

## **P1.39 THE DISCOVERY OF RED SPRITES AS AN OPPORTUNITY FOR INFORMAL SCIENCE EDUCATION**

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### **1. INTRODUCTION**

For over 100 years, anecdotal reports have appeared in the scientific literature describing brief luminous glows high above thunderstorms. They were given little more credence than UFO sightings until 1989, when university researchers accidentally captured a “red sprite” on a low-light video camera. Sprites are now known to flicker like transient, phantasmagoric auroras in the mesosphere, at the very edge of space, whenever unusually powerful lightning flashes within storms far below. The National Science Foundation funded the development of a DVD/video production on this discovery (with a companion educational web site) for presentation in planetariums, science centers and the classroom. The goal is to promote informal scientific education by illustrating the excitement of discovery, the scientific method at work, and the interconnectedness of energy flows in the Sun-Earth system.

For the earthbound, in order to view the wonders of the universe, we first must look through the atmosphere. Normally, for astronomers, the atmosphere is a source of frustration, with clouds, haze, reflected city lights and refractive index gradients all degrading seeing on far too many nights. But where does the atmosphere end and space begin? There is a region at the edge of space, between 30 and 100 km above the ground, which aeronomers have only half jokingly called the “ignorosphere,” due to our profound lack of knowledge of the phenomena occurring there. At this interface between air and space, recent discoveries have revealed a virtual “zoo” of bizarrely-shaped, albeit tenuous, electrical phenomena appearing like will’o’the wisps above some thunderstorms. These aurora-like flashes, collectively termed transient luminous events (TLEs), exist mostly at the lower level of

human visual acuity, even against the darkest night sky. But startled eyewitnesses, who have caught them out of the corner of their eye, have been reporting them in the scientific literature for over a century (since 1886). Even papers by a Nobel Laureate in Physics, C.T.R. Wilson, who first predicted them theoretically in 1925 and actually reported his own sighting in 1956, went largely ignored. The few such reports that made it into science textbooks were often in the same chapters as “strange but true” tales of living turtles encased in hailstones or half meter wide snowflakes falling in Montana. Barely escaping being lumped in with UFO sightings and other paranormal gibberish, the mainstream scientific establishment steadfastly paid the reports little attention, until the night of 6 July 1989. Then serendipity struck, as the late Prof. John R. Winckler, an auroral physicist at the University of Minnesota, was testing a low light television (LLTV) camera for an upcoming rocket launch. On the tape appeared a mere two frames of video showing bright columns of light towering high above distant thunderheads over northern Minnesota. This was the first documented proof of what was at first called “cloud-to-space lightning,” but has since become known as the red sprite. The sprite sightings were soon followed by blue jets, elves, trolls, gnomes and pixies...fanciful names all chosen to avoid implying that we knew more about the physics of the phenomena than was warranted.

The tale of the hundred year hunt for the red sprite is a story of how science works. It is story illustrating that science, rather than knowing all there is to know, stands barely on the threshold of many more discoveries about our complex and fascinating universe. It is a story that the National Science Foundation, through its informal science education program, believes can foster science education for citizens of all ages.

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## 2. SCIENTIFIC BACKGROUND.

Since 1989, thousands of sprites have been imaged, many at the Yucca Ridge Field Station near Ft. Collins, CO, where the first intentional hunt for sprites using LLTVs yielded a haul of 248 events in the very first night of monitoring in 1993 (Lyons et al. 2000). Mesospheric sprites, at 40 to 90 km altitude, are induced by lightning discharges with highly unusual characteristics (Lyons et al. 2003a). During the summer of 2000, a meteorological field campaign called STEPS (Severe Thunderstorm Electrification and Precipitation Study) focused on discovering just what is different about the small percentage of lightning flashes which trigger the ghostly sprites near the base of the ionosphere. Using video cameras, 3-D lightning mappers and extremely low frequency (ELF) radio receivers deployed around the globe, scientists are gradually unraveling the nature of the giant lightning discharges which spawn sprites. In the process they have found other unusual electrical discharges atop thunderstorms. Evidence is mounting that sprites affect the electrodynamics and chemistry of the middle and upper atmosphere in a variety of ways. Figure 1 illustrates some of the TLEs which dance above thunderstorms at the edge of space.

## 3. PROJECT SUMMARY

Under NSF auspices, Sky Fire Productions, Inc. (also housed at the Yucca Ridge Field Station) produced and continues to distribute a DVD-based planetarium program show kit directed at the general public (5<sup>th</sup> grade and up). The main program lasts 42 minutes and is entitled, "The Hundred Year Hunt for the Red Sprite." It documents the application of the scientific method to unraveling the century old mystery surrounding strange lights in the night sky. The observations were so unexpected that one scientist noted it was as if "biologists had suddenly discovered a new human body part." The program also contrasts the story of the sprites discovery to the pseudo-science prevalent today surrounding topics such as UFOs. A companion educational website ([www.Sky-Fire.TV](http://www.Sky-Fire.TV)) allows students, teachers and adults wishing to supplement their planetarium experience to further investigate sprites and related atmospheric science topics (Fig. 2). The interactive web site encourages visitors to test their knowledge. Twenty Question Red Sprite Quiz Games are available for both beginners and the more advanced players. Immediate feedback and scoring, plus a certificate of completion is

presented to the visitor finishing the quiz. (This provides an ideal way for a teacher to be assured a homework assignment has been completed). On the web site, the public is also encouraged to actively search the sky for these fleeting phenomena. We also solicit photographs of rare upward lightning events recently brought to the attention of science by amateurs (Lyons et al. 2003b).

## 4. EDUCATIONAL GOALS

This Informal Science Education project (a supplement to an active NSF Research Award) is designed to increase scientific literacy among Americans. The program chronicles a scientific detective story that leads to the discovery of an entirely new class of atmospheric optical events above storms. It is hoped the show will motivate the planetarium visitors to engage in self-directed learning through the companion interactive website [[www.Sky-Fire.TV](http://www.Sky-Fire.TV)]. The science concepts addressed cover many of the topics covered in general and Earth science courses, giving them life and meaning in a pleasing learning environment.

The basic "take home" messages of the planetarium show and companion website include:

*The excitement of scientific discovery.* Sprites were something unexpected. Science has not come even remotely close to discovering all the facets of the natural world about us. Science can actually be fun!

*How the scientific method works.* Showing how scientists patiently documented, verified and began explaining these "strange lights in the night sky" - in contrast to pseudo-science and UFO "research." We aim to instill healthy skepticism.

*Demonstrate the interconnectedness of energy flows within the Sun-Earth system.* The sun is shown as the energy source which drives the Earth's weather. The similarities and differences between sprites and aurora are demonstrated. A basic tutorial on weather on all the planets, including Earth, is used to set the scene and provide the necessary factual knowledge to understand the relationship of sprites to lightning.

*Motivate to learn more on your own.* Planetarium and science center visitors are directed to the interactive website for a variety of

science vignettes, tutorials and quizzes. Self directed learning is encouraged with many links to other science-related web sites.

***Participate in the scientific enterprise.***

Interested amateurs are shown how to “hunt” for sprites and contribute their own observations. By filling out the online report forms, visitors are exposed to the need for care and precision in making and reporting scientific observations. A number of very interesting sightings have already been submitted.

## **5. PRODUCTION**

The show kit was produced in-house by Sky Fire Productions with input from the U.S. Air Force Planetarium. The show kit, which is made available to planetariums and science centers at a subsidized price, contains the DVD (or VHS) program, a collection of graphics images, suggested program introductions, a timed script, and hand out masters for students (a fact sheet) and teachers (the red sprite quiz and answer sheets). A classroom version (DVD or VHS) of the main program is also available for purchase on the [www.Sky-Fire.TV](http://www.Sky-Fire.TV) web site.

The program was developed at Sky Fire Productions, which has launched a facility called CECIL (Collaborations for Educational Computing and Interactive Learning). This state-of-the-art digital image acquisition, production, editing, and authoring facility will be employed for a number of similar future projects now in the planning stages. The underlying motivation behind CECIL is to facilitate working scientists wishing to become personally involved with informal public science education. The sprite program’s producer (Lyons) is also a contributor to the research documented in the program. Educational consultants were also involved throughout the program development to assure that the educational goals were being advanced.

The chief collaborator for this project was Mickey Schmidt, Director of the U.S. Air Force Academy Planetarium, in Colorado Springs, CO. The USAF Academy Planetarium in May, 2003 hosted the “world premiere” of the program. Since then over a dozen planetaria have committed to presenting the program over the next several years.

We note the published vision statement of the National Science Foundation comments on the need to “integrate research with education, infuse education with the joy of discovery, and an awareness of its connections to explorations through directed inquiry, careful observations and analytical thinking for students of all ages.” We hope we have been able to advance these goals. We would also note that attention to production values, scripting and the use of inspiring music resulted in “The Hundred Year Hunt for the Red Sprite” winning three major video awards (a 2003 Telly Award, a Videographer Award, and an Aurora Award).

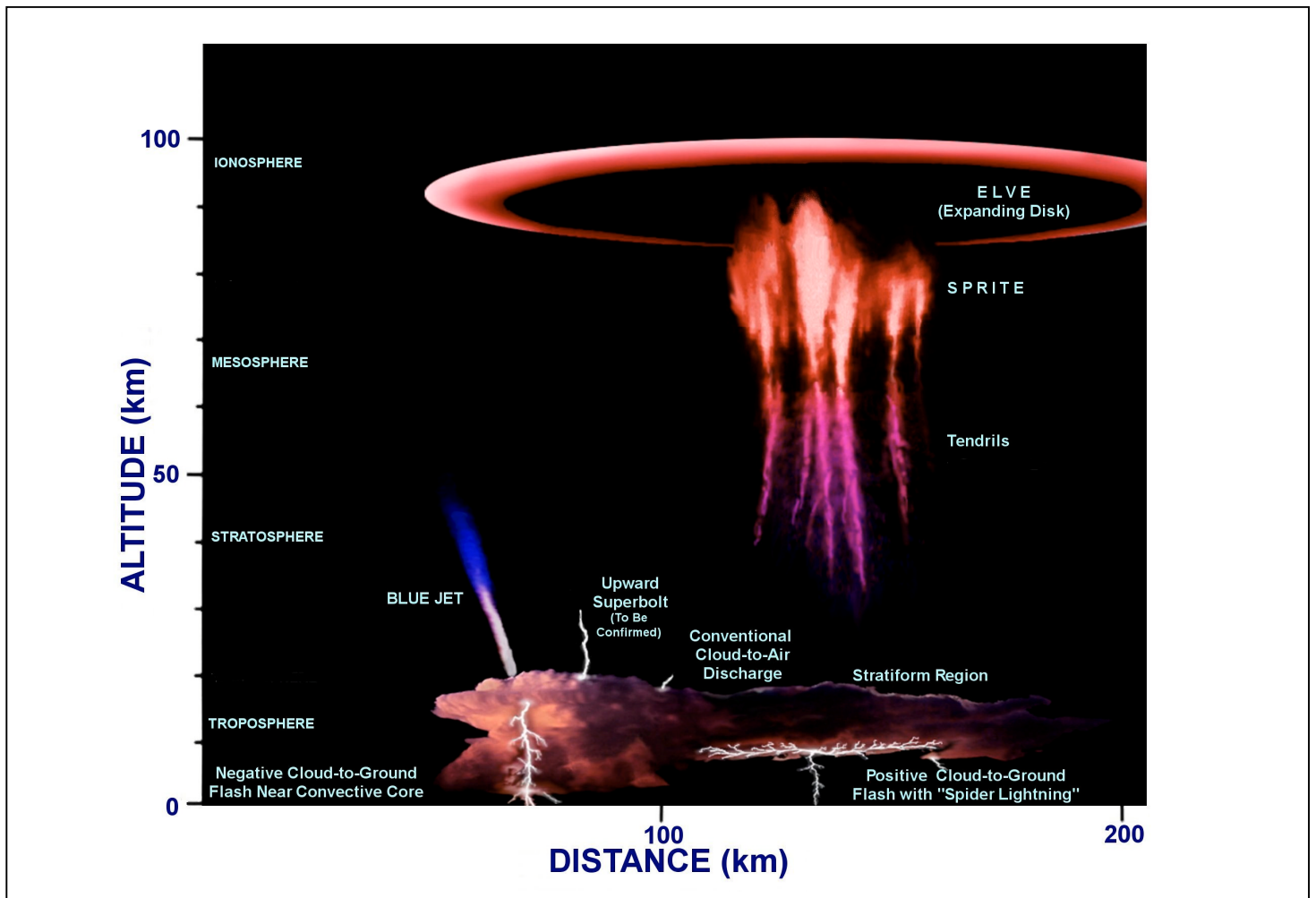
## **6. ACKNOWLEDGMENTS**


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## **7. REFERENCES**

- Lyons, W. A., T. E. Nelson, E. R. Williams, S. A. Cummer and M. A. Stanley, 2003a: Characteristics of Sprite-Producing Positive Cloud-to-Ground Lightning during the 19 July 2000 STEPS Mesoscale Convective Systems. Mon. Wea. Rev., **131**, 2417-2427.
- Lyons, W. A., T. E. Nelson, R. A. Armstrong, V. P. Pasko and M. A. Stanley, 2003b: Upward Electrical Discharges from Thunderstorm Tops. Bull. Amer. Meteor. Soc., **84**, 445-454.
- Lyons, W. A., R. A. Armstrong, E. R. Williams and E.A. Bering, 2000: The Hundred Year Hunt for the Red Sprite. Eos, Trans. Amer. Geophys. Union, **81**, 373-377.

Figure 1. A depiction of various transient luminous events in the middle atmosphere above thunderstorms (from Lyons et al., 2000).






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Home

**The Hundred Year Hunt for the Red Sprite**


### Play the Sprite Game

Test your knowledge about storms, sprites, lightning and clouds. See just how weatherwise you are!  
 Get Your Score Right Away-coming soon!  
 Beginner Quiz Advanced Quiz




### Sprite Gallery

See our amazing array of sprites!




### Name that cloud!

Can you identify the main cloud types?



### Daily Weather Factoids

Did you know this?



### Where are the sprites tonight?

National radar, infrared GOES satellite images and lightning strike maps.

[Weather Websites](#)

**You can help science unravel the mystery of strange lights in the night sky - that are real!**

[A short history of the discovery of sprites](#)


[Tips on how to search for sprites and blue jets yourself.](#)

[How to contribute your observations to assist in the scientific search](#)


[Latest observations](#)

[Scientific websites about sprites and sprite researchers](#)


Facts, Figures and Fun about:



**Sprites & Blue Jets**



**Tornadoes**



**Lightning**

This section of our website is partially funded by the U.S. National Science Foundation, Informal Science Education Program. A service of FMA Research, Inc. and Sky Fire Productions, Inc.

A triple award-winner, "The Hundred Year Hunt for the Red Sprite" will be showing in planetariums and science centers around the US. Watch this space for venues near you.

[The Sprite Video/DVD is also available for home viewing.](#)

### Sprite Art

Sprites as interpreted by Canadian artist Peter McLeish.

### About the Music

[Tell a friend about our website.](#)

Sign up for our [Sprite Watchers Newsletter](#) - learn about new show venues and other DVD/videos on weather as they become available.

[Interested in a career in the atmospheric sciences?](#)

Figure 2. The top page of the sprite section of www.Sky-Fire.TV.