Constraints on dust composition in the Magellanic Clouds from gas-phase zinc, silicon, chromium, and iron abundances

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We present abundance measurements of zinc, silicon, chromium, and iron (Zn, Si, Cr, and Fe) along 16 sightlines through the interstellar medium (ISM) of the Large and Small Magellanic Clouds (LMC and SMC). The Zn, Si, and Cr abundances are derived from new near-ultraviolet spectra taken using the Cosmic Origins Spectrograph on the Hubble Space Telescope. The Fe abundances are derived from archival Far Ultraviolet Spectroscopic Explorer spectra. Zn is thought to be a good metallicity indicator in diffuse neutral gas, as it is almost completely undepleted in warm neutral clouds in the Milky Way (MW). Si, Cr, and Fe are thought to be dust tracers, as they are somewhat depleted even in warm neutral gas; this suggests that the resilient cores of some MW dust grains are made up of these elements, among others. By comparing the abundances of the non refractory element, Zn with the refractory element, Cr, we derive a metallicity ([Zn/H]), and a relative measure of dust-to-gas mass ratios ([Cr/Zn] ratio) for each line-of-sight with an estimated uncertainty of $< 25\%$. Our current knowledge of the LMC and SMC dust-to-gas mass ratios is based on estimates from dust emission and gas line emission in the far-infrared to radio wavelength ranges and have uncertainties of factors of > 3 because of our imprecise knowledge of the dust composition and total molecular hydrogen gas mass. These more refined constraints on these elemental depletions in the ISM will provide crucial constraints for our dust evolution models of these galaxies. Our targeted sightlines are primarily diffuse neutral gas with molecular hydrogen fractions ranging from 10^{-6} to 10^{-1} and reddening ranging from an E(B-V) of 0.11 to 0.36, corresponding a maximum visual extinction of roughly one magnitude. Each of these sightlines also includes a measurement of the MW which we use as a comparison set. We have found that Zn is noticeably depleted even in warm gas, suggesting that it should be used more cautiously as a metallicity indicator for $Z \sim 0.2 - 0.5$ environments. Si, Cr, and Fe show depletions at least equivalent to those in the MW. The depletions of all elements measured show positive correlations with total hydrogen column and reddening.