

Insects as unidentified flying objects

Philip S. Callahan and R. W. Mankin

Five species of insects were subjected to a large electric field. Each of the insects stimulated in this manner emitted visible glows of various colors and blacklight (uv). It is postulated that the Uintah Basin, Utah, nocturnal UFO display (1965–1968) was partially due to mass swarms of spruce budworms, *Choristoneura fumiferana* (Clemens), stimulated to emit this type of St. Elmo's fire by flying into high electric fields caused by thunderheads and high density particulate matter in the air. There was excellent time and spatial correlation between the 1965–1968 UFO nocturnal sightings and spruce budworm infestation. It is suggested that a correlation of nocturnal UFO sightings throughout the U.S. and Canada with spruce budworm infestations might give some insight into nocturnal insect flight patterns.

Introduction

Saint Elmo's fire is probably responsible for more ghost stories and tales of apparitions than any other natural phenomenon. Typically Saint Elmo's fire is seen in stormy weather at prominent points such as church steeples (Fig. 1), the yardarms and mastheads of sailing ships, and more commonly at the tips of wings and propellers on aircraft. The senior author has observed it rolling along the wings and on the propeller tips when he was flying above Northern Hokkaido during an ice storm. Saint Elmo's fire is a brush discharge of static electricity that is typically reddish purple, green, or bluish hue.

The name for this ghostly electric discharge is a corruption of the Italian name of Saint Elmo (Saint Erasmus in English). Saint Elmo, an Italian bishop and martyr in the fourth century, is the patron saint of sailors. During severe storms in the Mediterranean the occurrence of Saint Elmo's fire around a masthead and topmost yardarm was considered a good omen by the sailors of that region.

Our interest in Saint Elmo's fire was aroused by a recent book by Frank B. Salisbury, a plant physiologist and director of the Plant Science Department at the State University of Utah.¹ Salisbury has written a fascinating book, *The Utah UFO Display: A Biologist's Report*. As J. Allen Hynek, Chairman of the Astronomy Department at Northwestern University,

stated in the foreword of Salisbury's book,¹ "It is both refreshing and rewarding to find a treatment of the tremendously fascinating subject of unidentified flying objects (UFOs) by one who has a keen understanding of the scientific method." That was exactly the feeling of these authors as we read this fascinating, well written, and reasonable account of Salisbury's study of a long series of UFO displays that occurred over the town of Roosevelt in the Uintah Basin in northeast Utah.

As the senior author was reading the narrative of night sightings of the Utah UFOs, it occurred to him that the descriptions which Salisbury recorded were quite similar to the flight antics of swarms of day-flying insects. The classic book by Johnson² on insect migration contains excellent descriptions of the structure and cohesion of insect swarms in flight.

The following paragraphs are quoted from eye witness accounts of the Utah display recorded by Salisbury from the eighty sightings that he considered reliable.¹ These eighty sightings were observed by 260 witnesses. On p. 23 of *The Utah UFO Display* we read: *They ran outside in time to see a large object, flat on the bottom with a dome on top hovering over the house, almost appearing to balance on top of the house. It was twice as large as the small home. They heard a humming noise, and lights around the bottom edge of the object were blinking on and off, giving a predominantly red impression, but also appearing at times to be green and yellow* (20 September 1966).

Page 51. *So I pulled up, and I stopped on top of this hill and watched it, and the son-of-a-gun moved along, stayed on about the same plane, and then it broke the horizon, and there it sat, and gee, we couldn't imagine what it was—and then it hovered there for a minute, and then it went almost straight again. This time when it finally took off, it just kind of hovered out there, and it seemed to be a little bit smaller this time,*

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Fig. 1. Saint Elmo's fire from the steeple of a chapel in the Tyrolean Alps. Drawing by Jim Brogden.

but when it left, you could see something fall away from it (1 September 1967).

Page 57. Suddenly this big ball of light about two hundred yards away started moving toward me. It looked about three yards in diameter, getting bigger, orange in color. The light began to change color to a fluorescent blue and settled directly over the truck (11 October 1967).

Page 71. So we stopped the car and watched it, and as we watched it came down, real slow, just like it was kind of hovering and getting lower all the time. It got down, oh I'd say a quarter-mile from the ground, and then a light came out of it and shined off into the heavens, and the light looked like it was spliced. It came out real bright for a ways and then it was dark, and then there was another stretch (Fall 1966).

The similarity between these descriptions and the sound and flight antics of swarms of insects is startling.

At first thought it would seem that a luminescent colored flying object with a somewhat regular outline, such as a UFO must have, could not be a night swarm of insects. The edge shape of swarms of daylight-flying locusts is well documented by entomologists; and they do indeed have defined shapes. As Baron³ states "However strange the shapes it (swarms) may take, however many the columns and curtains which may appear and disappear, it seems to be governed above all by the need to stick together." Further on he states, "On the contrary, the edge of the swarm remained quite clear-cut, as group after group, having reached it, turned as though on some mysterious order and flew back into the main body." Many insect swarms exhibit just such cohesion.

Obviously, if night swarms of insects are to be mistaken for UFOs, there must be some mechanism for lighting up the swarms. Since the insect exoskeleton is a dielectric⁴ surrounding a conducting medium (the insect body fluid), Saint Elmo's fire is one very likely possibility. The physics of brush discharge allows one to treat each insect as a small point or focusing mecha-

nism for the discharge as in the case for the tip of a church steeple or a tip of a ship mast. We decided to test the possibility in the laboratory.

Methods And Materials

Five species of test insects were chosen for the experiments: *Trichoplusia ni* (Hübner), Noctuidae; *Euthyrhynchus floridanus* (L.), Pentatomidae; *Tylocerina nodosus* (F.), Cerambycidae; *Conotrachelus nenuphar* (Herbst), Curculionidae; and *Choristoneura fumiferana* (Clemens). The plum curculio was chosen for its small size and the long-horned cerambycid for its large size. The predaceous pentatomid has characteristic pointed projections on its elytra and appeared to be suitable for testing for a brush discharge from the small points extending from its body. The cabbage looper and spruce budworm were chosen as a representative of the night flying moths that are important in agriculture and forestry. Five specimens of four species were tested; only a single long-horned beetle was available. Two separate methods were used to produce the electric field. In one method a Molelectron high voltage dc power supply produced a potential (range: 0-20 kV) across a capacitor built with two 20-cm² aluminum electrodes separated by an air gap of 1.9 cm. The insects were suspended between the plates by sticking them to the tip of a pair of tweezers covered with freshly applied Duro rubber cement. In the second method the test specimen was similarly glued to the tip of a Cenco high intensity, high frequency Tesla coil. The rubber cement was poured over the tip of the coil and allowed to harden over the tip so that there was a depth of plastic rubber between the insect and coil tip of approximately 1 cm [Fig. 2 (top)]. This layer of plastic rubber provided excellent insulation and prevented direct contact of the specimen with the coil. It also provided a dielectric support to prevent ohmic heating of the test specimen. The Tesla coil is adjustable to provide up to about 10 kV/cm. A brush discharge would occur at 2-3 kV/cm. The term kV/cm represents the potential of 1000 V between two large parallel plates 1 cm apart (1-cm air gap). All photographs were taken with a Honeywell Pentax SPII camera with a macro lens from a distance of 1 ft (0.3 m) using Plus X film or Kodachrome II film.

Results

At about 2.1 kV/cm all test insects (except the curculio) displayed brilliant colored flares or brushes of bluish white light from various external points on their bodies such as the distal tip of mandibles, ovipositors, antennae, and leg joints (Figs. 2, 3, and 4). The curculio began to display at about 2.6 kV/cm. Occasionally, red, green, or orange flares would appear at or near the spiracles [Fig. 2 (bottom)]. The display was continuous from the insects on the Tesla coil and intermittent from the insects in the capacitor. Slowly varying the voltage across the capacitor caused the display from the insect to occur more frequently. During stimulation in the high electric field, the insects appeared initially to be agitated, but after a few minutes they settled down and

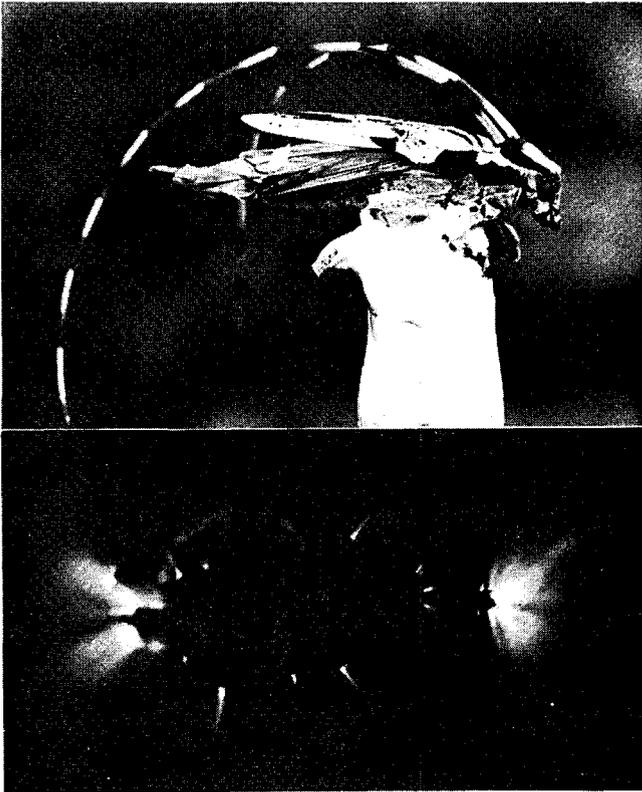


Fig. 2. (Top) long-horned beetle, *Tylocerina nodosus* mounted in insulative rubber cement above the top of the Tesla coil. (Bottom) dorsal view of the long-horned beetle showing Saint Elmo's fire from around the spiracles and the ovipositor (right) and head (left) of the beetle. Voltage about 2500.

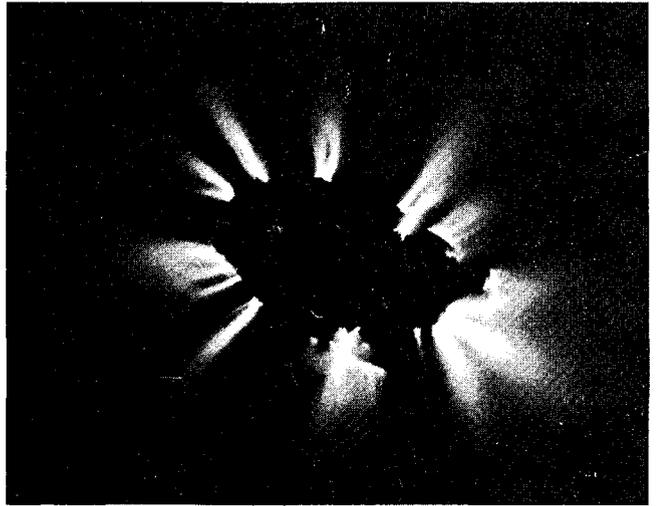


Fig. 4 Predatory stink bug, *Euthyrhynchus floridanus*, dorsal view showing glow from head (right) and tip of abdomen (left) and points of the pronotum. Voltage about 2500

suffered no apparent injury from the high field. Specimens, subjected to the field of the Tesla coil for 2 h and then taken out and fed, lived on for a normal period. *Trichoplusia ni* lived from 5 days to 7 days after exposure, and the plum curculios and stink bugs were alive 2–4 weeks later. In the dc field of the capacitor, however, the insect would sometimes die if an intense spark arced to the body.

Dead dry insects did not normally luminesce. However, if the dried insects were treated by immersion in water for a few minutes the flares typical of live insects reappeared. After dessication the flare disappeared again.

A Photovolt model 502M photometer indicated that an insect the size of a stink bug subjected to the Tesla coil field (about 5–7 kV/cm) produces a radiant flux density of about $3.75 \mu\text{W}/\text{cm}^2$ in the 350 (near uv or blacklight)–450-nm (blue) spectral range at a distance of 18 cm.

Comparison of Laboratory Conditions with Natural Conditions

The flare of colored lights surrounding an insect in a strong electric field is a corona discharge similar to Saint Elmo's fire.⁵ It is also related to the phenomenon of Kirlian photography.⁶ Penning⁷ and Loeb⁸ give good reviews of the physical mechanism involved. The discharge comes from gas molecules that have been excited to release energetic electrons during collisions with an avalanche of electrons. The avalanche is caused by the strong electric field that propels electrons from the pointed exposed surfaces of the insect where forces binding the ions to the surface are weakest. The predominantly bluish color indicates that most of the radiation is from nitrogen.⁸

A corona discharge arises only from a conductor. Live insects that are composed of an excellent dielectric

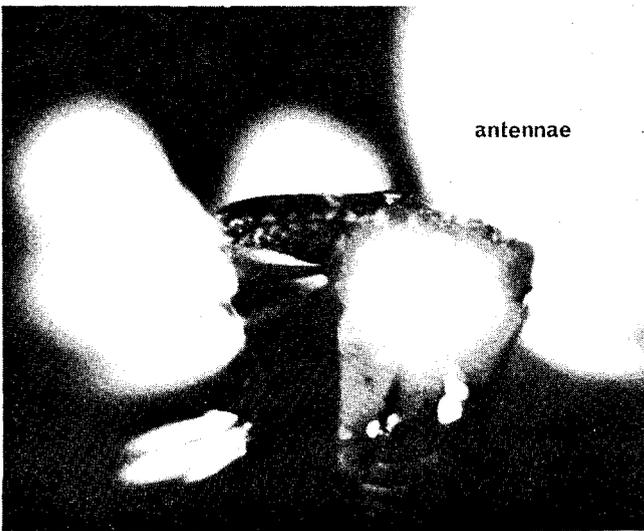


Fig.3 Long-horned beetle, *Tylocerina nodosus*, lateral view showing tremendous glow from the antennae and lesser glows from the legs and tip of the feet. Voltage about 2500.

surrounding an electrolyte (body fluids) meet this requirement. Dead dried out insects with no conducting electrolyte do not.

For a corona discharge to occur, a strong electric field must be present. The atmosphere produces more than enough voltage under certain weather conditions by what is termed triboelectric processes (from tribo, to rub) and by the high nonuniform electric fields produced under thunderheads. Studies by Nasser and Loeb⁹ and Loeb¹⁰ indicate that corona discharge from a point occurs when the local electric field intensity reaches 1.7–2.2 kV/cm. These conditions occur frequently near thunderheads. Static charges caused by rubbing particles (triboelectric conditions) reach tremendous potentials. Sutton¹¹ observes that the total potential under a single thunderhead may reach a maximum of 200 million to over a billion volts. Kamra¹² observed an incident of triboelectric phenomenon while measuring electrification in dust storms. Rapid changes of potential gradient were measured near a thunderstorm of 0.015 kV/cm, and sparks extended from sand dunes during high winds. No sparks occurred when thunderstorms were absent.

In a 6-year Army-Navy precipitation static study, Gunn¹³ found that aircraft developed fields of up to 0.45 kV/cm by flying through dry crystalline snow and of 0.02 kV/cm by flying through pollution haze over a city. This is an appreciable fraction of the field required for a visible corona discharge. Near thunderstorms the measured electric field averaged 1.3 kV/cm, and fields as high as 2 kV/cm were common. Values as high as 3.4 kV/cm were measured. The measured values near a thunderstorm were lower than the actual values because the aircraft used during the measurements is a conductor and disturbs the normal field. A combination of thunderstorms plus a high density of particulate pollution would without a doubt give electric fields far above the 1.7–2.2 kV/cm necessary for a corona discharge.

Thus, there is absolutely no doubt at all that, given the right weather conditions, nature can produce a high enough electric field to light up flying insects.

Discussion

Our research into Saint Elmo's fire from insects led to speculation as to what species of insect might contribute to an outbreak of UFO sightings in the Uintah Basin. Because the intensity of a corona discharge is small, only a fairly large swarm of night flyers would be visible. The maximum distance from which a lighted insect swarm is visible in the dark can be estimated from our data. Since one insect with an output of 3.75 $\mu\text{W}/\text{cm}^2$ was visible 20 ft (6 m) across a dimly lighted laboratory, by the inverse square law, a thousand closely spaced insects would be visible from about 600 ft (180 m). Larger concentrations would be visible from longer distances.

The fact that the Uinta Mountains north of the basin are covered with Douglas Fir, *Pseudotsuga menziesii* (Mirb.) Franco, led us to postulate that night flights of

spruce budworms, *Choristoneura fumiferana* (Clemens), might be responsible for some of the UFO sightings. This species of insect was postulated as a possible source of the heavenly lights, even before we had any idea that swarms of spruce budworms occurred in clouds 64 miles (102 km) long and 16 miles (25 km) wide as reported by U.S. Weather Service radar personnel tracking spruce budworms.¹⁴ Scales from Lepidoptera are dielectrics and collect high static charges by the rubbing (triboelectricity) mechanism. A cloud of spruce budworms would produce a veritable thunderhead of such charged particles.

According to Henson¹⁵ mass flights of spruce budworms always take place in the late evening or early part of the night. Flights have been observed generally from March to November. This is the same time period when most of the UFO sightings occurred.¹ Henson¹⁵ states: *The heavy evening flight of the moths is a response to lights of decreasing intensity, the number of insects in flight being directly related to the rate of decrease of light. Reconstruction of the meteorological situation at the times of the mass flight leads to the conclusion that the insects were carried by convective storms which precede typical cold fronts.*

Henson points out that sudden reduction in the amount of light and pressure brings about changes that result in heavy mass flights of moths. He concluded that the prefrontal thunderstorms are responsible for the mass flights. There is a strong updraft in the front of each cell of the storm, and flying insects may be drawn into this thin updraft with other small particulate matter and carried aloft to be tossed out the sides or top of the clouds and deposited miles away in the open country. What Henson describes for mass flights of spruce budworms is an ideal environment for the stimulation of Saint Elmo's glow.¹⁰ There is no reason to believe that moths carried by such storm fronts would be injured or otherwise affected unless they were battered by ice deposition.¹⁶

According to Salisbury¹ 88.75% of the UFO sightings occurred between the summer of 1965 and the winter of 1968. Over half of the sightings from that period occurred in the fall. We contacted Lawrence Stipe of the USDA Forest Service, Ogden, Utah,¹⁷ to see if 1965–68 were outbreak years for spruce budworm in the Utah mountains.

The Forest Insect Conditions (Report) for the Fishlake and Ashley National Forests in the Uinta Mountains, just north of Roosevelt, a town in the basin area where most of the sightings took place, states: *The spruce budworm continues to infest Douglas fir, white fir, and to a lesser extent, subalpine fir and Engelmann spruce in portions of Beaver River and Thousand Lake Mountain. The infestation, first reported in 1964, and covering upward to 20,000 acres, decreased to 10,000 acres in 1965, continued to drop to an even lower level in 1966, and has maintained this low status through 1967. The Uintah Basin UFO display began in the summer of 1965! In other words there were severe infestations of spruce budworms in the 2 years just preceding the main period of UFO display and smaller in-*

festations throughout the entire period. The UFO display occurred when mass moth migrations would be expected from the area!

A closer examination of the infestation maps (Fig. 5) supplied to us by the U.S. Forest Service revealed some startling similarities between places where infestations were reported and places of reliable UFO sightings. For example, from Salisbury's table of sightings we extracted the following: Date—21 March 1968; Observer—Henry Wopsock, Whiterocks; Shape—half dome; Time—night; Distance—?; Description—moved over house in Whiterocks for a few minutes. The U.S. Forest Service maps showed two heavy areas of defoliation sighted in the aerial survey for 1968 in the Whiterocks-Red Pine Canyon area only a few miles from the town of Whiterocks (map, Fig. 5).

The Whiterocks infestations were located on the western end of the large defoliated areas that were observed between 1966 and 1968 on a line from Roosevelt along a northeast vector to a phosphate plant north of Vernal, Utah. Along this line, and slightly north of all the UFO sightings in the open high foothills of the mountains, eight major sites of budworm infestations were seen during the aerial survey of 1968 (Map, Fig. 5). Along the ridges of the highest mountains of the Uinta range in Daggett County, just north of Uintah County, there were scattered infestations in the entire area (map, Fig. 5) between 1965 and 1968. Most of the UFO

sightings took place in a triangular area between Whiterock, Vernal, and Roosevelt in the rolling open country south of the mountain range. This is not only the area of highest human population, and therefore the area where sightings are most likely to occur, but also the area where particulate matter in the air (dust-devils are common) would be most likely to occur. Since the area is open, it also is an area over which dispersing swarms of spruce budworms are likely to fly during their night migration. Although we have no weather data for the area, high static charges from thunderheads and particulate matter are highly probable over the slopes of high mountains. Blais¹⁸ describes how spruce budworms emerge and fly upward to migrate on convective storms.

The witnesses' descriptions of the erratic flight behavior, blinking colored lights, and humming sounds given off by the Uintah nocturnal lights, contribute significantly to our belief that swarms of insects were responsible for certain Uintah Basin UFO displays. Airborne insects that were disturbed in flight, as they would be if they flew into a high voltage field, are likely to fly erratically, hover, and blink on and off as they enter the field of high voltage or attempt to escape from such a field. The fact is that we stimulated moths in our laboratory to emit various colored lights and, in particular, uv blacklight, and these emissions had no effect on the life of the insects. Even dead insects would display until they dried out. Such a display would definitely contribute to the impression by an observer that he or she was witnessing a UFO from outer space. Anyone who has visited a modern-day discotheque can well imagine the impression that a free-floating discotheque in the sky might leave.

Lest the reader surmise from this paper that the authors do not believe in the existence of visitors from outer space, this does not follow. Perhaps they do visit. But visitations from outer space are not the reason for writing this report. An agricultural scientist might well ask what difference it makes that swarms of insects are mistaken for UFOs. We should point out that according to the Condon Report¹⁹ the U.S. Air Force has over 30,000 good sighting descriptions stored on tape. A significant number of these could be nocturnal light sightings. If some enterprising U.S. or Canadian Forest Service researcher could prevail upon the Air Force to release these tapes, the sightings might be correlated with spruce budworm and other insect infestations all over Canada and the U.S. It is possible that we could obtain significant data on the migration of these damaging insects by just such analysis of nocturnal UFOs. Migration of nocturnal insects is one of the least understood of natural phenomena, so why not study UFOs as insects?

R. W. Mankin is a laboratory technologist from the University of Florida, Department of Entomology & Nematology, working under a cooperative agreement with USDA.

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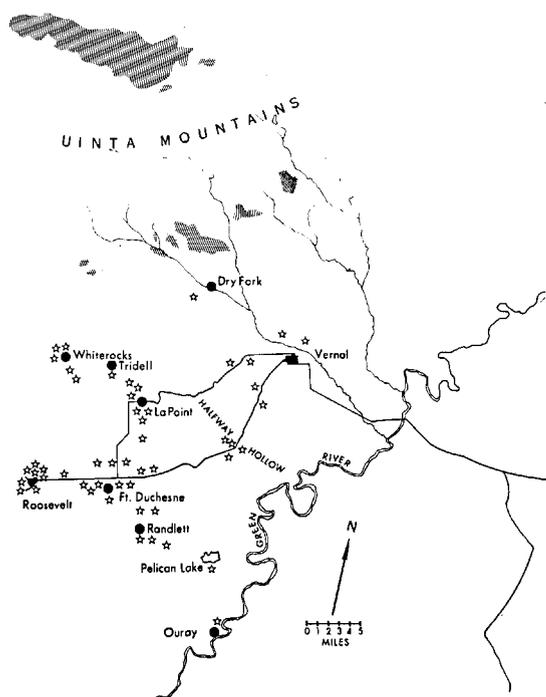


Fig. 5 Map showing the major UFO sightings 1965-1968 (stars) in the Roosevelt-Vernal Uintah Basin and the major spruce budworm infestations 1965-1968 in the Uinta mountains 10-20 miles (16-32 km) north of the highways where most sightings occurred. Both the north and south slopes of the mountains were infested. The high ridge of the range runs east and west along the line of the map caption (Uinta Mountains). Convection thunderheads would certainly be common on the slopes.

References

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Meetings Calendar continued from page 3354

1979

May

27-1 June 7th Canadian Congress of Applied Mechanics, U. of Sherbrooke N. Galanis, Faculty of Appl. Sci., U. of Sherbrooke, Sherbrooke, P.Q. J1K 2R1

30-1 June IEEE/OSA Conference on Laser Engineering and Applications, Washington Hilton Hotel J. W. Quinn, OSA, 2000 L St. N.W., Washington, D.C. 20036

June

? AAS Meeting, Wellesley, Mass. L. W. Frederick, P.O. Box 3818, Univ. Station, Charlottesville, Va. 22903

13-15 Applications of Ferroelectrics, IEEE internat. symp., Sheraton Ritz Hotel, Minneapolis S. T. Liu, Honeywell Corp. Res. Ctr., 10701 Lindale Ave., S., Bloomington, Minn. 55420

17-20 2nd Joint MMM-Intermag Conference, New York R. M. Josephs, Sperry Univac Computer Systems, P.O. Box 500, Blue Bell, Pa. 19422

18-21 USNC/URSI/IEEE, mtg., Seattle A. Ishimaru, Dept. of Electrical Eng., FT-10, U. of Washington, Seattle, Wash. 98195

18-22 Laser '79 Exhibition and Congress, West Germany C. Werner, DFVLR, Inst. für Physik der Atmosphäre, 801 Oberpfaffenhofen, Post Wessling/OBB, German Federal Republic

20-22 ISA 1979 Wilmington Symp., U. of Del. M. L. Griffin, 400 Stanwix St., Pittsburgh, Pa. 15222

July

1-6 21st Colloquium Spectroscopium Internationale/8th International Conference on Atomic Spectroscopy, Cambridge Secretariat, P.O. Box 109, Cambridge CBI 2HY, U.K.

2-6 9th Internat. Laser Atmospheric Studies Conf., Munich C. Werner, DFVLR, Inst. für Atmosphärische Phys., 8031 Oberpfaffenhofen, Post Wessling/OBB, W. Germany

9-13 14th Internat. Conf. on Phenomena in Ionised Gases, Grenoble Comité d'organisation, ICPIG 14, Ave. d'Innsbruck, 38029 Grenoble Cedex, France

August

? National Heat Transfer Conference, San Diego R. Vis-kanta, School of Mechanical Eng., Purdue U., West Lafayette, Ind. 47907

12-24 Joint Cryogenic Eng. and Internat. Cryogenic Materials Confs., U. of Wisc., Madison D. Belsher, NBS, Boulder, Colo. 80303

20-22 4th Internat. Conf. on Ellipsometry, Berkeley R. H. Muller, Mater. and Mol. Res. Div., Lawrence Berkeley Lab., U. of Calif., Berkeley, Calif., 94720

27-31 Amorphous and Liquid Semiconductors, 8th internat. conf., Harvard U. Sci. Ctr. Conf. Secretariat, 20 Garden St., Cambridge, Mass. 02138

September

10-14 Symp. on Atomic Spectroscopy, Tucson J. O. Stoner Jr., Phys. Dept., U. of Ariz., Tucson, Ariz. 85721

12-13 How will tomorrow's microprocessor-based process instrumentation communicate? Sira Inst. and Warren Spring Lab. seminar, London Sira Inst., South Hill, Chislehurst, Kent, BR7 5EH, England

17-19 Optical Communication Conf., Assoc. of 5th European Conf. on Optical Communication and 2nd Internat. Conf. on Integrated Optics and Optical Communication, Amsterdam (J. H. C. van Heuven, Philips Labs., Eindhoven, Netherlands)

19-21 4th Nat. Quantum Electronics Conf., Heriot-Watt U. B. S. Wherrett, Phys. Dept., Heriot-Watt U., Edinburgh EH14 4AS, Scotland

October

7-12 OSA Annual Mtg., Rochester J. W. Quinn, OSA, 2000 L St. N.W., Washington, D.C. 20036

November

? Optical Photonics and Iconics Engineering Mtg., Strasbourg P. C. Legall, European Photonics Assoc., 3, rue de l'Université, 67000 Strasbourg, France

25-30 ASME Winter Mtg., New York ASME, 345 E. 47th St., New York, N.Y. 10017

December

10-15 Infrared and Near Millimeter Waves, 4th internat. conf., Americana at Bal Harbour, Miami Beach, Fla. K. J. Button, MIT, Nat. Magnet Lab., Cambridge, Mass. 02139

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