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Modeling MIF during CO photolysis using line-by-line spectra: Implications for the early solar system

James Lyons
University of California, Los Angeles, USA (jimlyons@ucla.edu)

During the past several years CO self-shielding has been investigated as the source of the ^{16}O-poor endmember of the CAI mixing line [1-4]. A key assumption in most of the models is that the δ^{17}O/δ^{18}O ratio (i.e., 'slope') associated with CO photodissociation under self-shielding conditions (when C^{16}O is optically thick) is unity or very close to unity. Laboratory CO photodissociation experiments by Chakraborty et al. [5] found slopes ranging from $\sim$ 1.8 at 107 nm to $\sim$ 0.6 at 94 nm. Such a strong dependence of slope on wavelength appears to be inconsistent with the CO self-shielding hypothesis.

Here I present simulations of these CO experiments, and also of the solar nebula, using complete line-by-line spectra for the oxygen isotopologues of CO. The questions I address are 1) What is the origin of the wavelength dependence in δ^{17}O/δ^{18}O ratio of photoproduct O (as CO_2)?; 2) Can a line-by-line spectrum capture the wavelength dependence or is a more complete spectral model necessary?; 3) What are the implications for the self-shielding theory for the solar nebula?

I computed line-by-line spectra for 37 bands of ^{12}C^{16}O, ^{12}C^{17}O and ^{12}C^{18}O at 300 K from published collections on CO molecular constant data [6,7]. Bands 31-33 have a resolution of 1x10^{-5} nm, and all other bands have a resolution of 3x10^{-5} nm. Simulations of photolysis experiments yield slopes for atomic O of 0.7 to 0.8 at 92.6, 94.1 and 97.0 nm. Measured values [5] were between 0.6 and 1.0, and the calculations agree with the measurements that slopes are < 1 at 92 and 94 nm. Computed and measured slopes at 107 nm are > 1, as is also found in previous simulations [8], which results from an optically thick column of C^{18}O.

Solar nebula modeling was performed with the computed spectra added to the disk model of [3]. Calculations were done at 30 AU and 50 K, and also at 10 K and 1500 K to explore the temperature dependence of the slope. A slope of $\sim$0.9 is found for 50 K (and 1500 K), and $\sim$ 1.2 for 10 K. Thus, temperature dependence is predicted for the slope, which may be useful in eliminating some versions (i.e., locations) of the self-shielding theory. The large range of slopes seen by Chakraborty et al. [5] is not evident in disk models, nor in cloud models [7].

[1] Clayton, R. N. (2002) *Nature* 415, 860-861.

[2] Yurimoto & Kurimoto (2004) *Science* 305, 1763–1766.

[3] Lyons J. R. and E. D. Young (2005) *Nature* 435, 317-320.

[4] Lee et al. (2008) *Meteorit Planet. Sci.* 43, 1351–1362.

[5] Chakraborty et al. (2008) *Science* 321, 1328-1331.

[6] Eidelsberg et al. (1991) *Astron Astrophys S.S.* 90, 231-282,

[7] Visser et al (2009) *Astron. &Astrophys.* 503, 323-343.

[8] Lyons, J. R. (2009) 40^{th} *LPSC*, abstract 2377.