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Editorial: Women in science: astronomy and space sciences

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Editorial on the Research Topic

Women in science: astronomy and space sciences

At present, according to UNESCO, less than 30% of researchers worldwide are women. Long-standing biases and gender stereotypes are discouraging girls and women away from science-related fields, and STEM research. Science and gender equality are, however, essential to ensure sustainable development as highlighted by UNESCO. To change traditional mindsets, gender equality must be promoted, stereotypes defeated, and girls and women should be encouraged to pursue STEM careers. The International Day of Women and Girls in Science took place on the 11th February 2022, commemorating the goal of full and equal access and participation for women and girls in science, and International Women's Day took place on the 8th March 2022. Both occasions aim to highlight the need for gender equality.

In this Research Topic, *Women in science: astronomy and space sciences*, prominent researchers in the field of Space Sciences and Astrochemistry presented their valuable studies, touching hot topics, such as the acceleration of energetic particles that propagates in the inner heliosphere towards the Earth, the properties of solar wind turbulence over a broad range of dynamical scales by exploiting data from new space missions, such as Solar Orbiter (Müller et al., 2020) and Parker Solar Probe (Fox et al., 2016), and the spectroscopic characterization and subsequent radioastronomical search for a complex organic molecule in the interstellar medium (ISM). This Research Topic collects four research papers led by female scientists of different countries, mainly focusing on observation and comparison with theoretical predictions.

Batra et al. provided an important contribution in the field of Astrochemistry. In the last few years, the molecular discovery in space has made tremendous progress in terms of both the number of identified molecules and their complexity. The vast majority of the detected molecules has been identified by means of radioastronomy. Batra et al. performed a comprehensive investigation of the rotational spectra of the two most stable conformers of methyl cyanoacetate (MCA). Using the rotational spectroscopy data obtained, they searched for both conformers towards the G+0.693-0.027 molecular cloud, located in the Sgr B2 region of the Galactic Center. Since none of the MCA conformers were detected, they computed upper limits for their column density (N) under the assumption of Local Thermodynamic Equilibrium ($1.2 \times 10^{13} \text{ cm}^{-2}$ for the most stable conformer and $0.4 \times 10^{13} \text{ cm}^{-2}$ for the other). MCA is a complex organic molecule with twelve atoms and bearing seven heavy atoms: four carbon (C), two oxygen (O), and one nitrogen (N) atoms. So far, the most complex CON-containing species detected in the ISM are lighter than MCA. Therefore, it is not surprising that

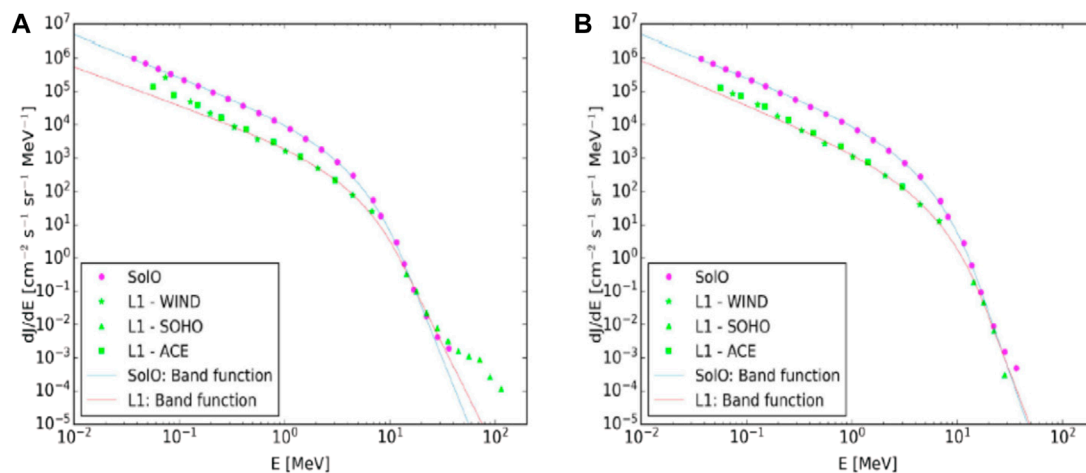


FIGURE 1

Overview of the differential fluxes in different energy bands of energetic particles as detected by Solar Orbiter (purple dots) and at 1 au from Wind (green stars), ACE (green squares), and SOHO (green stars), before (A) and after (B) background subtraction. Best fits are also shown by solid lines (as indicated in the figure's legend). Adapted from [Chiappetta et al.](#), this volume.

all that its abundance in the ISM is low. Indeed, the general trend is the abundance decreases when increasing the chemical complexity. To detect complex molecules such as MCA and, thus, to study the growth of chemical complexity in the ISM, observations with higher sensitivities are needed.

[Chiappetta et al.](#) analyzed an energetic storm particle (ESP) event associated to solar energetic particles emitted from the solar corona through the interplanetary space observed on 2021 November 3rd both by Solar Orbiter at 0.85 au and by Wind, ACE, and SOHO at 1 au. This represented a great opportunity to track at two radial distances a potential dangerous event for the near-Earth environment. Energetic particle fluxes from 30 keV up to 82 MeV peaked at the shock passage with a typical time profile predicted by the diffusive shock acceleration (DSA) theory at low energies, namely, an exponential decay upstream and a constant profile downstream. High energy fluxes were decreasing downstream. Indeed, the analysis of the differential particle energy spectra highlighted downstream a shape well fitted by a double power-law, typical of a stochastic acceleration (SA) mechanism (see [Figure 1](#)), thus authors claimed a DSA process for low energy particles and SA for high energy particles. The latter was also corroborated by the analysis of downstream turbulence that showed a significant enhancement of the magnetic field fluctuation power downstream, both at 0.85 au and at 1 au, as expected when passing from upstream to downstream, and also an increase of turbulence intermittency; this suggests the presence of more turbulent structures downstream over a broad range of scales. The augmented turbulent fluctuations actually favour a SA process.

[Perrone et al.](#) presented a detailed investigation on a slow solar wind stream observed by Solar Orbiter at 0.64 au, characterized by a high degree of Alfvénicity, typical of fast wind. In particular, kinetic aspects of the magnetic field turbulent cascade were studied, since this portion of solar wind is, as expected, populated by coherent structures, emerging naturally from the turbulent cascade over a broad range of time/spatial scales. These structures are

mainly current sheets and vortices. An in depth-analysis showed that within portions of the stream dominated by these structures the proton and alpha velocity distribution functions (VDFs) deviate from a Maxwellian distribution (the latter expected in case of a thermodynamic equilibrium) and present well recognizable beams. In the proton VDF the beam is field aligned (namely, it propagates along the mean magnetic field direction), while in the alpha VDF the beam tends to be perpendicular to the local magnetic field direction, a new aspect that needs to be further investigated.

[Teodorescu et al.](#) investigated the intermittency properties of the plasma turbulence in the young slow solar wind that was observed during the first close encounter of Parker Solar Probe in the interval of 1–9 November 2018. Intermittency is invoked to describe the inhomogeneity of the energy transfer in the turbulence cascade from the injection scales to dissipation scales. As customary, in this work, the intermittency is assessed based on the behavior of the flatness parameter calculated from magnetic field measurements. The analyzed data show highly variable flatness which is an indication for the presence of intermittency in the young solar wind turbulence and imply that the underlying dynamics of the magnetic field time series is nonlinear. The flatness starts growing steadily in the inertial range at scales of several hours down to smaller scales, where it peaks at 4 s and then starts decreasing again towards the kinetic scales. The significance of the intermittency is evaluated through statistical analysis with surrogate time series, obtained with the same statistical characteristics of the original data to establish if the flatness behavior results from the inherent non-linear dynamics of processes governing the young solar wind turbulence or it comes from the amplitude distribution of the signal. It is concluded, that the flatness obtained from long stationary data sample reliably reflects the non-linear dynamic nature of the magnetic field turbulence, while when there is a presence of strong isolated events such as switchbacks, which violate the stationarity of the signal, the intermittency is affected mostly by the amplitude distribution of the fluctuations, rather than describing the underlying dynamics.

Author contributions

SP: Writing–original draft, Writing–review and editing. EY: Writing–original draft, Writing–review and editing. CP: Writing–original draft, Writing–review and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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