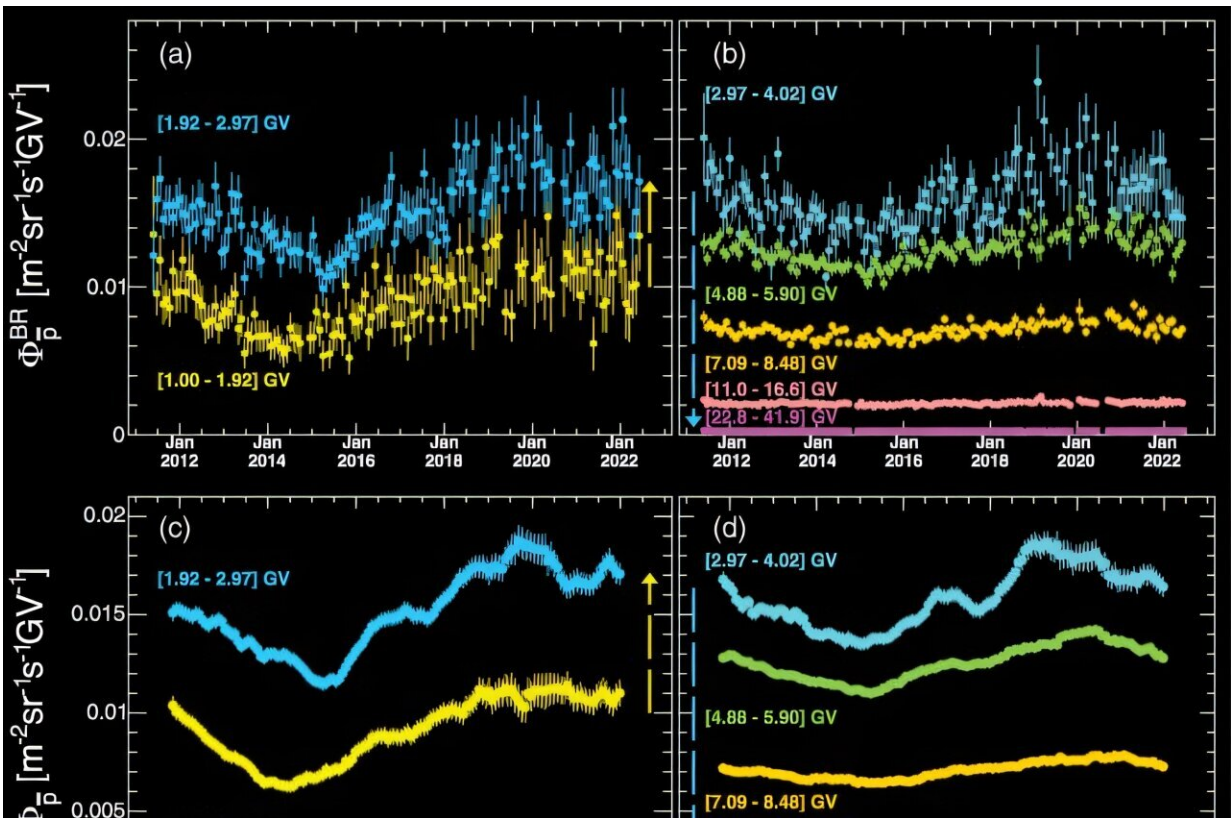


Solar cycle study reveals trends in charged particle numbers and interactions

February 5 2025, by Bob Yirka



Temporal evolution of Φ_p^{BR} for (a) below 2.97 GV where the fluxes Φ_p^{BR} increase with increasing rigidity and (b) above 2.97 GV where the fluxes Φ_p^{BR} decrease with increasing rigidity, as indicated by the arrows. (c) and (d) present the Φ_p using their 13-BR moving average values. The data point for each Bartels rotation period is calculated from a time window of 13 BR centered around that period, taking into account the correlation in the systematic errors. In (a)–(d), the error bars are the quadratic sum of the statistical and time-dependent systematic errors. As seen, over a Solar cycle of 11 years, Φ_p exhibit significant temporal

variation up to ~ 10 GV and the relative magnitudes of the flux temporal variations decrease with increasing rigidity. Above ~ 10 GV, the flux variations are not visible. In (e) and (f), the three-dimensional variation of Φ_{p^-} as functions of time and rigidity is shown. Credit: *Physical Review Letters* (2025). DOI: 10.1103/PhysRevLett.134.051002

A large team of researchers working on the Alpha Magnetic Spectrometer Collaboration, which has been analyzing eleven years' worth of data from the Alpha Magnetic Spectrometer (AMS) aboard the International Space Station, has found trends in the number of particles moving around in the heliosphere and in the way they interact with one another.

The team has published two papers in the journal *Physical Review Letters*; one describing trends they found surrounding [antiproton and elementary particle](#) behavior over a single [solar cycle](#) and the other covering [solar modulation of cosmic nuclei behavior](#), also over a single solar cycle.

Prior research has shown that the sun follows a cycle that repeats itself every 11 years. The AMS has been running for more than 11 years, but the researchers working on both efforts focused on conditions during just one cycle. They wanted to know how the sun impacted energy particles in the [heliosphere](#) and beyond.

Prior research has shown that the strength of the heliospheric magnetic field rises and falls over a predictable 11-year cycle, exerting a variable force on the [charged particles](#) that are moving around in the heliosphere, some of which emanate from the sun and the planets and others that are part of the stream of galactic cosmic rays (GCRs) that come from places beyond the solar system. The AMS measures the masses and energies of

all such particles when struck.

In looking at the data from the AMS for one solar cycle, the researchers found some trends in the number of particles that struck the sensor and how they interacted with each other.

In one part of their effort, the researchers focused mainly on GCR antiprotons and the way they behave in the heliosphere due to changes in the heliospheric magnetic field and also in interactions with other particles—all of which were reflected in the charges of the particles that wound up colliding with the ACM.

In the second part of their effort, they looked at properties of cosmic nuclei, He, Be, Li, B, N, C, and O fluxes over a single solar cycle and found some similar variations in time and amplitudes, which they were able to correlate with differences in cosmic nuclei fluxes.

More information: M. Aguilar et al, Antiprotons and Elementary Particles over a Solar Cycle: Results from the Alpha Magnetic Spectrometer, *Physical Review Letters* (2025). [DOI: 10.1103/PhysRevLett.134.051002](https://doi.org/10.1103/PhysRevLett.134.051002)

M. Aguilar et al, Solar Modulation of Cosmic Nuclei over a Solar Cycle: Results from the Alpha Magnetic Spectrometer, *Physical Review Letters* (2025). [DOI: 10.1103/PhysRevLett.134.051001](https://doi.org/10.1103/PhysRevLett.134.051001)

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