



## Time-delayed correlation for inner and outer heliospheric energetic particle fluxes

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**Abstract:** Acceleration and propagation histories of suprathermal and energetic particles reaching a spacecraft at a given time depend on various factors. While acceleration at or near the Sun is often taken as granted for energetic particles detected in the inner heliosphere, other sources such as co-rotating interaction regions are known to contribute as well. The energy-dependent dispersion features expected are not always seen in flux increases. In the distant heliosphere, velocity dispersion of upstream particles presumably coming from the vicinity of the termination shock are of particular interest. We shall discuss the time-delayed cross-correlation of fluxes (and of log fluxes) detected in different energy channels of both inner and outer heliospheric spacecraft, from Helios to Voyager.

### Introduction

Flare and CME generated Solar Energetic Particle (SEP) events at 1 AU often show both time asymmetrical flux profiles and velocity dispersion, although both features depend on details of injection, acceleration, and propagation. Case studies are typically done on large events with identified source regions. Smaller flux enhancements are often of unknown origin, and are due partly to small flare and CME contributions, and partly to CIRs and to changes of magnetic connection to various solar and interplanetary acceleration regions. Different causes correspond to different velocity dispersion characteristics. Time-shifted long-term cross correlation between different energy channels of the same detector yield information on dispersion features at a given phase of the solar cycle and for a given orbit of the spacecraft. By cross-correlating either the particle fluxes themselves or their logarithm, different weighting is given to small and large flux enhancements.

### Some of the data sets to be used

The two spacecraft that reached the smallest heliospheric radii was Helios 1 and 2. Any change in the time-shifted cross-correlation profiles be-

tween ions of different energies with heliocentric distance is of great interest.

Several data sets exist at or near 1 AU that can contribute to a better understanding of the change of cross-correlation profiles with energy and with the phase of the solar cycle (IMP-8, ISEE-3, SOHO, ACE). Ulysses data at somewhat larger heliospheric radii are also of great interest.

Recent Voyager data allow to study the dispersion features of flux enhancements in the heliospheric foreshock (for both Voyager 1 and 2), and in the heliosheath (for Voyager 1 after 16 December 2004). In addition to cross-correlating omnidirectional fluxes at different energies, time-shifted cross-correlations between directional fluxes will also be studied.

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