A spectral code for non-equilibrium plasma and its applications

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Abstract

The spectral code for non-equilibrium plasma has been developed based on the updated atomic database. The first application is for winds from super stellar clusters for which a self-consistent physical model has been made based on a combination of a 1-D steady-state adiabatic wind solution and a non-equilibrium ionization calculation. Comparing with the case of collisional ionization equilibrium, we find that the non-equilibrium ionization effect is significant in the regime of a high ratio of energy to mass input rates and manifests in a stronger soft X-ray flux in the inner region of the stellar cluster. Implementing the model in X-ray data analysis softwares (e.g. XSPEC) directly facilitates comparisons with X-ray observations. The physical quantities such as the mass and energy input rates of stellar winds can be estimated by fitting observed X-ray spectra. The fitted parameters may then be compared with independent measurements from other wavelengths. Applying our model to the star cluster NGC 3603, we find that the wind accounts for no more than 50% of the total "diffuse" emission, and the derived mass input rate and terminal velocity are comparable to other empirical estimates. The remaining emission most likely originate from numerous low-mass pre-main-sequence stellar objects. The second application is about line diagnostics. Incorporating the UV and X-ray background radiation field and two temperature structures, we improve the radiative shock flow model and make it suitable to the intergalactic medium. The column densities of the interested ions have been predicted from two radiative shock flows and made the coarse comparison with the limited observational data. The comparisons are encouraging. Delayed ionization dominates the ionization structure, and the flow may not be fully cooled within the Hubble time. The existing UV and X-ray background radiation fields do affect the column densities of the lower ionized ions. ^

Subject Area

Physics, Astronomy and Astrophysics

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