Physics Colloquium
Verification and application of atomic polarization and spectral data for diagnostics of coronal plasma by their XUV spectra and spectral images

Dr. Alexander M. Urnov
P.N. Lebedev Physical Institute of RAS, 53 Leninskii prospect, 119991, Moscow, Russia

Abstract:
Present talk contains a short survey of the results concerning various issues of the method for diagnostics of so called “coronal plasmas” based on simultaneously measured spectra and/or spectral images of their X-ray and EUV (XUV) emission. Accurate calculations of atomic polarization and spectral data and their verification in laboratory experiments is shown to be a crucial point for successful application of this method aimed at a study the structure and dynamics of coronal plasma in astrophysical and laboratory conditions.

Polarization degree of w, x, y and z lines due to, respectively, the resonance, magnetic quadrupole, intercombination and forbidden transitions of [He] argon ions excited by electron beams were obtained with account for radiative cascades from excited states in the framework of collisional-radiative model. An accuracy of corresponding atomic data for magnetic sublevels of [He] argon ions obtained by different methods of calculations is discussed. It was shown that the most important effect on polarization of x and z lines is due to cascade transitions from the levels with principal quantum numbers n=2 and 3. Polarization degree of z line, being not polarized by direct excitation of electron beam, is of 18% at the threshold and changes its sign at energies of about 1500 keV. The importance of the account for the effects of low energy cut-off in the energy spectrum of electron beams as well as a multi-temperature content of plasma sources for the modeling of their linear spectra is outlined. High-resolution spectra from the Ar XVII and Ar XVI ions measured at the TEXTOR tokamak (Julich, Germany) were used to verify the basic atomic data with 10% accuracy necessary for spectroscopic diagnostics of hot coronal plasma. It was shown that previously observed factor of 1.3–2 discrepancies between the measured and calculated values can be explained by the use of less accurate atomic data and simplified atomic kinetics model. The results of such verification of collisional characteristics of [He] and [Li] argon ions calculated by means of various code packages are discussed.

The Bayessian iterative method (BIM) in the framework of so called probabilistic approach, based on mathematical formalization of the inverse spectroscopic problem different to traditionally used “algebraic one”, have been proposed to derive the differential emission measure DEM(T) need for analysis of plasma temperature content. The results of the tests, including the analysis of the BIM level of confidence, made for applications to XUV spectral images of solar corona and tokamak plasmas are given. Some applications of the method developed for diagnostics of space-time dynamics of the temperature and density in hot plasma structures of solar corona are also demonstrated.

Monday, August 2nd, 2010
3:00-4:00 pm
Goudsmit Conference Room, LP 208