Interstellar Extinction and Elemental Abundances

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Elements in the interstellar medium (ISM) exist in the form of gas or dust. The interstellar extinction and elemental abundances provide crucial constraints on the composition, size, and quantity of interstellar dust. Most of the extinction modeling efforts have assumed the total (gas and dust) abundances of the dust-forming elements—known as the "interstellar abundances," "interstellar reference abundances," or "cosmic abundances"—to be solar and the gas-phase abundances to be environmentally independent. However, it remains unclear whether the solar abundances are an appropriate representation of the interstellar abundances. Meanwhile, the gas-phase abundances are known to exhibit appreciable variations with local environments.

Here we explore the viability of the abundances of B stars, the solar and protosolar abundances, and the protosolar abundances augmented by Galactic chemical enrichment (GCE) as an appropriate representation of the interstellar abundances by quantitatively examining the extinction and abundances of 10 interstellar sight lines for which both the extinction curves and the gas-phase abundances of all the major dust-forming elements (i.e., C, O, Mg, Si and Fe) have been observationally determined.

Instead of assuming a specific dust model and then fitting the observed extinction curves, for each sight line we apply the model-independent Kramers-Kronig relation, which relates the wavelength-integrated extinction to the total dust volume, to place a lower limit on the dust depletion. This, together with the observationally derived gas-phase abundances, allows us to rule out the B-star, solar, and protosolar abundances as the interstellar reference standard and support the GCE-augmented protosolar abundances as a viable representation of the interstellar abundances.