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Turning the moon into a cosmic ray detector

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Scientists from the University of Southampton are to turn the Moon into a giant particle detector to help understand the origin of Ultra-High-Energy (UHE) cosmic rays - the most energetic particles in the Universe.

The origin of UHE cosmic rays is one of the great mysteries in astrophysics. Nobody knows where these extremely rare cosmic rays come from or how they get their enormous energies. Physicists detect them on Earth at a rate of less than one particle per square kilometre per century.

Dr Justin Bray, a Research Fellow in Cosmic Magnetism at the University of Southampton, is lead author of a proposal to use the Square Kilometre Array (SKA), set to become the largest and most sensitive radio telescope in the world, to detect vastly more UHE cosmic rays by using the Moon as a giant cosmic ray detector.

On Earth, physicists detect these high-energy particles when they hit the upper atmosphere triggering a cascade of secondary particles that generate a short and faint burst of radio waves only a few nanoseconds long.

It is this signal that astronomers hope to pick up from the Moon, but as these signals are so short and faint no radio telescope on Earth is currently capable of picking them up.

With its large collecting area and high sensitivity, the SKA will be able to detect these signals using the visible lunar surface - millions of square kilometres - giving the researchers access to more data about UHE cosmic rays than they have ever had before.

The current largest detector on Earth is the Pierre Auger Observatory in Argentina that covers an area of 3,000 square kilometres, about the size Luxembourg. The SKA will be more than 10 times larger (33,0000 square kilometres) and researchers hope to detect around 165 UHE cosmic rays a year from the Moon compared to the 15-a-year currently observed.

Dr Bray announced details of the project at a major SKA conference in Italy.. He says: "Cosmic rays at these energies are so rare that you need an enormous detector to collect a significant number of them - but the moon dwarfs any particle detector that has been built so far. If we can make this work, it should give us our best chance yet to figure out where they're coming from."

Dr Bray is working with Professor Anna Scaife, also from Physics and Astronomy at the University of Southampton, who leads the development of the SKA's Imaging Pipeline as part of the Science Data Processor (SDP) work package consortium.

Professor Scaife says: "Defining science goals for the telescope is crucial for ensuring that the appropriate technical capabilities are considered during the design phase."

Using a network of radio antennas in the Southern hemisphere, the SKA will advance our understanding of how the Universe evolved and challenge Einstein's theory of relativity. With receivers across Australia and Africa, its dishes and antennas will provide detailed information on the large scale 3D structure of the Universe.

When operational in the early 2020's, the SKA radio telescope will produce more than 10 times the current global traffic of the Internet in its internal telecommunications system. To play back a single day's worth of SKA data on an MP3 player would take about two million years.

Provided by University of Southampton