Session 5

A tabletop device for investigating spectropolarimetric responses to anisotropic/magnetized plasmas

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Spectropolarimetry is a popular tool for investigating the dynamics of magnetized plasmas. The population density of atomic sublevels represents the strength of anisotropic collisions and electromagnetic interactions to atoms. On the other hand, atomic structure is determined by many-body systems consisting of electrons and a nucleus in addition to the fields/colliding particles to be considered. Furthermore, non-equilibrium plasmas in three dimensions dynamically create non-uniform anisotropic field structures. How we have interpreted such complex systems is to develop quasi-equilibrium models of atomic structure, population density structure, plasma structure, and radiative transfer. These models need to be verified experimentally in a simpler system by controlling atomic interaction with external fields and particles.

We set up a tabletop plasma device designed especially for spectroscopic measurements of plasmas interacting with external lasers, particle beams, and magnetic fields. The device consists of a quartz pipe coupling an antenna and of a vacuum chamber made of stainless steel. A radio-frequency (RF) power supply of 13.56MHz with a forward RF power of 5kW at maximum is used for plasma production. Density of neutral particles is controlled by vacuum pumps and a mass-flow controller, while it is monitored by pressure gauges. Electron temperature and density are measured by Langmuir probes, and these typical values are Te ~ 1e4 K and Ne ~ 1e12 cm-3. We performed experiments by setting the device in front of the focal plane of the Horizontal Spectrograph of the Domeless Solar Telescope at Hida Observatory of Kyoto University. By using the spectropolarimetric system with high spectral resolution and high polarimetric sensitivity, we directly compared helium spectra emitted from the laboratory plasmas and solar prominences. In the presentation, we introduce the apparatus, obtained spectra, and results of the comparison with solar spectra.