

Flashes and bursts – Mysterious happenings in the sky

The American Geological Union a few months ago held a symposium to discuss the phenomena relating to high-altitude flashes (also called sprites, jets or bursts), which are mystifying scientists all over the world. Although very little is understood about these, many speculate that these flashes in our restless atmosphere may even be hazards to high-flying aircraft and satellites.

More than a 100 years ago observations have been recorded of intense optical flashes appearing much above thunder clouds during electrical storms (Figure 1).

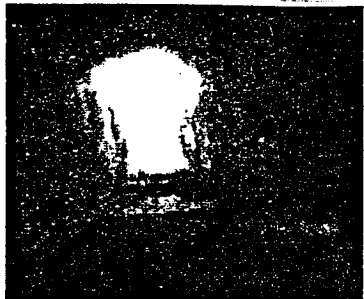
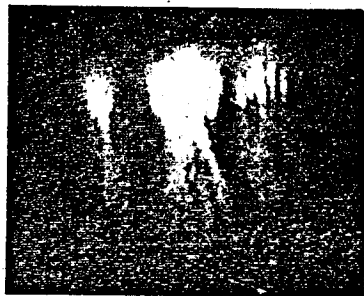


Figure 1. The fantastic light flashes that occur much above thunderstorm clouds in the stratosphere.

Very few took this seriously till these ghost-like luminous discharges were no longer found to be rare. More than a 1000 flashes were seen each year. A few years ago these flashes were given respectability by being mentioned in the *Handbook of Unusual Natural Phenomena*. The documentation since then has been quite reliable. The Space Shuttle in one of its flights recorded 18 such flashes over Australia, Africa, South and North America. High-flying aircraft have recorded hundreds of flashes within a few hours.

Visual reports say that the flashes, which have variously been described as carrot-, turnip- or jelly fish-shaped, exhibit a variety of colours like red, yellow, green, pink and blue. These colours have now been recorded photographically and by video cameras. The flashes have an unusual appearance and some consist of dazzling arrays of fireworks which seem to dance for milliseconds much above the clouds. The red ones are known to reach more than 90 km above the top of the storm clouds. The blue ones have a completely different structure, usually narrowly collimated sprays of light in the form of fans which propagate at a speed of 100 km s^{-1} .

The early theories followed the concept formulated by C. T. R. Wilson (famous for his cloud chamber) that electrical fields generated by lightning can propagate upwards. It was now thought that these fields go through the mesosphere and stratosphere and rip off electrons from molecules there. Avalanches result when more electrons are created and crash into other molecules. The red colour is caused from emission from positively ionized oxygen, while the singly ionized

negative nitrogen ions are responsible for the green and the blue colours. It was thought that ultraviolet and infrared studies would give much deeper insight into these phenomena.

At this stage the plot thickened and the subject became more confusing because two entirely new phenomena were discovered. The satellite launched to test ways of monitoring nuclear blasts detected radio flashes which are at least 10,000 times more intense than the radio signals normally generated by storms or lightning.

The Compton Gamma-Ray Observatory, which was launched to study celestial γ -rays, discovered accidentally extremely intense γ -ray flashes which originated in the upper atmosphere about 30 km above the storm clouds. These new discoveries in the radio and γ -ray regions seem to be beyond the pale of the earlier theories based on Wilson's ideas as the energies required are much too high.

Theorists and modelers are hard at work. The latest and most acceptable speculations take recourse to extraterrestrial sources. A single powerful cosmic-ray particle probably collides with an air molecule in the mesosphere or stratosphere and starts off a runaway breakdown. Workers in the field are optimistic that this model may possibly explain emissions in the optical radio and γ -ray regions. The general consensus is that it is too early to theorize and that more observations are essential before there is any real understanding of these phenomena (*Science*, 1994, 264, 1250, 1313 and *E.O.S.*, 1994, 75, 601).

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