THE GENESIS MISSION: A UNIQUE OPPORTUNITY FOR SCIENTIFIC COLLABORATION. A. J. G. Jurewicz[1], J.M. Laming[2], and R. Christofferson[3], [1]CMS m/c 6004, ASU, Tempe AZ 85287 (Visiting Scientist Dartmouth College, Hanover NH) (Amy.Jurewicz@asu). [2]Naval Research Laboratory, Space Science Division, Code 7684, Washington DC 20375. [3]Jacobs, NASA Johnson Space Center, Houston, TX, 77059

Premise: The Genesis Solar Wind Sample Return was flown with the goal of creating a baseline of elemental and isotopic solar photospheric composition from solar matter (not rocks!) for use in cosmochemical modeling. No uses for the samples outside of Cosmochemistry were advertised, and for good reason. In these days of limited funding, there is an overwhelming tendency to look inward instead of recognizing that the best outcomes of science tend to be interdisciplinary. So, below, we suggest two radical acts of collaboration that we believe will accelerate the advancement of science.

1) Collaboration with Cosmochemistry and Solar Physics: The Genesis solar wind (SW) sample is not a solar photospheric sample. Cosmochemists can extract precise solar wind measurements from the Genesis samples; however, input from solar physicists is needed to extrapolate the composition from solar wind to solar. But that conversion from SW to solar requires models, and solar physicists need a "ground truth" to confirm that their theoretical calculations mimic reality.

The necessity for collaboration between cosmochemists and solar physicists -- and the interdependence of the results -- was recognized prior to the spacecraft design. Accordingly, a little-advertised solar physics experiment became central to the spacecraft's SW collection system. Specifically, the Array Collectors (FIG 1 and *[1]*) collected separate samples of bulk, interstream, coronal hole, and coronal mass ejection solar wind. These samples will have different SW/photospheric fractionations but, if correct, theoretical models will give the same photospheric composition.

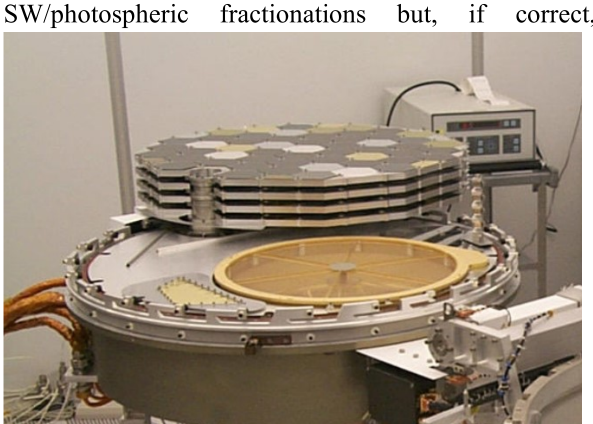

FIG 1. Stack of plates holding collectors constitute the Array Collector. Each plate under the top (bulk) collector was deployed under specific SW conditions. Photo: NASA.

Although Genesis data is useful for solar physicists, the downside is that the Genesis sample has a (nominal) two-year integrated timescale, so individual features are difficult to detect. That is, however, not always the case. Work by *[2]* isolated the CME mass ejection from the Halloween storms by comparing data from bulk and CME Array collectors (FIG. 2). This data were then deconvolved into the SW component wind speeds using SRIM (www.srim.org), which is possible because there is negligible diffusion of SW in the Genesis diamond-like carbon on silicon (DoS) collectors (see *[3]*, *[4]*).

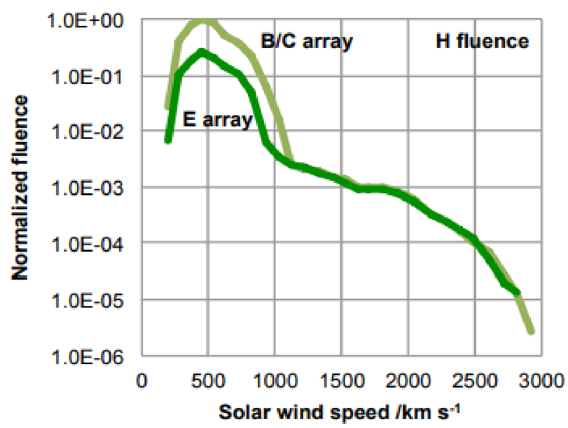

***FIG 2.** SW H measured in Genesis DoS and deconvolved into the component SW speeds from [2]. This data is comparable with integrated ACE (spacecraft derived) fluences.*

Again, cosmochemists need solar physics for the extrapolation to solar composition and solar physicists need Genesis SW data to anchor and confirm their models. An excellent, visual example of this interdisciplinary work is given in *[5]*, some of which is reproduced below (FIG. 3). Laming et al. *[5]* models fractionation of elements and isotopes during SW formation and, while the fits for elemental fractionation shown in FIG 3 are very good, the light isotopes do not fit as well in the Laming models. Accurate isotopic measurements are, thus, important for confirming the completeness of the physics behind theoretical models of SW formation and to underscore which issues will be important for continued model development. FIG 4 gives an example of a technical development study that measured Mg isotopes in Genesis DoS collectors and used their results to evaluate fractionation models.

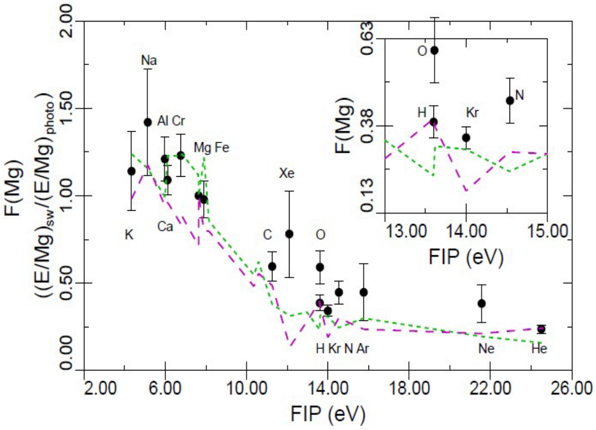

FIG 3. Models of solar wind fractionation during formation from first principles, using ponderomotive force (green line) ponderomotive force with the first adiabatic variant added (purple line) by [5]. Note: Genesis data are used as an anchor.

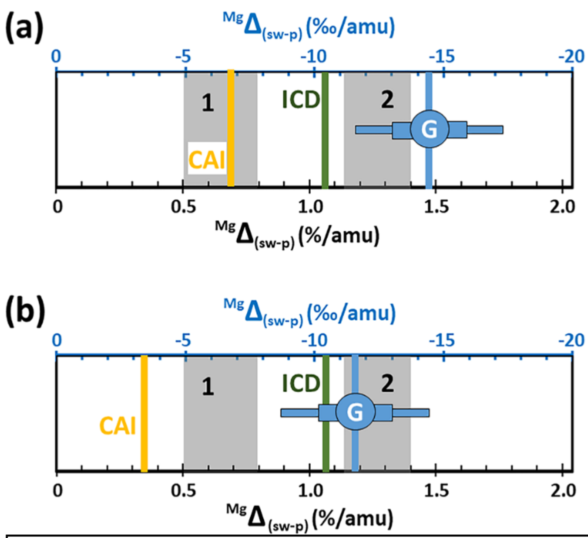

FIG 4. Genesis Mg isotope results from [3] (Blue with 1 and 2 sigma horizontal bars) compared with models of [5] (grey boxes 1,2) and [6](Green vertical line ICD) as well as the cosmochemical proxy of [7] (yellow vertical CAI line). (a) without gravitational settling in the solar convective zone; (b) gravitational settling added.

Collaboration with Space Weathering and Materials Science: An area of collaboration growing in importance centers around the Genesis collectors themselves; specifically, how these materials responded to exposure to space. This collaboration is not new. The first important science result from Genesis was a more accurate interpretation of SW implanted into lunar regolith *[8]*. Instead of two solar noble gas components with distinct isotopic composition, Genesis results showed that the depth profile of solar wind Ne in lunar regolith was simply the current SW modified by a component of surface sputtering from millennia of slow SW implantation. This collaboration is currently gaining importance as we study methods of cleaning and analyses of Genesis silicon collectors. Structural changes may allow unexpected cleaning methods (e.g., *[9]*), and movement of SW species within the collectors mean that some species are found closer to the surface than expected from estimates using SRIM (e.g., *[4]*). Also, some silicon collectors have an amorphous layer near the surface while others, even from the same array, do not *[10]*. Understanding the formation of amorphous silicon and its affects on both analyses and solar wind re-tention is quickly becoming important. This work requires a suite of TEM studies combined with the effort of materials engineers and/or experts in space weathering and in all types of collectors, not just silicon.

For scientists interested in materials and space weathering, the bonus of working on Genesis samples is that the suite of Genesis array collectors were implanted to high fluences by SW at very low currents: i.e., these samples of "space weathering" could never be reproduced in the lab. The implantation of SW H ranged from ~0.033 – 0.040 nA/cm^2 for fluences ranging from 4E15 to 1.6E 16 ions/cm^2 at SW energies mostly ~1.5 keV. SW He was about 3 – 5% of the H fluence, and everything else was trace.

Conclusion: Work on Genesis science has always been quietly interdisciplinary. But, now there is more need for active collaborations between Genesis researchers and researchers from other fields. The results of these collaborations will be greater than could be achieved by each group alone. As with all sample returns, there are great opportunities for many disciplines to be involved, and they will be able to forward their individual science while supporting mission goals. Science works most efficiently when interdisciplinary, and the breakthroughs are bigger and come more often. .

References: [1] Jurewicz et al. (2003) Space Sci. Rev. 105:535–560. [2] Yurimoto et al. (2019) 50th. LPSC Abstract #2221 [3] Jurewicz et al. (2020) DOI (10.1111/ maps.13439). [4] Jurewicz et al. (2021) DOI (10.1039/D0JA00375A). [5] Laming et al. (2017). *Astrophys. Jour. Letters* 851:L12. [6] Bochsler (2007). *Astron. Astrophys. Rev.* 14:1– 40. [7] McKeegan et al. (2011) *Sci.* 332:1528–1532. [8] Grimberg et al. (2007) Sci. 314:1133-1135. [9] Paramasivan et al. (2018) 49th.LPSC Abstract #2886. [10] Allton et al. (2019) 50th LPSC Abstract #1118.