*Cosmic Evolution and Galaxy Formation: Structure, Interactions, and Feedback*
*ASP Conference Series, Vol.* $3 \times 10^8$*, 2000*
*J. Franco, E. Terlevich, O. López-Cruz and I, Aretxaga, eds.*

# Current Development of Cloudy

P.A.M. van Hoof[1,2], P.G. Martin[1], G.J. Ferland[2]

[1] *CITA, 60 St. George Street, Toronto, ON M5S 3H8, Canada*

[2] *University of Kentucky, 177 CP Building, Lexington, KY 40506, USA*

The current grain model was introduced to Cloudy in 1990 to facilitate more accurate modeling of the Orion nebula (for a detailed description see Baldwin et al., 1991, ApJ, 374, 580). The model has since undergone some minor revisions but remained largely the same. Recently, our knowledge of grains has been greatly advanced by the results from the ISO mission. In view of these rapid developments we have undertaken a major upgrade of the grain model in Cloudy. The two main aims are to make the code more flexible and to make the modeling results more realistic.

In particular, in the current model the grain opacities for a handful of grain species are hard-wired in the code. Furthermore, only a single equilibrium temperature is calculated for each species. This is inappropriate for a grain size distribution since small grains will be hotter than large grains. This is caused by the fact that grain opacities depend quite strongly on grain size. To improve the model, the following changes are being implemented:

- We will include a spherical Mie code in Cloudy. The necessary optical constants needed to run the code will be read from a separate file. This allows greater freedom in the choice of grain species. Files with optical constants for a range of materials will be included in the Cloudy distribution. However, the user can also supply his own optical constants for a completely new grain type.

- We will introduce mixing laws to the code. This will allow the user to define grains which are mixtures of different materials. Cloudy will then calculate the appropriate opacities by combining the optical constants of these grain types. This will allow the user to simulate aggregate or 'fluffy' grains.

- The absorption and scattering opacities will be calculated by Cloudy for more arbitrary grain size distributions. This will give the user considerably more freedom. Currently only a standard ISM and a truncated Orion size distribution are included in the code.

- The size distribution will be split up in many small bins, and an equilibrium temperature will be calculated for each bin separately. This allows non-equilibrium heating to be treated and more realistic grain emission spectra to be calculated. First tests show that under realistic conditions this can make large differences in the flux (at least a factor of two) in the Wien tail of the grain emission. The total flux emitted by the grains remains virtually unchanged however.