Title :

Refining PAS Proton and Alpha Particle Moments for Solar Wind and Magnetic Reconnection Studies

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Abstract :

Parker Solar Probe and Solar Orbiter have shown that large amplitude non linear waves, called switchbacks, are ubiquitous in the solar wind. These are characterized by rapid deflections of the radial magnetic field component, which span many timescales, down to the ion gyro-periods. Their origin is thought to be due to magnetic reconnection in the low corona which may leave traces in the particle Distribution Functions (DFs), for example, through alpha abundance modulation during patches of switchbacks.

The Proton-Alpha Sensor (PAS), onboard Solar Orbiter, measures the 3D distribution functions of ions in the solar wind at temporal cadences ranging from 1 to 4 seconds (Louarn et al. 2020). This unique time resolution allows probing the properties of ion species, densities, bulk velocities and temperatures anisotropies, down to the kinetic scales. However, the current moments calculation algorithm (Ďurovcová & Přech 2021) presents some limitations. In particular, the fitting method works best when the proton and alpha population are well separated. This depends on the differential streaming of both species and leaves gaps in the current data release.

To overcome these challenges, we are developing a new algorithm that fits directly the proton and alpha populations on the energy spectrum using a Gaussian Mixture Model. Once identified, the populations are transformed into velocity phase space in the magnetic field-aligned frame using the MAG instrument. A Bi-Maxwellian fit is then applied to compute the moments (density, bulk velocity, temperatures). We compare the obtained moments with the CDPP AMDA L3 products during patches of switchbacks observed by Solar Orbiter.