Probing the Interstellar Dust in Galaxies over >10 Gyr of Cosmic History

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Dust has a profound effect on the physics and chemistry of the interstellar gas in galaxies and on the appearance of galaxies. Understanding the cosmic evolution of dust with time is therefore crucial for understanding the evolution of galaxies. Despite the importance of interstellar dust, very little is known about its nature and composition in distant galaxies. We describe the results of our ongoing programs using observations of distant quasars to obtain better constraints on dust grains in foreground galaxies that happen to lie along the quasar sightlines. These observations consist of a combination of mid-infrared data obtained with the Spitzer Space Telescope and optical/UV data obtained with ground-based telescopes and/or the Hubble Space Telescope. The mid-IR data target the 10 and 18 μm silicate absorption feature, while the optical/UV data allow determinations of extinction curves, 2175 Å bumps, element depletions etc. Measurements of such properties in absorption-selected galaxies with redshifts ranging from $z \sim 0$ to $z > 2$ provide constraints on the evolution of interstellar dust over the past > 10 Gyr. The optical depth of the 10 μm silicate absorption feature (τ_{10}) in these galaxies correlates well with the amount of reddening along the sightline. But there are indications [e.g., based on the τ_{10} / E(B-V) ratio, possible grain crystallinity] that suggest that the dust in these distant galaxies may differ in structure and composition from the dust in the Milky Way and the Magellanic Clouds. We discuss the implications of these results for the evolution of galaxies and their star formation history.

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