[GC-03] ENERGY DISSIPATION OF COSMOLOGICAL SHOCK WAVES IN THE LARGE SCALE STRUCTURE

Renyi Ma[1], Dongsu Ryu[1], and Hyesung Kang[2]

[1]Department of Astronomy and Space Science, Chungnam National University

2Department of Earth Sciences, Pusan National University

To investigate the complex cosmological shocks, we explore the statistic properties of cosmological shock waves in terms of preshock density and temperature. It is shown that the most frequent shocks are the external shocks that formed around shee-like structures, and for the WHIM and intercluster medium (ICM), internal shocks dominate over external shocks both in frequency and shock kinetic energy flux at present epoch. The mean properties of weak internal shocks depend mainly on the pre- or post-shock temperature. More importantly, as previous paper we calculate the acceleration effency of the shocks by adopting a DSA model for
quasi-parallel shocks, but more complete set of parameters are considered. The efficiencies for different parameters are fitted with algebric formula. We further calculate the time integrated energy fluxes that pass through the shocks. It is found that the energy density of the accumulated cosmic ray (CR) protons can be consistent with the upper limits constrained by observations.

[GC-04] Galactic Spiral Shocks with Thermal Instability in Self-Gravitating, Vertically-Stratified Disks

Kim, Chang-Goo[1], Kim, Woong-Tae[1], and Ostriker, Eve C.[2]

[1]Department of Physics and Astronomy, Seoul National University,

[2]Department of Astronomy, University of Maryland

Galactic spiral shocks are dominant morphological features and believed to be responsible for substructure formation of sprial arms in disk galaxies. They can also provide a large amount of kinetic energy for the interstellar gas by tapping the rotational energy. In this work, we use numerical hydrodynamic simulations to investigate the turbulence driving and clump formation by two-dimensional galactic spiral shocks in self-gravitating, vertically-stratified disks subject to radiative cooling and heating. We initially consider an isothermal disk in vertical hydrostatic equilibrium. Due to cooling and heating, the disk rapidly evolves to a dense slab near the midplane surrounded by rarefied, hot gas at high-altitude regions. The imposed stellar spiral potential forms a vertically curved shock that exhibits strong flapping motions along the direction perpendicular to the arm. The flows across the spiral shock are characterized by transitions from rarefied to dense phases at the shock and from dense to rarefied phases at the postshock expansion zone. The shock flapping motions stirs the disk, supplying the gas with random kinetic energy. The flows achieve a quasi-steady state after a few orbits. The density-weighted velocity dispersions in the vertical directions are measured to be $\sigma_z \sim 1.5\text{-}3$ km/s for the rarefied gas and $\sigma_z \sim 0.5\text{-}1.5$ km/s for the dense gas. Despite clumpy structure of spiral shocks with thermal instability, time-averaged profiles of surface density are similar to those of viscous isothermal spiral shocks. When self-gravity is included, spiral shocks form large dense condensations by collecting high-altitude gas that falls toward the midplane right after the shock compression. Internal motions of these condensations gradually change from supersonic to subsonic values as they move downstream from the shock front.