Alfvénic fluctuations and switchbacks evolution in the solar wind: insights from Parker Solar Probe

The solar wind carries a broadband of fluctuations in density, velocity and magnetic fields that, at the large scales, have been interpreted in terms of an ongoing magnetohydrodynamic turbulent cascade. Alfvénic fluctuations have been observed in the solar wind since the first in-situ measurements, and they are thought to provide a possible mechanism to heat the solar corona at temperatures in excess of one million degrees and to accelerate the solar wind.

Parker Solar Probe (PSP) was launched in August, 2018. It will be the first spacecraft to fly into the sun's corona, to within about 10 solar radii from the sun's surface, with the goal to understand what heats the corona and accelerates the solar wind. Although PSP will reach its closest approach to the sun in 2024, early measurements have already provided us with a wealth of data from regions of space never explored before. Measurements from the first orbits of PSP have indeed shown the ubiquitous and persistent presence of the so-called switchbacks. These are magnetic field lines which are strongly perturbed to the point that they produce local inversions of the radial magnetic field. Switchbacks are embedded in the continuous flux of turbulent fluctuations emanating from the sun, and may be the remnant of coronal processes leading to solar wind formation – although their origin is still open to debate. After reviewing the main properties of Alfvénic fluctuations and switchbacks in the solar wind, we will address how their evolution is affected by parametric instabilities and kinetic effects. We will also address the possible role of expansion by comparing models with observations of the evolution of switchbacks amplitudes and their occurrence rates with radial distance from the sun. We will conclude by discussing what are the implications of our results for models of switchback generation and open questions.