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The Evolution of the Large-scale ISM: Bubbles, Superbubbles and Non-Equilibrium Ionization

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The ISM, powered by SNe, is turbulent and permeated by a magnetic field (with a mean and a turbulent component). It constitutes a frothy medium that is mostly out of equilibrium and is ram pressure dominated on most of the temperature ranges, except for T< 200 K and T> 1E6 K, where magnetic and thermal pressures dominate, respectively. Such lack of equilibrium is also imposed by the feedback of the radiative processes into the ISM flow. Many models of the ISM or isolated phenomena, such as bubbles, superbubbles, clouds evolution, etc., take for granted that the flow is in the so-called collisional ionization equilibrium (CIE). However, recombination time scales of most of the ions below 1E6 K are longer than the cooling time scale. This implies that the recombination lags behind and the plasma is overionized while it cools. As a consequence cooling deviates from CIE. This has severe implications on the evolution of the ISM flow and its ionization structure. Here, besides reviewing several models of the ISM, including bubbles and superbubbles, the validity of the CIE approximation is discussed, and a presentation of recent developments in modeling the ISM by taking into account the time-dependent ionization structure of the flow in a full-blown numerical 3D high resolution simulation is presented.

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