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A Macroscopic description of Coherent Geo-Magnetic Radiation from Cosmic rays

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Abstract content

In an air shower induced by a cosmic ray, due to the high velocities, most of the particles are concentrated in the relatively thin shower front, which, for obvious reasons, is called the 'pancake'. This pancake, which for the present discussion is assumed to be charge neutral, contains large numbers of electrons and positrons. It has a typical thickness of a few meters and is moving to the surface of the Earth with (almost) the velocity of light, *c*. When this pancake is moving through the Earth magnetic field the Lorentz force on the charged particles induces a drift velocity and thus an electric current in a direction which is perpendicular to the magnetic field and the shower axis. This fast-moving electrical current induces an electromagnetic pulse which can be detected at the Earth surface. Because of the typical length and time scales involved, the intensity of the radiation is maximal in the frequency range of 1-10 MHz, and can thus be detected with radio receivers.

To show the basic principles of the Macroscopic Geo-Magnetic Radiation (MGMR) model and we confine ourselves to a rather simple geometry where the cosmic shower moves straight to the Earth surface and where the Earth magnetic field is parallel to the Earth surface. In the limit where the thickness of the pancake is shrinked to zero even a simple analytic form for the electric pulse can be derived. This shows that the pulse height falls rapidly with distance to the shower core, that with increasing distance the pulse lengthens, and that the leading part of the pulse carries the information on the earlier parts of the air shower.

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Summary

Reference

Proceedings of the 30th International Cosmic Ray Conference; Rogelio Caballero, Juan Carlos D'Olivo, Gustavo Medina-Tanco, Lukas Nellen, Federico A. Sánchez, José F. Valdés-Galicia (eds.); Universidad Nacional Autónoma de México, Mexico City, Mexico, 2008; Vol. 4 (HE part 1), pages 569-572

Primary author(s) : SCHOLTEN, Olaf (KVI / RUG)

Co-author(s) : WERNER, Klaus (Subatech)

Presenter(s) : SCHOLTEN, Olaf (KVI / RUG)

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