

# Giant natural particle accelerator discovered above thunderclouds

14 April 2010



Dr Füllekrug and colleagues have discovered that natural particle accelerators can be formed by lightning storms (Photo by Axel Rouvin)

(PhysOrg.com) -- A lightning researcher at the University of Bath has discovered that during thunderstorms, giant natural particle accelerators can form 40 km above the surface of the Earth.

Dr Martin Füllekrug from the University's Department of Electronic & Electrical Engineering presented his new work on Wednesday 14 April at the Royal Astronomical Society National Astronomy Meeting (RAS NAM 2010) in Glasgow.

His findings show that when particularly intense lightning discharges in thunderstorms coincide with high-energy particles coming in from space (cosmic rays), nature provides the right conditions to form a giant particle accelerator above the thunderclouds.

The cosmic rays strip off electrons from air molecules and these electrons are accelerated upwards by the electric field of the lightning discharge. The free electrons and the lightning electric field then make up a natural particle accelerator.

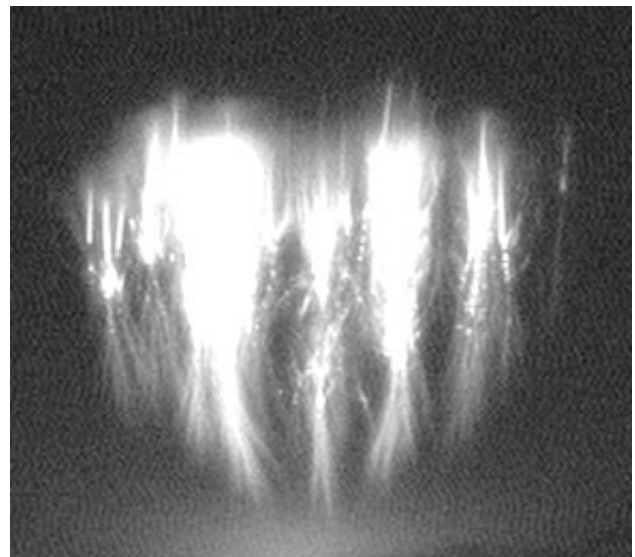
The accelerated electrons then develop into a narrow particle beam which can propagate from the lowest level of the atmosphere (the

troposphere), through the middle atmosphere and into near-Earth space, where the energetic electrons are trapped in the [Earth's](#) radiation belt and can eventually cause problems for orbiting satellites.

These are energetic events and for the blink of an eye, the power of the electron beam can be as large as the power of a small nuclear power plant.

Dr Füllekrug explained: "The trick to determining the height of one of the natural particle accelerators is to use the radio waves emitted by the particle beam."

These radio waves were predicted by his co-worker Dr Robert Roussel-Dupré using computer simulations at the Los Alamos National Laboratory supercomputer facility.



A sprite formed by an intense thunderstorm (Credit: Oscar van der Velde, Universitat de Catalunya, Spain and Serge Soula, Laboratoire d'Aerologie, France)

A team of European scientists, from Denmark,

France, Spain and the UK helped to detect the intense lightning discharges in southern France which set up the particle accelerator.

They monitored the area above thunderstorms with video cameras and reported lightning discharges which were strong enough to produce transient airglows above thunderstorms known as sprites. A small fraction of these sprites were found to coincide with the particle beams.

The zone above thunderstorms has been a suspected natural [particle accelerator](#) since the Scottish physicist and Nobel Prize winner Charles Thomson Rees Wilson speculated about [lightning](#) discharges above these storms in 1925.

In the next few years five different planned space missions (the TARANIS, ASIM, CHIBIS, IBUKI and FIREFLY satellites) will be able to measure the energetic particle beams directly.

Dr Füllekrug commented: "It's intriguing to see that nature creates particle accelerators just a few miles above our heads. Once these new missions study them in more detail from space we should get a far better idea of how they actually work.

"They provide a fascinating example of the interaction between the Earth and the wider Universe."

Provided by University of Bath

APA citation: Giant natural particle accelerator discovered above thunderclouds (2010, April 14) retrieved 20 June 2019 from <https://phys.org/news/2010-04-giant-natural-particle-thunderclouds.html>

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