Evolution of dust abundance and grain size distribution in galaxies

Hiroyuki Hirashita
Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan
E-mail: hirashita@asiaa.sinica.edu.tw

Dust formation and evolution affect the star formation properties even at the early stage of galaxy evolution. In particular, the grain size distribution strongly influences the absorption and emission properties of dust. We model the evolution of grain size distribution by including some relevant processes: dust production in stellar ejecta (especially supernovae), shattering in interstellar turbulence, and coagulation and accretion in dense clouds. By applying our models to high-redshift ($z > 5$) galaxies, we find that these processes are efficient enough within the short cosmic ages. Moreover, we show that the observed extinction curves in high-z quasars can be reproduced if the dust supplied from supernovae is processed by shattering in interstellar turbulence. We also calculate the evolution of grain abundance and compare our theoretical results with the observed dust abundances in high-z quasars. We find (i) that grain growth by accretion is crucial to explain the large dust content in high-z quasars, and (ii) that shattering is crucial to activate grain growth since small-grain production by shattering raises the grain growth rate by accretion significantly. The latter point means that the evolution of grain size distribution plays a critical role in governing the dust abundance in high-redshift galaxies. We also apply our models to nearby galaxies.

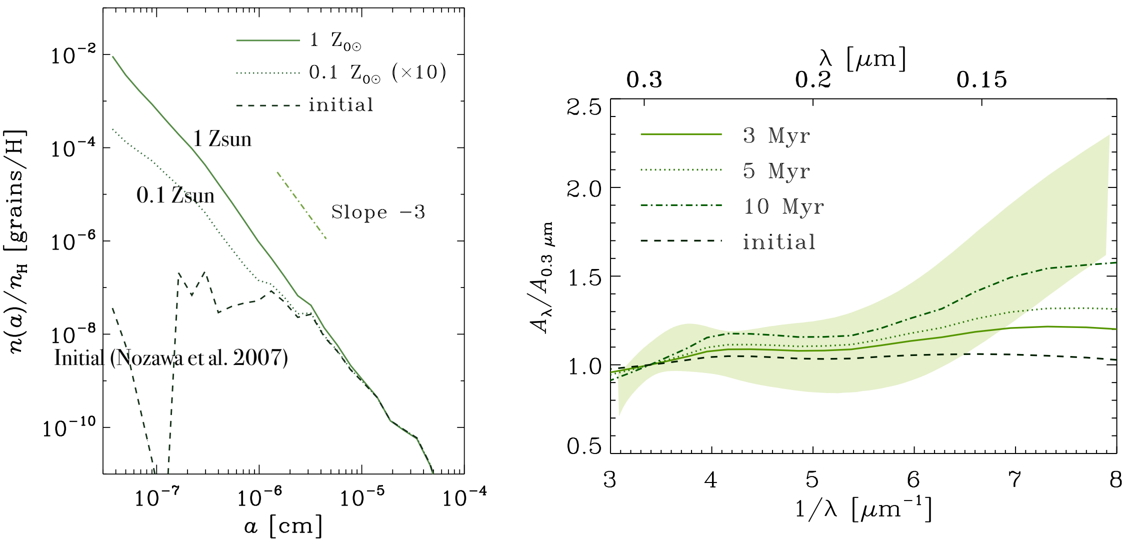

Figure 1: Examples of our calculations. *Left*: The size distribution of dust produced by supernovae is modified by shattering in interstellar turbulence (duration = 5 Myr). The grain abundance is scaled with the metallicity (we show the results for 1 and 0.1 solar metallicity). *Right*: Time evolution of extinction curve by shattering in interstellar turbulence. The shaded area shows the observed extinction curve in a high-redshift quasar.

References

[1] H. Hirashita and H. Yan, *Mon. Not. R. Astron. Soc.* **394**, 1061 (2009).

[2] H. Hirashita, *et al.*, *Mon. Not. R. Astron. Soc.* **404**, 1437 (2010).

[3] T.-M. Kuo and H. Hirashita, *Mon. Not. R. Astron. Soc.*, in press (2012).