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Three dimensional non stationary mathematical model describing Forbush decreases of galactic cosmic ray intensity

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Using experimental data we show that there exist a clear dependence of the exponent γ of the rigidity R spectrum $\delta D(R)/D(R) \propto R^{-\gamma}$ of the Forbush decrease (Fd) of the galactic cosmic ray (GCR) intensity on the exponent ν of the Power Spectral Density (PSD) of the interplanetary magnetic field (IMF). To confirm this finding by theoretical study we propose a three dimensional (3D) non stationary model of the Fd of GCR intensity based on the Parker's transport equation taking into account diffusion, convection, drifts due to gradient and curvature of the IMF, and on the heliospheric neutral sheet with the energy changes in the diverged solar wind. This model implements the parameter describing the temporal changes of the IMF turbulence via the exponent ν of the PSD of the IMF. Owing to this innovation we confirm a relationship between the rigidity spectrum exponent γ and the exponent ν based on the numerical solutions of the 3D non stationary model of Fd. Also, we show that an increase of the size of the disturbed vicinity of the space causes the hardening of the rigidity spectrum of the Fd; namely, an increase of the size of the disturbed vicinity involves GCR particles with relatively larger larmour radius (in other equal conditions), so the GCR particles with the higher rigidities are modulated, which leads to the hardening of the rigidity spectrum (decreases). We find that for the higher rigidities of GCR particles a recovery time of the Fd is less than for the lower rigidities; a rate of the intensity reduction decreases with the increase of the diffusion coefficient and increasing GCR particle's rigidity. Theoretical calculations are compatible with the results obtained based on the neutron monitors and muon telescopes experimental data and confirm theoretically a unique dependence of the expected rigidity spectrum exponent γ of the Fd on the exponent ν of the PSD of the IMF turbulence.