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PROGRESS REPORT FOR 1989-1990 ON

THE INVESTIGATION OF ELECTRON-ION RADIATIVE AND DIELECTRONIC RECOMBINATION IN HIGH-TEMPERATURE PLASMAS

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PROGRESS REPORT

The unified description of radiative and dielectronic recombination has been extended to treat processes involving more than a single state of the initial ion, the autoionizing resonance, and the recombined ion. This extension has been published in Phys. Rev. A 40, 80 (1989), in collaboration with S. L. Haan. The major theoretical effort is now centered on the generalization of this description to self-consistently incorporate the effects of charged-particle collisions and plasma electric fields. A manuscript is in preparation on the influence of relaxation phenomena, in collaboration with J. Cooper and S. L. Haan. Specific calculations will be carried out for K-shell dielectronic satellite transitions in He-like and Li-like ions, using the autoionization and radiative transition rates that have been recently provided by M. Chen, at the Lawrence Livermore National Laboratory. Comparisons will be made between the predictions of the conventional and unified theories.

The K_α model for the dielectronic satellite spectra of highly-charged Fe ions has been incorporated into the muti-ion-species transport code developed at the Princeton Plasma Physics Laboratory, in collaboration with M. Bitter of PPPL and P. Beiersdorfer of LLNL. The immediate objective is to produce a realistic simulation of the observed Fe K_α spectra from PLT and TFTR. The ultimate goal is to identify satellite features that reveal the effects of plasma transport processes, both collisional and anomalous.

A detailed investigation is in progress involving calculations of the dielectronic recombination satellite spectra in the presence of a distribution of plasma electric microfields. The calculations have been carried out for the lowest-lying n=2 satellites, which are affected by the electric fields only in high-density laser-produced plasmas. For application to the lower-density conditions in Tokamak plasmas, a number of alternatives are under consideration for evaluating the recombination rates for Rydberg autoionizing states, in a more detailed manner than was done in the original theory presented in 1976 by V. L. Jacobs. A manuscript on the effects of electric microfields on argon dielectronic satellite spectra from the n=2 levels is now undergoing final revisions prior to publication in the Physical Review A, in collaboration with L. A. Woltz and C. F. Hooper.

The investigation has been completed on the effects of indirect processes involving autoionization resonances for electron-density sensitive line-intensity ratios. The resonance contributions have been found to be comparable with the direct electron-impact excitation rates for magnetic-quadrupole transitions in highly-charged ions. The results of this investigation have been published in Phys. Rev. **A 41**, 1041 (1980), in collaboration with P. L. Hagelstein and M. H. Chen. Line-intensity ratios have been identified which are sensitive to density in the density region characteristic of Tokamak plasmas.

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