Efficiency of different mechanisms for solar particle acceleration in relativistic energy range

E.V. Vashenyuk[1], L.I. Miroshnichenko[2], and J. Perez-Peraza[3]

[1]*Polar Geophysical Institute, Apatity, Murmansk Region, 184200, Russia*
[2]*Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation (IZMIRAN), Troitsk, Moscow Region, 142190, Russia*
[3]*Instituto de Geofisica, UNAM, C.U., Coyoacan 04510, Mexico D.F., Mexico*

In this paper a relative efficiency of different mechanisms responsible for the spectrum formation of solar cosmic rays (SCR) in relativistic energy range is considered. To analyze the problem we invoke mainly data on the spectra of relativistic solar protons (RSP) obtained in a number of Ground Level Enhancements (GLE) during the 22-23 solar activity cycles. The spectra were derived by modeling of the responses of neutron monitors of the worldwide network and comparing them with observations. The modeling comprised an optimization procedure as well as proton trajectory calculations in the up-to-date magnetosphere models. The spectra, pitch-angle distributions and anisotropy of RSP obtained for successive moments of time allowed to study the dynamical changes of these parameters during the events. The events have been shown to comprise the early, rigid impulse-like intensity increase (prompt component, PC) and late gradual increase with a soft spectrum (delayed component, DC). The spectra of prompt component were exponential in rigidity and softened with time. The DC spectra had a variable slope. We discuss these spectral features in the framework of two-source model of SCR production at/near the Sun. To make more clear the problem, three main acceleration concepts are invoked: 1) direct electric field acceleration due to current sheet formation; 2) diffusive shock acceleration, and 3) stochastic acceleration by plasma turbulence.