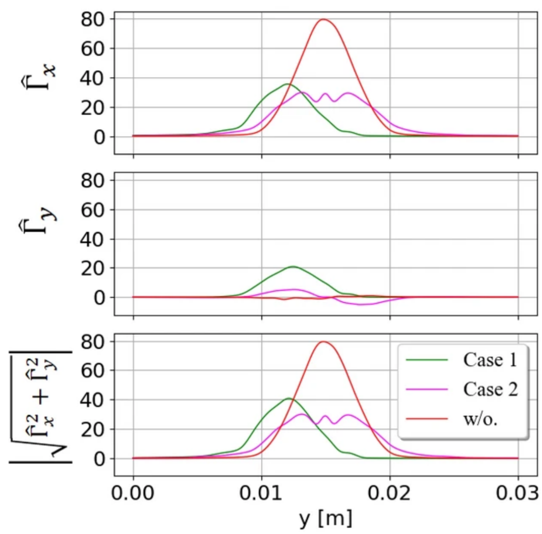
On the other hand, satellites and spacecraft are constantly exposed to high-energy particle beams in space, which causes malfunctions and hindrances to manned flight. Applying the techniques developed in magnetic confinement fusion research allows heat flux to be controlled and reduced simply by attaching a mechanism that generates a magnetic field to the satellite or spacecraft.

Methods

In magnetic confinement fusion, magnetic fields control the heat flux. In this case, the coils create the magnetic field, which must be installed as close to the plasma as possible. In future fusion reactors, coils cannot be installed near the plasma because of neutrons produced by the fusion reaction. Therefore, a method is proposed to reduce the heat flux by passing the current filaments through the plasma instead of coils. Using this method, the heat flux can be controlled and reduced simply by providing a loop through which the current flows without needing large coils.

Results

Numerical simulations using the Particle-In-Cell (PIC) method are performed to qualitatively examine why current filaments can control and reduce heat flux. Plasma can be treated as an electromagnetic fluid. Still, it is also a collection of charged particles, and the PIC method is a hybrid method that solves for plasma using particle and fluid properties. An example of the results is shown in the figure, where the PIC simulation evaluates the heat flow velocity on the outer wall of the spacecraft. The red line shows the case without a magnetic field (current loop), and the green and pink lines (Case 1 and 2) show the case with a magnetic field. In the case with a magnetic field, the maximum heat flux is smaller than in the case without a magnetic field, and the distribution is smoother. Since heat flux is evaluated by the work rate per unit area, a sharp heat flux distribution is exposed to a larger heat flux. On the other hand, a smooth distribution means that the heat flux is reduced.



Comparisons of heat fluxes with and without magnetic fields.

References

Trang Le, Yasuhiro Suzuki, Hiroki Hasegawa, Toseo Moritaka, and Hiroaki Ohtani, Scientific Reports **13**, 8300 (2023) doi:10.1038/s41598-023-35109-4