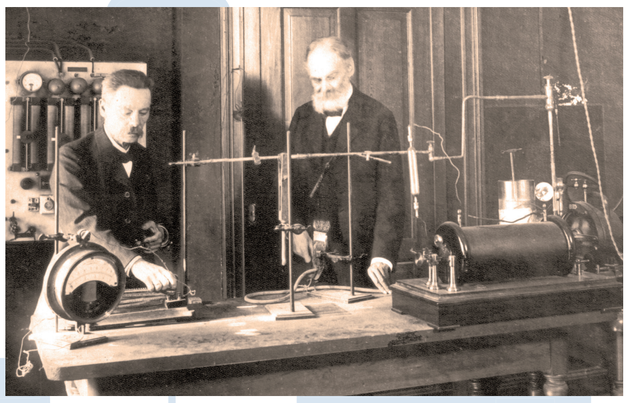
1900—1911 The Pre-Discovery Period

1900

J Elster and H Geitel, CTR Wilson: Explanation of why air becomes conductive



Elster and Geitel in their private lab

Following the discovery of radioactivity and X-rays, the ionisation of gases was systematically investigated. For these measurements, electrometers originally invented in 1789 to study electrical phenomena were used.
Julius Elster and Hans Geitel (Wolfenbüttel), and Charles Thomson Ress Wilson (Cambridge) found that ion production appears in closed and isolated detectors even in the absence of a source. The general conclusion was that this unexpected ionisation is caused by radioactive substances in the detector's walls or in its neighbourhood.
Wilson was the first to ask the question: can this penetrating radiation be extraterrestrial?

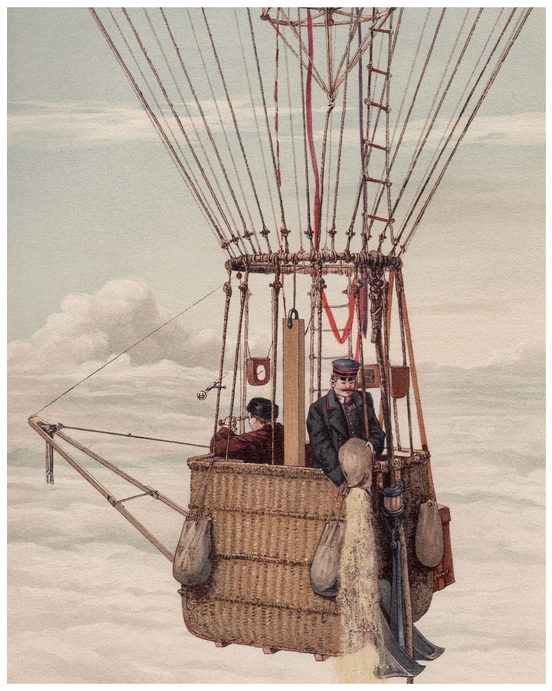
1901

CTR Wilson: Extraterrestrial radiation mentioned for the first time

1902—1903

F Linke: First investigation of penetrating radiation with balloon flights

During six balloon flights, Franz Linke (Berlin), a meteorologist and geologist, performed ionisation measurements with an electrometer provided by Elster and Geitel. He measured the ionisation compared to on the ground. It was about the same between altitudes of 1000m to 3000m and larger by a factor of four at 5500m. His published results have obviously (and unfortunately) never been recognised.



The Phoenix balloon (Berlin) in 1894, drawn by H Groß

1902—1909

General consensus that ionisation is caused by the natural radioactivity of the Earth

Over the following years, the ionisation effect was studied by many scientists in Canada, Germany, Britain and the US. The electrometers were surrounded by such different materials as water, wood, bricks and lead. The goal was to study the absorption of penetrating beta rays and gamma rays coming from radioactive elements in the ground and in the air of the environment. With increasing absorber thickness, the ionisation could be reduced, but a small fraction remained.

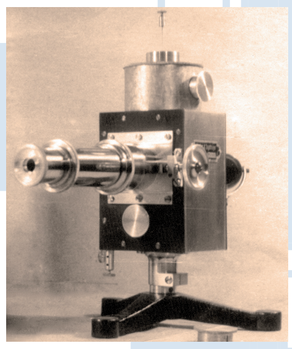
1908

T Wulf: Improvement of the electrometer's design

1908

A Gockel and T Wulf coin the term "cosmic radiation"

Theodor Wulf



Two-string electrometer designed by Wulf

Theodor Wulf, a German Jesuit, studied physics in Innsbruck and Göttingen. He improved the electrometer's design by replacing the thin metal foils with two thin metal fibres. This new electrometer was much easier to calibrate and became the state-of-the-art detector for outdoor measurements.

Wulf and Albert Gockel (Switzerland) were the first to study the ionisation rate on high mountains in the Alps. They did not observe strong deviations from measurements at sea level. In their publication, the term "cosmic radiation" was used for the first time.

1909

K Bergwitz, A Gockel: New high-altitude measurements with balloons

Albert Gockel

Near Braunschweig, Karl Bergwitz reached an altitude of 1300m with a balloon. He measured the ionisation with an improved electrometer as designed by Wulf. The measurements were continued by Albert Gockel (Fribourg). Neither observed a decrease of ionisation with distance from the ground, as had been expected for radiation sources in the Earth's crust. Because of problems with the detectors, it was difficult to draw definitive conclusions.

Wulf began a series of measurements on top of the Eiffel Tower. Even at only 300m above ground, he observed a smaller reduction in radiation when compared with theoretical estimates. He came to the same conclusion as Bergwitz and Gockel: the radioactivity of the air must contribute essentially to the measured ionisation.

Karl Bergwitz

1910

T Wulf: Ionisation measurement on the Eiffel Tower

1910—1911

D Pacini, GC Simpson and CS Wright: Measurement of ionising radiation on and below a water surface

Domenico Pacini with an electrometer

In Italy, Domenico Pacini (Bari) performed ionisation measurements in the bay of Livorno at a distance of 300m from the coast on the water's surface and 3m below it. Since ionising radiation from solid materials could be excluded on the sea, he concluded that the source of ionisation must be a penetrating radiation in the atmosphere.
George Simpson and Charles Wright were scientific members of RF Scott's British Antarctic Expedition. Sailing from Britain to New Zealand, they measured the ionisation and observed a dependence of the rate on the barometric air pressure, not knowing that it was connected with cosmic rays.

DESY ASPERA Durham University