Universe’s Highest-Energy Particles Traced Back to Other Galaxies

Every so often, a subatomic particle crashes into Earth’s atmosphere packing as much energy as a large hailstone. Physicists have struggled for decades to determine where such ultrahigh-energy cosmic rays come from, what they consist of, and how they are accelerated to energies 100 million times greater than particle accelerators have reached. Now answers may be in sight. Ultrahigh-energy cosmic rays appear to come from the neighborhoods of certain nearby churning galaxies, physicists working with the gigantic Pierre Auger Observatory in western Argentina report on page 938. The finding marks a first big step toward explaining the mysterious particles, others say.

“This is of the greatest importance,” says Veniamin Berezinsky, a theorist at Gran Sasso National Laboratory in Assergi, Italy. “If it is correct, it solves one part of this puzzle completely.” Alan Watson, an astrophysicist at the University of Leeds in the U.K. and spokesperson for the 300-member Auger collaboration, says, “For myself, it’s deeply satisfying to have gotten to the beginning of the end of this whole riddle.”

To trace the cosmic rays, the Auger team employed a detector array larger than Tokyo. When a cosmic ray hits the atmosphere, it triggers an avalanche of particles tens of kilometers long called an extensive air shower. By sampling the shower with detectors on the ground, physicists can determine its direction and, hence, the direction of the cosmic ray. The shower also causes nitrogen molecules in the air to fluoresce, so on moonless nights, special telescopes can see the showers. Because the highest energy cosmic rays arrive at a rate of less than one per square kilometer per century, the Auger team has carpeted 3000 square kilometers of Argentina’s Pampa Amarilla with more than 1300 detectors and deployed four batteries of telescopes.

Physicists measure the energy of the highest energy rays in exa–electron volts (EeV). The Auger team finds that rays with energies higher than 57 EeV—of which they see 27—generally come from directions within 3° of “active galactic nuclei” (AGNs) that lie within roughly 250 million light-years of Earth. That’s close enough that the particles aren’t sapped of their energy by interactions with the atmosphere of the AGNs; presumably, our galaxy’s magnetic field deflects them in transit. Details of the analysis suggest that the cosmic rays are protons.

The results don’t prove AGNs are sources of the rays. “Anything else that’s distributed on the sky in the same way as AGNs could be the source,” Watson says. For example, galaxies tend to clump, so some other sort of galaxy might be the culprit. James Cronin, a particle physicist at the University of Chicago in Illinois and co-founder of the project, says the key point is that cosmic rays do not arrive in equal numbers from all directions. Such “anisotropy” suggests that researchers are finally on the trail of the rays’ origins and gives scientists a new way to view the heavens. Cronin says: “It’s the beginning of an astronomy of cosmic rays at the highest energies.”

Others had claimed to trace the origins of the highest energy rays before. In 2001, theorists Peter Tinyakov and Igor Tkachev of the Russian Academy of Sciences in Moscow analyzed data from Japan’s Akeno Giant Air Shower Array (AGASA), a 100-square-kilometer array outside Tokyo that took data from 1993 to 2004. The highest energy rays appeared to come from objects called BL Lacs, galaxies with jets of matter and energy shooting out of them directly at Earth, they reported. That claim was disputed by researchers working with Hi-Res, twin batteries of fluorescence telescopes located in Dugway, Utah, that took data from 1997 to 2006. Last year, Hi-Res researchers argued that there was no correlation in either AGASA’s data or their own but that there was correlation in their data if they included another subtype of BL Lac.

These claims suffered from a key weakness, says Todor Stanev, a theorist at the University of Delaware, Newark. The sky is full of possible sources, so by selecting the sources in just the right way, researchers can inadvertently manufacture a specious correlation, he says. The only way to guard against that is to test the claimed correlation in a new data set. That’s what the Auger team did. First, researchers searched data collected from 1 January 2004 to 26 May 2006 to find a
correlation; then they confirmed the correlation by analyzing data collected from 27 May 2006 to 31 August 2007 using the same criteria. “The Auger collaboration has been excellent in setting the rules and not deviating from them for any reason,” Stanev says.

Still, not everyone is convinced that the observation will hold up as Auger collects more data. Even with the check against the second data set, the Auger team estimates that there is a 1-in-1000 chance the correlation with AGNs is a meaningless fluke. Statistically speaking, that makes it a “three-sigma” observation, says Gordon Thomson, an experimenter at Rutgers University in Piscataway, New Jersey, and a member of the Hi-Res team. “There are many three-sigma signals that come and go,” Thomson says. But he adds that Auger’s claim “is sufficiently interesting that a postdoc and I are looking at our data” for a correlation with AGNs.

Spurred by their first big result, the Auger team is pushing to build a second array at least three times larger in the Northern Hemisphere, which would enable them to view the entire sky. Researchers hope to submit a proposal within a year, Cronin says. Meanwhile, theorists have a puzzle to solve: Exactly how might an AGN accelerate a proton to such mind-boggling energies?

—ADRIAN CHO

Postdoc Survey Finds Gender Split on Family Issues

A new survey of how young biologists view their prospects suggests that the main concern for women is not a hostile climate but insufficient time to juggle the needs of family and career. The study of 1300 postdocs at the National Institutes of Health (NIH) in Bethesda, Maryland, includes a call for more family-friendly policies at U.S. research institutions.

“What these findings are telling us is that universities and funding institutions need to tune the academic system to the needs of women,” says Elisabeth Martinez, lead author and a former NIH postdoc who is now a pharmacology instructor at the University of Texas Southwestern Medical Center in Dallas. Martinez and her nine co-authors are members of the Second Task Force on the Status of NIH Intramural Women Scientists. (The first issued a report in 1992 calling for equity in pay and hiring practices.) The new report recommends that institutions set up part-time positions for principal investigators (PIs), offer grant supplements to hire qualified spouses on separate or related projects, and provide affordable childcare for all researchers.

NIH is one of the places where the system is out of whack. The share of women among its 900 tenured investigators has barely budged in the past decade, from 18% to 19%, and the figure for tenure-track positions has remained at 29%. (By comparison, women received more than 40% of the Ph.D.s in the life sciences awarded in the United States during the same time frame.)

The survey found that more than 70% of the men have their sights set on a PI position compared with only 50% of the women. (The results were published in the 29 October issue of *EMBO Reports.* Men were also more confident—by a margin of 59% to 40%—that they would become PIs. One apparent reason for the gender discrepancy is that women appear more willing to make career sacrifices for the sake of their families (see graph). For example, 57% of female postdocs who were married but without children said that having children would influence their career choices compared with only 29% of married men without children. Similarly, 31% of married women expressed a willingness to make concessions to accommodate their spouses’ careers versus 21% of the men.

At the same time, male and female postdocs said that they felt equally comfortable in their working environments. “Overt discrimination does not seem to be the issue,” says Martinez. Three other surveys still under way are analyzing the task force’s recommendations. For example, NIH used to allow only tenured investigators to have staff scientists. Now, tenure-track researchers can request the same support if they need to work part time for short stints to take care of a child or a family member. NIH also encourages researchers to telecommute if possible, she adds.

Biologist Sue Rosser of Georgia Institute of Technology in Atlanta agrees that family-friendly policies are key. But she warns against underestimating how gender discrimination affects women, especially at higher rungs of the academic ladder. “It gets complicated pretty quickly,” she says, adding that many female faculty members face isolation and dismissive attitudes throughout their careers.

Schwartz says NIH is already addressing some of the task force’s recommendations. For example, NIH used to allow only tenured investigators to have staff scientists. Now, tenure-track researchers can request the same support if they need to work part time for short stints to take care of a child or a family member. NIH also encourages researchers to telecommute if possible, she adds.

But providing affordable childcare is another matter. More than 1000 people are on a waiting list for 350 slots available on and off campus, says Schwartz, and employees receive preference. That makes it tough on postdocs, who are technically trainees. “Building another daycare center on campus is a priority,” she says, “but there’s no money at the moment.”

—YUDHIJIT BHATTACHARJEE

Tough choice. Family responsibilities seem to affect career goals of women on the academic track more than those of men.

**Academic Aspirations**

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<tr>
<th>Percentage who want to be a PI</th>
<th>Women</th>
<th>Men</th>
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<tbody>
<tr>
<td>Single</td>
<td>60%</td>
<td>55%</td>
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<tr>
<td>Married, childless</td>
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<td>75%</td>
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<tr>
<td>Married, with children</td>
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<td>65%</td>
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<tr>
<td>Overall</td>
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