

# Erich Regener – a forgotten cosmic-ray pioneer

Per Carlson and Alan A. Watson



Born West Prussia 1881

Full prof. Technical univ. Stuttgart 1920

"Provisional retirement" 1937

Return to Stuttgart 1946

Vice president, Max Planck Society 1948

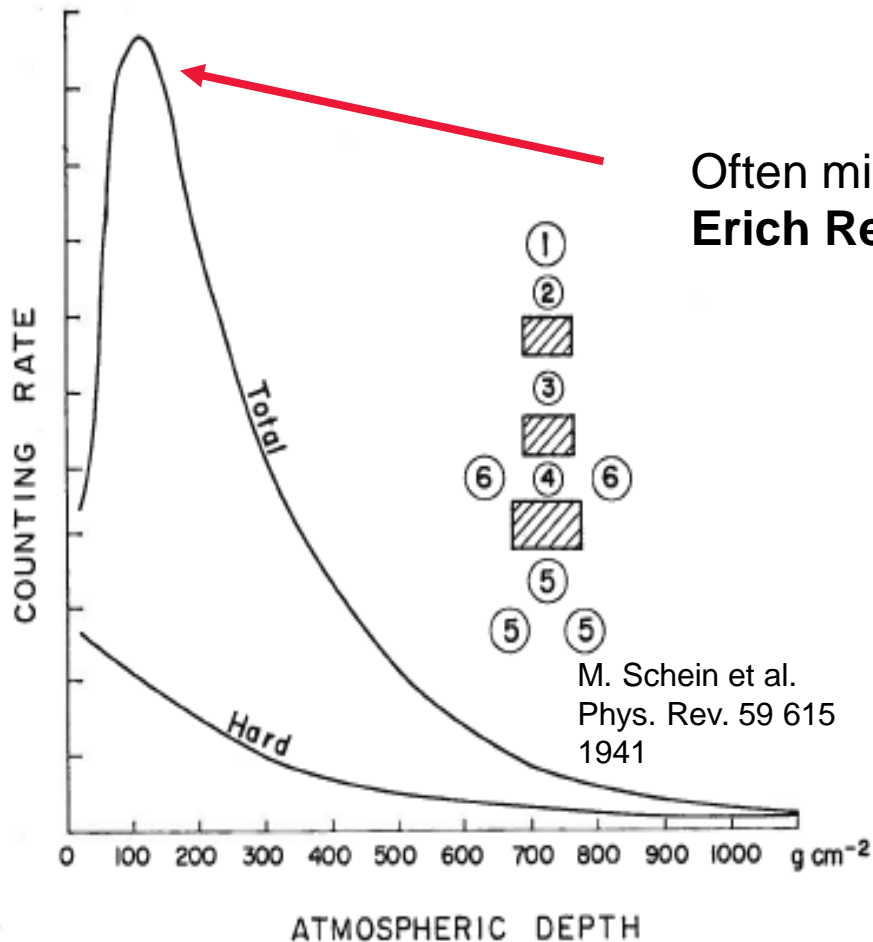
Retired 1951

Died 1955, 73 years old

Excellent contributions to cosmic-ray physics, in particular atmospheric ionisation

APS April meeting 2013, Denver

# Cosmic ray intensity vs atmospheric depth



Often misleadingly called the Pfitzer maximum  
**Erich Regener** was the true leading scientist

M. Schein et al.  
Phys. Rev. 59 615  
1941

Cosmic ray work started in Stuttgart 1928

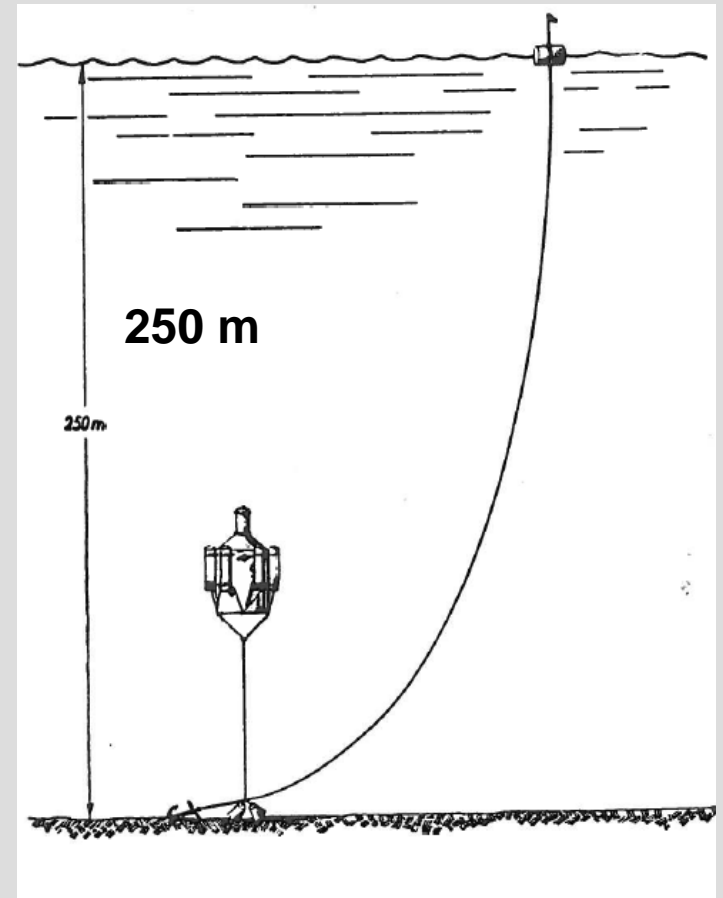
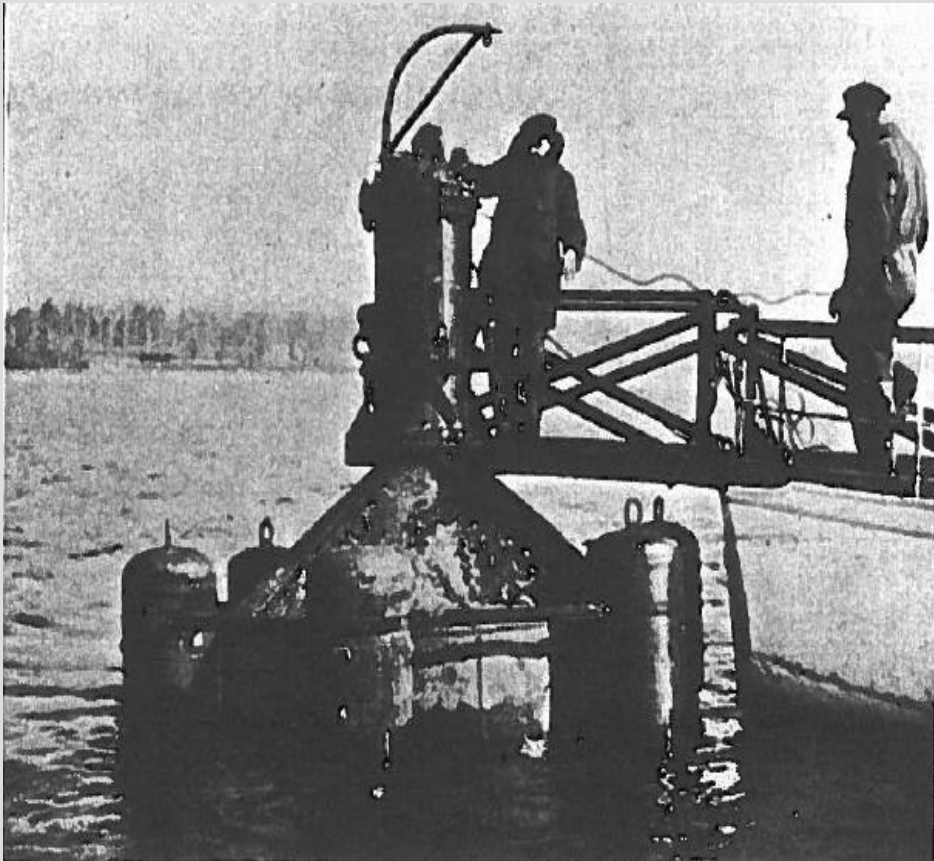
**Ionisation measurements:**

**Deep in Lake Constance 1930-34**

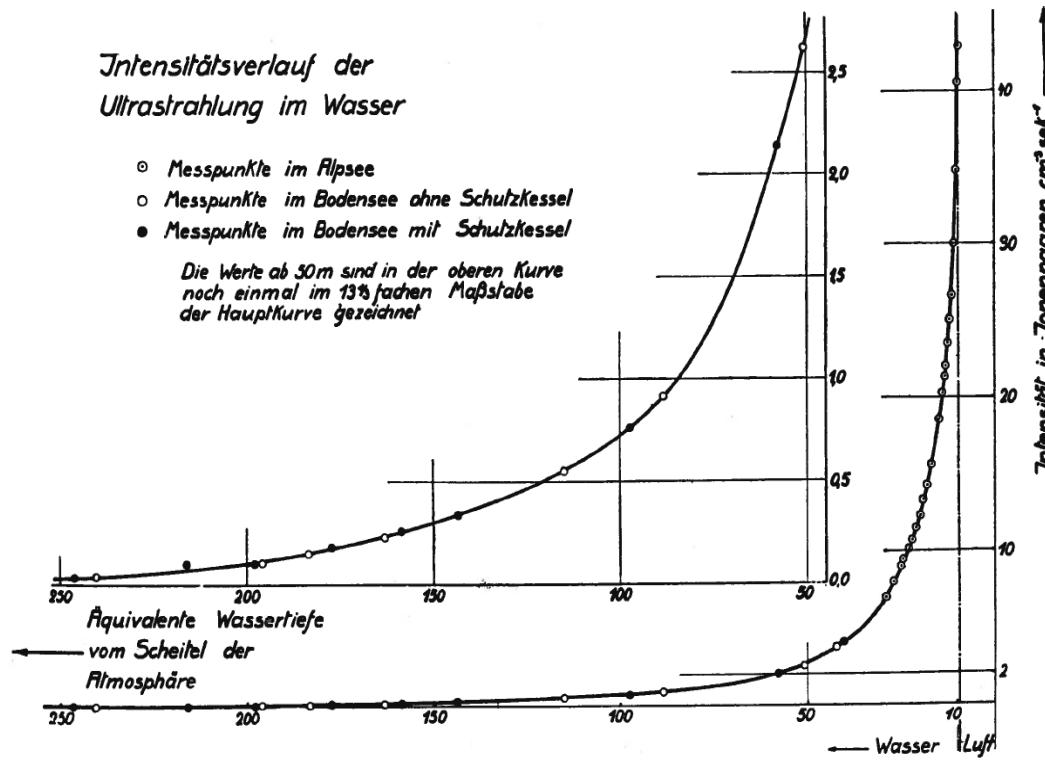
**High up in the atmosphere 1931-35**



# Lake Constance, early 1930s



Regener reached a depth of over 230 m and observed a continuous decrease of the radiation. Millikan had stated that between 57 and 67 m depth there was no further decrease.



Ion pairs  $\text{cm}^{-3}\text{s}^{-1}$

← Depth (m)

# Discussion on Ultra-Penetrating Rays 1931

Proc Roy Soc A 132, 331 1931

Lord Rutherford and others praised Regener's work. Rutherford concluded:

What interpretation can we give? Is it gamma-type? Electrons?  
Inconclusive. My own speculation: gamma-type!

Regener believed cosmic rays were gamma-rays.

# The early 1930's:

Several balloon flights measuring the atmospheric ionisation, reaching pressures less than 50 mm Hg. Many papers.

Confirming Kolhörster's results

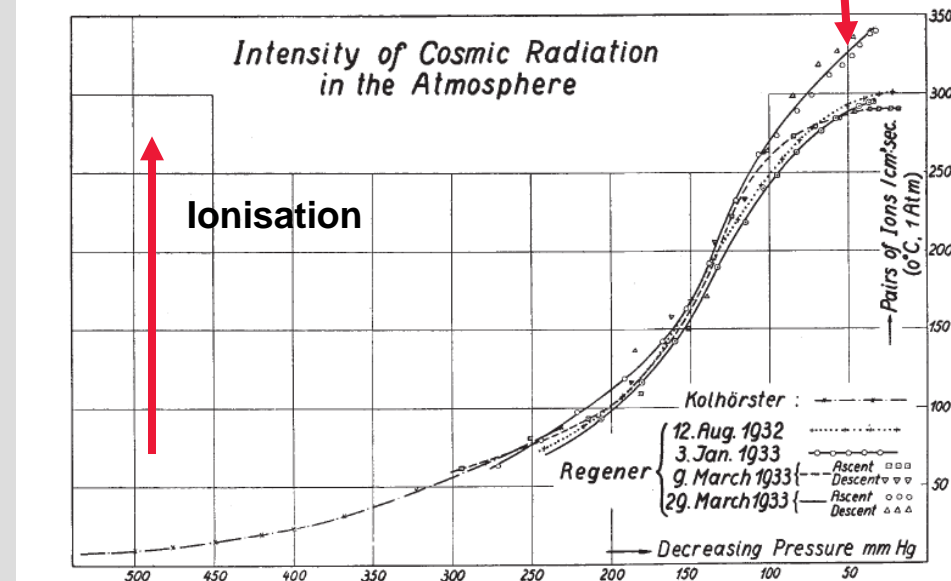
Estimated by integration the cosmic ray energy density

Realised the importance of estimating and measuring the intensity of *vertically* incident rays

Suggested to Gross to calculate the vertical intensity from the all-direction intensity

Introduced PhD student Pfozter to the work

Flight 29 March 1933

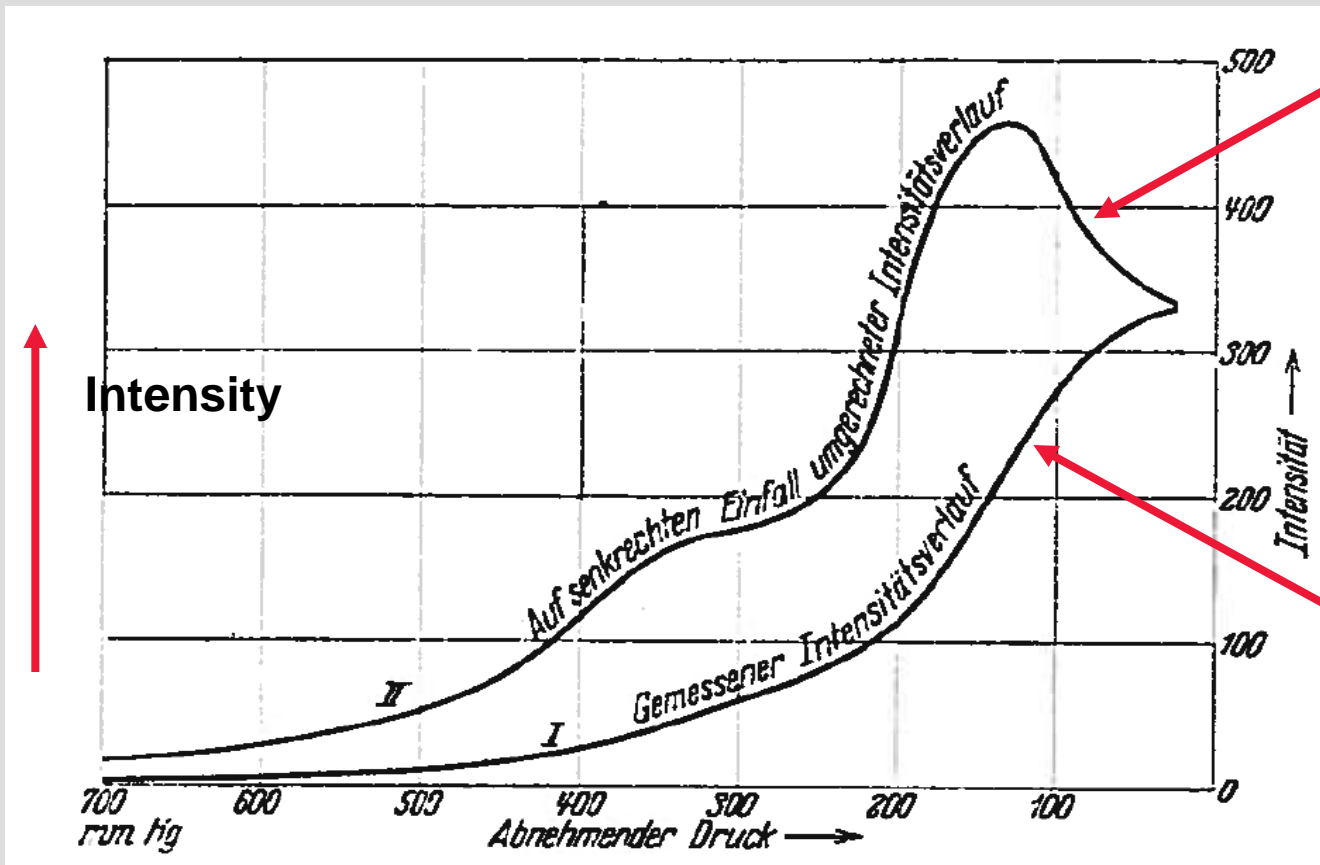


Regener Nature 1933

Decreasing pressure

# Gross 1933 calculation

Gross acknowledges Regener for suggesting the problem and for help with the work.



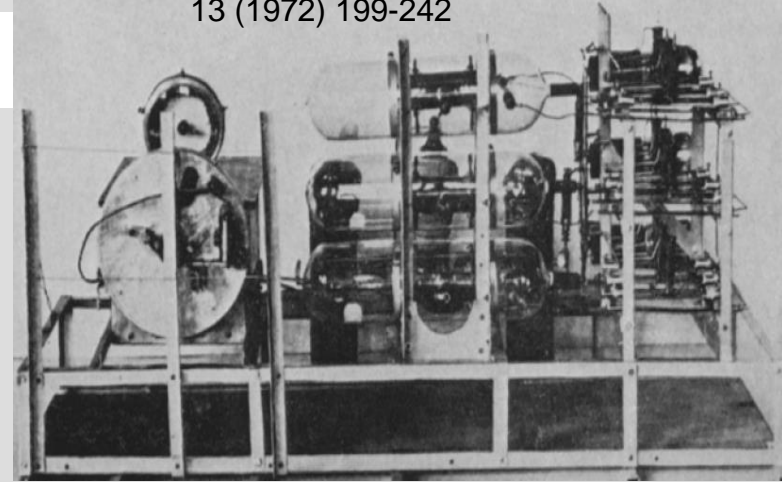
Calculated intensity for vertically incident rays. **A clear maximum for a pressure of about 100 mm Hg.**

Measured intensity for all-direction incident rays

Decreasing Pressure



# Ascent with 3 GM tubes in coincidence

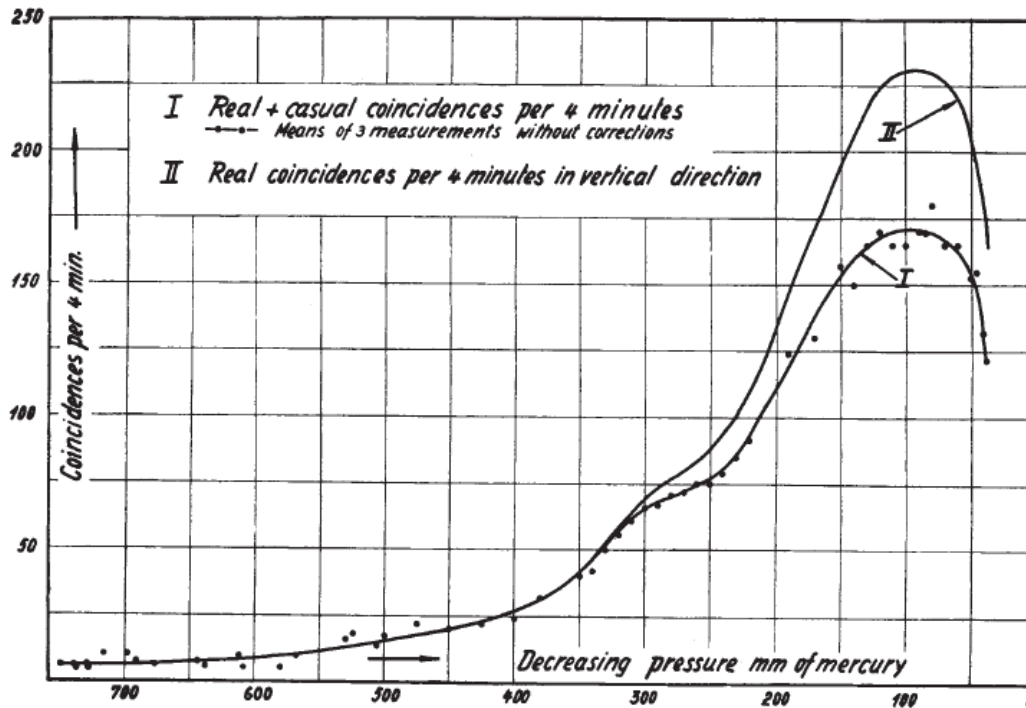


**A clear maximum in agreement with Gross' calculations!**

The 3 GM-tubes

E Regener and G Pftzer  
Nature 134, 325 1935

Coincidence rate



Pressure (mm Hg)

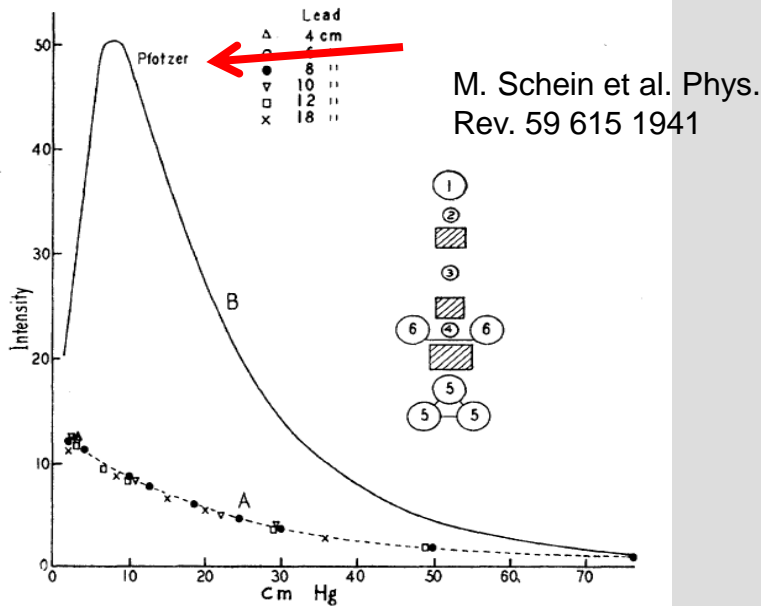
# Pfotzer's work

Pfotzer was a student of Regener and his thesis was presented on 15 May 1936, in part published in Zeit. Physik.

It is clear that it was Regener's idea. This is further supported by the acknowledgements in Pfotzer's thesis.

## Misleading

The maximum is misleadingly called the Pfotzer maximum in articles and in text books.



## On the Nature of the Cosmic Radiation near the Pfotzer Maximum at $\lambda = 41^\circ\text{N}^* \dagger$

S. F. SINGER

*Applied Physics Laboratory, Johns Hopkins University,  
Silver Spring, Maryland*

January 9, 1950

# BUT 2 EXCEPTIONS

Putting  $h = 2.37$ ,  $\varphi = 30^\circ$  and taking for  $R$  the value corresponding to the maximum of the Regener-Pfotzer curve, namely,  $100 \text{ gm./cm.}^2$ , we get  $\Delta l \sim 4 \times 10^5 \text{ cm.}$

B. Rossi, Nature 142 993 1938

*B—The Regener curve at High Altitudes*

H. J. Bhabha and W. Heitler *Proc. R. Soc. Lond. A* 1937 **159**, 432-458

# Schrödinger nominated Regener for the 1938 Nobel Prize



**Erwin Schrödinger 1887-1961 Nobel Prize 1933 (shared with Dirac)**



## Important dates



February 27, 1933, the *Reichtag* took fire

The same night journalist Carl von Ossietzky, pacifist and democrat, journalist in opposition to secret German rearmament was arrested and taken to concentration camp.

November 23, 1936, Ossietzky was awarded the 1935 Nobel Peace Prize (that had been reserved).

January 31, 1937, Hitler issued a decree forbidding German nationals to accept any Nobel Prize.

January 17, 1938, Schrödinger writes his nomination for Regener

Graz II, 17. Januar 1938.



An  
Das Nobelkomitée für Physik,  
Stockholm 50, Schweden.

Hochverehrte Herren!

Die Erstattung eines Vorschlages für den diesjährigen Nobelpreis für Physik ist für den einzelnen, durch die gütige Einladung der Schwedischen Akademie der Wissenschaften hiezu Berufenen aus dem Grunde schwierig, weil wir nicht wissen, ob die Akademie sich letzten Endes dafür entscheiden wird, bei der Zuerkennung, so wie es bisher geschah und wie es auch den Statuten entspricht, auf die Nationalität nicht zu achten, oder ob sie sich dafür entscheiden wird, die Angehörigen einer bestimmten Nation entweder überhaupt auszuschliessen, oder, drittens diejenigen unter ihnen, die im Hoheitsgebiet dieser Nation ihren Wohnsitz haben - oder ob sie irgendeine andere denkbare Modifikation des Vorgehens wählen wird.

Falls man diesen zwei Grundsätzen folgen will, so schiene mir dazu kein anderes Mittel als dieses. Die Akademie trifft ihre Entscheidung völlig unbeeinflusst durch die in Rede stehende Verfügung. Diese Entscheidung wird aber gegebenen Falles streng geheim gehalten so lange, bis durch einen unauffälligen sicheren Sendboten der Preisträger befragt worden ist, ob und wann er die Bekanntgabe wünscht.

Für den diesjährigen Nobelpreis für Physik schlage ich vor  
Erich Regener in Stuttgart

um der bahnbrechenden Versuche willen, in denen er die kosmische  
Strahlung systematisch und eingehend <sup>detailliert</sup> untersucht hat bis zu rund  
dreissig Kilometer Höhe in der Atmosphäre und bis zu über 200 m  
tief (entsprechend etwa zwanzig Atmosphären Absorption) im Boden-  
see.

Nur eventua~~l~~iter - im Falle die Akademie aus den Gründen,  
auf die im Anfange dieses Schreibens Bezug genommen wurde, die Zu-  
teilung des Preises an den eben Genannten grundsätzlich nicht in  
Betracht zu ziehen beschliesst, schlage ich vor, den Preis zu teil-  
len zwischen

W. Pauli, Zürich

und

E. Fermi, Rom.



## Final comment



Why is Regener forgotten?

Why is the  $100 \text{ g/cm}^2$  maximum called the Pfozter maximum?

Is Regener's difficulties with the National Socialist party a reason? Pfozter's thesis came 1936, Regener had to leave his Stuttgart chair 1937.



**Erich Regener 1881-1955**

Thank you!