1913—1926 Confirmation, Refusal, Confirmation

1913—1914 W Kolhörster: Confirmation of the discovery of cosmic rays

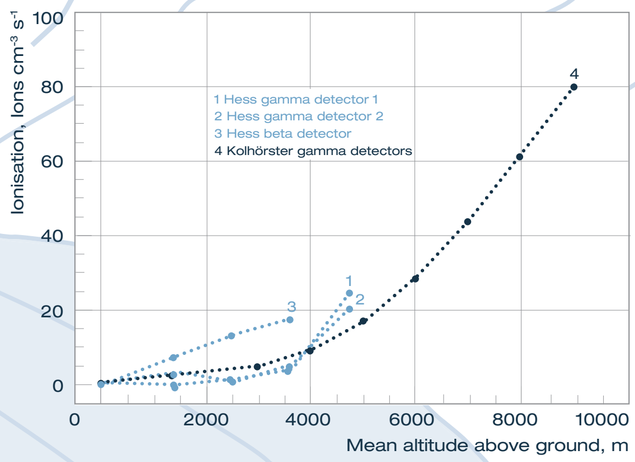
W Kolhörster (at back centre) in 1913

Werner Kolhörster from the University of Halle (Germany) took the important step towards very high altitudes. In 1913 he performed three flights with a hydrogen balloon up to 6000m and confirmed the results of Hess.
Kolhörster started his record flight at the end of June 1914 with improved electrometers, reaching an altitude of 9300m.
The ionisation reached 80.4 ions cm^{-3} s^{-1}, and its increase (see figure) was a perfect confirmation that the high-energy radiation had an extraterrestrial origin. He estimated the absorption coefficient of this penetrating radiation to be smaller than the value for gamma rays from radium D by a factor of at least five.

1914 A Gockel, VF Hess and M Kofler: High-altitude measurements in the Alps

Gockel demonstrated the hardness of the radiation with measurements 6m below the surface of Lake Constance, in the Alps at Jungfraujoch and on the Aletsch Glacier at 3400m and 2800m of altitude.

Hess and Kofler performed long-term studies of the ionisation, as dependent on time and weather conditions. Two electrometers were installed on the 2044m-high Obir in the Austrian Alps.



Ionisation measured by VF Hess and W Kolhörster, as dependent on altitude

1915 E von Schweidler: First discussion of different assumptions about the origin of cosmic rays

E von Schweidler

For the Festschrift marking the 60th birthdays of Elster and Geitel, a first theoretical investigation of possible sources of the cosmic radiation was presented by von Schweidler (Vienna).
Based on the existing knowledge of ionising radiation, he excluded the upper atmosphere, the moon, the planets, the sun and other fixed stars as sources of cosmic rays. Schweidler concluded that “the less extreme requirements prefer the hypothesis of radioactive substances distributed in outer space.”

1918 VF Hess, W Schmidt: Estimate of the distribution of radioactive gases in the atmosphere

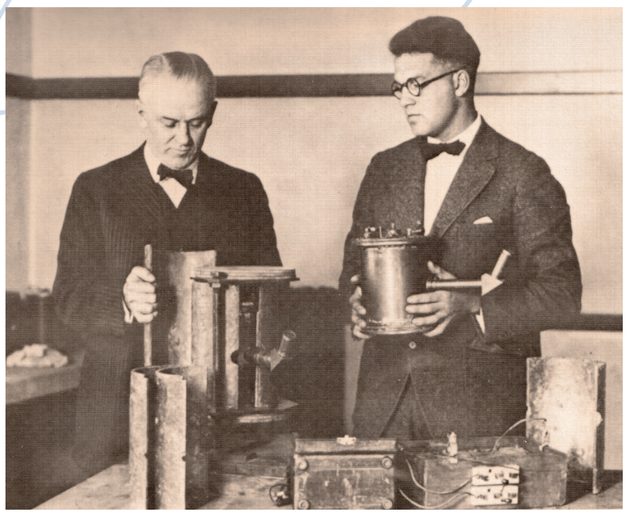
The model developed by Hess and Schmidt described a distribution of radioactive emanations in the atmosphere in agreement with experimental data.
As shown in the table (at right), only radium D can reach the upper atmosphere. All other radioactive emanations are concentrated near the Earth’s surface because of their short lifetimes.

The altitude where the fraction of radioactive emanations is reduced to 50% compared to the Earth’s surface was estimated for different radioactive products:

Radium emanations and short-lived decays:	~1200m
Radium D and decay products:	<10000m
Thorium emanations and thorium A:	2m—3m
Thorium B and decay products:	100m—150m
Actinium emanations and actinium A:	0.5m—1m
Actinium B and decay products:	10m—20m

1923 RA Millikan et al: Radiation measurements in the atmosphere

RM Otis (Pasadena), a co-worker of Millikan, observed with ionisation measurements in aeroplanes up to 5400m of altitude a dependence similar to that found by Hess and Kolhörster. However, the increase was smaller. RA Millikan and IS Bowen used an unmanned sounding balloon. A very light electrometer registered the ionisation, temperature and barometric pressure automatically on a photographic film. They measured only one averaged ionisation value between 5km and 15km of altitude, which was smaller than expected from the European results by about a factor of four. Millikan concluded that there is no radiation of cosmic origin with the absorption coefficient estimated by Hess and Kolhörster.



RA Millikan and GH Cameron in 1925

1926 RA Millikan et al: Disproof of European results, “rediscovery” of cosmic rays

From measurements in snow-fed lakes at high altitudes, Millikan and Cameron deduced an absorption coefficient for the penetrating radiation in water supposedly smaller than found in Europe.
Claiming the discovery of cosmic rays, Millikan caused strong reactions by Hess, Kolhörster and others.

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