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The spectrum of relativistic cosmic rays measurements and numerical simulation

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The spectra of relativistic proton were obtained from measurements with the worldwide network of neutron monitors. The relativistic protons appeared after the flares occurring in the west side of the Sun disk arrive to the Earth after time of flight ∼15 min without collisions. This prompt anisotropic flux must bring information about spectrum of protons ejected from the solar cosmic ray source. The spectrum of prompt component of relativistic protons is exponential $\sim e^{-E/E_0}$, where typical E_0 is order of 0.5 GeV. After delay of 15 - 20 min the proton flux becomes isotropic with power spectrum $E^{-\gamma}$ where $\gamma \sim 5$. Apparently, beam instability is developed. The proton acceleration in the flare is numerically simulated. The MHD simulation of current sheet creation before the flare is carried out. Initial and boundary conditions have been set using photospheric magnetic field measurements. No assumption about solar flare mechanism is used. Appearance of a current sheet in the solar corona above the active region is proved by comparison of the current sheet position obtained by MHD simulations and the position of observed flare thermal X-ray source. During a flare the magnetic field energy is transferred into the particle energy. The positions of current sheets obtained by MHD simulation above the active region NOAA 10365 are coincided with the positions of soft X-ray emission sources for flares M1.4 May 27, 2003 in 02:53 and X1.2 May 29, 2003 in 00:51. Proton acceleration up to relativistic energy can occur in the electric field applied along the singular line in a current sheet. The electric field E = $-V \times B/c$ is created due to the rate reconnection V. At typical V = 2×10^7 cm/s the measured spectrum coincides with the calculated spectrum.

Primary author(s) : Dr. PODGORNY, Alexander (Lebedev Physical Institute RAS); Prof. PODGORNY, Igor (Institute of Astronomy of the Russian Academy of Sciences)

Co-author(s) : Dr. VASHENYUK, Eduard (Polar Geophysical Institute KSC RAS); Dr. MESHALKINA, Natalia (Institute for Solar-Terrestrial Physics SB RAS); Dr. BALABIN, Yuri (Polar Geophysical Institute KSC RAS)

Presenter(s) : Dr. PODGORNY, Alexander (Lebedev Physical Institute RAS)

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