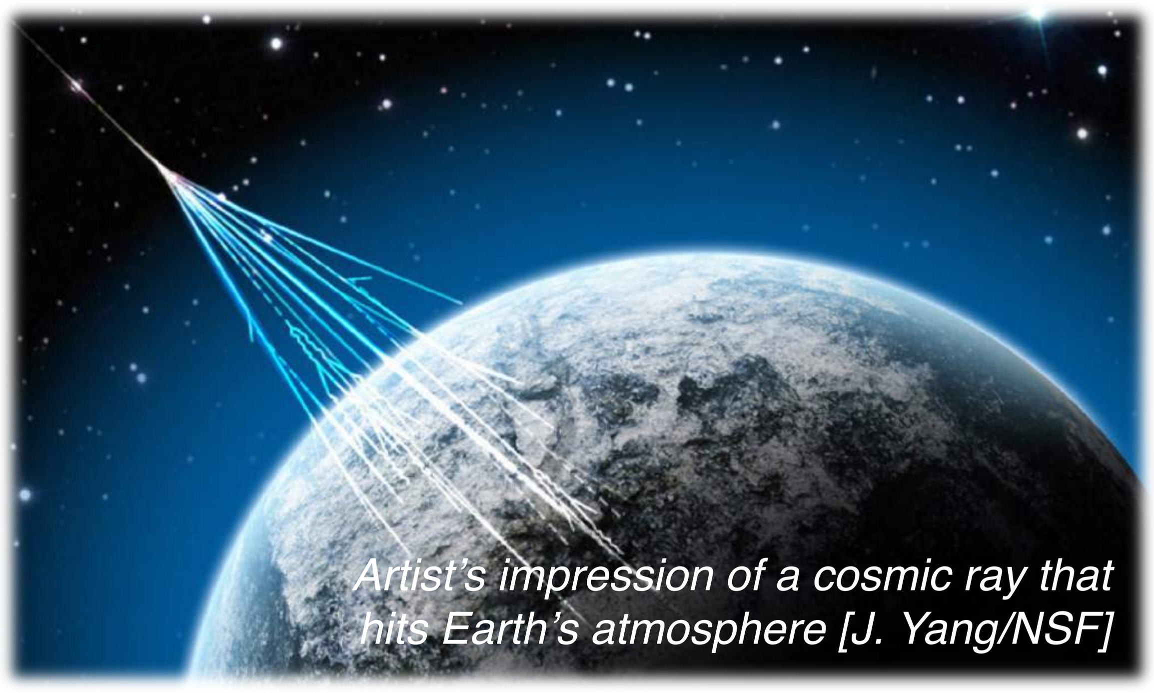
A Shifting Shield Provides Protection Against Galactic Cosmic Rays

by Susanna Kohler, AASNova

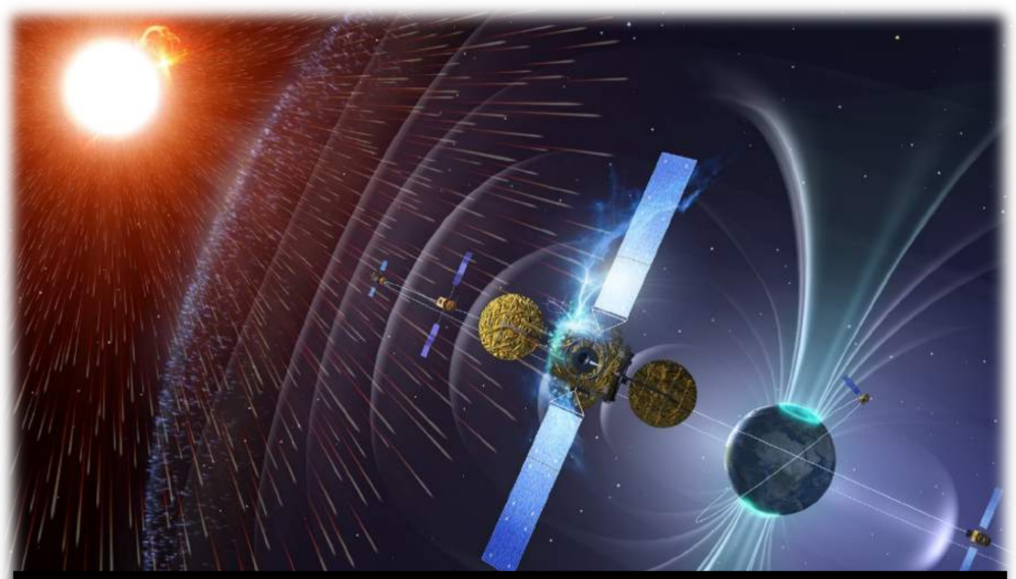
*The Sun plays an important role in protecting us from Galactic **cosmic rays**. But can we predict when and how it will provide the most protection, and use this to minimize the damage to space missions?*

The challenge of cosmic rays

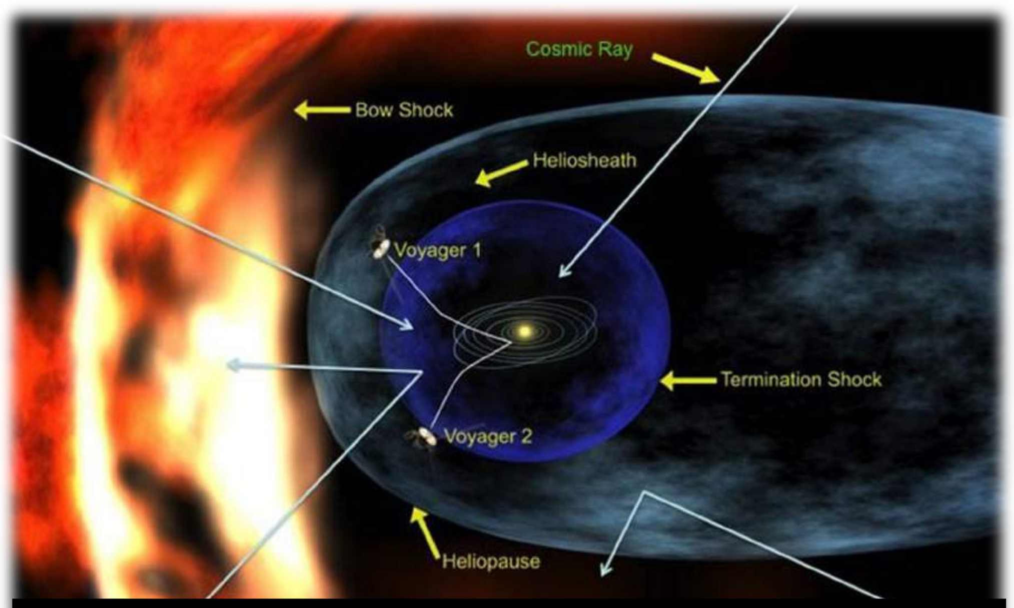
Galactic cosmic rays are high-energy, charged particles that originate from violent astrophysical processes outside of our solar system. One reason to care about the cosmic rays arriving near Earth is because these particles can provide a significant **challenge for space missions** traveling above Earth's protective atmosphere and magnetic field. Since impacts from cosmic rays can damage human DNA, this risk poses a major barrier to plans for **interplanetary travel** by crewed or robotic spacecraft.



Artist's impression of a cosmic ray that hits Earth's atmosphere [J. Yang/NSF]



Spacecraft outside of Earth's atmosphere and magnetic field are at risk of damage from cosmic rays. [ESA]



The magnetic field carried by the solar wind provides a protective shield against galactic cosmic rays [NASA GSFC's Conceptual Image Lab]

Shielded by the Sun

Conveniently, we do have some natural protection against cosmic rays: **a built-in shield provided by the Sun**. The interplanetary magnetic field, which is embedded in the solar wind, deflects low-energy cosmic rays from us at the outer reaches of our solar system, decreasing the flux of these particles that reach us at Earth. ☺

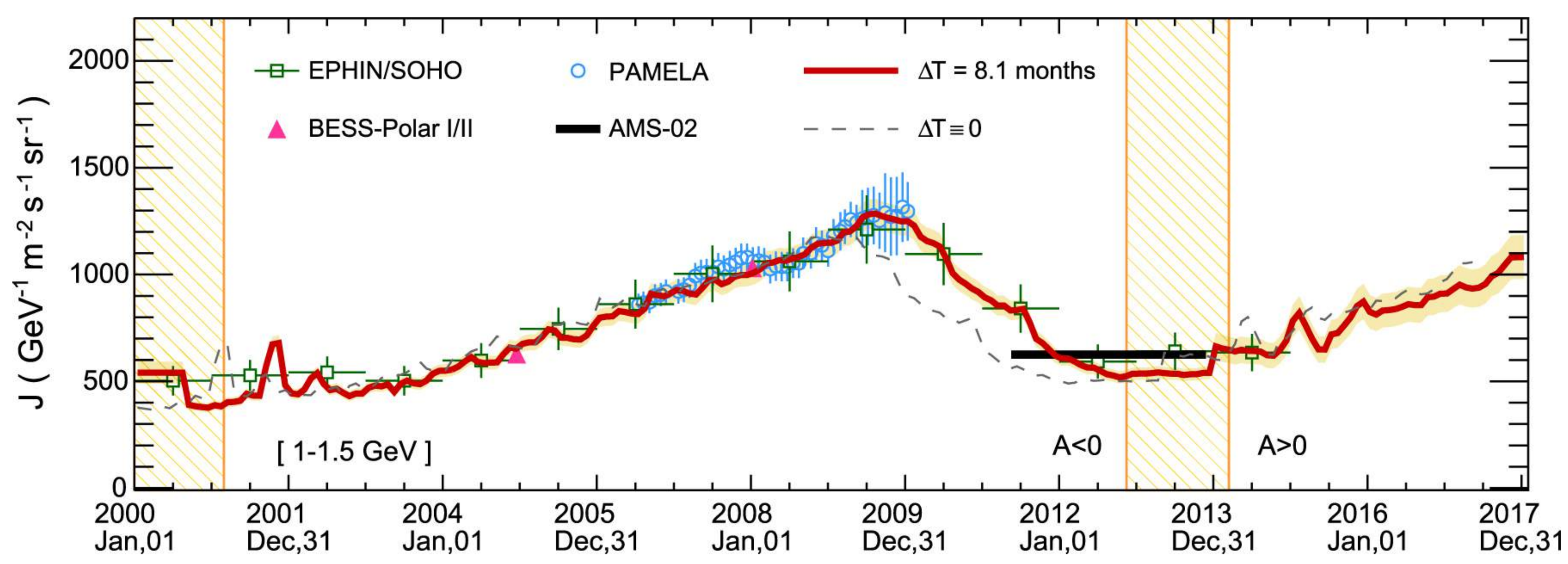
This shield, however, isn't stationary. Instead, **it moves and changes** as the solar wind moves and changes. This results in a much lower cosmic-ray flux at Earth when solar activity is high (i.e., at the peak of the 11-year solar cycle) than when solar activity is low. This visible change in local cosmic-ray flux with solar activity is known as **"solar modulation"** of the cosmic ray flux.

In a new study, a team of scientists led by Nicola Tomassetti (University of Perugia, Italy) has modeled this solar modulation to better understand the process by which the Sun's changing activity influences the cosmic ray flux that reaches us at Earth.

Modeling a time lag

Tomassetti and collaborators' model uses two solar-activity observables as inputs: the number of **sunspots** and the **tilt angle** of the heliospheric current sheet. By modeling basic transport processes in the heliosphere, the authors then track the impact that the changing solar properties have on incoming galactic particles. In particular, the team explores the time lag between when solar activity changes and when we see the responding change in the cosmic-ray flux.

By comparing their model outputs to the large collection of cosmic-ray data from space, Tomassetti and collaborators show that the best fit to data occurs with an **~8-month lag** between changing solar activity and local cosmic-ray flux modulation. This is an important outcome for studying the processes that affect the cosmic-ray flux that reaches Earth.



Cosmic-ray flux observations are best fit by the authors' model when an 8-month lag is included (red bold line). A comparison model with no lag (black dashed line) is included.

There's an additional intriguing consequence of this result: knowledge of the current solar activity could allow us to **predict** the modulation that will occur for cosmic rays near Earth **an entire 8 months from now!** If this model is correct, it brings us one step closer to being able **to plan safer space missions** for the future.

[By Susanna Kohler, AASNova: Research highlights from the journals of the American Astronomical Society - http://aasnova.org]

Multichannel Investigation of Solar Modulation Effects in Galactic Cosmic Rays
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