How do the extinction curves in galaxies evolve?

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Dust grains scatter and absorb stellar light, in particular, shorter wavelengths like ultraviolet (UV) (this is called extinction), and re-emit the thermal emission at far-infrared (FIR). Thus, understanding of dust grains is crucial for obtaining accurate observational information about galaxies. The effect of extinction depends strongly on the size distribution, amount, and species of dust grains. We construct an evolutionary model of the extinction curves based on the theoretical model of the evolution of grain size distribution and investigate the evolution of extinction curves of galaxies.

In the earliest stage of the galaxy evolution, the main source of dust grains is supernovae explosions. Since these dust grains are relatively large, the extinction curves are flat. As the galaxy evolution proceeds, the effect of shattering becomes more significant, and the number of small grains (< 0.01 μ m) increases. Further on, the small grains grow due to the metal accretion onto the grains. Consequently, the number of dust grains with the radius of ~ 0.01 μ m increases, and the extinction curves at UV wavelength become steeper. We also found that the bump of 2175Å becomes prominent. It implies that at this stage galaxies may be observed as infrared (IR) galaxies extremely luminous at IR.

After the coagulation becomes effective, the extinction curves become flatter and similar to the extinction curve of the Milky Way. However, the predicted extinction at UV wavelength is larger, when compared to the extinction curve of the Milky Way. This fact requires to be explained.

There are three possible solutions of the problem: (1) to neglect the effect of the metal accretion, (2) to neglect the shattering of silicate dust grains (3) to introduce a stronger contribution of the coagulation. Among these three solutions, (1) and (2) cannot successfully explain the evolution of dust mass; therefore, (3) appears to be the most plausible solution. Thus, the effect of coagulation may be larger than we have assumed.
We conclude that the extinction curves of galaxies drastically change in the galaxy lifetime mainly because the grain size distribution changes with time.