THE OPAL OPACITY CODE

F.J. ROGERS AND C.A. IGLESIAS

Lawrence Livermore National Laboratory, Livermore, CA 94550, USA

The OPAL opacity effort was undertaken in 1985 in response to speculation that the existing opacity data were not of sufficient accuracy to model observed stellar properties. We have taken the view that a completely new code with improved equation of state, atomic physics and line broadening was required. It was apparent that the most computationally intensive part of the calculations would be to obtain the vast amount of atomic data needed for the bound-bound and bound-free absorption cross-sections. To meet this challenge we developed a parametric potential method, that was fast enough to allow on-line calculations, while achieving accuracy comparable to that of the single-configuration Dirac-Fock method. This on-line capability was also chosen to allow flexibility to study the effect of various coupling and data averaging methods. It also makes it easy to study the effect of adding more elements.

The OPAL equation of state is based on the many-body statistical mechanics of partially ionized plasmas in the grand canonical ensemble. This is the so-called "physical picture" method. In this approach one works directly with the electrons and nuclei present in the plasma. The effect of the plasma environment on the internal states is obtained directly from the statistical mechanical analysis. A convergent partition function is a natural consequence of this approach.

OPAL includes degeneracy and plasma collective effects in the free-free absorption using a screened form of the parametric potentials. Similar corrections to the Thomson scattering are obtained from the method of Boercker (1987). The spectral line broadening for one, two and three electrons ions are obtained from a suite of codes provided by R.W. Lee (1988) that include linear Stark theory. For all other transitions we use Voigt profiles where the Gaussian width is due to Doppler broadening and the Lorentz width is due to the natural width plus fits to the electron impact collision width (Dimitrievic and Konjevic 1980).

A discussion of recent developments and a comparison with results from the Opacity Project will be given.

Boercker, D.B. 1987, ApJ, 316, L95
Dimitrievic, M.S. & Konjevic, N 1980, J. Quant. Spectrosc. Rad. Transf., 24, 451
Lee, R.W. 1988, J. Quant. Spectrosc. Rad. Transf., 40, 561