Dust populations in hydrodynamical simulations of galaxies

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Dust in galaxies is an important tracer of galaxy properties and their evolution over time. The physical origin of the grain size distribution, chemical composition of dust and associated optical extinctions in diverse galaxies remains elusive. To address this issue, we introduce a model for dust evolution in the RAMSES code for simulations of galaxies with multiphase interstellar medium. Dust is modeled as a fluid transported with the gas component, and is decomposed into two sizes, 5 nm and 0.1 micron, and two chemical compositions for carbon and silicate grains. This dust model captures the growth of dust by accretion of refractory elements from the gas phase and by the release of dust in stellar ejecta, the destruction by thermal sputtering, supernovae, and astration, and the exchange of dust mass between the two main populations of grain sizes by coagulation and shattering. Using isolated disc simulations with different masses and metallicities, the simulations are able to account for several key properties of the dust in galaxies. The simulated Milky Way analog reproduces the dust-to-mass ratio, size distribution and extinction curves of the Milky Way. Galaxies with lower masses and lower metallicities have lower dust-to-metal ratios and Magellanic Cloud-like extinction curves. Massive gas-rich galaxies also have a steep extinction curve typical of high-redshift galaxies. Together with the metallicity and the gas fraction, or turbulence of galaxies, it is possible to mimic two basic properties of extinction curves: the steepening of the UV-to-optical slope, and the damping of the bump at 2175 angstroms.