Numerical simulations of the life cycle of dust in forming and evolving disk galaxies

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We incorporate dust growth and destruction, formation of molecular hydrogen on dust grains, and star formation into 3D Nbody/hydrodynamical simulations of galaxy formation and evolution in order to discuss spatial and temporal variations of interstellar dust and other galaxy properties in a self-consistent manner. Previous galaxy-scale hydrodynamical simulations did not include dust recycling process and star formation from molecular hydrogen self-consistently, so the present simulation, for the first time, enables us to discuss the evolution processes of various components of interstellar medium (ISM) in galaxies. The preliminary results are as follows. The star formation histories of disk galaxies are regulated by dust, mainly because the formation efficiency of molecular hydrogen is controlled by dust. The observed correlation between dust-to-gas-ratio and gas-phase oxygen abundance can be reproduced by the present simulations. The simulated disk galaxies show negative radial gradients (i.e., larger in inner regions) of dust-to-gas-ratio and molecular gas fraction. The surface mass densities of dust in disk galaxies are correlated more strongly with the total gas densities than with molecular hydrogen densities. More massive disk galaxies are more likely to show higher dust-to-gas ratios and higher molecular hydrogen fraction. Galaxy merging between disk galaxies can significantly reduce the dust mass fraction owing to consumption of dust in active star formation during merging. We briefly discuss how galaxy-scale star formation and chemo-dynamical evolution of forming galaxies depends on modeling of interstellar dust.