HU-ACE NEWS LETTER

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Activities of the Core

Jun. 14-Aug. 2, 2021	Lecture of Fuels, Combustion and Modern Society
Aug. 17, 2021	Hiroshima University HU-ACE Seminar
Aug. 24, 2021	Hiroshima University HU-ACE Seminar
Aug. 27, 2021	The 62nd HU-ACE Steering Committee Meeting

The Hiroshima University HU-ACE Seminars were Held.

On August 17th and August 24th, 2021, we held the HU-ACE Seminars in a hybrid format (both online and face-to-face). The speaker was Prof. Mats Andersson, a world-renowned researcher who has long conducted laser and image measurement research on engine fuel spray at Chalmers University of Technology. From July 1st to August 1st, Prof. Andersson joined us remotely from Sweden, and from August 2nd to August 31st, he visited the HU campus to conduct joint research on high-speed image measurement of air-fuel mixture concentration distribution in fuel spray.

Prof. Mats Andersson

Seminar (face-to-face)

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Member Introduction No.31

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Research Field: Plasma science
Keyword: Plasma/Magnetohydrodynamics/Nuclear fusion

Abstract

Background

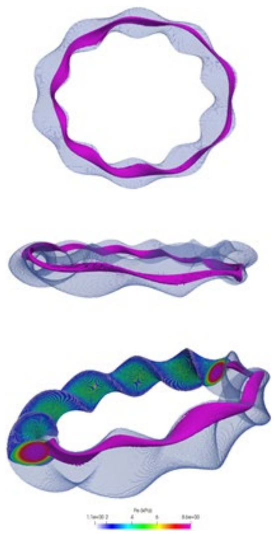
In order to meet energy mix goals by 2030 and carbon neutrality by 2050, it is necessary to develop energy and power sources without CO_2 emissions. Nuclear fusion is the ultimate carbon-neutral energy source that can generate huge amounts of energy without CO_2 emissions. Several ideas have been proposed regarding nuclear fusion. I am studying the magnetic confinement fusion, in which hydrogen isotopes taken from seawater are converted to the plasma state (100 million degrees Celsius!) and confined by the magnetic field to trigger the fusion reaction. The magnetic confined fusion is being studied worldwide as a fast track to realize nuclear fusion.

Method

Plasma is a state in which the atoms and molecules of extremely high temperature gas are separated into ions and electrons, and is also called "the fourth state of matter". Plasma consists of many particles such as ions and electrons, but when confined, it also has the properties of a fluid. However, unlike usual fluids such as water or air, plasma is an electromagnetic fluid whose flow can be controlled by electric or magnetic forces. The theory that deals with plasma as a fluid is called Magnetohydrodynamics. In this study, we conducted numerical simulations using a supercomputer to clarify the complex behavior of fusion plasmas.

Results

In magnetic confinement fusion, hydrogen isotopes frozen into pieces of several millimeters in diameter (called ice pellets) are injected into the center of the plasma at a high speed of over 1000 m/s. Since the ice pellet is injected into the plasma, inhomogeneity of high and low temperature regions is created in the plasma. This temperature inhomogeneity drives the magnetohydrodynamic instability and significantly deforms the plasma shape. The figure shows the growth of the instability caused by the temperature inhomogeneity in the plasma, as analyzed by a supercomputer. The figure reproduces the large expansion of the temperature inhomogeneity (shown in purple) in the plasma when a single pellet is injected. This result is found to be a good explanation for the instability observed in the experiment.



Perturbed pressure driven by magnetohydrodynamic instability

Reference

Shimpei Futatani and Yasuhiro Suzuki, Non-linear magnetohydrodynamic simulations of plasma instabilities from pellet injection in Large Helical Device plasma, Plasma Phys. Control. Fusion, 61 (2019) 095014.