Cosmic dust through X-ray eyes: a laboratory and space study

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Direct measurements of dust in astrophysical environments have traditionally relied on infrared and radio spectral studies of rotational and vibrational spectra. (Optical studies also provide much information, but based on depletion measurements, the dust detections are *in*-direct.) With its ability to penetrate through atoms, X-rays enable a powerful direct probe of both gas *and* ($\lesssim 10\mu$m) dust over orders of magnitude absorption and temperatures, to provide complementary knowledge to the wealth of existing information. I will discuss how the combination of experimental programs at synchrotron beam-lines and high spectral resolution X-ray studies of compact objects (e.g. black holes and neutron stars) can be used as a powerful new tool for revealing information about cosmic dust properties, including the element-specific gas-to-dust ratio in addition to its composition and structure. I will discuss how these studies together with physiochemical modeling can be used to track the environment in which the dust was formed, and our plans for a publicly available database of standards.