# Galaxies with grains: unraveling dust evolution and extinction curves with hydrodynamical simulations

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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, the dust chemical composition and, hence, the associated ultraviolet-to-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 a resolved multiphase interstellar medium. Dust is modelled as a fluid transported with the gas component, and is decomposed into two sizes, 5 nm and 0.1 μm, and two chemical compositions for carbonaceous and silicate grains. This dust model includes the growth of dust by accretion of 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 a suite of isolated disc simulations with different masses and metallicities, the simulations can explore the role of these processes in shaping the key properties of dust in galaxies. The simulated Milky Way analogue reproduces the dust-to-metal mass ratio, depletion factors, size distribution and extinction curves of the Milky Way. Galaxies with lower metallicities reproduce the observed decrease in the dust-to-metal mass ratio with metallicity at around a few 0.1 $Z_\odot$. This break in the DTM corresponds to a galactic gas metallicity threshold that marks the transition from an ejecta-dominated to an accretion-dominated grain growth, and that is different for silicate and carbonaceous grains, with $\simeq 0.1\ Z_\odot$ and $\simeq 0.5\ Z_\odot$ respectively. This leads to more Magellanic Cloud-like extinction curves, i.e. with steeper slopes in the ultraviolet and a weaker bump feature at 2175 Å, in galaxies with lower masses and lower metallicities. Steeper slopes in these galaxies are caused by the combination of the higher efficiency of gas accretion by silicate relative to carbonaceous grains, and by the low rates of coagulation that preserves the amount of small silicate grains. Weak bumps are due to the overall inefficient accretion growth of carbonaceous dust at low metallicity, whose growth is mostly supported by the release of large grains in SN ejecta. We also show that the formation of CO molecules is a key component to limit the ability of carbonaceous dust to grow, in particular in low-metallicity gas-rich galaxies.