

X-ray absorption spectroscopy and scattering of interstellar dust

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Interstellar (IS) dust grains are an integral part of IS evolution in galaxies, but to date our knowledge of their properties primarily derives from observations of the UV/optical extinction, infrared emission, and polarization from grains. We can also learn about grains by studying the X-ray halos seen around absorbed X-ray sources in combination with studies of the line of sight X-ray absorption by these grains. Small-angle X-ray scattering creates halos that arcminutes in scale via the coherent interactions of all of the electrons in the grains. As a result, X-ray halos are strongly affected by the size distribution of the grains, and to a lesser extent their position, composition (including porosity), and shape. I will describe how X-ray observations with Chandra and XMM-Newton have been used to survey Galactic X-ray halos and, with the gratings, to observe their composition directly in order to answer the many outstanding questions about IS dust grains, such as the total grain mass, density, and composition. Combining this X-ray halo data with the other UV, optical, and IR observations have allowed us to place tight constraints on all dust models. By analyzing data from many lines of sight, we have characterized both the mean X-ray halo and the variation. This will include sightlines through dense clouds where UV/optical extinction cannot be measured, and in-depth studies towards lightly absorbed sources where absorption lines can be used to characterize the sightline. With the upcoming launch of Astro-H, we expect an explosion in usable lines of sight for such work which should lead to a revolution in our understanding of IS dust grains.