Constraining the lifecycle of dust and metals in neutral gas from the UV to radio

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Abstract

Our understanding of the chemical enrichment of the Universe relies on the characterization of the dust-to-metal ratio (D/M) as a function of environment. I will present results from independent efforts to measure the dust-to-gas (D/G) and D/M in the Magellanic Clouds and other nearby low-metallicity galaxies. An analysis of the gas-to-dust ratio variations in the LMC and SMC (with metallicities 0.5 and 0.2 solar, respectively) based on the modeling of far-infrared emission shows that the dust abundance increases by factors 3-7 between the diffuse ISM and dense molecular clouds, albeit with significant degeneracies with dust opacity and CO-dark gas. Two large HST programs, METAL (LMC, 50% solar metallicity) and METAL-Z (IC 1613, 15% solar and Sextans A, 8% solar) are aimed at resolving those degeneracies by constraining D/M and D/G using UV absorption spectroscopy. We find that the gas-phase fractions of key components of dust grains (Si, Mg, Fe, Ni) but also other volatile elements (Zn, S) decrease with increasing hydrogen column density. This supports dust growth in the ISM via accretion of gas-phase metals onto dust. Depletion patterns differ between the Milky Way, the LMC, and SMC, with differences in D/M offsetting almost exactly the total (gas + dust) metallicity differences between these galaxies. This leads to the surprising finding that, for a given hydrogen column density, gas in the Milky Way, LMC, and SMC have the same gas-phase metallicities, despite the large differences in stellar mass and total metallicities for these galaxies. With the very recent METAL-Z program, we are investigating these trends at metallicities below the critical metallicity (0.2 solar) at which chemical evolution models predict D/M decreases steeply

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