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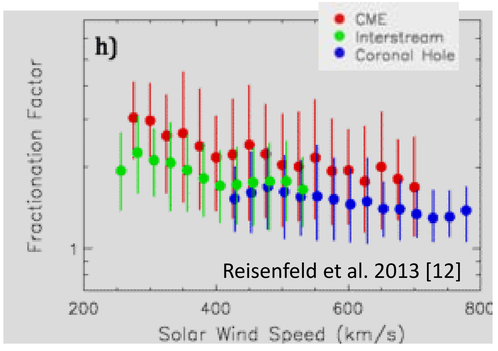
Elemental Abundances of Noble Gases in Solar Wind Regimes Collected by GENESIS

Nadia Vogel[1], Veronika S. Heber[2], Peter Bochsler[3], Donald S. Burnett[4], Colin Maden[1], Rainer Wieler[1]

[1]ETH Zürich, Earth Sciences, Zürich, Switzerland; [2]Paul Scherrer Institute, Villigen, Switzerland; [3]Univ. Bern, Physikalisches Institut, Bern, Switzerland; [4]Caltech, Geological & Planetary Sciences, Pasadena, USA

wieler@erdw.ethz.ch

Genesis' three regimes:



Coronal Hole = "Fast"

Interstream = "Slow"

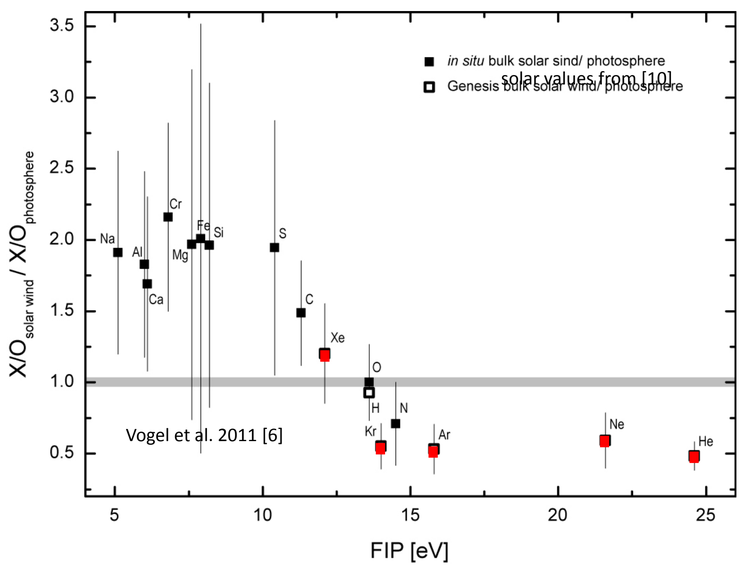
Coronal Mass Ejections = CME

Many noble gas data available for Bulk Solar Wind (SW) targets (e. g. refs. 1-8), but few from regime targets

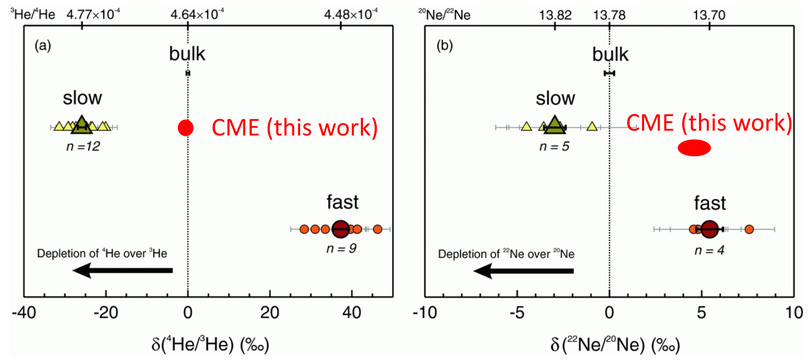
This work:

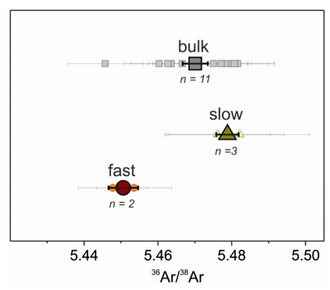
- Elemental abundance data of Ar, Kr, & Xe in regimes
- Elemental and isotopic data of He, Ne, & Ar in all regimes, including CME

Key findings from earlier work (2, 5, 6, 9)



Xe in SW enhanced by a factor 2 - 2.5 relative to other noble gases



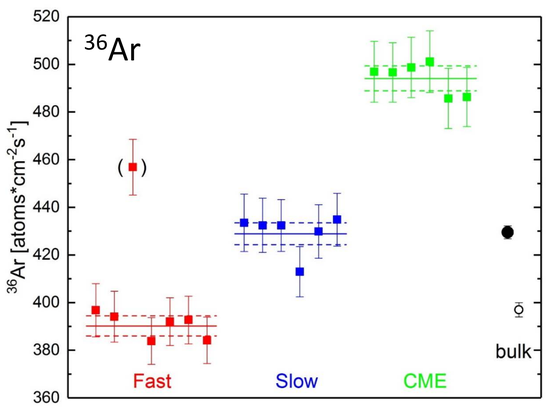


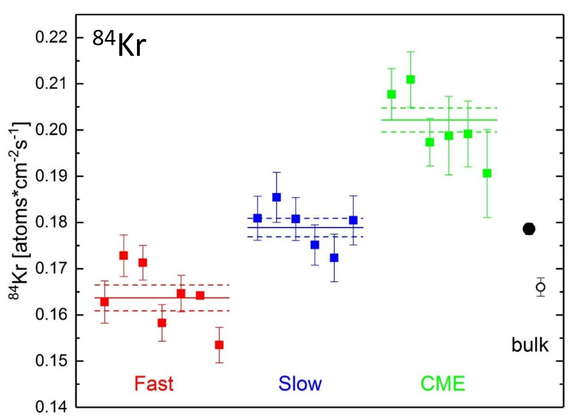
Heber et al. 2012 [3]

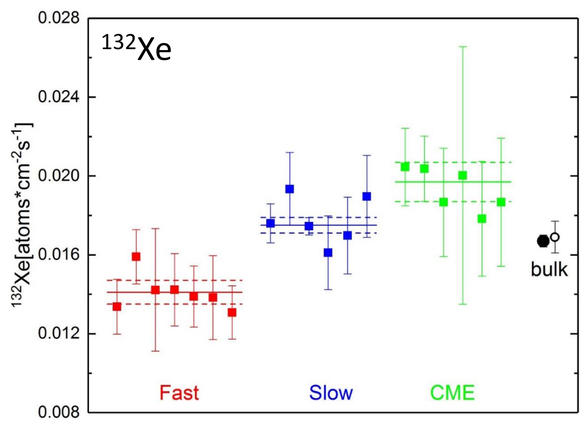
Isotopic fractionation between Fast and Slow SW: He>>Ne>Ar

Results and Discussion

Ar, Kr, Xe Fluxes

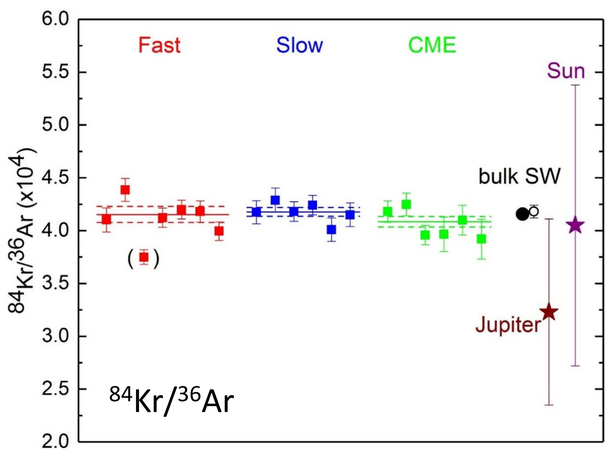


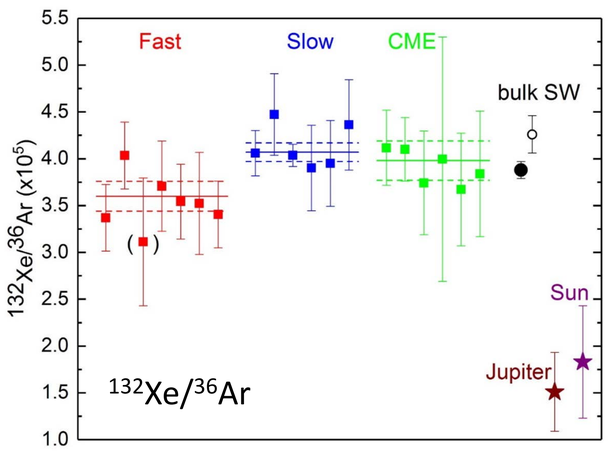




- Ar, Kr, Xe fluxes regime-dependent, Fast < Slow < CME. Expected since SW proton momentum flux ~invariant [11]
- Proton flux difference Fast - Slow in Genesis GIM [12] and Ulysses [13] similar: Fast & Slow regime definitions Genesis - Ulysses agree quite well
- He enhancement in Genesis CME lower than in Ulysses [14]: "Contamination" with normal SW

Kr/Ar & Xe/Ar Elemental Ratios

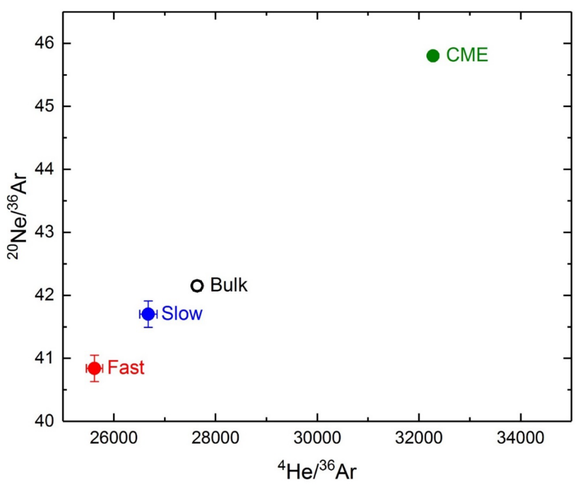




- Xe/Ar in SW higher than in Sun [10] and slightly (12%) higher in Slow SW than Fast SW
- Kr/Ar no clear differences
- Inefficient Coulomb Drag of Xe likely overcompensated by efficient ionisation of Xe in ion-neutral separation region. Xe behaves like a Low-FIP element (Low FIT)
- FIP effect of Xe in Fast SW less pronounced than in Slow SW, in agreement with regime data

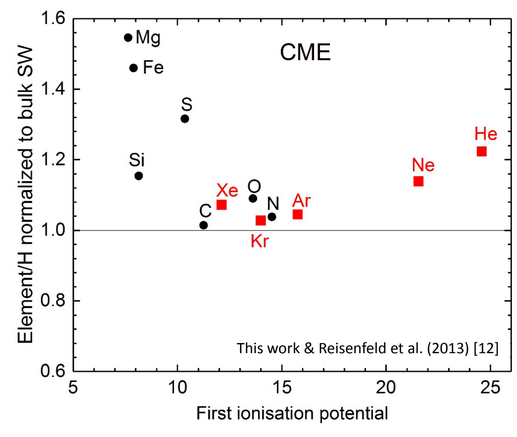
Speculation: Additional mechanism enhancing Xe in SW?:
resonant charge exchange between H and Xe (but not between H and Kr), similar to mechanism proposed by Zahnle et al. (2019) [15] to explain early Xe loss from terrestrial atmosphere [16]

He/Ar & Ne/Ar Elemental Ratios



Problem: He (and Ne) in CME enhanced, but He & Ne isotopes inconspicuous (see top right)

Conventional view: ^{4}He and ^{22}Ne (unfavourable Coulomb drag) enriched in lower corona and blown off during CMEs. Not observed!



References: **[1]** Grimberg A. et al. (2006) Science 314, 1133. **[2]** Heber V. S. et al. (2009) GCA 73, 7414. **[3]** Heber V. S. et al. (2012) ApJ 759, 121. **[4]** Meshik A. P. et al. (2007) Science 318, 433. **[5]** Meshik A. P. et al. (2014) GCA 127, 326. **[6]** Vogel N. et al. (2011) GCA 75, 3057. **[7]** Pepin R. O. et al. (2012) GCA 89, 62. **[8]** Crowther S. A. & Gilmour J. D. (2013) GCA 123, 17. **[9]** Wieler R. & Baur H. (1995) ApJ 453, 987. **[10]** Lodders K. et al. (2009) In: Landolt Börnstein Database, Springer. **[11]** Steinitz R. & Eyni M. (1980) ApJ 241, 417. **[12]** Reisenfeld D. B. et al. (2013) Space Sci. Rev. 175, 125. **[13]** von Steiger R. et al. (2010) GRL 37, L22101. **[14]** Neukomm R. O. (1998) PhD Thesis Univ. Bern. **[15]** Zahnle K. J. et al. (2019) GCA 244, 56. **[16]** Avice G. et al. (2018) GCA 232, 82.