
CPIPES - A software for the non-equilibrium ionisation evolution of the supernova and cosmic-rays driven ISM

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Abstract

CPIPES (Collision + Photoionization Plasma Emission Software) traces the evolution of the ionisation structure and emission processes of optically thin plasmas. It can be used as a standalone software or coupled to any hydrodynamical and magnetohydrodynamical software tracing the dynamical evolution of the interstellar plasma. In particular it is being used to calculate the joint thermal and dynamical evolutions of the supernova and cosmic-rays driven interstellar medium. The physical processes included in CPIPES are electron impact ionization, inner-shell excitation auto-ionization, radiative and dielectronic recombination to excited levels (followed by cascades), charge-exchange reactions (recombination with and and ionization with and), continuum (bremsstrahlung, free-bound, and two-photon) and line (permitted, semi-forbidden, and forbidden) emission. The radiative model further comprises detailed calculations of the relative populations due to electron impact excitation and de-excitation, and spontaneous emission using up to a 70-levels model. The code further includes photoionization due to an external radiation field, and inner-shell photoionization due to cascades. In addition, Auger and Coster-Kronig photo-ejection of deep shell electrons is taken into account. CPIPES includes thermal and non-thermal distributions of electrons and protons and is used to determine the ionization structure and emission of ionized plasmas with cosmic rays.

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