

## **On The Possibility That Lightning is Initiated by Cosmic-Ray Extensive Air Showers**

Intended for the Lightning Physics Session Topic

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Approximately four decades ago it was first suggested that cosmic rays might play a role in lightning initiation. About five decades before that, C.T.R. Wilson suggested that free electrons that happen to fall within the regions in thunderstorms with strong electric fields ought to be accelerated by the strong fields and, further, that the evidence for this ought to be found in the presence of bremsstrahlung x-rays in thunderstorms. The occurrence of x-rays in strong electric fields in thunderstorms has been demonstrated by Eack et al. (1996a, 1996b). The x-rays occurred in the strong-field region before a lightning flash and were not caused by the lightning flash itself but rather, apparently, by the strong fields. Approximately two decades ago many papers appeared in the literature that in effect took it as a forgone conclusion that lightning is initiated by relativistic runaway electron avalanches (RREA), yet to date there has been no observational evidence in support of or substantially refuting the hypothesis that RREA initiate lightning. The only plausible source of free electrons with enough energy to participate in RREA suitably energetic to initiate lightning in thunderstorms is cosmic-ray extensive air showers (CREAS). Therefore we reason that if the RREA hypothesis holds true, it ought to be possible to observe a correlation between detections of CREAS with lightning initiation. In this paper we summarize the pros and cons of the RREA lightning initiation hypothesis, possible ways to investigate the hypothesis experimentally, and report progress on a program to observe extensive air showers of cosmic rays by means of an array of muon detectors at the surface and to compare the air shower detections with initiation of lightning observed by means of the Oklahoma Lightning Mapping Array.