Rocky Flats radiation remains unexplained

Recently publicized data showing low-level radioactive contamination of soil and groundwater at the Rocky Flats nuclear weapons plant near Golden, Colo., neither confirm nor rule out that an uncontrolled nuclear chain reaction took place there, according to EPA and the Colorado Department of Health.

The radiation findings concern health officials because radioactive cesium and strontium are produced only during fission, the splitting of atoms. Rocky Flats has no nuclear reactor. Both the Energy Department, which owns the facility, and Rockwell International Corp., which operates it, maintain that the radiation, measured in 1987, came from atmospheric nuclear weapons testing.

But the EPA refuses to accept that explanation without further study. And the FBI is investigating the possibility of illegal dumping of hazardous chemicals at Rocky Flats.

According to EPA chemical engineer Martin Hestmark, Rockwell scientists found trace levels of radioactive strontium and cesium at several drill sites under a hillside at the plant. However, they made no measurements of contaminants at other sites at Rocky Flats or surrounding areas. Hestmark notes that many of the radiation values were no larger than the error estimates for the measurement technique; other values had no error estimates.

State and federal health officials say that until better studies are conducted, the radiation source cannot be explained and an unreported nuclear accident cannot be ruled out. "If you can't trust the data, you can't trust the conclusion," says Nathaniel J. Miullo, EPA's Rocky Flats liaison.

Scientists say an accurate ratio of radioactive cesium to strontium would help pinpoint the radiation's origin.

— R. Cowen

The ups and downs of solar flares

Even a huge solar flare is tiny compared with the mass of the whole sun, but such an outburst ought to make itself felt somehow in a simultaneous downward movement of matter. To date, scientists have published only a single example of such balanced momentum associated with a flare, based on a 1985 observation. Now a group of scientists has identified four more such events.

The team began looking after the discovery of the 1985 flare. The key to the observations is the change in the wavelength of light emitted by solar material moving toward or away from the instrument measuring it. This effect, called the Doppler shift, is the same one that causes a train's whistle to rise or fall in pitch as the train approaches or recedes.

During each of the four newly analyzed flares, which occurred in 1980, instruments aboard the Solar Maximum Mission satellite detected a wavelength decrease, or "blueshift," in X-rays emitted by ionized calcium. The shift shows that calcium in a flare was moving out toward the satellite, while the X-rays revealed its temperature to be about 15 million kelvins, typical of the flaring corona.

As Solar Max recorded each blueshift, astronomers observing the same regions of the sun from the National Solar Observatory in New Mexico recorded "redshifts" in hydrogen (H-alpha) emissions, suggesting downward movement of hydrogen. The hydrogen temperature was "only" thousands of kelvins, typical of the chromosphere, the layer beneath the corona.

In other words, flares shot up from the corona just as material from the underlying chromosphere drove downward. To see whether the movements were really balanced, a group including Richard C. Canfield of the University of Hawaii in Honolulu and Dominic M. Zarro of Applied Research Corp. in Landover, Md., combined the Doppler wavelength measurements with estimates of the mass of solar material going up and down. According to the researchers, who have submitted their report to ASTROPHYSICAL JOURNAL, the momentum of the upflowing plasma producing the X-rays equaled that of the downflowing H-alpha plasma "to within an order of magnitude" each time.

Canfield says the evidence for momentum balance is rare because of the difficulties in observing red- and blueshifted emissions at the same time and from the same location on the sun. Also, Solar Max's polychromator, which measures the blueshifted X-rays, was inoperative from late 1980 until astronauts fixed it in April 1984.

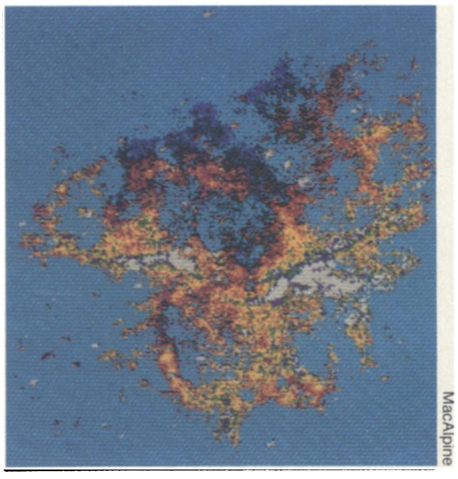
The researchers' paper discusses several solar processes that might produce simultaneous X-ray and H-alpha flows. Most, however, either seem to send both kinds in the same direction, rather than X-ray plasmas up and H-alpha down, or do not produce a balance of momentum. The authors suggest such flares result from what amounts to an explosion — "the sudden creation of a high-pressure region at the footpoint of a coronal loop." The result would be "upflowing, hot (coronal) plasma and downflowing, cool (chromospheric) plasma," with "equal and opposite momenta."

— J. Eberhart

Supernova mystery: Cracking the Crab

The Crab Nebula, a patch of glowing gas representing the debris from a stellar explosion bright enough for Chinese scholars to record nearly 1,000 years ago, has long been the target of telescopes and astronomical investigations. However, despite its well-documented start and much subsequent study, a great deal remains to be learned. Recent studies indicate the nebula has an unusual distribution of chemical elements and a surprisingly complex structure, including gigantic bubbles within its envelope of expanding gas. Such findings may force a revision of theories concerning what happens during a supernova explosion.

"The Crab Nebula is one of the most studied but least understood objects in our galaxy," says astronomer Gordon M. MacAlpine of the University of Michigan in Ann Arbor, who has been investigating the nebula's composition. He and his coworkers described their most recent results at last week's American Astronomical Society meeting in Ann Arbor.



MacAlpine

Several of the Crab Nebula's unusual features show up in a color-coded image comparing the amount of light emitted by hydrogen and helium atoms in the cloud. A white strip (see illustration), several light-years across, appears to be a ring of nearly pure helium gas encircling the spinning neutron star, or pulsar, at the nebula's center. Huge, rapidly expanding, bubble-like structures lie above and below this ring. In the dark-blue region near the picture's top, the nebula's gas seems to have jammed itself up against a molecular cloud. This region has an unusually high concentration of nickel.

A new estimate of the amount of gas in the nebula suggests the supernova star that produced the nebula was at least twice as massive as astronomers had thought. MacAlpine's calculations put the star's mass at 20 to 30 times that of the sun.

— I. Peterson

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