

# “Nonlinear dynamics of cosmic rays and Forbush effect”

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## Annotation

This report focuses on the study of the movement dynamics of charged particles (cosmic rays) within the Earth's non-uniform dipole magnetic field. The paper analyzes the potential chaotic nature of cosmic ray trajectories. Within the theoretical framework, the formation process of the Van Allen radiation belts is modeled, and the influence of the particles' initial energy on the geometric characteristics of these belts is investigated.

In parallel with the theoretical models, the study examines the impact of the May 10, 2024, geomagnetic storm on cosmic rays reaching the Earth. Based on experimental data from the Tbilisi Cosmic Ray Laboratory, the Forbush effect accompanying the storm is analyzed.

Additionally, non-linear dynamics methods, specifically Recurrence Quantification Analysis (RQA) and Cross-Recurrence Quantification Analysis (Cross-RQA), are employed for data processing. Through phase space reconstruction, it is demonstrated that during the geomagnetic storm, the seemingly chaotic fluctuations of the cosmic ray flux actually transition into a structured and deterministic state.

**Key words:** Cosmic rays, Forbush effect, Recurrence quantification analysis

## References

- [1] *S. Pikelner - Physics of Interstellar Space*
- [2] *Artsimovich L. , Lukyanov S. Motion of charged particles in electric and magnetic fields*
- [3] *Tsulukidze, L. K., Kharshiladze, O. A., Ghurchumelia, A. P., Sorriso-Valvo, L., Elbakidze, K. Z., & Matiashvili, T. G. (2024). Coherent Analysis of Intense Geomagnetic Disturbances Using Dusheti Observatory Data and the DST Index. Journals of Georgian Geophysical Society, 27(2).*
- [4] *J.E. Garc'ia-Farieta, A. Hurtado(2024). Simulation of charged particles in Earth's magnetosphere: an approach to the Van Allen belts. arXiv:2403.00778v1 [physics.space-ph] 15 Feb 2024*