

# Scientists close in on source of X-rays in lightning

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University of Florida and Florida Institute of Technology engineering researchers have narrowed the search for the source of X-rays emitted by lightning, a feat that could one day help predict where lightning will strike.

"From a practical point of view, if we are going to ever be able to predict when and where lightning will strike, we need to first understand how lightning moves from one place to the other," said Joseph Dwyer, a professor in the department of physics and space sciences at FIT. "At present, we do not have a good handle on this. X-rays are giving us a close-up view of what is happening inside the lightning as it moves."

An article detailing the UF and FIT team's findings appears this week in the online edition of *Geophysical Research Letters*, published by the American Geophysical Union.

The researchers used an array of electric field and X-ray detectors at a UF/FIT-operated lightning research facility in North Florida to hunt the source of X-rays emitted by lightning strokes. Their main conclusion: As the lightning comes down from the cloud toward the ground in 30- to 160-foot stages known as "steps" in a "step leader" process, the X-rays shoot out just below each step, mere millionths of a second after the step completes.

"Nobody understands how lightning makes X-rays," said Martin Uman, a professor of electrical and computer engineering. "Despite reaching

temperatures five times hotter than the surface of the sun, the temperature of lightning is still thousands of times too cold to account for the X-rays observed."

That said, Uman added, "It's obviously happening. And we have put limits on how it's happening and where it's happening."

As far back as 1925, theorists predicted that thunderstorms and lightning might make X-rays. However, scientists spent decades seeking evidence, with little success. Then in 2001 and 2002, researchers at New Mexico Institute of Mining and Technology, the University of Florida and Florida Tech reported solid confirmation that lightning does indeed produce large quantities of X-rays. Scientists worldwide have been seeking to understand and explain the phenomenon since then, Uman said.

The New Mexico Tech researchers detected high-energy radiation from natural lightning. The UF/FIT's International Center for Lightning Research Laboratory, located on a military base in Clay County, triggers lightning using wire-trailing rockets fired into passing storm clouds. In 2002, Uman's team showed "triggered lightning" produces X-rays.

In the latest research, electrical engineering doctoral student Joey Howard, the paper's lead author, and other UF/FIT researchers used a series of electric field detectors and sodium iodide X-ray detectors to try to probe X-rays more closely.

In the 2002 paper, the UF/FIT researchers confirmed that X-rays are produced by the stepped leader in natural lightning. In the latest paper, they narrowed the production of X-rays to the beginning of each step of the step leader, based on data gathered from one natural lightning strike and one triggered strike, Uman said.

"We could see when the electric field arrived at the sequence of stations, and it was the same with the X-rays," Uman said. "We then went back and calculated what the source location was for the field and the X-ray."

Dwyer said the research is one more step toward using X-rays to understand how lightning travels.

"A spark that begins inside a thunderstorm somehow manages to travel many miles to the ground, where it can hurt people and damage property," he said. "Now, for the first time, we can actually detect lightning moving toward the ground using X-rays. So just as medical X-rays provide doctors with a clearer view inside patients, X-rays allow us to probe parts of the lightning that are otherwise very difficult to measure."

Uman said the research will continue with more expensive, faster and more sensitive X-ray detectors. One area of future interest, he said, is whether lightning strikes to airplanes could produce X-rays harmful to passengers.

Provided by University of Florida

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