High School Students Will Soon Join in the Hunt for High-Energy Cosmic Rays

Using high school-based detectors, students in North America will be able to participate in ongoing cosmic-ray research.

There's a lot of excitement these days in high-energy cosmic-ray research (as the story on page 19 of this issue illustrates). Now, a collaboration of physicists in Canada and the US is looking to bring that excitement to high schools.

The idea is to deploy scintillation detectors at participating schools, hook them up to a central computer and thereby create an array capable of detecting the widely dispersed particle showers that form when high-energy cosmic rays strike Earth's atmosphere. Students will not only run the detectors, but also analyze and report the results. Conceptually, the North American Large Time Coincidence Array (NALTA), as it's called, is a less-sophisticated cousin to such large-area research arrays as Japan's Akeno Giant Air Shower Array (AGASA) and the recently funded Pierre Auger Project in the Americas. So far, NALTA includes proposed sites in Canada's Alberta province, as well as in Seattle, Boston and Lincoln, Nebraska.

"I was looking for a way to get high school students involved in cutting-edge research," recalls James Pinfold, the University of Alberta physicist who dreamt up the project about three years ago. "And the thought of seeing a *Physics Letters D* paper with high school students listed as coauthors amused me."

Experimental design

This fall, the first of the surface detectors are being set up on the roofs of four high schools in the Edmonton, Alberta, area. The detectors consist of a 0.5 m^2 sheet of acrylic scintillator sandwiched between two aluminum plates, with a photomultiplier tube at one end, and fitted into a weatherproofed box. As Pinfold explains, each school is getting three detectors so that the local direction of the shower can be determined; a Pentium-chip personal computer records any time coincidences among the signals, which are time-stamped by a Global Positioning System, or GPS, receiver. A central computer at the University of Alberta will compare time tags from the entire array, checking for large-area correlations; the larger the area, the more energetic the particle shower. An extremely rare 10^{20} eV shower, for example, would light up detectors across a 6 km area.

NALTA has the look and feel of a large-scale research collaboration, which in fact it is, says Pinfold, an experimental particle physicist who commutes regularly to CERN. A Web site is now being set up to allow the participating students and their teachers to monitor each other's progress. Students will also write scientific papers, which they'll present to the NALTA consortium, explains Dale Sware, a physics teacher at Edmonton's McNally High School who has been developing a 12th-grade physics curriculum block around NALTA. Students will do a range of experiments, from determining if the radiation level is higher during the day or at night, to trying to plot the sources of the radiation in the background star field.

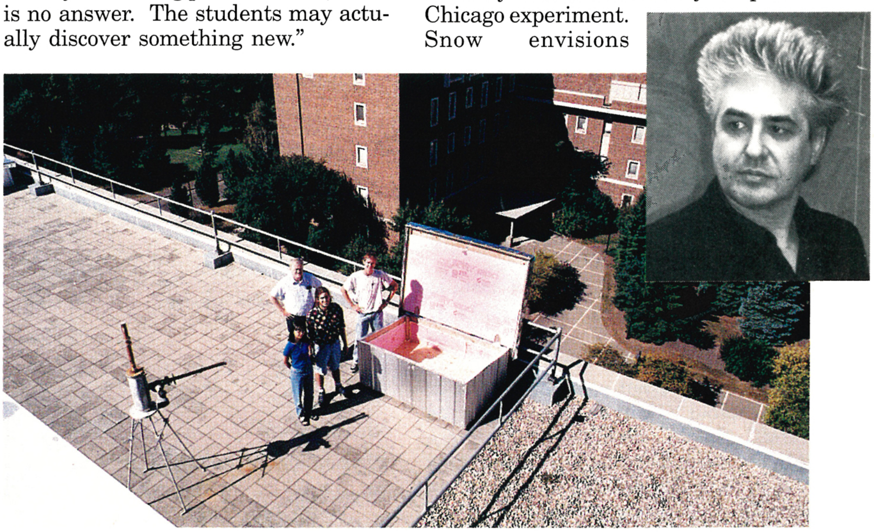
"Kids get so used to just duplicating activities from pre-1925 physics, knowing full well that there's a right or wrong answer," Sware says. "But when you're doing pure research, there is no answer. The students may actually discover something new."

A group of nuclear physicists at the University of Washington wants to set up NALTA detectors at middle and high schools in Seattle. "We're planning to install a test site at the university this winter, so that we can understand the hardware and technical difficulties," says Steven Elliott, a research assistant professor in the university's nuclear physics laboratory. "We also have to think about the implications of working with high school students."

Nebraska's CROP

Around the time Pinfold was dreaming up NALTA, Greg Snow at the University of Nebraska—Lincoln had virtually the same idea, which he called CROP, short for Cosmic Ray Observatory Project. "Several years ago, I had the opportunity to talk to Jim Cronin when he was designing the Chicago Air Shower Array. I was never involved with [that project] but I was inspired by the idea." Much later, when he was thinking of how to do more public outreach, he says, "it just came to me that there's a possible marriage between an air shower array and high schools." This year, he and colleague Dan Claes are looking to hook up six local schools using detectors recycled from the nearly completed Chicago experiment.

Snow envisions



SCINTILLATOR DETECTORS, like the one shown here on the roof of the physics building at the University of Alberta (alongside summer students Iva Cheung, Jeff Mottershead and Jason Blackstock and physics professor Wytze Brouwer), will soon be installed at several Edmonton high schools. James Pinfold, above right, has led the drive to create a high school-based detector array in Canada and the US.

CROP eventually growing to about a hundred schools throughout the state. Recently, he and Pinfold agreed to include the Nebraska array in the NALTA collaboration.

Finding funds, instilling wonder

The likelihood of NALTA's seeing interesting physics will of course increase as more schools are added to the array. But first, the money has to be there. The cost for setting up a NALTA station, including the detectors, PC, GPS receiver and wiring, is about $10 000 Canadian per site. That's a lot for most schools. So with no central funding source as yet, NALTA has been piecing together an array of support. The biggest donor to date is the University of Alberta, which has provided a total of Can $83 000 in cash, equipment and labor. The National Research Council of Canada, TRIUMF in Vancouver and the Bicron Corp of Newbury, Ohio, have each agreed to donate several thousand dollars' worth of scintillator. The Sudbury Neutrino Observatory is furnishing about 60 charge-to-voltage chips that it would have otherwise discarded because one of the four channels on each chip is damaged. "But they're ideal for our three-detector stations," explains Pinfold.

Of course, NALTA is not optimized in the way that the purely research-oriented ground arrays like AGASA and Auger are. "One doesn't get quite the same experimental control," notes Auger member John Swain, a physicist at Northeastern University who is trying to convince schools in the Boston area to join NALTA. There's no cross-calibration, for one thing, and, although the NALTA detectors may one day cover a wide area (over 10 000 km^2 in Alberta alone), they won't be uniformly dispersed.

That's almost beside the point. "We'll never be competitive scientifically with arrays like Auger," Snow says. "But this is a way of instilling wonder in students, of letting them see something that's otherwise invisible to them."

Pinfold and others in NALTA would like to see some of their students go on to major in physics. "Physics is demanding, and you have to do a lot of work to get what you want out of it," says Pinfold. "But it also trains the mind." Swain sketches a scenario: "Maybe some of these high school kids will get involved with this project, then go off to university and study physics and then go on to grad school and find they're working on Auger. That's a really exciting thought, to have such continuity."

It could happen.

JEAN KUMAGAI

Cross-Disciplinary Survey Offers Snapshot of Science PhD Employment

How common is it for scientists and engineers to take a postdoctoral position? How much time can a newly minted PhD expect to spend seeking a job? Are starting salaries for physics PhDs higher than those for microbiologists? How about for computer scientists? Although many people, particularly students, wonder about the job prospects in various fields, firm numbers have been difficult to come by. A few disciplines, such as physics, chemistry and psychology, have a longstanding tradition of monitoring employment trends within their respective fields, but others, such as the life sciences, have never tracked their graduates.

Now, for the first time, such a cross-disciplinary comparison is available, thanks to an ambitious survey of employment among recent science and engineering PhDs. Prepared under the aegis of the Commission on Professionals in Science and Technology (CPST), the study polled graduates several months after the close of the 1997 academic year, looking at where the new PhDs were working (or not working), what methods they had used to find their jobs and what they were earning (salary data are given in the table below). Professional societies representing 14 disciplines participated in the study; they included the American Institute of Physics (AIP), which collected data on physics and astronomy, and the American Geophysical Union (AGU) and American Geological Institute, which covered the Earth and space sciences.

"The intention is to help people make wise decisions about their career paths," says CPST executive director Catherine Gaddy. Among other things, the study confirms that unemployment among recent PhDs in the sciences remains far below the overall national average, which is currently about 4.5%. And respondents from all fields tended to "strongly agree" that their work was professionally challenging and "commensurate with my education and training." But in 6 of the 14 fields, including physics, chemistry and Earth and space sciences, a majority of respondents had taken postdocs or other temporary positions. "The point is not whether PhDs are finding jobs, it's what's the quality of the positions and are they using their skills appropriately?" says Gaddy. "That's important to know, particularly when we're using taxpayers' dollars to pay for graduate education and research."

So how does physics stack up against the other disciplines? "Physics is doing very well," says AIP's Roman Czujko, who with Patrick Mulvey helped formulate the four-page ques-

Median annual starting salaries for 1997 PhD recipients

	Sector of employment				
	Education (9–10 months)	Education (11–12 months)	Postdoc	Industry	Government
Biochemistry and molecular biology[1]	$35 800	$26 500	$25 300	$53 000	*
Chemical engineering	49 500	64 000	33 000	61 200	*
Chemistry	35 500	34 000	25 000	58 000	$45 000
Computer science	47 000	56 500	44 000	72 500	67 500
Earth and space sciences	33 000	40 000	34 000	58 600	47 500
Economics	48 000	51 000	42 800	73 500	54 800
Engineering	50 000	55 000	35 200	63 600	60 000
Mathematics	36 000	49 700	37 500	60 000	57 300
Microbiology[2]	33 000	26 000	26 000	44 200	47 500
Physics and astronomy	33 000	45 000	36 000	62 000	63 000
Physiology	33 500	27 200	24 000	45 000	52 400
Political science	37 200	36 900	30 000	38 900	42 700
Psychology	31 100	38 000	22 500	54 000	43 500
Sociology	37 000	39 800	31 700	*	53 500

[1] $35 500 for clinical/medical.
[2] $34 500 for clinical/medical.
* Insufficient data.

(Source: AIP Statistics Division)