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Giant Natural Particle Accelerator Above Thunderclouds

ScienceDaily (Apr. 14, 2010) — A lightning researcher at the University of Bath has discovered that during thunderstorms, giant natural particle accelerators can form 40 kilometers above the surface of the Earth.

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- Particle accelerator
- Van Allen radiation belt
- Subatomic particle
- Electron

On April 14, Dr. Martin Fullekrug presented his new work at the RAS National Astronomy Meeting (NAM 2010) in Glasgow.

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.

The trick to determining the height of one of the natural particle accelerators is to use the radio waves emitted by the particle beam, explains Dr. Fullekrug.

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 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.

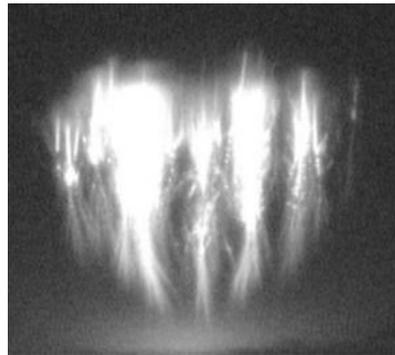
The zone above thunderstorms has been a suspected natural particle accelerator since the Scottish physicist and Nobel Prize winner Charles Thomson Rees Wilson speculated about lightning discharges above these storms in 1925.

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 Fullekrug comments: "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."

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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. On Wednesday 14th April Dr. Martin Fullekrug will present his new work at the RAS National Astronomy Meeting (NAM 2010) in Glasgow. The image shows a transient airglow or 'sprite' above a thunderstorm in France in September 2009. (Credit: Serge Soula / Oscar van der Velde)

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