

100 Years of Cosmic Rays

1947—1959 Extensive Air Showers

1947 First International Cosmic Ray Conference in Krakow



The first edition of the biennial International Cosmic Ray Conference was held in Krakow, Poland. In the front row of the photo stand P Blackett, J Blaton, A Wheeler and W Heitler. Other prominent participants included P Auger, G Bernardini, J Clay, M Cosyns, L Janossy, L Leprince-Ringuet and CF Powell.

1947 D Skobeltsyn et al: Start of air shower experiments in the Pamirs

After WWII, a broad cosmic ray research programme began in the Soviet Union. At 3860m of altitude, an experiment using Geiger counters was installed over an area of 1000m in diameter. For the first time a reduction of random signals was achieved by forming coincidences of local counters, followed by the requirement of coincidences of counters at a greater distance.

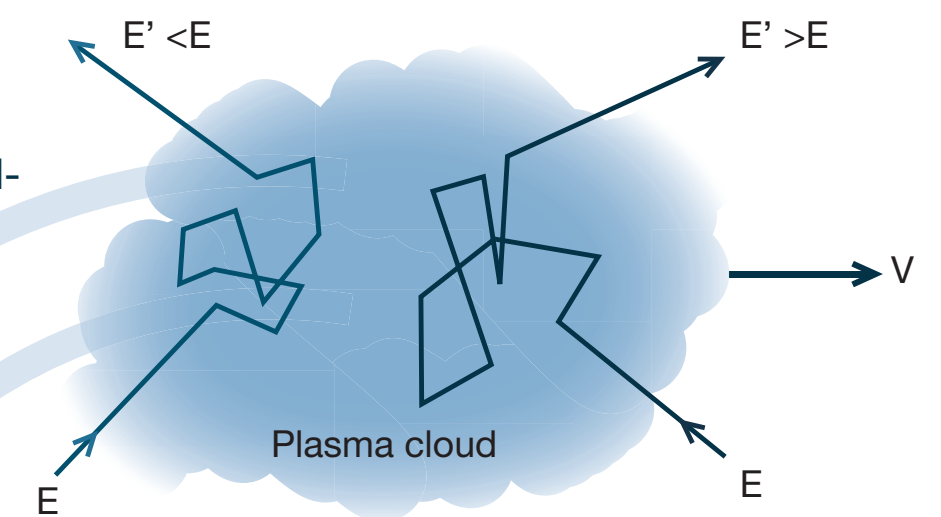
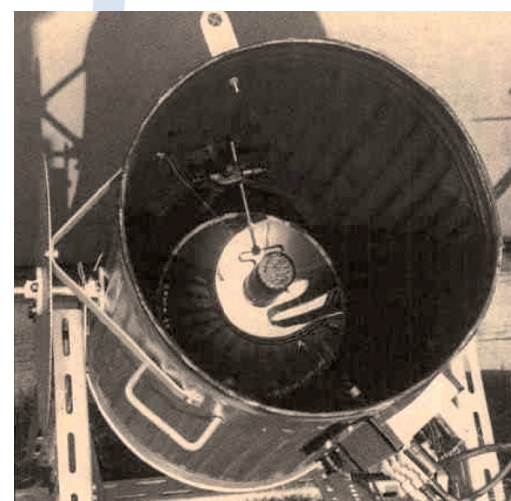


Illustration of Fermi's acceleration model

1949 E Fermi: Model of cosmic particle acceleration

The basic idea behind Fermi's model was that particles reach a higher energy when they enter the front of a plasma cloud which is moving with the very high velocity v . Such plasma clouds are produced, for instance, in supernova explosions. But the model cannot explain acceleration to very high energies.

1953 W Galbraith and JV Jelley: First air Cherenkov counter



The availability of very sensitive photon detectors (photomultipliers, or PMTs) allowed for proving PMS Blackett's hypothesis that cosmic air showers produce Cherenkov light. The British physicists W Galbraith and JV Jelley built the first very simple air Cherenkov counter using a rubbish bin. Working on cloudless nights, a mirror on the bottom of the bin focussed the incoming light on a PMT in front of the mirror. But it would take 36 years before the Cherenkov telescope detected high-energy gamma rays from the Crab Nebula.

First air shower Cherenkov counter

1954—1961 First generation of extensive air shower (EAS) arrays

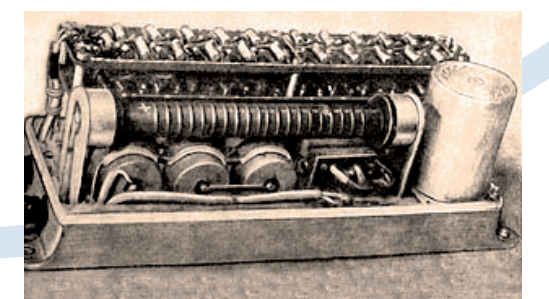
In Britain an EAS array of 91 Geiger-Müller counters was built by TE Cranshaw and W Galbraith, covering an area of about 0.6km². It operated from 1954 to 1957 and measured primary energies of up to 10¹⁷eV. At MIT, a group led by B Rossi developed a pioneering detector

type. The fast timing of scintillation counters and PMTs allowed for the determination of shower direction and core position. Also the analysis techniques were the basis of future EAS experiments. Other strong activities were taking place in Japan and the Soviet Union.

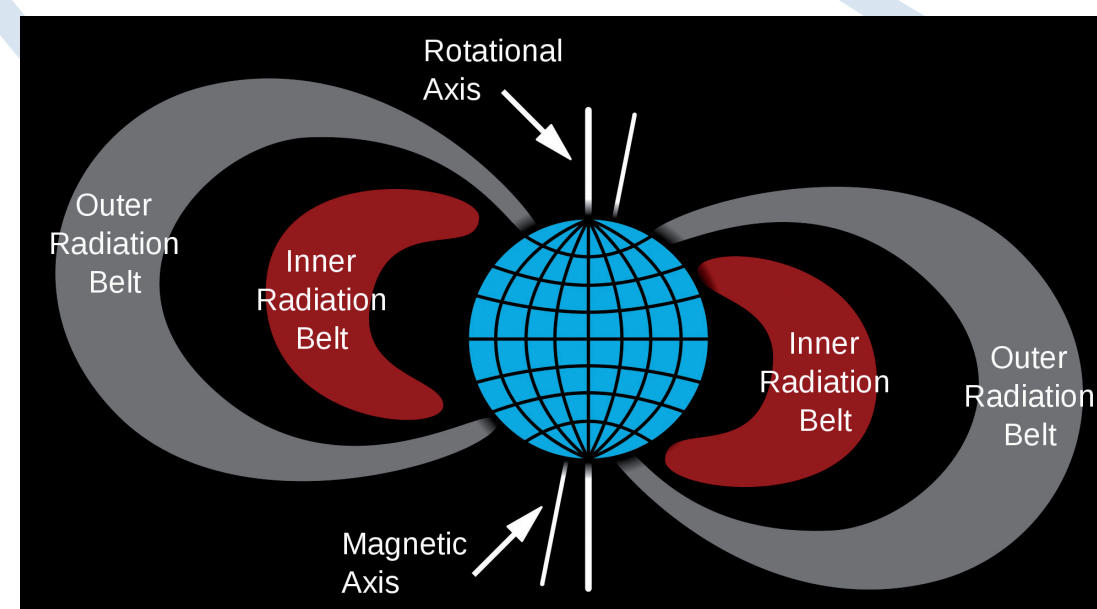
1957 Launch of Sputnik 2, with Geiger counter for cosmic particle detection

The era of space experiments started with Sputnik 2. With a Geiger-Müller counter built by Vernov's group (Moscow State University), the intensity of cosmic rays was measured from 3—9 Nov. A strong increase in radiation was measured at a latitude of 60°. Later, it would be interpreted as the outer radiation belt.

Geiger-Müller counter installed in Sputnik 2



1958 J Van Allen: Discovery of belts of radiation



Van Allen discovered with Geiger counters installed on the Explorer 1 and Pioneer satellites that the Earth is surrounded by "clouds" of cosmic particles which are trapped by the Earth's magnetic field.

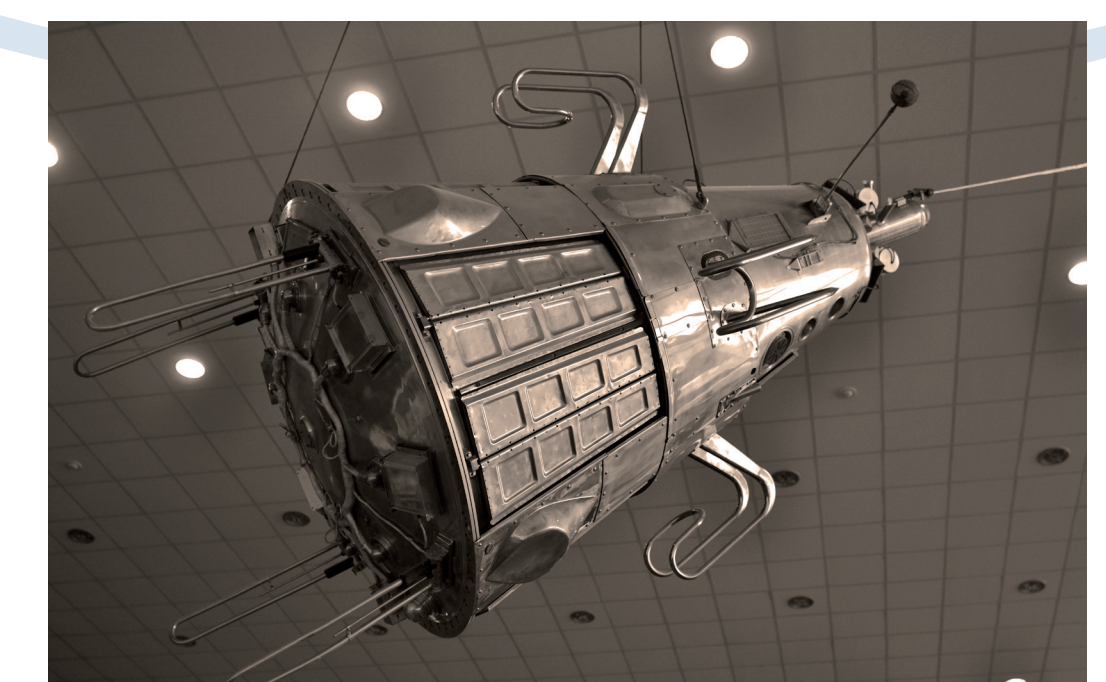
Van Allen belts surrounding the Earth

1958 Launch of Sputnik 3

This was the first mission with several novel scientific instruments which collected data over a period of two years. Cosmic rays were measured with a scintillation counter and their nuclear components with a Cherenkov counter.

1958 E Parker: Theory of the solar wind

The solar wind was originally discovered by L Biermann in 1951. Parker was the first to develop a theory of how electrons and protons can escape from the surface of the sun to follow the field lines of the sun's magnetic field. The solar wind was first measured by the Luna 1 satellite on its way to the lunar fly-by.



Sputnik 3

1958 NA Porter: Prototype of a water Cherenkov detector

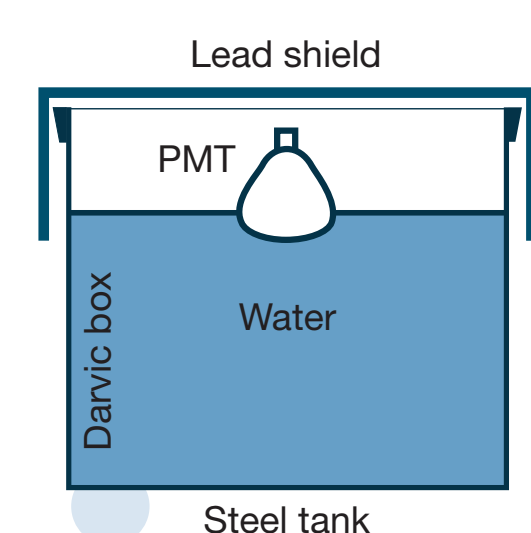


Illustration of the first water Cherenkov counter

Not only was the air Cherenkov detector built in Britain, but so was the first water Cherenkov detector. NA Porter used a water-filled steel tank with a photomultiplier looking from the top into the water. Relativistic charged particles produce Cherenkov light in the water, which is measured by the PMT. The construction from 1958 is not so different from the design of modern water Cherenkov detectors at IceTop and the Pierre Auger Observatory.

1959 GV Kulikov/GB Khristiansen: Discovery of the "knee" of the cosmic ray spectrum

With data from the Pamirs EAS and an earlier experiment, Kulikov and Khristiansen demonstrated that there is a change in the slope of the distribution of the number of particles per shower. They interpreted this discovery to mean that particles with energies greater than 10¹⁶eV (corresponding to more than 10⁷ particles per shower) are probably of metagalactic origin, now known not to be true.

