AMS experiment measures antimatter excess in space

Geneva 3 April 2013. The international team running the Alpha Magnetic Spectrometer (AMS[1]) today announced the first results in its search for dark matter. The results, presented by AMS spokesperson Professor Samuel Ting in a seminar at CERN, are to be published in the journal Physical Review Letters. They report the observation of an excess of positrons in the cosmic ray flux.

The AMS results are based on some 25 billion recorded events, including 400,000 positrons with energies between 0.5 GeV and 350 GeV, recorded over a year and a half. This represents the largest collection of antimatter particles recorded in space. The positron fraction increases from 10 GeV to 250 GeV, with the data showing the slope of the increase reducing by an order of magnitude over the range 20-250 GeV. The data also show no significant variation over time, or any preferred incoming direction. These results are consistent with the positrons originating from the annihilation of dark matter particles in space, but not yet sufficiently conclusive to rule out other explanations.

"As the most precise measurement of the cosmic ray positron flux to date, these results show clearly the power and capabilities of the AMS detector," said AMS spokesperson, Samuel Ting. *"Over the coming months, AMS will be able to tell us conclusively whether these positrons are a signal for dark matter, or whether they have some other origin."*

Cosmic rays are charged high-energy particles that permeate space. The AMS experiment, installed on the International Space Station, is designed to study them before they have a chance to interact with the Earth's atmosphere. An excess of antimatter within the cosmic ray flux was first observed around two decades ago. The origin of the excess, however, remains unexplained. One possibility, predicted by a theory known as supersymmetry, is that positrons could be produced when two particles of dark matter collide and annihilate. Assuming an isotropic distribution of dark matter particles, these theories predict the observations made by AMS. However, the AMS measurement can not yet rule out the alternative explanation that the positrons originate from pulsars distributed around the galactic plane. Supersymmetry theories also predict a cut-off at higher energies above the mass range of dark matter particles, and this has not yet been observed. Over the coming years, AMS will further refine the measurement's precision, and clarify the behaviour of the positron fraction at energies above 250 GeV.

"When you take a new precision instrument into a new regime, you tend to see many new results, and we hope this this will be the first of many," said Ting. *"AMS is the first experiment to measure to 1% accuracy in space. It is this level of precision that will allow us to tell whether our current positron observation has a Dark Matter or pulsar origin."*

Dark matter is one of the most important mysteries of physics today. Accounting for over a quarter of the universe's mass-energy balance, it can be observed indirectly through its interaction with visible matter but has yet to be directly detected. Searches for dark matter are carried out in space-borne experiments such as AMS, as well as on the Earth at the Large Hadron Collider and a range of experiments installed in deep underground laboratories.

"The AMS result is a great example of the complementarity of experiments on Earth and in space," said CERN Director General Rolf Heuer. *"Working in tandem, I think we can be confident of a resolution to the dark matter enigma sometime in the next few years."*

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[1] The AMS detector is operated by a large international collaboration led by Nobel laureate Samuel Ting. AMS involves about 600 researchers from China, Denmark, Finland, France, Germany, Italy, Korea, Mexico, the Netherlands, Portugal, Spain, Switzerland, Taiwan, and the United-States. The AMS detector was assembled at CERN, tested at ESA's ESTEC centre in the Netherlands and launched on 16 May 2011 onboard NASA's Space Shuttle Endeavour. It is installed on the International Space Station where it tracks incoming charged particles such as protons, electrons and antimatter particles such as positrons, mapping the flux of cosmic rays with unprecedented precision.