CPS Plasma Page

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Lightning Sparks Interest at Capitol Hill Educational Luncheon

On May 8, Prof. Vladimir Rakov of the University of Florida, speaking at a CPS educational luncheon on Capitol Hill, discussed the science behind one of the most commonly viewed plasmas on earth – lightning.

In a talk entitled "What You Don't Know About Lightning," Rakov began his presentation by reviewing the spatial distribution of lightning around the world, illustrating that while parts of Florida receive the most lightning flashes in the U.S., central Africa appears to be the global hot spot.

We typically think of lightning as descending from the sky toward the earth, but lightning can also extend upward from a tall, grounded building or monument, like the Eiffel Tower. Rakov explained that the direction of the branches off the main lightning channel reveals the direction of the lightning.

We also hear of planes being "struck" by lightning. In fact, a plane can trigger lightning. Rakov showed an impressive slide of a plane just after take-off, initiating columns of plasma that extended both upward and downward. Rakov noted that if the plane had not been there, the lightning would not have occurred.

Lightning can be triggered intentionally as well, most often using a simple rocket with a trailing wire connected to ground. Rakov introduced the audience to the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, Florida, where researchers trigger lightning to investigate its effects and to determine ways of protecting people, objects and buildings.

For example, researchers at the Center investigated the effects of lightning on underground power cables. They buried three cables (each with varying degrees of insulation or protection) to see what effect lightning strikes would have on them. They discovered that even the cable with the most protection (an insulating jacket and PVC pipe) was severely damaged.

Rakov spoke also about fulgurites, which occur when lightning strikes the ground, melting the sand and soil, and creating glassy structures that sometimes snake and branch through the ground. The world's longest excavated fulgurite (about 5 m) was made by triggered lightning at Camp Blanding in 1996. The talk included video footage of triggered lightning strikes, accompanied by thunderous audio.

Following the presentation, a number of attendees had questions. One congressional staffer wondered whether rubber tires really do make a car the safest place to be during a lightning storm. Another asked about the potential for extracting energy from lightning.

Prof. Vladimir Rakov answers questions after his talk on lightning. He stands in front of a slide of lightning striking the Washington Monument. Photo by Paul Rivenberg

A two-page write-up about lightning, recently completed by Rakov and CPS, was available at the luncheon, along with other topics in the "About Plasmas" series.

Plasmas Are Everywhere... Except in Many K-12 State Science Education Standards

Although most students can identify three states of matter (solid, liquid, gas), relatively few know that a fourth state - plasma - exists and that it makes up almost the entire visible universe. Part of the reason for this gap is that many state science standards simply do not require that plasmas be recognized as a state of matter. Standards may require knowledge about lightning, the sun and stars, fusion, atomic theory, but still never mention "plasma."

As part of its goal to promote plasma education at the K-12 level, CPS has long been interested in addressing plasma's omission from many K-12 state science education standards. The Coalition, along with the American Physical Society Division of Plasma Physics, played a major role in getting the topic of plasma included in the Georgia state science standards. The opportunity for change arose when the APS-DPP education group visited Savannah in February 2004 to schedule some outreach programs in conjunction with the annual fall meeting. By coincidence, at that time the state was completing the review of their science standards. A glance at the nearly final draft revealed that plasmas were nowhere mentioned. Letters sent to the Georgia Department of Education and the Supervisor for Science from both CPS and APS-DPP successfully argued the case for including plasma as the fourth state of matter. Today plasma is taught as a state of matter in Georgia schools.

The Coalition is ready to continue this effort across the country, but we NEED volunteers. Only a bit of time would be needed from any volunteer. The first step simply entails reviewing the science standards for a given state (or states), and reporting on when the standards were last updated, and where plasmas appear within those standards - if anywhere. This task is neither labor intensive, nor lengthy. Vol-

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unteers are free to choose any states they would like to review, on a first come basis. Some states may be assigned to ensure complete coverage.

After receiving this information from the volunteers, CPS will contact the appropriate Boards of Education.

The Coalition for Plasma Science's educational brochure states "Plasmas Are Everywhere," from interplanetary space to the fluorescent lighting in most classrooms. With help from volunteers, plasmas will also be found in the science standards of every state in the U.S.

To volunteer for this effort, please contact: Lee Berry at berryla@ornl.gov or 865 574 0998.

Young Canadian Wins CPS Prize at Intel ISEF

For the second year, CPS presented its Excellence in Plasma Science Award at the Intel Science and Engineering Fair (ISEF). Now in its 57th year, ISEF is the world's largest pre-college science competition for students in grades 9 – 12. This year almost 1500 students from 47 countries and 45 states came to Indianapolis, Indiana to participate in the event.

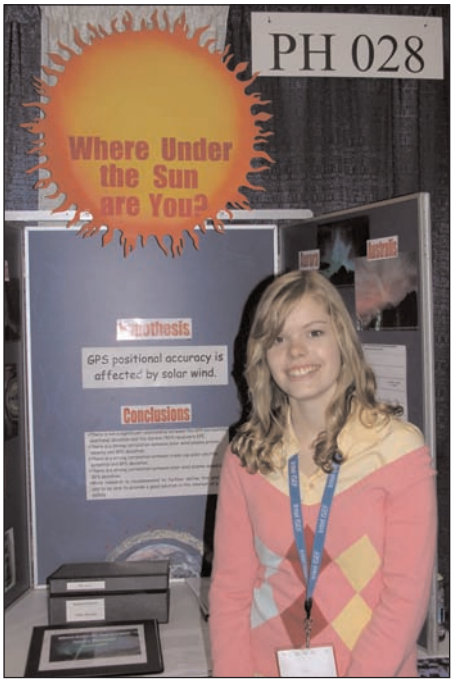
CPS is one of about 70 organizations that offer awards or scholarships at ISEF. The CPS Excellence in Plasma Science Award is given to the best project in the broad area of plasmas (e.g., lighting, displays, materials processing, space physics, terrestrial phenomena, fusion and basic plasma science). Criteria include overall scientific merit, understanding of the problem, and the approach to the topic.

Sarah Lynn McCuskee, 14, from Campbell Collegiate in Regina, Saskatchewan, Canada, was selected as the winner. Her project, "Where Under the Sun Are You?" examined the proposition that the solar wind and the ionosphere affect the accuracy of a Global Positioning System (GPS). She concluded that "solar wind and the ionosphere have a direct effect on GPS positional accuracy."

The plasma between a GPS receiver and a GPS satellite is known to affect position measurements. Based on this understanding, Sarah hypothesized that there would be correlations between measured position variations for a fixed-position receiver and measures of ionosphere and solar wind properties. She first determined that the indicated position of her GPS receiver did vary by leaving it in one place for two weeks and measuring its indicated position every 30 seconds. To test the role of plasma, she cross-correlated these position variations with measures of solar wind and ionosphere activity (obtained from research web sites). She found that there were indeed correlations, confirming her hypothesis.

A GPS receiver estimates the uncertainty of a position, in addition to estimating the position itself. Sarah recorded this estimated error, and correlated it with variations in the measured position. She found almost no correlation over the two week period, indicating that the manufacture's formula for estimating error may be deficient.

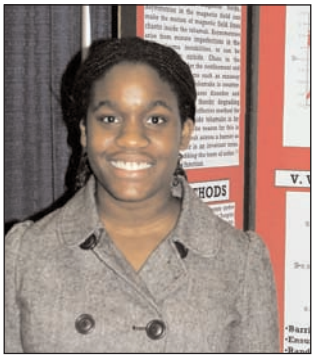
CPS Chair Lee Berry was impressed with Sarah's scientific method, the way she asked questions, sought answers, and modified her hypothesis. CPS Judge Steve Allen noted the thorough nature of her research notes that documented her evolving understanding of the problem.



Sarah Lynn McCuskee impressed the CPS judges with her study of how plasma in the ionosphere affects Global Positioning Systems. Photos by Lee Berry

Congratulations to Sarah, and the other four talented finalists.

Finalist Amanda Armstrong, Shorewood High School, Milwaukee, WI: Does Corona Discharge Wear Out Carbon Nanotubes?



Finalist Esther Oluchukwu Uduehi, Joseph Reitz High School, Evansville, IN: Chaos from Order - Order from Chaos: Can there be a Way of Containing Chaos in Tokamaks?

Finalist Carl Turner, New Prague High School, New Prague, MN: Designing an Optical Sensor to Easily Decipher the Relative Longevity of a High Pressure Sodium Light through Spectral Analysis

Finalist Rohith Chandrasekar, Princeton High School, Princeton, NJ: Synthesis of Nanoparticles using Aerodynamically Enhanced Plasma

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