X42a Galaxy simulation with the evolution of grain size distribution

青山尚平, 平下博之, 長峯健太郎

We compute the evolution of interstellar dust in a hydrodynamic simulation of an isolated disc galaxy. We newly implement the evolution of full grain size distribution by sampling 32 grid points on the axis of the grain radius. We solve it consistently with the chemical enrichment and hydrodynamic evolution of the galaxy. This enables us to theoretically investigate spatially resolved evolution of grain size distribution in a galaxy. The grain size distribution evolves from a large-grain-dominated ($\gtrsim 0.1\ \mu$m) phase to a small-grain production phase, eventually converging to a power-law-like grain size distribution similar to the so-called MRN distribution. We find that the small-grain abundance is higher in the dense ISM in the early epoch ($t \lesssim 1$ Gyr) because of efficient dust growth by accretion, while coagulation makes the small-grain abundance less enhanced in the dense ISM later. This leads to steeper extinction curves in the dense ISM than in the diffuse ISM in the early phase, while they show the opposite trend later. The radial trend is also described by faster evolution in the inner part. We also confirm that the simulation reproduces the observed trend in the relation between dust-to-gas ratio and metallicity, and in the radial gradients of dust-to-gas ratio and dust-to-metal ratio. Since the above change in the grain size distribution occurs in $t \sim 1$ Gyr, the age and density dependence of grain size distribution has a significant impact on the extinction curves even at high redshift.