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Status and perspectives of the radio detection technique of cosmic ray air showers

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At LOFAR we measure the radio emission from extensive air showers (EAS) in the frequency band of 30-80 MHz in dual-polarized antennas. Through an accurate antenna calibration we can determine the complete set of four Stokes parameters that uniquely determine the linear and/or circular polarization of the radio signal for an EAS. The observed dependency of the circular polarization on azimuth angle and distance to the shower axis is explained as due to the interfering contributions from the two different radiation mechanisms, a main contribution due to a geomagnetically-induced transverse current and a secondary component due to the Askaryan effect.

The same Askaryan mechanism is also driving radio emission from ultra-high energy particles (neutrinos as well as cosmic rays) impinging on the moon. Plans will be discussed for observations of ultra-high energy neutrinos and cosmic rays on the basis of this process with LOFAR and SKA.

Having a very detailed understanding of radio emission from EAS, the emitted radio signal can be used to determine the magnitude and direction of the induced currents in an EAS. We will show that the linear as well as the circular polarization of the radio waves carry clear information on the magnitude and orientation of the electric fields at different heights in the thunderstorm clouds.

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