Solar Wind Argon from Genesis AloS Regime Collectors.

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Introduction: Determining solar noble gas isotopic ratios are one piece of the puzzle needed to constrain models of the evolution of terrestrial planets, as well as to understand solar composition and processes. Solar wind (SW) remains the best available source of solar material, even though there is potential for fractionation between true solar values and the solar wind. Here we will focus on SW argon.

In 1974 Cerutti analyzed Apollo SWC foils and found a $^{36}Ar/^{38}Ar$ ratio that could not be resolved from the terrestrial value of 5.3 [1]. But with examination of lunar soils, a difference between solar and terrestrial Ar emerged. Unfortunately, analysis of these soils produced varying results, from 5.48 [2] to 5.80 [3]. With Genesis Aluminum on Sapphire (AloS) samples, we are now able to precisely define the solar wind value and clearly differentiate it from the terrestrial value.

Results: Previously reported Ar data [4] are now confirmed by additional measurements. These measurements were made using samples of bulk SW and the three individual SW flow regimes: interstream SW (low-speed), coronal hole SW (high-speed), and coronal mass ejections (CME). The averages of the isotopic ratio, ^{36}Ar flux, and $^{20}Ne/^{36}Ar$ ratio for each regime are given in the table below. Errors shown for $^{36}Ar/^{38}Ar$ ratios are 1σ statistical errors; for the ^{36}Ar flux and $^{20}Ne/^{36}Ar$ ratios, the numbers in parentheses are uncertainties based on the spread in the measured amounts ^{36}Ar and ^{20}Ne.

Sample	$^{36}Ar/^{38}Ar$	^{36}Ar Flux ($10^6/m^2 \cdot s$)	$^{20}Ne/^{36}Ar$
Bulk SW	5.501 ± 0.005	3.81 (0.2)	59 (5)
High-Speed	5.502 ± 0.010	2.78 (0.1)	66 (6)
Low-Speed	5.508 ± 0.010	3.63 (0.4)	46 (5)
CME	5.467 ± 0.017	3.68 (0.8)	59 (4)
Terr. Atm. [5]	5.319 ± 0.008	–	0.524
Terr. Atm. [6]	5.305 ± 0.008	–	–

Discussion: These results define the bulk SW $^{36}Ar/^{38}Ar$ ratio to be 5.501 ± 0.005, (with similar precision as the terrestrial value), which is 3.40 ± 0.09% lighter than terrestrial atmospheric Ar. This has implications for atmospheric retention models. Coulomb Drag Theory predicts a small isotopic fractionation between the low- and high- speed SW regimes [7]. Our data restricts this to less than 0.6% for the $^{36}Ar/^{38}Ar$ ratio. Differences between the flow regimes of the $^{20}Ne/^{36}Ar$ ratio suggest elemental SW fractionation, with the low-speed SW ~25% heavier than the other regimes. This probably reflects differences in the efficiency of the FIP effect in the different SW flow regimes.

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