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Physicists find a particle accelerator in the sky

Apr 19, 2010 7 comments

Is there a giant accelerator lurking above the clouds?

The first evidence that thunderstorms can function as huge natural particle accelerators has been collected by an international team of researchers.

In a presentation at a meeting of the Royal Astronomical Society in Glasgow last week, Martin Füllekrug of Bath University described how the team detected radio waves coinciding with the appearance of "sprites" – glowing orbs that occasionally flicker into existence above thunderstorms. The radio waves suggest the sprites can accelerate nearby electrons, creating a beam with the same power as a small nuclear power plant.

"The discovery of the particle accelerator allows [one] to apply the knowledge gained in particle physics to the real world, and put the expected consequences to experimental testing," Füllekrug told *physicsworld.com*.

An old idea

The idea of natural particle accelerators existing just kilometres above our heads first came in 1925, when the UK physicist and Nobel laureate Charles Wilson investigated the effects of a thundercloud's electric field. Wilson claimed that the electric field would cause an electrical breakdown of the Earth's atmosphere above the cloud, leading to transient phenomena such as sprites.

These sprites, physicists suggested, would do more than just light up the sky. As highly energetic particles or "cosmic rays" from space bombard our atmosphere, they strip air molecules of their outer electrons. In the presence of a sprite's electric field, these electrons could be forced upward in a narrow beam from the troposphere to near-Earth space. Moreover, the changing electron current would, via Maxwell's equations, produce electromagnetic waves in the radio-frequency range.

In 1998 Füllekrug's colleague Robert Roussel-Dupré of Los Alamos National Laboratory in New Mexico, US, used a supercomputer to simulate these radio waves. The simulations predicted they would come in pulses with a fairly flat spectrum – contrary to the

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electromagnetic spectrum of the lightning itself, which increases at lower frequencies.

Predictions confirmed

In 2008, while a group of European scientists timed the arrival of sprites from a mountain top in the French Pyrenées, Füllekrug was on the ground with a purpose-built radio-wave detector. The signals he detected coincided with the sprites and matched the characteristics of Roussel-Dupré's predictions.

"It's intriguing to see that nature creates particle accelerators just a few miles above our heads," says Füllekrug, adding: "They provide a fascinating example of the interaction between the Earth and the wider universe."

Füllekrug notes that he has no particular applications in mind for a sky-based particle accelerator, although he believes there may be wider implications for science. Researchers have many questions about the middle atmosphere because it is so difficult to set up observational platforms there. But by employing what physicists have learned about how such electron beams interact with matter, researchers could use this phenomenon to study this part of the atmosphere.

Indeed, we might be hearing a lot more about natural particle accelerators in the near future. The IBUKI satellite from Japan could soon be looking at the movement of charged particles in the atmosphere. In the next few years several missions – including CHIBIS from Russia and TARANIS from France – should provide more data about these accelerators.

The research is published in the *Journal of Geophysical Research*.

About the author

Jon Cartwright is a freelance journalist based in Bristol, UK

7 comments

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1 **Magnum**
Apr 19, 2010 11:53 PM

How narrow are the beams, and how high the energy?

I've never been one of those nuts who think the LHC will destroy the world, but I've never been satisfied with the argument that it's safe because "cosmic rays collide with particles in our atmosphere 'all the time'".

The difference with the LHC is that particle bombardments are rapidly repeated, not one-off like those from a cosmic ray. But if these lightning-generated beams are powerful enough ("small nuclear reactor") and narrow enough, perhaps that hole in the LHC argument can be plugged.

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2 **kasuha**
Apr 20, 2010 9:36 AM
Prague, Czech Republic

There might be a lot of energy stored in these "beams" but also a lot of electrons is affected so I believe even relatively small university accelerator can outperform these on a per-particle energy basis, not mentioning that they can deliver particles exactly to the point where they can be useful.

Regarding LHC, the main argument is that there is not only no proof but even no signs suggesting that it could be dangerous. Hypotheses based on assumptions that the universe works way differently than what we imagine do not count as proofs, they're just unproven hypotheses. Assuming that every human is potential murderer is on similar level.

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3 **Raeq**
Apr 21, 2010 3:20 PM

Quote:

> *Originally posted by* ***kasuha***
> There might be a lot of energy stored in these "beams" but also a lot of electrons is affected so I believe even relatively small university accelerator can outperform these on a per-particle energy basis, not mentioning that they can deliver particles exactly to the point where they can be useful.
>
> Regarding LHC, the main argument is that there is not only no proof but even no signs suggesting that it could be dangerous. Hypotheses based on assumptions that the universe works way differently than what we imagine do not count as proofs, they're just unproven hypotheses. Assuming that every human is potential murderer is on similar level.

Exactly.

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4 **jjeherrera**
Apr 21, 2010 5:46 PM
Ciudad Universitaria, Mexico

Quote:

> *Originally posted by* ***Magnum***
> How narrow are the beams, and how high the energy?

The role of the high energy cosmic rays is to trigger an electron avalanche. However the energy of the accelerated electrons is in the range of tens of MeV; quite large, but far short from the TeV energies achieved in the Tevatron or the LHC.

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5 **dratman**
Apr 23, 2010 4:44 AM
cherry Hill, United States

Quote:

> *Originally posted by* ***kasuha***
>
> Hypotheses based on assumptions that the universe works way differently than what we imagine do not count as proofs, they're just unproven hypotheses. Assuming that every human is potential murderer is on similar level.

I understand your point about "unproven hypotheses," that is, speculation. Anything can be speculated.

But "every human is a potential murderer" sounds correct to me! In my experience, anything a human CAN do, some humans eventually WILL do.

That's why it's so much easier to reason about physics than about human beings. You never know what those mad creatures will be up to next.

Edited by dratman on Apr 23, 2010 4:45 AM.

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6 **jurajg**
Apr 23, 2010 5:17 PM
city, Slovakia

Quote:

> *Originally posted by* ***dratman***
>
> But "every human is a potential murderer" sounds correct to me! In my experience, anything a human CAN do, some humans eventually WILL do.

back to LHC hypothetical dangers... you can show us plenty of cases of murders and murderers, but i think you can't show us just one case of particle that destroyed some other world :)

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7 **fulely**
May 4, 2010 2:13 AM
weatogue, United States

Reactive Plasmatic Mantle prerequisite to Sprite

I have been working on this since 1961 when I witnessed a (Mantle) fall apart in front of me. A Mantle is what I have named them, a 15ft ball of Liquid oxygen with a 4ft center of plasma. The Mantle was 15ft away from me and dumped 55 gallons of Liquid Oxygen on the ground and then the plasma shot out like a Sprite. I knew it was important but at 8yrs old did not have enough life experience to go for it, now i have and here I am. I have seen them on three occasions, the last time was 2004 and the start of my serious chase. Its what makes Oxygen to breath and charged particles for everything else. And to add more excitement, it travels in diff. dimension's. It also has force fields as the video I have of them show birds bouncing off them and I have seen them pass thru trees. Its made by lightning and then after a few minutes it leaves and returns later after it looses energy. It produces a wonderful white light and pulses at the same time, and when it goes dimensional so does the light. I have found drawings of them in cave art in Europe and in Egyptian and Mayan art in religious means. This is the way for us to get rid of oil for ever. There is so much more to talk about with this and I'm preparing a paper on it that will be out soon. I have found some thing that will show us Dimensional travel and the string theory and give us a clean way of creating a nuclear reaction. I have over 100 videos of them from every where on earth on their returning journey. Please see Http://www.youtube.com/fulely

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