Geophysical Research Abstracts
Vol. 18, EGU2016-16761-11, 2016
EGU General Assembly 2016

Measurements of Heavy Ion Differential Streaming with SOHO/CELIAS/CTOF and ACE/SWICS at 1 AU

Nils Janitzek, Lars Berger, Andreas Taut, Christian Drews, and Robert Wimmer-Schweingruber
Institute of Experimental and Applied Physics, University of Kiel, Kiel, Germany (janitzek@physik.uni-kiel.de)

Helios measurements in the early 1980s showed the existence of a systematic velocity difference, called "differential streaming", between solar wind bulk protons and alpha particles with the alphas streaming faster than the protons. The absolute differential speed between these species decreases with radial distance to the Sun and decreasing proton speed. In the fast wind it was measured to be approximately half of the local Alfvén speed. However, the detailed processes of acceleration and regulation of differential streaming are still not well understood. A proposed key process is resonant wave particle interaction between the ions and Alfvén waves near the ion-cyclotron frequency which is able to accelerate the alphas preferentially due to their higher mass-per-charge ratio. Measuring the differential speed of a wide set of solar wind heavy ions and therefore extending the mass-per-charge range significantly can provide additional information on the underlying processes that we cannot infer from the alphas and protons alone.
We analysed data measured at L1 by SOHO/CELIAS/CTOF in 1996 and ACE/SWICS from 2001 to 2010. Both instruments are linear time-of-flight mass spectrometers which measure the ions' radial 1D velocity distributions with a cadence of 5 and 12 minutes, respectively. Comparing the mean ion speed, with the mean proton speed measured routinely by the SOHO/CELIAS/MTOF/PM and ACE/SWEPAM, respectively, we obtain the differential streaming for major charge states of solar wind carbon, oxygen, neon, magnesium, silicon and iron. In the case of the SWICS data the magnetometer on-board ACE (ACE/MAG) allows us to directly relate the differential streaming to the ambient Alfvén velocity while the lack of in-situ magnetic field measurements on SOHO is compensated by a B-field extrapolation from the WIND spacecraft (WIND/MAG) to the SOHO site.
Both instruments show a similar result: significant differential streaming between heavy ions and protons on the order of the local Alfvén speed for solar wind above 400 km/s. While for slow solar wind the picture is more complex, the differential streaming is ubiquitous in the fast wind. Neither of the instruments measured a clear trend with ion mass-per-charge as would be expected from simple models including ion cyclotron resonance as the main driving process. Finally, we discuss a possible dependence of the differential streaming on the solar cycle.