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Sun Down: High-Energy Cosmic Rays Reach a Space Age Peak

A prolonged lull in the sun's activity has allowed energetic particles to penetrate the solar system with record intensity

By John Matson

It's been a slow two years for solar activity, with 2008 bringing the greatest number of blank, or sunspot-free, days in nearly 100 years. And now this year, albeit there are signs of stirring on the sun, is on pace to top 2008 as the sleepiest since 1913.

One consequence of this deep and prolonged lull in solar activity is an unprecedented bounty of high-energy cosmic rays that stream in from violent astrophysical events outside the solar system. Data collected by NASA's Advanced Composition Explorer (ACE) spacecraft show that cosmic rays now are as intense as they have ever been since the Space Age began, the space agency announced last week.

When the sun is at a low ebb, the solar shielding that usually deflects cosmic rays from our neighborhood recedes, and a long dormancy such as the one at present is accompanied by a large swell in radiation. That surge serves as a reminder that the solar system is a dynamic place in constant flux, and raises questions about the amount of shielding necessary to protect astronauts on future missions to the moon or Mars.

ACE has been in orbit since 1997, near the tail end of the last solar minimum (solar activity waxes and wanes in a cycle that repeats about every 11 years). "We've compared this solar minimum to the last, and then we've used data from other spacecraft to go back to the 1960s, when the first real cosmic-ray measurements at solar minimum began," says Richard Mewaldt, a California Institute of Technology heliophysicist and a member of the ACE science team. "Most solar minima have looked the same, to within a few percent, as far as cosmic rays go, but in this one...they've reached roughly 20 percent higher than what's ever been seen before."

Cosmic rays, often made of atomic nuclei that have been stripped of their electrons, zoom across the galaxy at nearly the speed of light. They are thought to originate in bulk from supernovae, or stellar explosions. Rarer species of cosmic-ray particles include electrons and their antimatter counterparts, positrons.

For the most part, Earth denizens are shielded from harm by the planet's atmosphere and magnetosphere, but even so, cosmic rays pack such a punch that they have been implicated in introducing errors in computer memories. Some researchers have even proposed that the energetic particles striking the atmosphere are what initiates lightning.

Outside Earth's protective shielding, space travelers would be seriously threatened by cosmic rays without proper safeguards, the development of which some researchers have deemed a possibly insurmountable obstacle to interplanetary travel. In a 2006 *Scientific American* article, physicist Eugene Parker cited a NASA estimate "that about one third of the DNA in an astronaut's body would be cut by cosmic rays every year," potentially causing cancer, cataracts and even brain damage.

Mewaldt notes that the recent rash of cosmic-ray bombardment coincides with a number of solar-minimum phenomena.

Among them: the weakening of the sun's magnetic field as well as the diminished pressure and speed of the solar wind —the stream of charged particles emanating from the sun. The solar wind, Mewaldt explains, is "what blows the bubble in the heliosphere that protects us from the interstellar medium. And since that pressure has been low for the last few years, that means the bubble is getting smaller."

The bad news for future space travelers is that the recent peak in the intensity of cosmic rays may not even be that unique. Mewaldt notes that on longer timescales, measurements in polar ice of a heavy ion of beryllium, produced in the atmosphere when cosmic rays strike, show that the Space Age may have simply begun in an anomalous span for solar activity and cosmic radiation. "If you look back over the last 1,000 years, cosmic rays were actually on average much higher than they are during the 50 years where we have direct measurements," he says. "Perhaps what we're observing is something that's more normal, and the space era has occurred when there was more solar activity, and so cosmic rays were excluded."

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