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Plasma Polarization Spectroscopy: Quantitative Evaluation of the Electron Anisotropic VDF and the possibility for the Proton VDF

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The electron and proton/deuteron velocity distribution function (VDF) in a plasma is one of the most important attribute of the plasma. When the EVDF is isotropic and then thermalized, the VDF is the Maxwellian. The determination of the VDF is equivalent to measuring the electron/proton temperature. However, the EVDF could be anisotropic. The microwave of the electron cyclotron resonance (ECR) heating accelerates the velocity component of the electrons which is perpendicular to the magnetic field. Ion cyclotron range (IFR) heating and neutral beam injection (NBI) heating may create anisotropic proton velocity distribution in plasmas.

Plasma Polarization Spectroscopy is a technique to evaluate qualitatively the anisotropic VDF by means of measurement the intensity and longitudinal alignment (polarization degree) of the emission lines from the atoms and ions in the plasma. The intensity is proportional to the population on the upper level. The longitudinal alignment is proportional to the alignment (population imbalance) over population on the upper level. We measured the intensity and the longitudinal alignment of emission lines from He I in ECR helium plasma confined in the cusp magnetic field. The least square fitting by means of the population-alignment collisional-radiative model shows that the electron anisotropic VDF is a pancake-like and the vertical velocity component is predominant.

Magnetic dipole transition between grand state fine structures in some highly-charged ions radiates photons in ultra-violet visible spectral region. The upper level of the fine structure state may be populated predominantly by the proton collisions than by the electron collisions in a certain density range. We report the results of the preliminary polarization separation spectroscopic measurements on the M1 transition in Ar XIV in the Large Helical Device (LHD) and PACR model simulation.