5. Basic, Applied and Innovative Researches

This section is reorganized from 2010 - 2011 fiscal year for the collaboration research activities under the topics of "basic, applied and innovative researches". It includes reports compiled in the "basic research and development" in the former 2009 - 2010 issue and a part of reports compiled in the section of "coordinated research center".

Basic plasma physics researches have been actively continued using the linear device HYPER-I equipped with an almost straight magnetic field and a microwave heating source. A status of eight research topics is summarized in the next page. Physics of various types of vortices produced in plasmas is a major topic in the experiment. Because plasmas in this device is not fully ionized, the interaction between plasmas and neutrals plays an important role for the structure formulation. Large efforts for developing diagnostics for measuring neutral particle motion were made. Other plasma diagnostics are also developed in this device: various types of probes, spectroscopy and the Helium beam probe.

Data analysis of the density fluctuation measurements in CHS experiment using a laser imaging method (LIM) has made a progress for obtaining higher resolution in the two dimensional propagation wave number profile. The separation of wave number vector corresponds to the spatial resolution of the fluctuation profile in the plasmas. The radial positions of strong fluctuations with different propagating directions are obtained at slightly different radii near the last closed flux surface. Another work of the data analysis of CHS experiments is a comparison of the plasma confinement for different isotopes of hydrogen. The purpose of this study is to supply preparatory data for the planned deuterium experiments in LHD. NBI discharges were analyzed for hydrogen and deuterium gas puff. Clear difference in the wall recycling was found but the energy confinement are almost the same for two discharges.

An arcjet plasma experiment was performed with a rectangular converging and diverging slit nozzle type arcjet plasma device. The separation of molybdenum anodes is 0.5 mm for the slit. The motivation of using a slit structure is to measure profiles of temperature and density in the nozzle. Electron density ($\sim 2.7\times10^{15}\mathrm{cm}^{-3}$) and temperature (6,000 K) are measured by the spectroscopic diagnostics.

The infrared absorption spectroscopy diagnostics is proposed for the study of the carbon dust growth in the edge region of the fusion plasmas. A small experimental device is built for the validation of this method and the observation of the agglomeration of carbon dusts is started. A simulation is also started to calculate the vibration excitation levels of hydrocarbons and carbon clusters using a code called Gaussian 03. For the basic study of plasma surface interaction, the characteristics of reflection were investigated for 1 keV H^+ ions from the surface of carbon nanotubes that are aligned vertically on the subtrate. The reflection rate strongly depends on the injection angle. For the study of the resonant excitation and ionization processes in electron-ion collision, an experiment device with a high-density ion source has been developed. In order to solve the space charge problem for a very intense ion beam, a high-density electron gun was designed to neutralize the space charge.

Two theoretical works are reported for the atomic processes. The first one is for the calculation of the symmetric resonant charge transfer rate for the Rydberg states of He atoms with very low collision energies. A motivation of this study comes from the observations of Doppler widths of Rydberg He atoms in the linear divertor plasma simulator MAP-II. The second one is for the relativistic configuration interaction calculations for the Ne-like ions. This work was motivated by the observation of a solar flare by means of the EUV Imaging Spectrometer on Hinode satellite. The observation showed a very different branch-ing ratio of two famous EUV lines of Fe XVII.

From the research field of tomography, two reports are given. The first one is for the application of the numerical techniques of analyzing signals and images to the field of biology and astronomy. In biology, it contributed to the successes of the phase contrast electron microscope work combined with three dimensional tomographic techniques. For astronomy, a work has started to contribute to the adaptive optics related to the three dimensional tomography of atmospheric turbulence for the Subaru Telescope and the image synthesis in the radio telescope ALMA. The second one is for the extension of the advanced measurement technology of the microwave imaging reflectometry of high temperature plasmas to the more practical field application such as the breast cancer detection and the concrete pillar diagnostics. The system will be able to emit microwaves to objects with the variable and higher frequency than those of the conventional practical imaging systems with the phase information of scattered waves.

Finally we have two reports for the applications of high power microwave technology to the industrial purposes. The first one is for the decomposition of the fluorinated hydrocarbons (Freon). A method using the concrete waste as an alkali metal oxide for the decomposition of Freon was tested for the conventional heating scheme and the microwave heating. It was found that the microwave heating scheme works similarly to the conventional one. Another one is for the development of microwave kiln for sintering ceramics. The advantage of this method compared to the conventional scheme is better uniformity of heating and the rapidness of processing. The collaborations with the Ceramics Processors Cooperative Association in Toki city have demonstrated these advantages in various conditions of ceramics production.

(Okamura, S.)