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Invited Lecture

CURRENT AND FUTURE DEVELOPMENT OF THE PHOTOIONIZATION CODE CLOUDY

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The interstellar medium (ISM) plays a crucial role in the cycle of matter in every galaxy. In the big bang only hydrogen and helium were created, out of which the first galaxies and stars were formed. In these stars heavier elements were synthesized which were eventually ejected into the ISM at the end of their evolution. This enriched gas then formed molecular clouds and the next generation of stars. These stars could then synthesize additional heavy elements, eventually enabling the creation of planets and life.

The gas and dust that is present in the ISM is usually very far removed from (local) thermodynamic equilibrium, and is some cases may also not be in a steady-state equilibrium with its surroundings. The material in the ISM can be heated by stellar light, but also by shocks, radioactive decay, and cosmic rays. As a result the physics of this material is complex and you need a sophisticated numerical code to model the spectrum emitted by this gas.

For this purpose the open-source photoionization code Cloudy has been available for several decades. It models the physical state of the gas and predicts the spectrum emitted by that gas. It is the only code that can make a self-consistent model of a photoionized region and the neutral and molecular regions beyond the ionization front. Such a code needs a vast amount of atomic and molecular data. Cloudy is continually being developed to improve the treatment of the microphysical processes and the database of fundamental data that it uses. In recent years we have been focusing on improving our predictions at high densities. In my lecture I will discuss the difficulties that exist when modeling high-density gas and how we are developing the code to tackle these issues. I will also discuss the experimental mode in Cloudy to model gas that is not in steady-state equilibrium. Finally I will discuss some aspects of the long-term development of the code.