A century of discoveries - Physicists celebrate centenary of the discovery of cosmic rays

July 31 2012

Victor F Hess in the balloon's basket sometime between 1911 and 1912, References: VF Hess Society, Schloss Pöllau/Austria

A constant shower of subatomic particles rains down from space. A hundred years ago, this "cosmic radiation" was discovered by the Austrian physicist Victor Franz Hess. Among other things, the discovery laid the foundation for a whole new field of research: high energy physics - which recently gave us, for instance, the first experimental

evidence for the Higgs boson. An anniversary conference looks at the past milestones of cosmic ray research and at future experiments.

When Hess landed his hydrogen balloon at Bad Saarow in the German state of Brandenburg at lunchtime on 7 August 1912, he had on board a discovery with far-reaching consequences, which he surely wasn't fully aware of at that very time. At his seventh balloon voyage in the course of this year, equipped with three ionization measuring instruments, Hess had just identified the existence of a pervasive radiation in 5300 metres altitude above the Schwieloch Lake in the southeast of Brandenburg. Only later it became evident that this so-called cosmic radiation was comprised mostly of energetic, electrically charged atomic nuclei. The discovery of cosmic rays won Hess the Nobel Prize in Physics 24 years later.

"The detection of the cosmic radiation was the discovery of a century and brought us completely new insights into the cosmos," says Prof. Christian Stegmann, head of the DESY institute at Zeuthen near Berlin. "Furthermore it became a cornerstone of early particle physics. Before the development of particle accelerators, cosmic ray research led to the discovery of many important elementary particles, among them the anti-particle of the electron - the positron - as well as the muon and the pion."

DESY, the University of Potsdam, and the Max Planck Institute for the History of Science in Berlin jointly organise a symposium on the 100th anniversary of the discovery of cosmic rays. From 6 to 8 August 2012, scientists from all over the world will meet in Bad Saarow, where Hess landed his balloon, to present and discuss the development of various sub-areas ranging from the historic beginnings up to ideas for new projects.

Along with physics nobelist Prof. James Cronin, one of the designers of today's largest cosmic ray observatory "Pierre Auger" in Argentina, and the 14th Astronomer Royal Prof. Sir Arnold Wolfendale, Hess'

grandsons William and Arthur Breisky have also registered for the conference. A memorial stone will be unveiled, participants may book balloon flights, and electroscopes that were then used all over the world to carry out ionisation measurements will be on display.

"The advent of a Centenary is a time for both looking back at the development of the subject and forwards: 'where do we go from here?'," says Sir Wolfendale. "Cosmic ray research has led to new areas of research, including 'the new astronomies' and the future for them is bright, indeed. Neutrino Astronomy is on the verge of starting and gamma ray astronomy has begun in earnest."

Physicists expect to gain new insights into the nature of cosmic particle accelerators, which are a million times stronger than the best accelerators on earth, from gramma ray astronomy. Single protons from the cosmic radiation may have as much energy as a powerfully-hit tennis ball, but due to their electric charge, the fast particles are deflected by numerous magnetic fields as they travel through the cosmos. This means that one cannot retrace their point of origin from their direction of flight when they hit the earth.

Therefore, a hundred years since their discovery, the mystery of the origin of cosmic rays is far from being solved. "The universe is full of natural particle accelerators, as for example in supernova explosions, in binary star systems, or in active galactic nuclei. So far, only 150 of these objects are known to us, and we have just an initial physical understanding of these fascinating systems," says Stegmann.

In contrast to what the name might suggest, cosmic radiation is mostly comprised of particles, but a small fraction is indeed gamma radiation, which is not deflected on its way through space and thus points directly to its source. As physicists expect the sources of cosmic gamma radiation to be the same as for cosmic particles, they are on the hunt for

cosmic particle accelerators with specialised gamma ray observatories.

Observatories like H.E.S.S. in Namibia, named in honour of the discoverer of cosmic radiation, MAGIC on the Canary Island La Palma, and VERITAS in the United States, with DESY participation, detected more than hundred high-energy cosmic gamma radiation sources by now. The planned Cherenkov Telescope Array CTA, for which DESY is currently building a first prototype telescope will follow this path of discovery. "The Cherenkov Telescope Array will observe thousands of these accelerators with unprecedented sensitivity," Stegmann points out.

Similar to gamma rays, cosmic neutrinos also open a window to the universe's particle accelerators. Neutrinos are lightweight, electrically neutral elementary particles, which are also not deflected by magnetic fields. This means that the incident path of a neutrino points back directly to its origin. With the participation of DESY, the world's largest neutrino telescope, IceCube in Antarctica, was finished in December 2010 and has just begun to look for cosmic neutrinos.

"On either route we expect fascinating insights into the natural particle accelerators in the universe, that will throw new light onto the remaining mysteries of cosmic rays," stresses Stegmann.

More information: Conference website: www.desy.de/2012vhess

Provided by Deutsches Elektronen-Synchrotron