Russian researchers find more evidence to support notion that lightning is caused by cosmic rays

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(Phys.org) —Russian physicists Alex Gurevich and Anatoly Karashtin claim, in a paper published in the journal *Physical Review Letters*, they have found more evidence to support their idea that lightning is caused by cosmic rays. The notion was first proposed by Gurevich back in 1992, and has been a source of debate ever since.

No one really knows what causes lightning to form and strike—the prevailing view is that it comes about as a result of collisions between ice crystals in clouds and hail stones. But because clouds and the lightning they produce are unpredictable and hard to pin down, no one has been able to prove this theory. Another theory, proposed by Gurevich twenty years ago, says that lightning is formed from the collisions between

cosmic rays and water droplets present in thunderclouds. Now he and a colleague claim to have found evidence to support this idea.

Gurevich suggests that cosmic rays entering thunder clouds cause the air in them to be ionized, resulting in a lot of free electrons floating around. The electronic field already present in the cloud, he continues, leads to the free electrons being boosted to higher energies. When the electrons present in the air collide with water atoms, more electrons are released, setting off what he describes as an avalanche of high-energy particles that eventually give way to a "runaway breakdown"—a discharge that is witnessed as a lightning strike.

As with other theories regarding the origins of lightning, Gurevich's ideas haven't been proved. But he hasn't been sitting still. In this new effort, he along with Karashtin have been measuring and analyzing radio waves in storm clouds as lightning occurs. The idea is that if such strikes are due to interactions with cosmic rays, there should be measurable amounts of radio waves given off.

Gurevich and Karashtin set up equipment to monitor storm clouds over Russia and Kazakhstan—recording radio waves emitted during 3,800 lightning strikes. In analyzing the data, they found that hundreds, and perhaps even thousands of short radio wave pulses occurred just as a bolt of lightning was about to form. Perhaps more importantly, they matched the models Gurevich had built years before. There was on hitch however, the amount of energy delivered by the cosmic rays in the model don't happen often enough in the real world to cause lightning strikes in most every thunderstorm.

Gurevich and Karashtin say the discrepancy can be explained by the addition of energy into the system by free electrons passing near hydrometeors (bits of hail or water droplets). When that happens, very small discharges result, adding to the total charge. Taken together they

say, enough energy is added to cause the cascade that leads to lightning formation.

More information: Runaway Breakdown and Hydrometeors in Lightning Initiation, *Phys. Rev. Lett.* 110, 185005 (2013). prl.aps.org/abstract/PRL/v110/i18/e185005

Abstract

The particular electric pulse discharges are observed in thunderclouds during the initiation stage of negative cloud-to-ground lightning. The discharges are quite different from conventional streamers or leaders. A detailed analysis reveals that the shape of the pulses is determined by the runaway breakdown of air in the thundercloud electric field initiated by extensive atmospheric showers (RB-EAS). The high amplitude of the pulse electric current is due to the multiple microdischarges at hydrometeors stimulated and synchronized by the low-energy electrons generated in the RB-EAS process. The series of specific pulse discharges leads to charge reset from hydrometeors to the free ions and creates numerous stretched ion clusters, both positive and negative. As a result, a wide region in the thundercloud with a sufficiently high fractal ion conductivity is formed. The charge transport by ions plays a decisive role in the lightning leader preconditioning.

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