On the acceleration and transport of relativistic particles in solar eruptive events

Karl-Ludwig Klein*[1], Bernd Heber[2], Stefan Jensen[2], Henrik Droege[2], Malte Hoerloeck[2], Patrick Kuehl[2], and Holger Sierks[2]

[1]LIRA et Observatoire radioastronomique de Nancay – Observatoire de Paris-Université PSL – France
[2]Christian Albrechts Universitaet Kiel – Allemagne

Résumé

In some rare eruptive solar flares protons are accelerated to relativistic energies, up to several tens of GeV. These events challenge our understanding of the processes by which particles gain such high energies, starting from a few hundreds of eV in the corona. Besides the acceleration itself, the process by which the energetic particles reach the Earth is poorly understood. The standard idea that the particles are guided by a heliospheric magnetic field with the geometry of the Parker solar wind model does not explain why the energetic particles may be observed even when the parent activity occurs several tens of degrees away of the coronal footpoint of the Parker spiral. Possible solutions comprise the acceleration by a spatially-extended structure, namely the shock wave driven by a fast coronal mass ejection, or coronal transport across the average magnetic field through the wandering of magnetic field lines or guiding-centre drifts. We confront these ideas with some well-observed relativistic solar particle events, using the observations of relativistic protons and electrons by ground-based neutron monitors and space-borne particle detectors, respectively, and employ radio emission from electrons in the corona and Heliosphere to trace charged-particle propagation. These observations argue against the role of guiding-centre drifts in particle transport, and in favour of transient magnetic connections from Sun to Earth due to a heliospheric magnetic field disturbed by previous mass ejections.

*Intervenant