The IRON Project, The Iron Opacity Project, and Astrophysical Diagnostics

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Abstract. The aims of the Iron Project are detailed study of radiative and collisional processes of astrophysically abundant atoms and ions, mainly iron and iron-peak elements, over a wide energy range, from infra-red to X-rays, and application to astrophysical problems. The project has been extended to the Iron Opacity Project to study the solar opacity problem. The discrepancy in the solar iron opacity in the convection zone due to particularly the iron ions from Fe~XVI to Fe XX is being investigated in collaboration with the experimental group at Sandia National Lab. We will report progress on the work including hitherto neglected atomic physics of resonances which are largely treated as lines in existing opacities calculations.
With inclusion of higher order relativistic effects in the Breit-Pauli R-matrix (BPRM) codes, under the Iron Project, high accuracy collision strengths are being computed for second row elements for astrophysical diagnostics in nebular plasmas. One of the most fundamental astrophysical problem has been the discrepancy in the abundances of these elements obtained from collisionally excited lines (CEL) and those from recombination lines (REL). Using the BPRM method, we find significant effects due to fine structure couplings in the low energy region. There are resonances produced only from fine structure, but not allowed in LS coupling. We present highly resolved collision strengths of Ne V for 10 low lying transitions in the infrared transitions that are used as temperature and density diagnostics of nebular as well as dust obscured astrophysical objects. Fine structure transitions among the ground state levels $1s^22s^22p^{33}P_{0,1,2}$ give rise to the well-known 14.3 μm and 24.3 μm lines. We will illustrate the effect of improved collision strengths on temperature and density sensitive line ratios of these lines. The study of the fine structure effects in low energy will be extended to the recombination process.