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Long-term evolution of the power-law spectrum of galactic cosmic rays in 1953-2016

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The power spectrum of galactic cosmic ray (GCR) variability is modulated by the heliospheric magnetic field and solar wind. The GCR power spectrum consists of a number of important peaks (related e.g., to solar cycle, solar rotation and diurnal variation) and the background power-law spectrum. The slope of the background power-law spectrum is often used as a quantitative indicator of energy scaling of the signal, indicating chaotic or stochastic behaviour like turbulence or Brownian motion.

We present a study of the statistical properties and long-term evolution of the power-law slope of the spectral density of cosmic rays calculated from 31 neutron monitors covering the time period from 1953 to 2016. We limit here the analysis of the slope to within the time scales of 50 to 130 hours (frequency range 5.56*10-6 to 2.14*10-6 Hz), where the power spectrum has the most perfect power-law behaviour outside the main spectral peaks. The mean power-law slope was found to be -1.81. We studied the slopes in different phases of the solar cycle, and found that they vary systematically within the solar cycle. Higher (less steep) slopes of around -1.67 (corresponding to the Kolmogorov spectrum) were observed during solar minima and steeper slopes of around -2 (corresponding to random processes) during solar maxima.