OXYGEN ISOTOPIC RATIOS RESULTING FROM CO SELF-SHIELDING. J. R. Lyons[1], [1]Earth & Space Sciences, UCLA, Los Angeles, CA 90095-1567; jimlyons@ucla.edu.

Introduction: A key issue with the CO self-shielding hypothesis [1] as the explanation for the oxygen isotope distribution of the solar system is the resulting $\delta^{17}O/\delta^{18}O$ value of the product oxygen. Simply put, does CO self-shielding yield a $\delta^{17}O/\delta^{18}O$ ratio that agrees with the CAI mixing line to within a few percent?

Most self-shielding models [2-4] have assumed equal or nearly equal fractionation in ^{17}O and ^{18}O during CO photodissociation. These papers relied on CO shielding functions [5] as a means of avoiding the complete integration over wavelength of the CO isotopic cross sections, but shielding functions were evaluated for only $C^{16}O$ and $C^{18}O$ in [5]. The shielding functions for CO isotopologues have recently been updated [6], and now include $C^{17}O$. Molecular constants for $C^{17}O$ in the FUV range (91-108 nm) are unmeasured, so the $C^{17}O$ shielding functions are necessarily approximate.

Measurements of isotope effects during CO photodissociation have been performed at the ALS synchrotron [7], and have yielded a wavelength dependence in the $\delta^{17}O/\delta^{18}O$ ratio. At long wavelengths (105 & 107.6 nm), they observed $\delta^{17}O/\delta^{18}O \sim 1.4$-1.8, and at short wavelengths (92 & 94 nm) they saw $\delta^{17}O/\delta^{18}O \sim 0.6$. The experiments in [7] were performed with very high CO column density, such that $C^{16}O$ had an optical depth up to 10^4 at 107.6 nm. This is not an astrophysically relevant scenario (because of dust absorption), but it does illustrate the effect of simultaneous $C^{16}O$ *and* $C^{18}O$ self-shielding at long wavelengths to yield $\delta^{17}O/\delta^{18}O > 1$. At short wavelengths, the shorter lifetimes of the CO excited states causes some line broadening and band overlap, with a resulting mass-dependent fractionation superimposed upon the mass-independent fractionation from discrete self-shielded lines. The resulting slopes will be < 1 as seen by [7].

Astronomical measurements of CO isotopologues in disks [8] and molecular clouds [9] demonstrate that CO self-shielding does occur in these environments, but the precision of the measurements is too low to be a test of CO self-shielding as an explanation for the meteorite oxygen isotope line.

Discussion: Here I will focus on two other factors that affect the $\delta^{17}O/\delta^{18}O$ ratio in CO self-shielding, namely excitation temperature and absorption by dust. Figure 1 shows solar nebula model results at CO excitation temperatures of 50 K and 5 K (the assumed H_2 excitation temperatures are 354 K and 11 K). The calculations use $C^{x}O$ shielding functions from [6], and assume a viscosity $\alpha = 10^{-2}$. The 50 K results for dust uniformly distributed in the gas yield $\delta^{17}O/\delta^{18}O \sim .88$, too low to explain the CAI line. Allowing dust to settle yields a slight increase in $\delta^{17}O/\delta^{18}O$ due to $C^{18}O$ self-shielding. Shielding functions at 5 K yield $\delta^{17}O/\delta^{18}O \sim 1.2$-1.3, depending on the assumed dust absorption parameter. Clearly, at 5 K CO will be frozen out in the nebula, so higher temperatures are being evaluated. The implication, however, is that self-shielding can yield $\delta^{17}O/\delta^{18}O$ values consistent with CAIs.

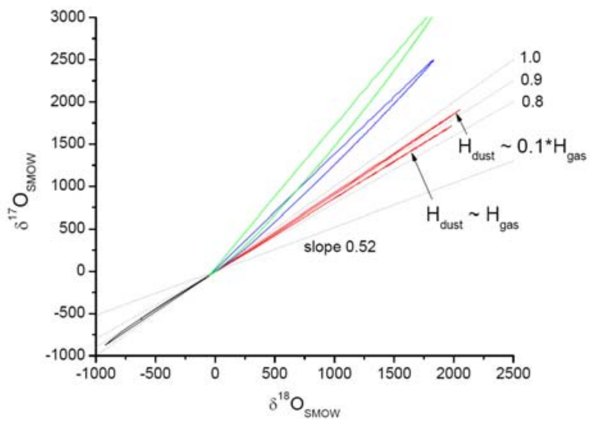

Fig. 1. Nebula model calculations at 30 AU at the midlpane for H_2O_{ice}. The curves in red use 50 K CO shielding functions (Doppler width 0.3 km s^{-1}) from [6]. Dust is 0.1 microns and is distributed with the gas ($H_{dust} \sim H_{gas}$) or is assumed to be settled ($H_{dust} \sim 0.1*H_{gas}$). The curves in green and blue use 5 K shielding functions from [6] (again b = 0.3 km s^{-1}), and for a dust absorption parameter $\gamma = 1.0$ (green) and 3.5 (blue). At 5 K CO will be frozen out, and so will not undergo gas-phase self-shielding, but the figure illustrates that a variety of $\delta^{17}O/\delta^{18}O$ ratios are possible from CO self-shielding. Other temperatures are being evaluated.

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