The Widespread Presence of Nanometer-size Dust Grains in the Interstellar Medium of Galaxies

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Interstellar dust spans a wide range in size distribution, ranging from ultrasmall grains of a few Ångströms to micronmeter-size grains. While the presence of nanometer-size dust grains in the Galactic interstellar medium was speculated six decades ago and was previously suggested based on early infrared observations, systematic and direct analysis of their properties over a wide range of environments has been lacking. Here we report the detection of nanometer-size dust grains that appear to be universally present in a wide variety of astronomical environments, from Galactic high-latitude clouds to nearby star-forming galaxies and galaxies with low levels of nuclear activity. The prevalence of such a grain population is revealed conclusively as prominent mid-infrared continuum emission at $\lambda \sim 10\,\mu m$ seen in the *Spitzer*/IRS data, characterized by temperatures of ~ 300–$400\,\mathrm{K}$ that are significantly higher than the equilibrium temperatures of common, submicron-size grains in typical galactic environments. We propose that the optimal carriers of this pervasive, featureless hot dust component are very small carbonaceous (e.g., graphite) grains of nanometer size that are transiently heated by single-photon absorption. This grain population accounts for $\sim$1.4% of the total infrared emission at $\sim$5–$3000\,\mu m$ and $\sim$0.4% of the total interstellar dust mass.