[박GC-19] Thermal and Dynamical Evolution of a Gaseous Medium and Star Formation in Disk Galaxies

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Formation of self-gravitating gas clouds and hence stars in galaxies is a consequence of both thermal and dynamical evolution of a gaseous medium. Using hydrodynamics simulations including cooling and heating explicitly, we follow simultaneously thermal and dynamical evolution of galactic gas disks to study dynamics and structures of galactic spiral shocks with thermal instability and regulation of the star formation rates (SFRs). We first perform one-dimensional simulations in direction perpendicular to spiral arms. The multiphase gas flows across the arm soon achieve a quasi-steady state characterized by transitions from warm to cold phases at the shock and from cold to warm phases in the postshock expansion zone, producing a substantial fraction of intermediate-temperature gas. Next, we allow a vertical degree of freedom to model vertically stratified disks. The shock front experiences unsteady flapping motions, driving a significant amount of random gas motions, and self-gravity promotes formation of bound clouds inside spiral arms. Finally, we include the star formation feedback in both mechanical (due to supernova explosion) and radiative (due to FUV heating by young stars) forms in the absence of spiral arms. At saturation, gravitationally bound clouds form via thermal and gravitational instabilities, which are compensated by disruption via supernova explosions. We find that the FUV heating regulates the SFRs when gas surface density is low, confirming the prediction of the thermal and dynamical equilibrium model of Ostriker et al. (2010) for star formation regulation.

[박GC-20] Dynamics of charged particles around a compact star with strong radiation

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It is the conventional wisdom that the Poynting-Robertson effect is essentially the outcome of the interplay between absorption and reemission processes. For a better understanding of the motion of charged particles around a compact star with strong radiation, we reached an alternative interpretation for the Poynting-Robertson effect based on the covariant formalism and found that it is attributed to the combination of the aberration and the Lorentz transformation of the radiation stress-energy tensor. As a general relativistic application of the Poynting-Robertson effect, we studied the dynamics of test particles around the spinning relativistic star with strong radiation. We discovered that the combination of the angular momentum and the finite size of the star generates "radiation counter drag" which exerts on the test particle to enhance its specific angular momentum, contrary to the radiation drag. The balance of the radiation drag and the radiation counter drag renders the particle to hover around the spinning luminous star at the "suspension orbit". The radial position and the angular velocity of the particle on the "suspension orbit" are determined by the angular momentum, the luminosity, and the size of the central star only, and they are independent of the initial position and velocity of the particle.