

Astronomy
magazine

TONIGHT'S SKY
Waukesha, WI September 24, 2014

SUN & MOON MERCURY & VENUS MARS, JUPITER & SATURN

Sun		Moon	
RISE	6:42 AM	7:04 AM	PHASE New
SET	6:47 PM	6:56 PM	DISK 0%

Sept. 27: Mars is 3° north of Antares

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Latest measurements from the AMS experiment unveil new territories in the flux of cosmic rays

The excess positrons in the flux could be an indicator of dark matter particles annihilating into pairs of electrons and positrons.

By CERN, Geneva, Switzerland | Published: Friday, September 19, 2014

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The Alpha Magnetic Spectrometer aboard the International Space Station.

NASA

The Alpha Magnetic Spectrometer (AMS) collaboration has presented its latest results based on the analysis of 41 billion particles detected with the space-based AMS detector aboard the International

Space Station. The results provide new insights into the nature of the mysterious excess of positrons observed in the flux of cosmic rays.

Cosmic rays are particles commonly present in the universe. They consist mainly of protons and electrons, but there are also many other kinds of particles, including positrons, traveling through space. Positrons are the antimatter counterparts of electrons, with the same mass but opposite charge. The presence of some positrons in space can be explained from the collisions of cosmic-rays, but this phenomenon would only produce a tiny portion of antimatter in the overall cosmic ray spectrum. Since antimatter is extremely rare in the universe, any significant excess of antimatter particles recorded in the flux of energetic cosmic rays indicates the existence of a new source of positrons. Dense stars, such as pulsars, are potential candidates.

The AMS experiment is able to map the flux of cosmic rays with unprecedented precision, and in the latest results, the collaboration presents new data at energies never before recorded. The AMS collaboration has analyzed 41 billion primary cosmic-ray events among which 10 million have been identified as electrons and positrons. The distribution of these events in the energy range of 0.5 to 500 GeV shows a well-measured increase of positrons from 8 GeV with no preferred incoming direction in space. The energy at which the positron fraction ceases to increase has been measured to be 275 ± 32 GeV.

“This is the first experimental observation of the positron fraction maximum after half a century of cosmic-rays experiments,” said AMS spokesperson Samuel Ting. “Measurements are under way by the AMS team to determine the rate of decrease at which the positron fraction falls beyond the turning point.”

This rate of decrease after the “cut-off energy” is important to physicists as it could be an indicator that the excess of positrons is the signature of dark matter particles annihilating into pairs of electrons and positrons. Although the current measurements could be explained by objects such as pulsars, they are also tantalizingly consistent with dark matter particles with mass of the order of 1 TeV. Different models on the nature of dark matter predict different behavior of the positron excess above the positron fraction expected from ordinary cosmic ray collisions. Therefore, results at higher energies will be of crucial importance in the near future to evaluate if the signal is from dark matter or from a cosmic source.

“With AMS and with the [Large Hadron Collider] to restart in the near future at energies never reached before, we are living in very exciting times for particle physics as both instruments are pushing boundaries of physics,” said Rolf Heuer from CERN.

AMS also reported a new observation that both the electron flux and the positron flux change their behavior at about 30 GeV, the fluxes being significantly different from each other both in their magnitude and energy dependence. In particular, between 20 and 200 GeV, the rate of change of

the positron flux is surprisingly higher than that for electrons. This is important proof that the excess seen in the positron fraction is due to a relative excess of high-energy positrons, and not the loss of high-energy electrons. This new result is very important for a better understanding of the origin of cosmic-ray electrons and positrons, and may be the sign of an unknown phenomenon.

Ting also presented some interesting new results to be published in the near future. These show that, at high energies and over a wide energy range, the combined flux of electrons plus positrons can be described by a single constant spectral index, with no existence of structure as suspected by previous measurements of other experiments