THE FIRST GOO: PHOTOCHEMISTRY AND THE OBSERVED ENRICHEMENT OF O, C, AND N ISOTOPES IN METEORITE IOM. J. R. Lyons[1], [1]Earth & Space Sciences, UCLA, Los Angeles, CA 90095-1567; jimlyons@ucla.edu.

Introduction: The remarkable O MIF signatures seen in acid-insoluble organic matter (IOM) from a CR2 meteorite [1] show some correlation with enhanced $\delta^{13}C$ values, suggesting that both enrichments may be a result of CO photochemistry. ^{2}H and ^{15}N enrichments in the same IOM do not correlate with ^{17}O and ^{18}O and/or ^{13}C enrichments, but do show some correlation with each other [1]. Both N and H isotopes have been shown to be strongly fractionated by ion-molecule reactions in molecular clouds [2, 3]. Here, the question I address is whether these results, particularly those for meteorite IOM [1], are consistent with expected photochemical and ion-molecule processes.

Discussion: It is well established that in model calculations CO self-shielding produces large enrichment in product ^{17}O and ^{18}O, which are then stored in H_2O. Product C is similarly enriched in ^{13}C, although by a factor of ~2 less than the enrichment in ^{17}O and ^{18}O [4]. Self-shielding enrichment of ^{13}C is predicted by photochemical models of disks [5], but CO exchange with C^+ and CO condensation [6, 7], are also important. Disk model calculations, including ^{13}C at temperatures well above CO condensation (> 20 K), are in progress using the oxygen isotope code of [8]. Shielding functions from [4] are used for $C^{13}O$.

As with CO, N_2 also undergoes self-shielding, producing enriched N and $N(^2D)$, with the N stored in HCN. The $N(^2D)$ rapidly forms NH, leading to reformation of N_2 by reaction of N and NH, and thus erasing much of the photo-induced fractionation. Large initial ^{15}N enrichments are possible by N_2 self-shielding, but the total amount of enriched material produced is small [9]. The relatively small ^{15}N enrichment in HCN, and the large error bars on $\delta^{15}N$ of Jupiter (Fig. 1), means that N_2 self-shielding cannot be used to rule out CO self-shielding in the outer solar system, based on comparing the Sun and Jupiter.

Preliminary $\Delta^{17}O$ values (not shown) for grain-bound CO_2, H_2CO and CH_3OH have also been computed. $CO_{2,gr}$ and CH_3OH_{gr} have $\Delta^{17}O > 0$ due to reactions with OH, but H_2CO_{gr} has $\Delta^{17}O < 0$ due to formation from CO gas. (Note that formation of CH_3OH from H_2CO on grains is not yet included in these calculations.) These results argue that exchange of IOM oxygen with nebula water is necessary to explain the high $\Delta^{17}O$ values measured in [1] for IOM from a CR2 meteorite. Or, alternatively, the oxygen in meteorite IOM derived from reactions of O atoms with hydrocarbon ions, which would yield O-containing organics with $\Delta^{17}O > 0$.

H_2 also has a line-type absorption spectrum, and so also undergoes self-shielding at the edges of clouds and high surface of disks. At greater depths into these objects, where CO and N_2 self-shielding become important, H_2 lines are highly broadened and will partially shield HD lines, thus reducing D enrichment. But not all HD lines will be shielded, suggesting that HD photodissociation could be a significant source of H isotope fractionation. Thus, the IOM results of [1] are consistent with a photochemical origin for O and (possibly) C isotopes signatures in IOM, and ion-molecule origin for N isotopes signatures.

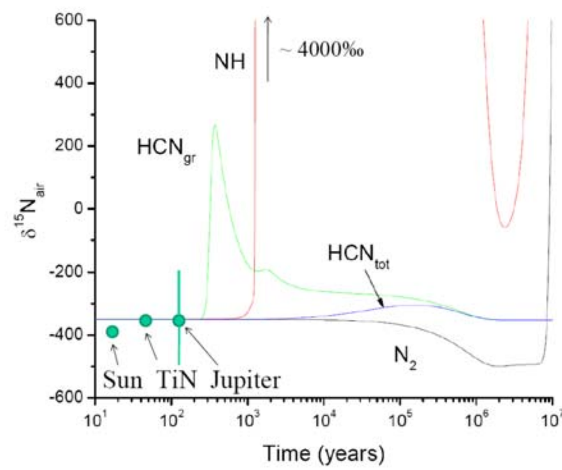

Fig. 1 Results of solar nebula modeling at 30 AU and for G_0 ~ 1000. Enrichment in $\delta^{15}N_{air}$ in HCN_{gr} (HCN on grains) due to N_2 self-shielding at the FUV surface of the nebula. Values for the Sun, TiN in CAIs, and Jupiter are shown also. The relatively small enrichment in $\delta^{15}N_{air}$ for HCN_{tot}, and the large error bars for Jupiter, do not allow comparisons between Jupiter and the Sun to be used to rule out CO self-shielding in the outer solar system.

References: [1] Hashizume K. et al. 2011. *Nature Geo.* **4**, 165. [2] Rodgers S. D. and Charnley S. B. 2008. *MNRAS* **385**, L48. [3] Aleon J. and Robert F. 2004. *Icarus* **167**, 424. [4] Visser R. et al. 2009. *A&A* **503**, 323. [5] Woods P. and Willacy K. 2009. *ApJ* **693**, 1360. [6] Smith R. et al. 2011. *42nd LPSC* abstract 1281. [7] Young E. and Schauble E. 2011. *42nd LPSC* abstract 1323. [8] Lyons J. R. and Young E. D. 2005. *Nature* 435, 317-320. [9] Lyons J. R. 2010. *73rd MetSoc* abstract 5424.