# Dust Processing in Elliptical Galaxies

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Dust evolves in galaxies through various processes. Since dust attenuation is more prominent in late-type galaxies than in early-type (or elliptical) galaxies, more efforts have been made on modeling dust evolution in late-type galaxies (e.g., Dwek 1998; Asano et al. 2013). On the other hand, dust has also been observed in elliptical galaxies through infrared emission and optical extinction (e.g., Goudfrooij et al. 1994). The physical state of the interstellar medium (ISM) in elliptical galaxies is different from that in late-type galaxies (smaller amount of cold gas and existence of prominent hot X-ray emitting component; e.g., O'Sullivan, Forbes & Ponman 2001). Thus, studying the dust in elliptical galaxies will potentially give us a clue for some processing mechanisms that can be only poorly constrained for late-type galaxies.

In this presentation, we reconsider the origin and processing of dust in elliptical galaxies (Hirashita et al. 2015). We theoretically formulate the evolution of grain size distribution, taking into account dust supply from asymptotic giant branch (AGB) stars and dust destruction by sputtering in the hot ISM, whose temperature evolution is treated by including two cooling paths: gas emission and dust emission (i.e., gas cooling and dust cooling). With our new full treatment of grain size distribution, we confirm that dust destruction by sputtering is too efficient to explain the observed dust abundance even if AGB stars continue to supply dust grains, and that, except for the case where the initial dust-to-gas ratio in the hot gas is as high as $\sim 0.01$, dust cooling is negligible compared with gas cooling. However, we show that, contrary to previous expectations, cooling does not help to protect the dust; rather, the sputtering efficiency is raised by the gas compression as a result of cooling.

We additionally consider grain growth after the gas cools down, in order to investigate the origin of the dust observed in elliptical galaxies. Dust growth by the accretion of gas-phase metals in the cold medium increases the dust-to-gas ratio up to $\sim 10^{-3}$ if this process lasts $\gtrsim 10/(n_{\rm H}/10^3\ {\rm cm}^{-3})$ Myr, where $n_{\rm H}$ is the number density of hydrogen nuclei. We show that the accretion of gas-phase metals is a viable mechanism of increasing the dust abundance in elliptical galaxies to a level consistent with observations, and that the steepness of observed extinction curves is better explained with grain growth by considering accretion.

In summary, a large fraction of dust is still destroyed in the hot ISM in elliptical galaxies even if we consider enhanced cooling by dust. However, the existence of dust in elliptical galaxies may be explained by subsequent dust growth by the accretion of gas-phase metals in the cooled gas, although we do not intend to deny a possibility that the dust is transported from outside by merging galaxies or accreting satellites.