Spontaneous Ionization
to
Subatomic Physics

Some Vignettes from Cosmic Ray History

James W. Cronin
Celebration of the centenary of the discovery of cosmic rays
College de France
Paris
June 26 2012

Question at end of 19^{th} century

Does air ionize spontaneously ?

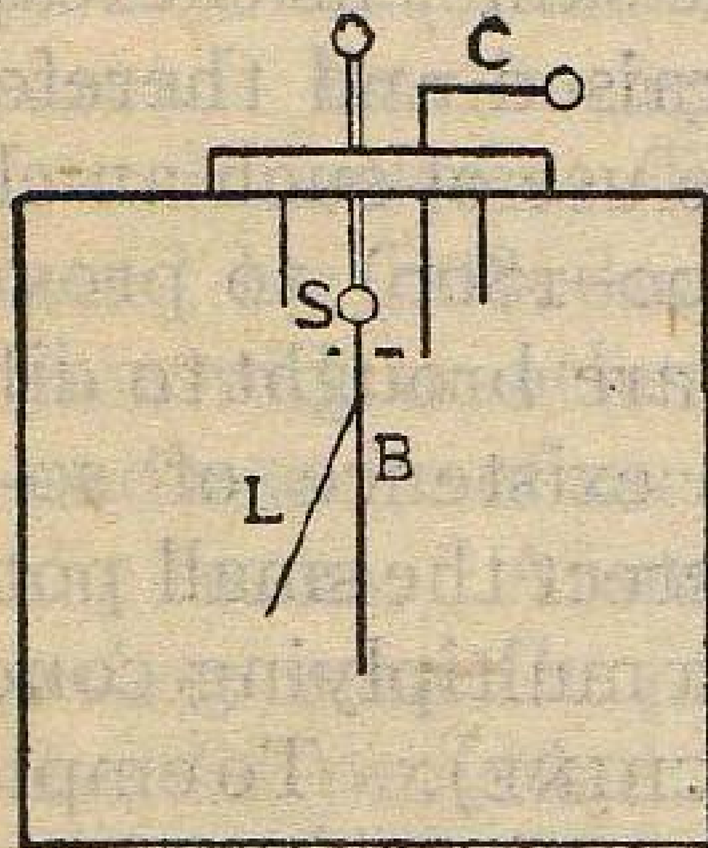


FIG. 6.—Elster and Geitel Electroscope.

Solution ?

Discovery of radioactivity by Becquerel in 1896

Proc. Camb. Phil. Soc. 26 32 (1900)

On the leakage of Electricity through dust-free air. By C. T. R. WILSON, M.A., Sidney Sussex College.

[*Read* 26 November 1900.]

Elster and Geitel have shown than an electrified body gradually loses its charge when freely exposed in the open air or in a room. Their results are in agreement with previous experiments of Linss. They conclude from their experiments that free ions exist in the atmosphere. The experiments described in this paper prove that ionisation can be detected in a small closed vessel containing dust-free air not exposed to any known ionising agents. To

The rate of leak is to a first approximation proportional to the pressure; at a pressure of 43 millims. the leakage is about one-fourteenth of that at atmospheric pressure.

If we take the value found by Prof. J. J. Thomson for the charge carried by each ion, $6{\cdot}5 \times 10^{-10}$ E.U., we can take the experiments as indicating that 20 ions of either sign are produced per second in each c.c. of air at atmospheric pressure.

C. T. R. Wilson Proc. Roy. Soc. A69 277 1901

Relative Conductivity (Air = 1).

Gas.	Radium rays (penetrating type).	Polonium rays.	Spontaneous ionisation.
Air	1·00	1·00	1·00
Hydrogen	0·157	0·226	0·184
Carbonic acid	1·57	1·54	1·69
Sulphur dioxide	2·32	2·04	2·64
Chloroform	4·89	4·44	4·7

Many investigations of
“ background” radiation

C. T. R. Wilson
Elster and Geital
Rutherford
A.S. Eve
Schrodinger
Pacini

2-1

Le Radium. 8 307 (1911)

La radiation pénétrante sur la mer[1]

Par D. PACINI

[Institut Central Météorologique et Géodynamique d'Italie.]

dans l'eau de la mer et dans l'air ne nous permettent pas de nous expliquer les valeurs élevées trouvées par l'expérience pour la radiation pénétrante sur mer[1], ni sur le continent (expériences de Gockel en ballon[2] et de Wulf sur la Tour Eiffel[3]) à une hauteur suffisante pour qu'on puisse négliger l'action directe des substances actives contenues dans le sol. D'ailleurs les résultats précédents semblent montrer *qu'une partie appréciable de la radiation pénétrante présente dans l'air, particulièrement celle qui est sujette à des oscillations notables, a une origine indépendante de l'action directe des substances actives contenues dans les couches supérieures de la croûte terrestre.*

[Manuscrit reçu le 2 Avril 1911].

[Traduit par L. Bloch].

I ≐ 2/cm³/sec

1. A. S. Eve, *Terr. Magn. and Atm. Elect.*, 1910. — D. Pacini, *Nuovo Cimento*, (1910) 449.
2. A. Gockel, *Phys. Zeitschr.*, (1910) 280.
3. Th. Wulf, *Phys. Zeitschr.*, (1910) 811.

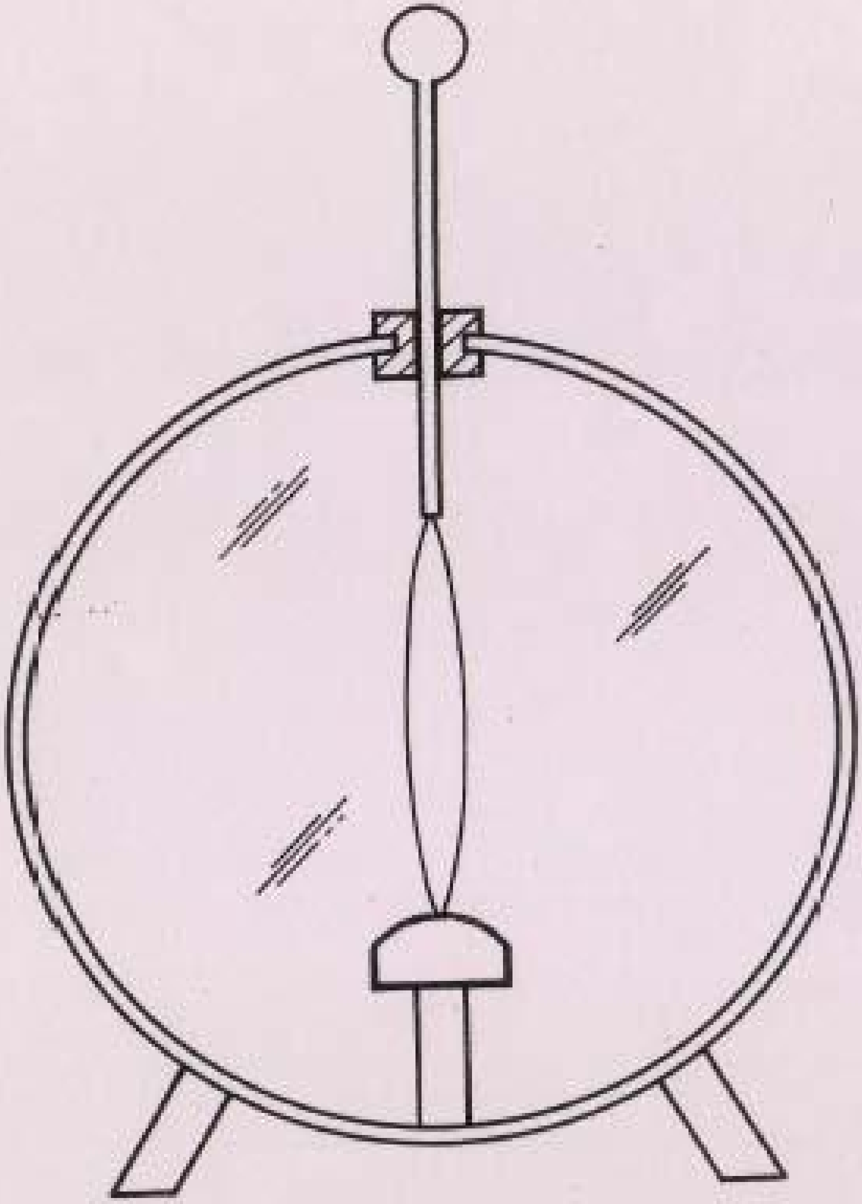


Fig. 1-3 The electroscope that was developed by Wulf in 1909 and was used in many of the early experiments on cosmic rays.

ns

Th. Wulf (SJ)

Phys. Zeit. 11, 811 (1910)

Datum	Ort	Ionen / ccm sec
28. März	Valkenburg	22,5
29. „	Paris, Boden	17,5
30. „	„ Eiffelturm	16,2
31. „	„ „	14,4
1. April	„ „	15,0
2. „	„ „	17,2
3. „	„ Boden	18,3
4. „	Valkenburg	22,0

Daraus ergeben sich als Mittelwerte für die drei Orte

Valkenburg	22,25	Ionen / ccm · sec
Paris Boden	18,0	„
Paris Eiffelturm . .	15,7	„

Viktor Hess

Institut für Radiumforschung, Vienna

Preceded by Swiss balloonist Gockel who rose to 1000 m

First balloon flights of Viktor Hess

Sitz-Ber Akad Wiss Wien 120 1575 (1911)

2) 1911 Two balloon flights

a) Aug 28 1911 ~ 300 m

Ionization constant within errors

b) Oct 12-13 1911

Height (m)	I (ions/cm³/sec)
0	32.3
150-440	28.1
450-800	34.7
800-900	34.3
900-1070	35.5
0	34.9

No change in ionization with altitude

Aeronautisches Gelände im Wiener Prater, von dem aus V. F. Hess in den Jahren 1911/12 seine ersten Freiballon-Forschungsfahrten unternommen hatte. (Courtesy of Heeresgeschichtliche Museum, Vienna)

7th flight 1600 m³
hydrogen filled balloon

(12)

Phys. Zeit 13 1084 (1912)

Aus der Abteilung für Geophysik, Meteorologie und Erdmagnetismus:

Viktor F. Hess (Wien), Über Beobachtungen der durchdringenden Strahlung bei sieben Freiballonfahrten.

Im Vorjahre habe ich bereits Gelegenheit gehabt, zwei Ballonfahrten zur Erforschung der durchdringenden Strahlung zu unternehmen; über die erste Fahrt wurde schon auf der Naturforscherversammlung in Karlsruhe von mir berichtet[1]). Bei beiden Fahrten ergab sich keine wesentliche Änderung der Strahlung gegenüber der am Erdboden beobachteten bis zu 1100 m Höhe. Auch Gockel[2]) hatte bei zwei Ballonfahrten nicht die erwartete Abnahme der Strahlung mit der Höhe finden können. Es wurde daraus der Schluß gezogen, daß außer der γ-Strahlung der radioaktiven Substanzen der Erdrinde noch eine andere Quelle der durchdingenden Strahlung vorhanden sein müsse.

7. Fahrt (7. August 1912).

Ballon: „Böhmen“ (1680 cbm Wasserstoff). Führer: Hauptmann W. Hoffory.
Meteorolog. Beobachter: E. Wolf. Luftelektr. Beobachter: V. F. Hess.

Nr.	Zeit	Mittlere Höhe absolut m	Mittlere Höhe relativ m	Beobachtete Strahlung Apparat 1 q_1	Beobachtete Strahlung Apparat 2 q_2	Beobachtete Strahlung Apparat 3 q_3	Beobachtete Strahlung Apparat 3 reduz. q_3	Temp.	Relat. Feucht. Proz.
1	15^h 15—16^h 15	156	0	17,3	12,9	—	—	—	—
2	16^h 15—17^h 15	156	0	15,9	11,0	18,4	18,4	1½ Tag vor dem Auf-	
3	17^h 15—18^h 15	156	0	15,8	11,2	17,5	17,5	stiege (in Wien)	
4	6^h 45—7^h 45	1700	1400	15,8	[illegible],4	21,1	25,3	+6,4°	60
5	7^h 45—8^h 45	2750	2500	17,3	12,3	22,5	31,2	+1,4°	41
6	8^h 45—9^h 45	3850	3600	19,8	16,5	21,8	35,2	—6,8°	64
7	9^h 45—10^h 45	4800	4700	40,7	31,8			—9,8°	40
		(4400—5350)				—	—		
8	10^h 45—11^h 15	4400	4200	28,1	22,7	—	—	—	—
9	11^h 15—11^h 45	1300	1200	(9,7)	11,5	—	—	—	—
10	11^h 45—12^h 10	250	150	11,9	10,7	—	—	+16,0°	68
11	12^h 25—13^h 12	140	0	15,0	11,6	—	—	(nach der Landung in Pieskow, Brandenburg)	

Dr. Werner Kolhörster im Jahre 1912.

Ber. deutsche Phys. Ges 16 719 (1914)

Messungen der durchdringenden Strahlungen bis in Höhen von 9300 m; von W. Kolhörster.

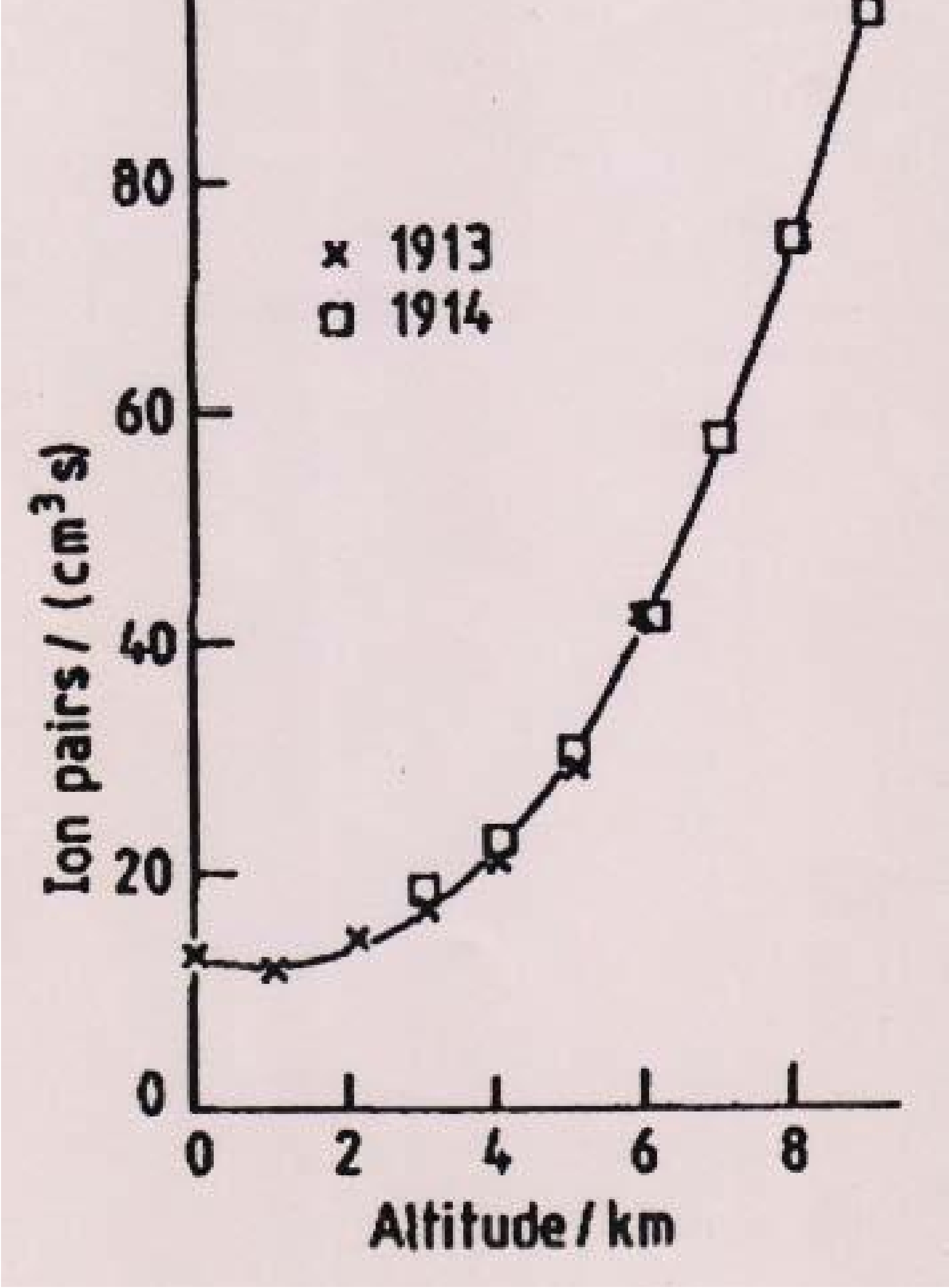
(Vorgetragen in der Sitzung vom 10. Juli 1914.)

(Vgl. oben, S. 681.)

(Aerophysikalischer Forschungsfonds Halle a. S., Abhandlung 14.)

Im vergangenen Sommer habe ich auf drei Freiballonfahrten zu Höhen von 4100, 4300 und 6300 m Messungen der durchdringenden Strahlungen mit einem Apparate nach Wulf meiner Konstruktion (I) ausgeführt und darüber an verschiedenen Stellen berichtet[1]). Danach nimmt die durchdringende Strahlung mit wachsender Erhebung über dem Erdboden bis auf 700 m zunächst ab, daraufhin erst langsam, dann schneller zu. Schon in ungefähr 1600 m werden die gleichen Ionenzahlen wie am Erdboden gefunden. Von 4000 m an wird der Anstieg beträchtlich, so daß in größeren Höhen eine verhältnismäßig sehr starke Zunahme der Ionisierungsstärke zu erwarten ist, was auch bei der Fahrt bis zu 6300 m bestätigt werden konnte. Der zu den Messungen benutzte Apparat ist im Gegensatz zu dem früher, besonders von Hess[2]) auf Ballonfahrten verwendeten Wulfschen Instrument[3])

Kolhorster



ROBERT A. MILLIKAN

In the early 1920's the existence of hohenstrahlung was questioned.

Otis and Millikan Phys Rev 23 778 (1924)

62. **The source of the penetrating radiation found in the earth's atmosphere.** Russell M. Otis and R. A. Millikan, California Institute of Technology.—Assuming, following Kolhorster's 1923 conclusions, a penetrating radiation of cosmic origin which produces 2 ions/cc/sec. at sea level and has an absorption coefficient per cm in water of 2.5×10^{-3}, we find that this radiation would produce 9 ions/cc/sec. on top of Pike's Peak (14100 ft). Inside our completely enclosing lead shield, 5 cm thick, it should produce 7.8 ions/cc/sec. The ionization in our apparatus contributed by the walls and the lead shield was found to be at least 7 ions/cc/sec., so that if there were no local radiation on Pike's Peak, the lowest obtainable value of the ionization in our shielded vessel should have been 14.8 ions/cc/sec. We observed as low as 11. We conclude, therefore, that there exists no such penetrating radiation as we have assumed. Second, we found as a result of a snow-storm on the mountain as large a percentage change (about 10 per cent) in the ionization inside our 5 cm lead shield as outside it. We interpret this result also as meaning that the whole of the penetrating radiation is of local origin. How such quantities of radioactive material get into the upper air is as yet unknown.

Sea level G. Hoffmann Phys. Zeit. 26 669 (1925)

Rough translation of Hoffmann's conclusions:

With these measurements the source of the ionization at high altitude is probably due to the known radioactive elements. How they got there is another question.

Upon further experimentation Millikan completely reverses his conclusions!

Nature (suppl) 121, 19, (1928)
Lecture at Leeds University

These facts, combined with the further observation made both before and at this time, that within the limits of our observational error the rays came in equally from all directions of the sky, and supplemented finally by the facts that the observed absorption coefficient and total cosmic ray ionisation at the altitude of Muir Lake predict satisfactorily the results obtained in the 15·5 km. balloon flight, *all this constitutes pretty unambiguous evidence that the high altitude rays do not originate in our atmosphere, very certainly not in the lower nine-tenths of it, and justifies the designation 'cosmic rays,'* the most descriptive and the most appropriate name yet suggested for that portion of the penetrating rays which come in from above. We shall discuss just how unambiguous the evidence is at this moment after having presented our new results.

These represent two groups of experiments, one carried out in Boliviá in the High Andes at altitudes up to 15,400 ft. (4620 m.) in the fall of 1926, and the other in Arrowhead Lake and Gem Lake, California, in the summer of 1927.

Hess Phys Zeit 27 159 (1926)

Not pleased with Millikan

Zu der eingangs zitierten Veröffentlichung von A. Millikan möchte ich vorerst bemerken, daß er die Geschichte der Entdeckung der Höhenstrahlung in einer Weise darstellt, die Mißverständnisse hervorrufen könnte[3]).

1) Physik. Zeitschr. 13, 1084, 1912; Wien. Ber. IIa, 121, 2001, 1912.

2) Physik. Zeitschr. 14, 610, 1913; Wien. Ber. IIa, 132, 1053, 1913.

3) Die neuerliche Feststellung der Existenz und der hohen Durchdringungskraft der Höhenstrahlung durch Millikan und seine Mitarbeiter wurde von amerikanischen naturwissenschaftlichen Zeitschriften wie „Science", „Scientific Monthly" zum Anlaß genommen, um für die Höhenstrahlung die Bezeichnung „Millikan-Strahlen" vorzuschlagen. Da es sich hier nur um die Bestätigung und Erweiterung der Ergebnisse der von Gockel, von mir und von Kolhörster 1910 bis 1913 ausgeführten Strahlungsmessungen im Ballon handelt, ist diese Benennung als irreführend und unberechtigt abzulehnen.

Hess: Physik. Zeitschr. 27, 159, (1926)

As concerns the publication of Millikan, cited above, I would like to remark that he tells a story of the discovery of hohenstrahlung that could be easily misunderstood.

The recent determination by Millikan and his colleagues of the high penetrating power of hohenstrahlung has been an occasion for American scientific journals such as "Science" and "Scientific Monthly" to introduce the term "Millikan Rays". Millikan's work is only a confirmation and extension of the results obtained by Gockel, by myself , and by Kolhorster from 1910 to 1913 using balloon borne measurements of the rays. To refuse to acknowledge our work is an error and unjustified.

Milliken believed that the cosmic radiation consisted of gamma rays,

but:

new experiments and new detection techniques showed that fore the most part the cosmic radiation consisted of charged particles.

From A.M. Hillas "Cosmic Rays"
Pergamon Press (London) 1972

Bothe and Kohlhörster

II. Main Experiment Zeit f Physik 56 751 (1929)

3. ARRANGEMENT AND METHOD OF EVALUATION

In Figure 1 is shown the arrangement which, with a few modifications, was used for all experiments on the high-altitude radiation. Both the counters Z_1, Z_2, had inner diameters 5 cm, and length 10 cm; they were originally made of brass 1 mm thick, but later of 1 mm thick zinc, and were closed at the ends by ebonite plugs which supported the central wires. They were prepared by the method of Geiger and Müller. The

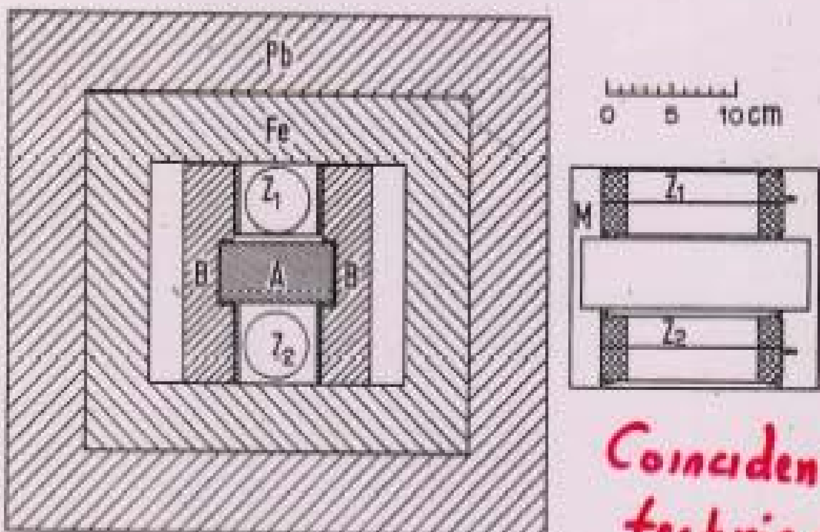


FIG. 1.

Coincidence technique

Radiation is corpuscular

Bruno Rossi and Enrico Fermi in the 1930s. The two scientists wrote together in 1933 a paper showing that it was impossible to detect the east-west effect at the latitude of Florence because of the atmospheric absorption. It was thus absolutely necessary to carry out measurements at low enough geomagnetic latitudes and at high enough altitudes above sea level.

A dramatic result by Bruno Rossi

B. Rossi

Zeit. f Physik 82 151 (1933)

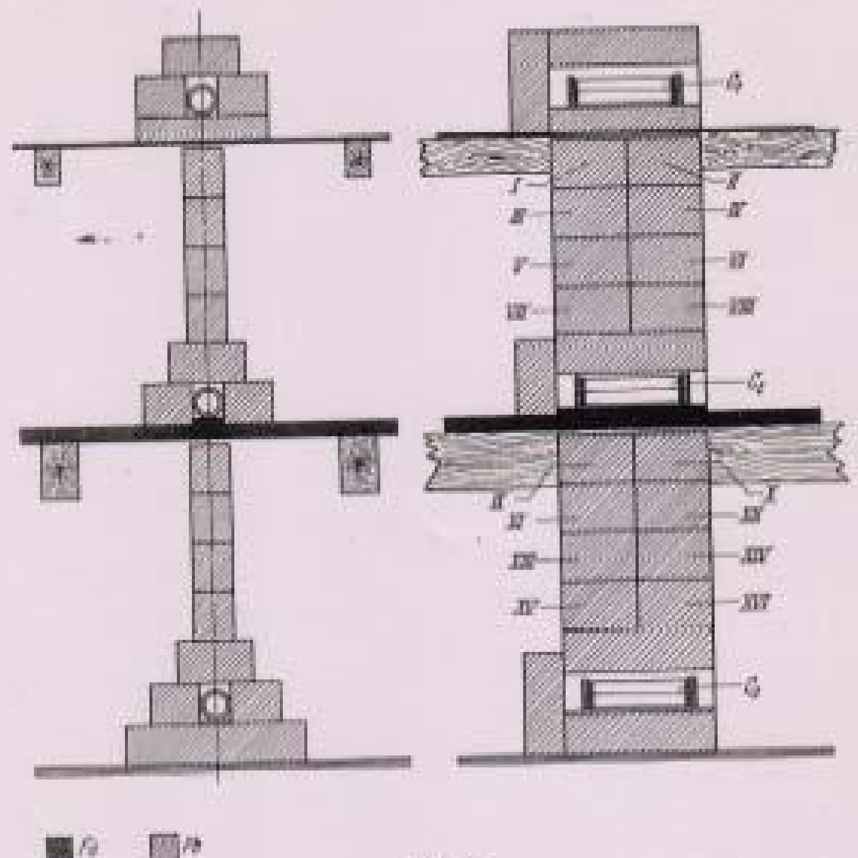


Fig. 2.

~ 50% of radiation at sea level can penetrate 1 meter of lead.

Arthur Compton influenced by Rossi organized a world wide survey of the dependence of cosmic intensity on geomagnetic latitude.

Fig. 6. Compton with the special ionization chamber which he designed and used for his world-wide cosmic-ray survey during 1931–33, which proved that cosmic rays are charged particles.

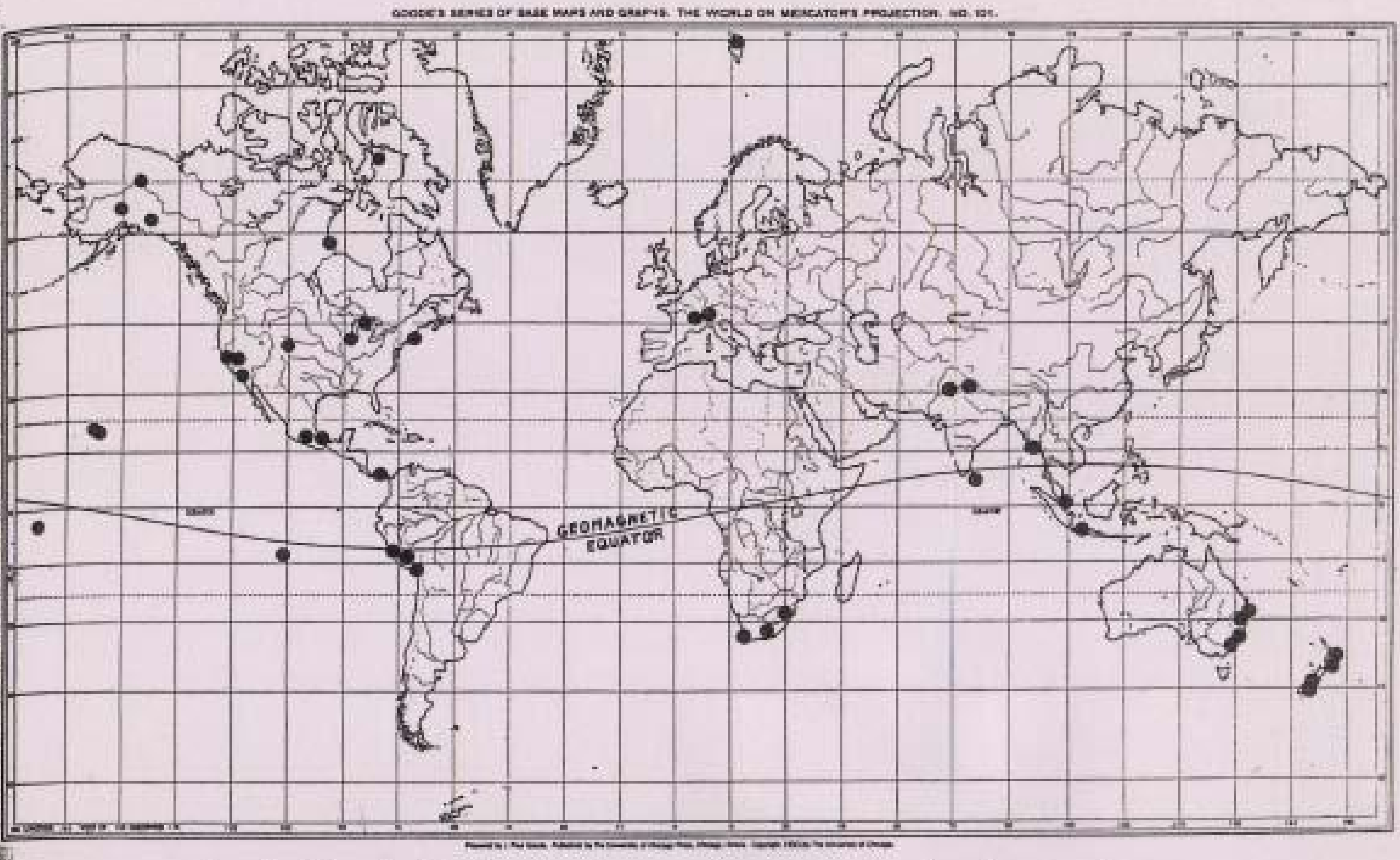


FIG. 1. Map showing location of our major stations for observing cosmic rays.

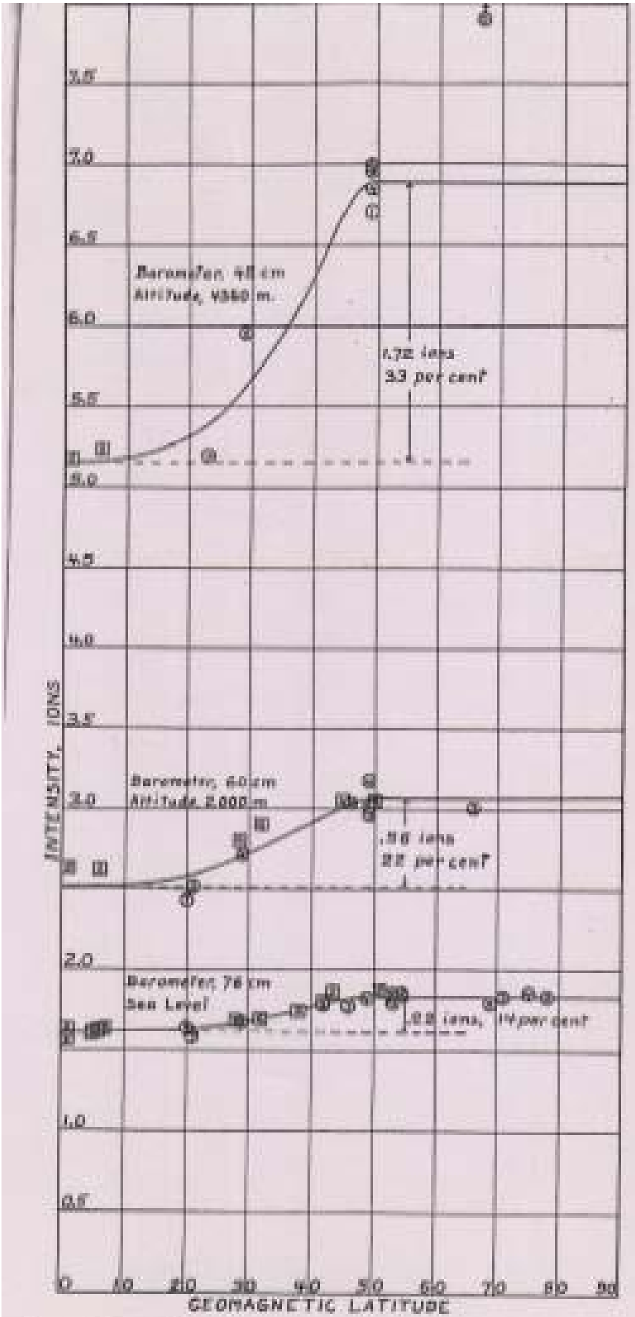


FIG. 6. Intensity *vs.* geomagnetic latitude for different elevations.

The New York Times

VOL. LXXXII....No. 27,370. December 31,1932

MILLIKAN RETORTS HOTLY TO COMPTON IN COSMIC RAY CLASH

Debate of Rival Theorists Brings Drama to Session of Nation's Scientists.

THEIR DATA AT VARIANCE

New Findings of His Ex-Pupil Lead to Thrust by Millikan at 'Less Cautious' Work.

William Lawrence

New York Times

December 1932

In an atmosphere surcharged with drama, in which the human element was by no means lacking, the two protagonists presented their views with the vehemence and fervor of those theoretical debates of bigone days when learned men clashed over the number of angels that could dance on the point of a needle. Dr. Millikan particularly sprinkled his talk with remarks directly aimed at his antagonist's scientific acumen. There was obvious coolness between the two men when they met after the debate was over.

In 1927 Skobelzyn in Leningrad found on occasion high energy particles in his study of Compton scattering with a cloud chamber.

Zeit. f Physik 43 354 (1927)

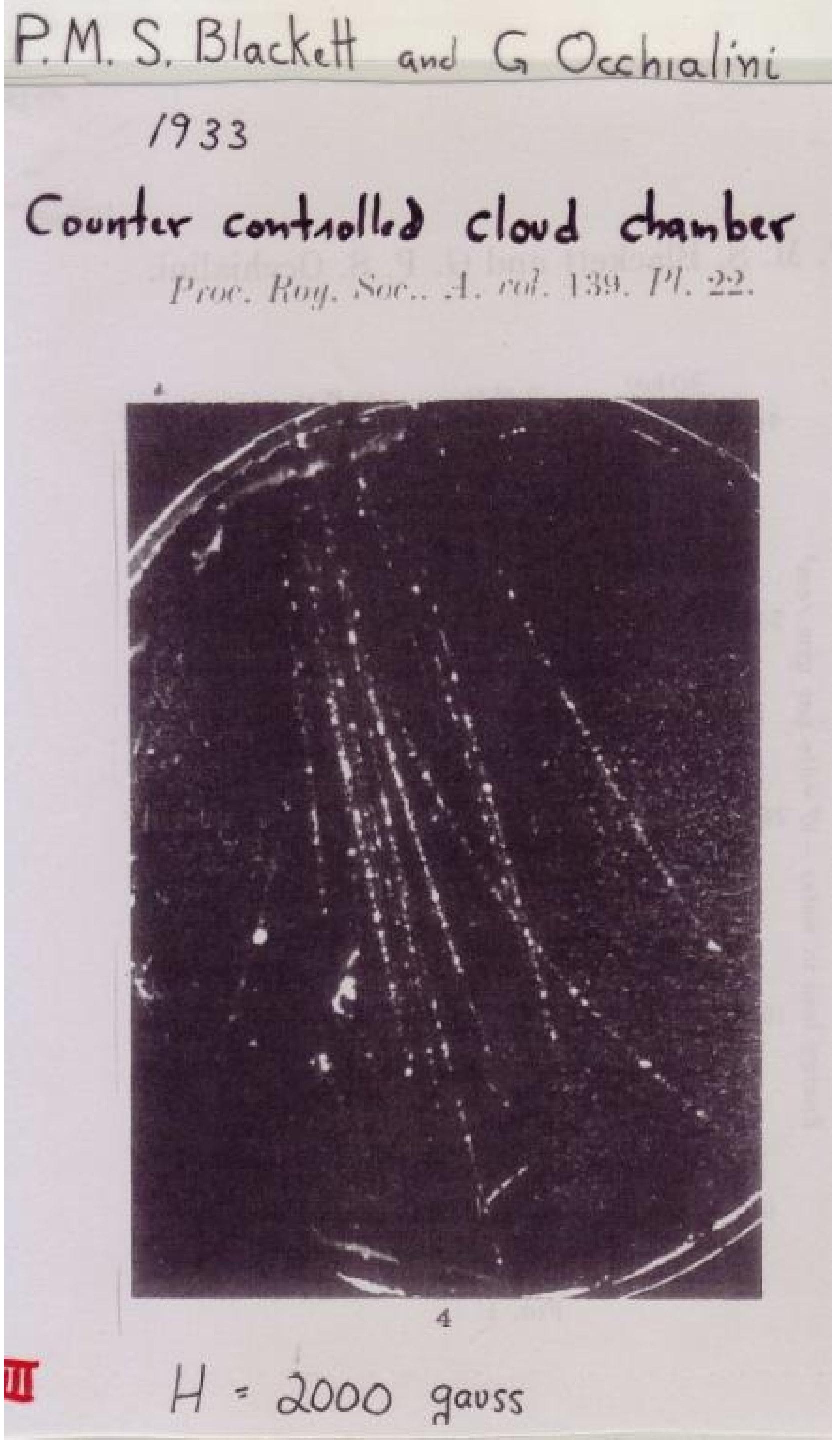
Fig. 4. $H = 1700$, $H\varrho = 24\,500$.

$\sim$ 7 MeV/c

1933

Blackett and Occhialini expand the cloud chamber when a Geiger counter array detects a cosmic ray. Half the photos contain cosmic ray events – many as showers of particles.

In these showers there are equal numbers of negative and positive particles



Proc. Roy. Soc. 139 699 1933
Received Feb 7 1933

Summary.

(1) A short description is given of a method of making particles of high energy take their own cloud photographs.

(2) The most striking features of some 500 photographs taken by this method are described, and the nature of the showers of particles producing the complex tracks is discussed.

(3) A consideration of the range, ionization, curvature and direction of the particles leads to a confirmation of the view put forward by Anderson that particles must exist with a positive charge but with a mass comparable with that of an electron rather with that of a proton.

(4) The frequency of occurrence of the showers is discussed, and also their possible relation to the bursts of ionization observed by Hoffman, Steinke and others.

(5) The origin of the positive and negative electrons in the showers is discussed, and the conclusion is reached that they are best considered as being created during a collision process.

(6) The subsequent fate of the positive electrons is discussed in the light of Dirac's theory of "holes."

(7) The probable existence of non-ionizing links in the processes giving rise to the multiple showers is discussed.

MARCH 15, 1933 PHYSICAL REVIEW VOLUME 43

The Positive Electron

CARL D. ANDERSON, *California Institute of Technology, Pasadena, California*
(Received February 28, 1933)

Out of a group of 1300 photographs of cosmic-ray tracks in a vertical Wilson chamber 15 tracks were of positive particles which could not have a mass as great as that of the proton. From an examination of the energy-loss and ionization produced it is concluded that the charge is less than twice, and is probably exactly equal to, that of the proton. If these particles carry unit positive charge the curvatures and ionizations produced require the mass to be less than twenty times the electron mass. These particles will be called positrons. Because they occur in groups associated with other tracks it is concluded that they must be secondary particles ejected from atomic nuclei.

Editor

ON August 2, 1932, during the course of photographing cosmic-ray tracks produced in a vertical Wilson chamber (magnetic field of 15,000 gauss) designed in the summer of 1930 by Professor R. A. Millikan and the writer, the tracks shown in Fig. 1 were obtained, which seemed to be interpretable only on the basis of the existence in this case of a particle carrying a positive charge but having a mass of the same order of magnitude as that normally possessed by a free negative electron. Later study of the photograph by a whole group of men of the electrons happened to produce two tracks so placed as to give the impression of a single particle shooting through the lead plate. This assumption was dismissed on a probability basis, since a sharp track of this order of curvature under the experimental conditions prevailing occurred in the chamber only once in some 500 exposures, and since there was practically no chance at all that two such tracks should line up in this way. We also discarded as completely untenable the assumption of an electron of 20 million volts entering the lead on one side and

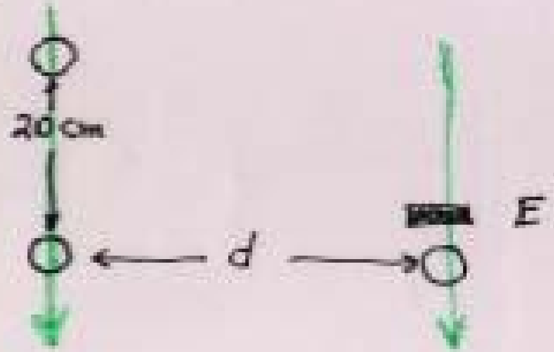
"For your discovery of cosmic radiation"

Shared with Carl Anderson for the discovery of the positive electron in the cosmic rays

V.F. Hess in 1936–37, on the occasion of Nobel prize.

PHYSIQUE NUCLÉAIRE. — *Les grandes gerbes cosmiques de l'atmosphère.* Note [1] de MM. **Pierre Auger** et **Roland Maze**, présentée par M. Jean Perrin.

1. Nous avons montré [2] l'existence de gerbes de rayons cosmiques produites dans l'atmosphère et dont les branches peuvent être distantes de plusieurs mètres. Nous avons pu étendre cette étude jusqu'à des distances de plusieurs dizaines de mètres et mettre ainsi en évidence les effets de corpuscules de très haute énergie dans leur traversée de l'atmosphère.

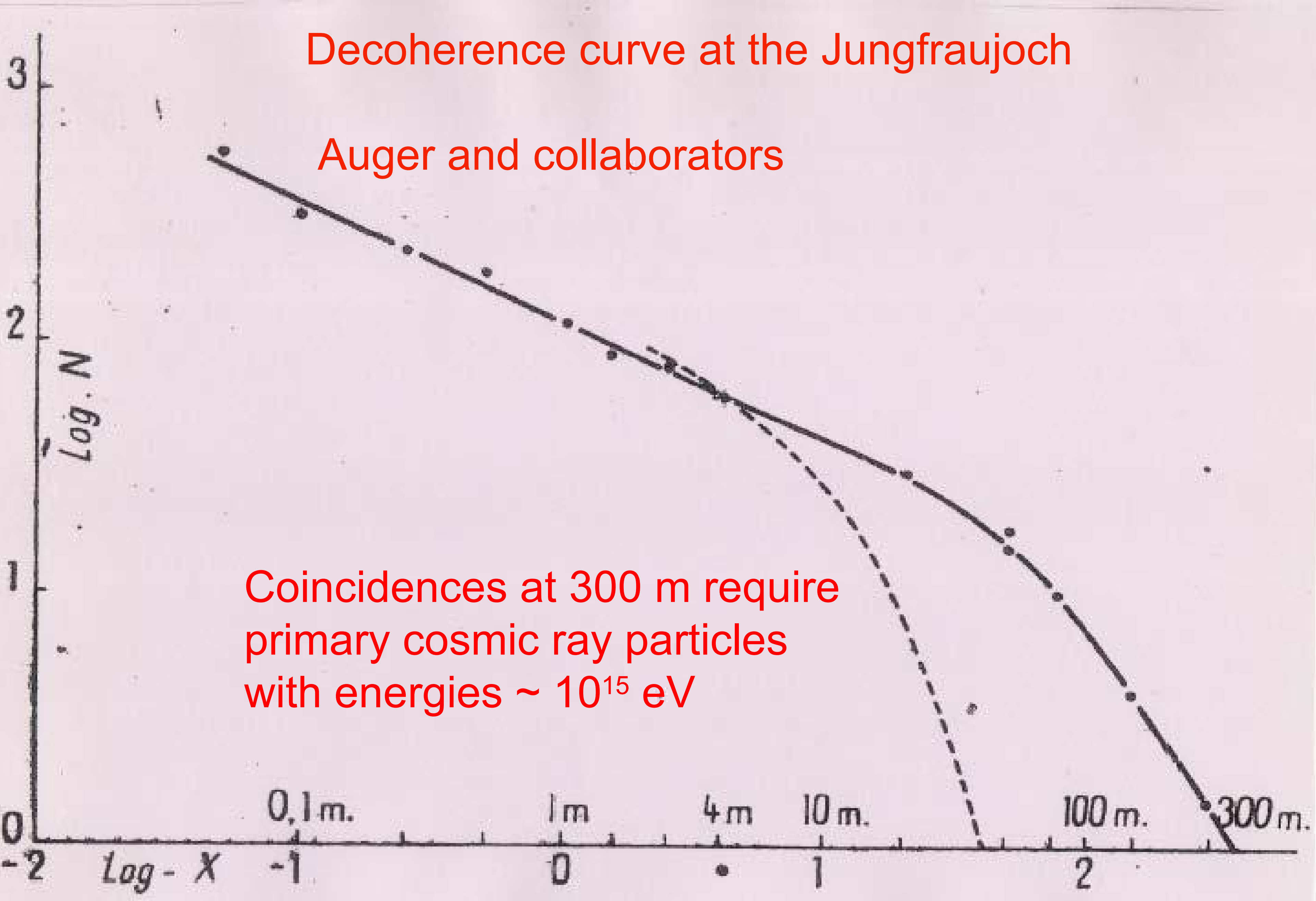


Discovery of extensive air showers.

d.	3 compteurs.				4 compteurs.	Δ.
	E = 0,2.	5.	10.	15.		
2m	1,7	0,86	0,2	$<$ 0,1	0,8	40
5m	1,4	0,7	–	–	–	–
20m	0,9	0,4	0,1	$<$ 0,1	0,45	30

Decoherence curve at the Jungfraujoch

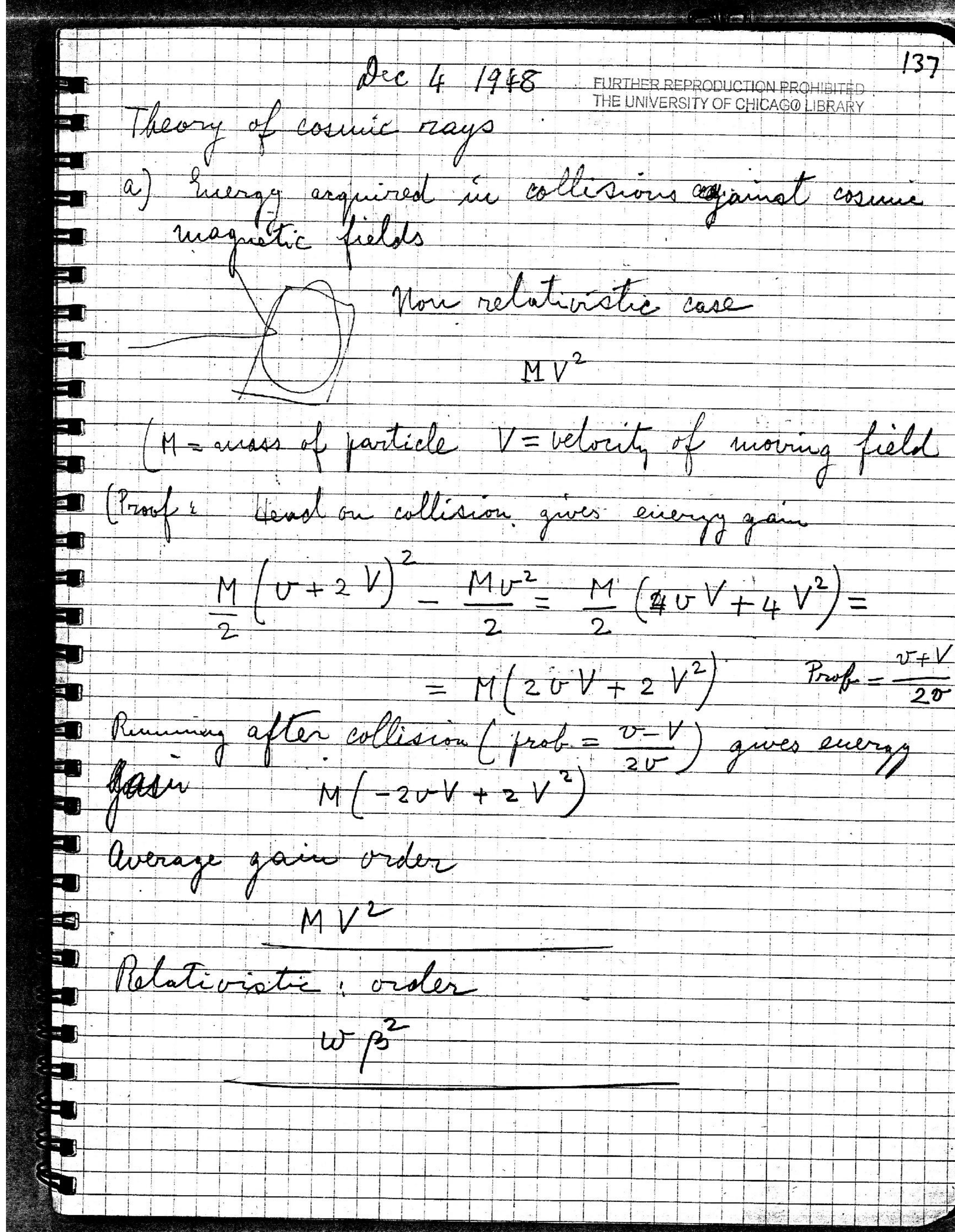
Auger and collaborators



Coincidences at 300 m require primary cosmic ray particles with energies ~ 10^{15} eV

Cosmic Ray Conference
University of Chicago July 1939

Fermi's theory for acceleration of cosmic rays



Dec 4 1948 137

Theory of cosmic rays

a) Energy acquired in collisions against cosmic magnetic fields

Non relativistic case

$$MV^2$$

(M = mass of particle V = velocity of moving field

(Proof: Head on collision gives energy gain

$$\frac{M}{2}(v+2V)^2 - \frac{Mv^2}{2} = \frac{M}{2}(4vV+4V^2) =$$

$$= M(2vV+2V^2) \qquad \text{Prob} = \frac{v+V}{2v}$$

Running after collision ($\text{prob} = \frac{v-V}{2v}$) gives energy gain

$$M(-2vV+2V^2)$$

Average gain order

$$MV^2$$

Relativistic: order

$$w\beta^2$$

PHYSICAL REVIEW VOLUME 75, NUMBER 8 APRIL 15, 1949

On the Origin of the Cosmic Radiation

ENRICO FERMI
Institute for Nuclear Studies, University of Chicago, Chicago, Illinois

(Received January 3, 1949)

A theory of the origin of cosmic radiation is proposed according to which cosmic rays are originated and accelerated primarily in the interstellar space of the galaxy by collisions against moving magnetic fields. One of the features of the theory is that it yields naturally an inverse power law for the spectral distribution of the cosmic rays. The chief difficulty is that it fails to explain in a straightforward way the heavy nuclei observed in the primary radiation.

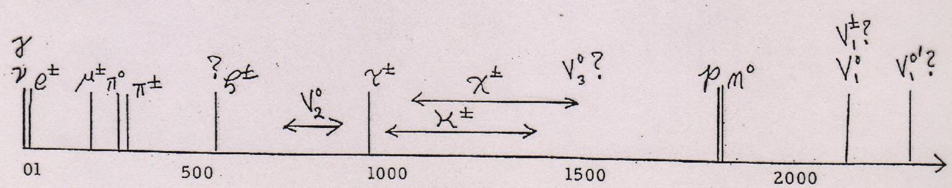
By 1952 a large number of new particles had been discovered in the cosmic radiation

3rd Rochester Conference 1952 32

December

Appendix VI: THE UNSTABLE "ELEMENTARY" PARTICLES OR MEGALOMORPHS

Particle Products	Observed by	Lifetime (sec.)	Q	Mass	Statistics	Spin	Parity
? $V_1^{0\prime} \to p + \pi^-$	c. c.	$> V_1^0$	~75 Mev	$2270 m_e$?	F. D.	n/2?	-
→ $V_1^0 \to p + \pi^-$	c. c.	3.5×10^{-10}	37 Mev	$2190 m_e$	F. D.	n/2?	-
? $V_1^\pm \to p + (?)^0$	c. c.	?	?	?	?	?	?
$m^0 \to p + e^- + \nu$	Spectrograph & counters	740	783 Kev	$1837 m_e$	F. D.	1/2	-
$V_3^0 \to K^- + \pi^+$	c. c.	?	?	$M_p > m_{V_3^0} > m_\pi$	?	?	?
$K \begin{cases} S^\pm, \chi^\pm, V^\pm \end{cases} \to \pi^\pm + (?)^0$, $m_0 \sim 800 m_e$	c. c.; c. c. & emul.	2×10^{-8} -2×10^{-9}	115 Mev	$1400 m_e$	B. E.	0?	S?
$\kappa^\pm, V^\pm \to \mu^\pm + ?2\nu$	emul. c. c.	?	?	$1100 m_e$	F. D.?	1/2?	-
→ $\tau^\pm \to \pi^\pm + \pi^+ + \pi^-$	emul. & c. c.	10^{-8} -10^{-9}	75 Mev	$975 m_e$	B. E.	0?	PS?
→ $V_2^0 \to \pi^+ + \pi^-$	c. c.	$\sim 10^{-10}$	210 Mev	$850 m_e$	B. E.	0?	S?
? $\zeta^\pm \to \pi^\pm + (?\pi^0)$	emul.	$?10^{-11}$	40 Kev $<Q<$ 6 Mev	$552 m_e$	B. E.	0?	S?
$\pi^\pm \to \mu^\pm + \nu$	counters	2.3×10^{-8}	5.9 Mev	$276 m_e$	B. E.	0	PS
$\pi^0 \to 2\gamma$; $\to e^+ + e^- + \gamma$	counters; emul. & counters	$\lesssim 5 \times 10^{-15}$	135 Mev	$266 m_e$	B. E.	0	PS
$\mu^\pm \to e^\pm + 2\nu$	counters	2.15×10^{-6}	105 Mev	$212 m_e$	F. D.	1/2	-



MASS IN m_e

CONGRÈS INTERNATIONAL SUR LE RAYONNEMENT COSMIQUE
BAGNÈRES-DE-BIGORRE, 6-12 Juillet 1953 Photo ALIX

Organized by Louis Leprince-Ringuet and Patrick Blackett

SEANCE DU SAMEDI - APRES - MIDI

Président de Séance : B. ROSSI

J - 1 TEXTE DE LA CONFERENCE DU PROF. B. ROSSI A LA SEANCE DE CLOTURE

Before concluding my remarks there is one point which I would like to make which was made already in the course of the conference: it is the very close similarity, between the masses of two of the best established particles, I mean the charged tau-particle with a mass of 970 and θ^0-particle with a mass of 971. This looks hardly like an accident, and on the other hand it is very difficult to see how the θ^0-particle could be the neutral counterpart of the tau-particle.

L. Leprince-Ringuet

J. de Physique (Colloque #8) V 43 (1982)

Au Pic du Midi c'était Ch. Peyrou, B. Grégory, A. Lagarrigue, R. Armenteros, F. Müller puis A. Astier. Ont participé non seulement les français mais aussi des étrangers comme Ronald Rao de Princeotn, Tinlot de Rochester, Destaebler de Mit et aussi B. Le Fretter, en partie. Vous savez ce qui a été étudié au Pic. Le congrès de Bagnères de Bigorre en 1953, je dirais, a sonné le glas des rayons cosmiques et c'est Powell lui-même qui, dans son discours de clôture a dit : "Messieurs, maintenant nous sommes envahis, nous sommes sumbergés, ce sont les accélérateurs". Effectivement, la plupart des laboratoires de rayons cosmiques dont le nôtre, ici à l'Ecole Polytechnique, puis au Collège de France, se sont orientés vers les grands accélérateurs de particules et je voudrais vous dire aussi que le mot hypéron a été annoncé pour la première fois au congrès de Bagnères. Il y avait B. Rossi, E. Amaldi, C. Powell. Et on s'est demandé comment appeler ces nouvelles particules qui s'arrêtaient, qui étaient lourdes et qui donnaient un méson. Alors on a proposé divers noms. Et je dois dire que c'est ma principale contribution à la physique, j'ai prononcé le mot hypéron : le mot hypéron n'a pas été bien accueilli par Rossi. Rossi a dit "oh, hypéron, piperone, ça va pas". Et au contraire Powell était là et a dit "oh hypéron (prononcer haiperon) mervelous". Et on a dopté le mot hypéron. Et il a à Bagnères de Bigorre l'avenue de l'hypéron: c'est peut être le seul endroit au monde où une particule fondamentale a donné un nom à une avenue.

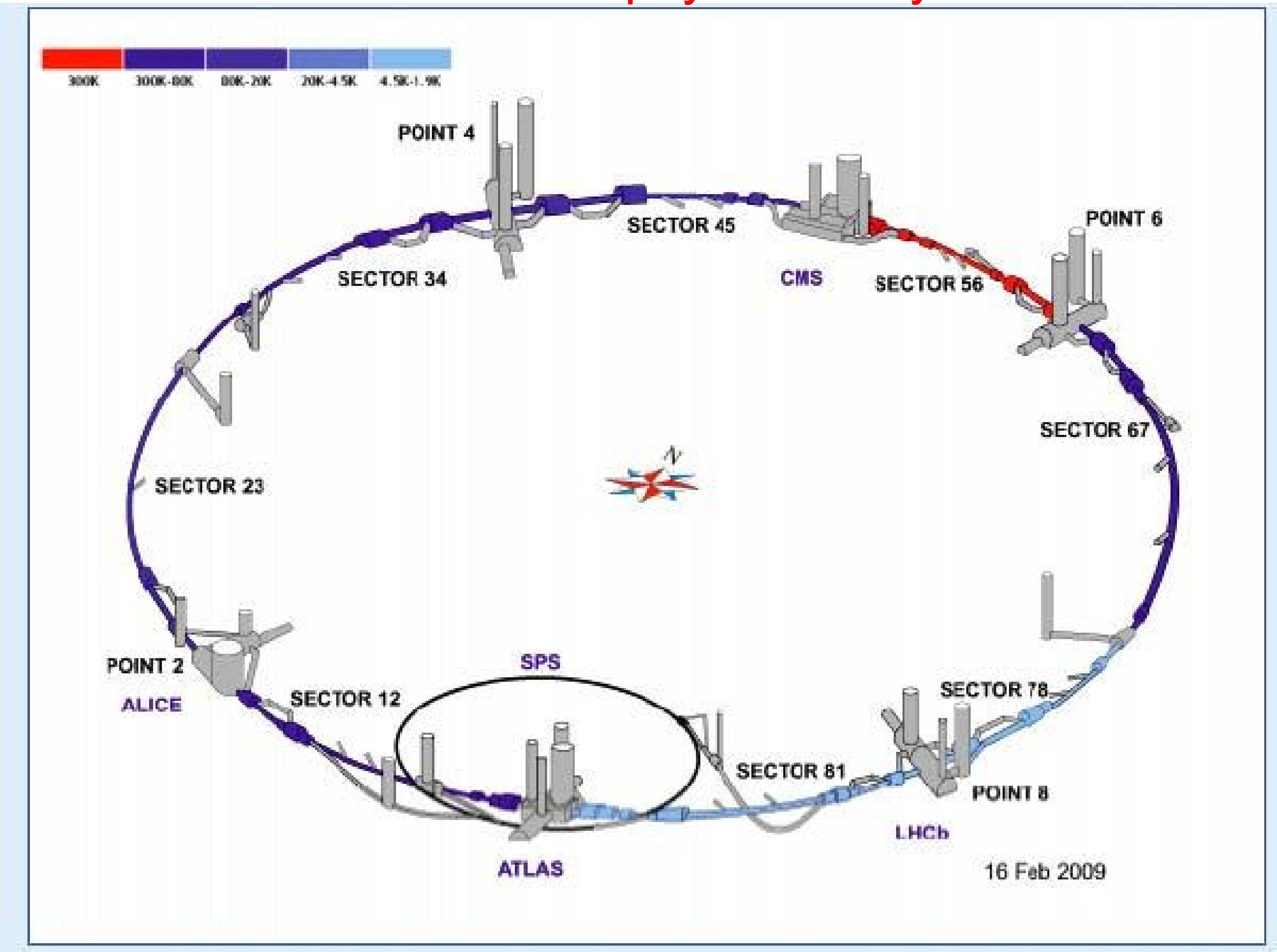
1953 after Bagneres de Bigorre

Subatomic physics → accelerators

Cosmic Rays → space*

* but on the surface for the highest energies !

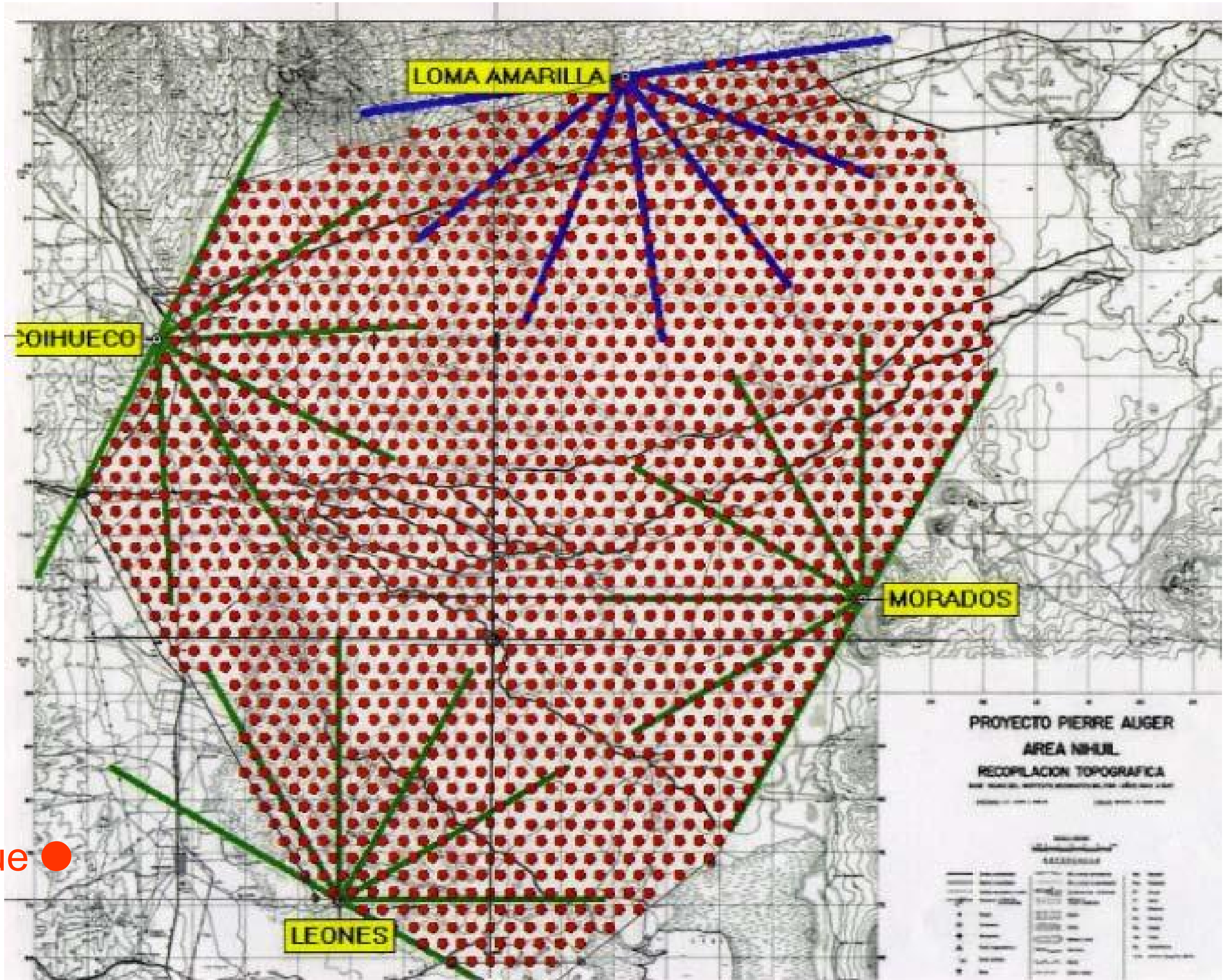
Sub-atomic physics today!



LHC Cooldown Status

High Energy Cosmic Rays today

3000 km^2



Malargue