Galactic cosmic rays in planetary magnetospheres

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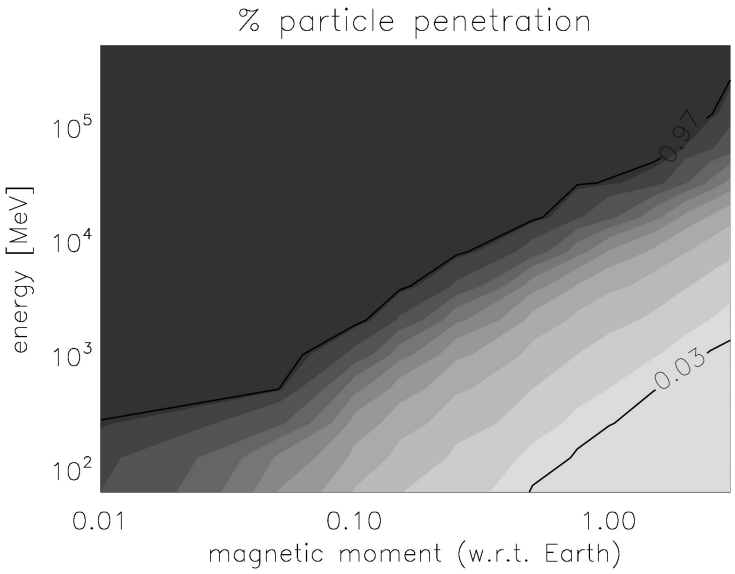
Theoretical arguments indicate that close-in terrestial exoplanets may have weak magnetic fields, especially in the case of planets more massive than Earth ("super-Earths"). Planetary magnetic fields, however, constitute one of the shielding layers which protect the planet against cosmic ray particles. In particular, a weak magnetic field results in a high particle flux to the top of the planetary atmosphere. We numerically analyze the propagation of cosmic ray particles through planetary magnetospheres. We evaluate the efficiency of magnetospheric shielding as a function of the particle energy (in the range 64 MeV < E < 500 GeV) and of the planetary magnetic field strength (in the range 0 M_{Earth} < M < 3 M_{Earth}). This allows to calculate the "critical energy" above which the particles reach the atmosphere in significant number. We discuss implications of this increased particle flux, including the modification of atmospheric chemistry, destruction of atmospheric biomarker molecules, and potential biological implications.



The minimum energy at which particles may penetrate the magnetosphere and reach the top of the planetary atmosphere strongly depends on the planetary magnetic moment.

References

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