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Advances in energetic particle physics with Solar Orbiter

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The Sun drives a supersonic wind which inflates a giant plasma bubble in our very local interstellar neighborhood, the heliosphere. Its boundaries and the turbulent magnetic field shield the solar system from much of the interstellar medium as well as the low-energy portion of galactic cosmic rays (GCRs) which are accelerated primarily by super-nova-driven shocks in our galaxy. The heliosphere is bathed in an extremely variable background of energetic ions and electrons which originate from a number of sources. Solar energetic particles (SEPs) are accelerated in the vicinity of the Sun, whereas shocks driven by solar disturbances are observed to accelerate energetic storm particles (ESPs). Moreover, a dilute population with a distinct composition forms the anomalous cosmic rays (ACRs) which are of a mixed interstellar-heliospheric origin. Particles are also accelerated at planetary bow shocks.

In February 2020, the European Space Agency (ESA) launched Solar Orbiter, a science mission to answer the question how the Sun creates and controls the heliosphere. Its orbit brings it within 0.3 astronomical units (au) from the Sun and will also reach moderately high solar latitudes to allow to understand why solar activity changes with time. The spacecraft carries instruments which observe the Sun and its surrounding remotely, others that measure the local environment, and one which can track solar disturbances as they travel away from the Sun.

The Energetic Particle Detector (EPD) on Solar Orbiter measures suprathermal and energetic particles in the energy range from a few keV up to (near-) relativistic energies (few MeV for
electrons and about 500 MeV nuc −1 for ions). Together with the other sophisticated instruments on Solar Orbiter it is designed to unravel how solar eruptions produce energetic particle radiation that fills the heliosphere.

Since launch, EPD has made several advances about GCRs, SEPs, ACRs, ESPs, and the particles around the Venusian magnetosphere.

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