



## **Circular polarization of radio emission from air showers probes atmospheric electric fields in thunderclouds.**

Thi Ngoc Gia Trinh (1), Olaf Scholten (1,2), Stijn Buitink (3,4), Arthur Corstanje (4), Ute Ebert (5,6), Emilio Enriquez (4), Heino Falcke (4), Jörg R Horandel (4), Anna Nelles (4,7), Pim Schellart (4), Jorg Rachen (4), Laura Rossetto (4), Casper Rutjes (5), Sander ter Veen (4), and Satyendra Thoudam (4)

(1) KVI - CART, University of Groningen, Netherlands (t.n.g.trinh@rug.nl), (2) Interuniversity Institute for High-Energy, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium, (3) Astrophysical Institute, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium, (4) Department of Astrophysics/IMAPP, Radboud University Nijmegen., P.O. Box 9010, 6500 GL Nijmegen, The Netherlands, (5) Center for Mathematics and Computer Science (CWI), P.O. Box 94079, 1090 GB Amsterdam, The Netherlands, (6) Eindhoven University of Technology (TU/e), P.O. Box 513, 5600 MB Eindhoven, The Netherlands, (7) Department of Physics and Astronomy, University of California Irvine, Irvine, CA 92697-4575, USA

When a high-energy cosmic-ray particle enters the upper layer of the atmosphere, it generates many secondary high-energy particles and forms a cosmic-ray-induced air shower. In the leading plasma of this shower electric currents are induced that emit electromagnetic radiation. These radio waves can be detected with LOw-Frequency ARray (LOFAR) radio telescope. Events have been collected under fair-weather conditions as well as under atmospheric conditions where thunderstorms occur.

For the events under the fair weather conditions the emission process is well understood by present models. For the events measured under the thunderstorm conditions, we observe a large fraction of the circular polarization near the core of the shower which is not shown in the events under the fair-weather conditions. This can be explained by the change of direction of the atmospheric electric fields with altitude. Therefore, measuring the circular polarization of radio emission from cosmic ray extensive air showers during the thunderstorm conditions helps to have a better understanding about the structure of atmospheric electric fields in the thunderclouds.