

Solar cosmic ray generation by solar flares and propagation in interplanetary space

Tuesday, 11 October 2016 16:15 (15)

The analysis of GOES spacecraft measurements confirms the data of worldwide network of neutron monitors about solar cosmic ray generation in the solar flares above of an active region with the complex magnetic field distribution. The proton acceleration in a particular flare is beyond doubt. The so-called prompt proton component arrives to the Earth from western flares with a sharp (~5 min) front. The fronts of the proton fluxes from the western flares begin to register with a delay not longer than the time of flight of the particles with their velocity. The protons of the prompt component can propagate without collisions along the magnetic lines of the Archimedes spiral. The proton from the eastern flare cannot reach the Earth moving along magnetic field lines. They can be transferred across the field lines by solar wind and propagate due to diffusion at scatterings with field fluctuations. The front of proton flux from flares that appeared on the eastern part of the disk is gently sloping. Its duration is bigger than 10 hours. The front of such protons arrives with a delay of several hours, which is much less than time of solar wind propagation from the Sun to the Earth. The typical duration of fast proton emissions from the flare that obtained using γ -ray pulses measurements is order of ten minutes, but the tails of proton flux from western and eastern flares (delayed components) last several days. Isotropic velocity distribution and long time duration of proton fluxes demonstrate diffusion particle propagation in the pulse tail of western and eastern flares. The proton scattering with field fluctuation can appear due to proton beam instability at the front, where particle distribution is anisotropic.

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Session Classification : Cosmic rays - parallel IV

Track Classification : Cosmic rays