Göttingen Physics History

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Since 1714, the Elector of Hanover, Georg Ludwig, was - as **Georg I.** - the King of Great Britain.

But there was no University in the electorate, which was equivalent to the new power and importance of Hanover.

Georg August II. decided in 1734 to place „his“ new University in Göttingen

Georg August II. (1683 – 1760)
Elector of Hanover,
Duke at Brunswick - Lüneburg
King of Great Britain and Ireland

The Göttingen Master-Plan: (1732/33)

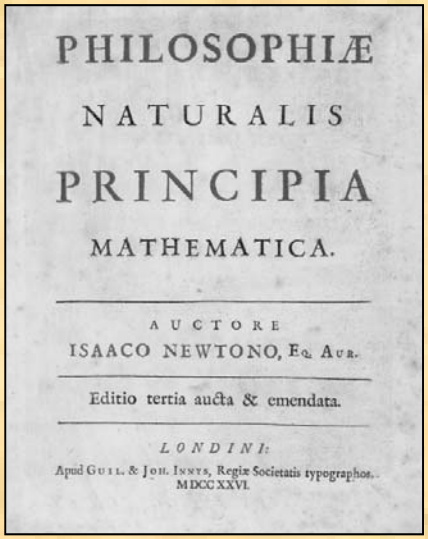
Faculty:	Theology,	Law,	Medicine,	Philosophy
# chairs:	3	4	2-3	3 + 2

following the principles of **Aristoteles,**

Physics belonged to the Philosophy

Mathematics

Logics and Metaphysics


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA.
AUCTORE
ISAACO NEWTONO, Eq. Aur.
Editio tertia aucta & emendata.
LONDINI:
Apud Guil. & Joh. Innys, Regiæ Societatis typographos.
MDCCXXVI.

Isaac Newton, London, 1726
SUB Göttingen, digital

„Introduction into the whole Philosophy“

by: Prof. **Samuel Christian Hollmann**

Vol. 1 (1734): ***Logics and Metaphysics***

Vol. 2 (1737): ***Physics:***

- **a:** ***General properties of Rigid Bodies***
- **b:** ***Geophysics, Mineralogy, Meteors, Animals, Plants***
- **c:** ***Astronomy***

Georg Christoph Lichtenberg
(1742 - 1799)

Professor of physics, mathematics and astronomy
Göttingen 1770 - 1799

Age of teaching

- lectures in his private house
  „Lichtenberg-house“

- Inventor of **experimental lectures**

- **Physical Cabinet**
  ⟶ faculty museum

- first experiments with **electricity**

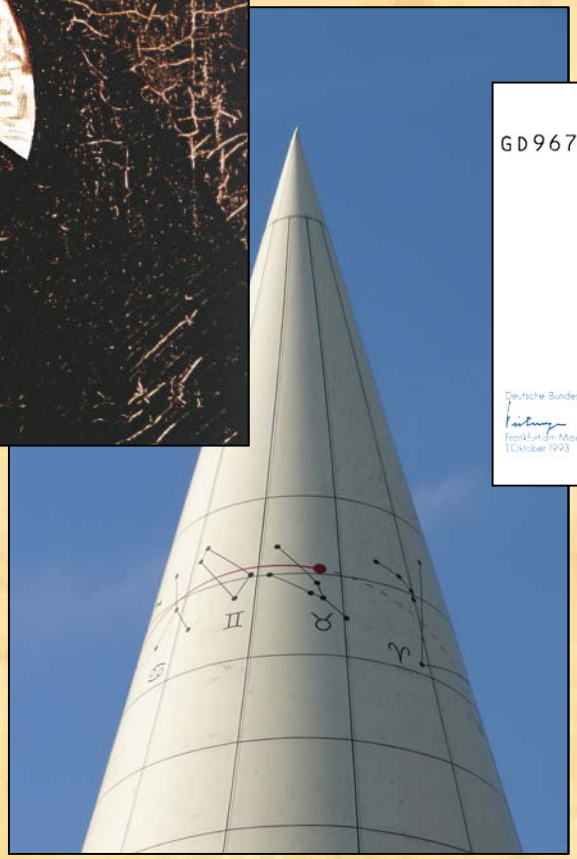
„Everyone is a genius at least once a year.

The real geniuses simply have their bright ideas closer together.“

Sudelbücher

Carl Friedrich Gauß (1777-1855)

- Prodigy at the age of 3 years
- studied in Göttingen,
  solved old mathematical problems
- Calculation of **CERES-orbit**, Dec.1801



- supported by his duke
- Professor of Astronomy and Director of the observatory,

Göttingen 1807-1855

- probability distribution, statistics, number theory, analysis,….
- triangulation of the Kingdom Hanover (**Brocken**)

New Observatory (1803-1816)

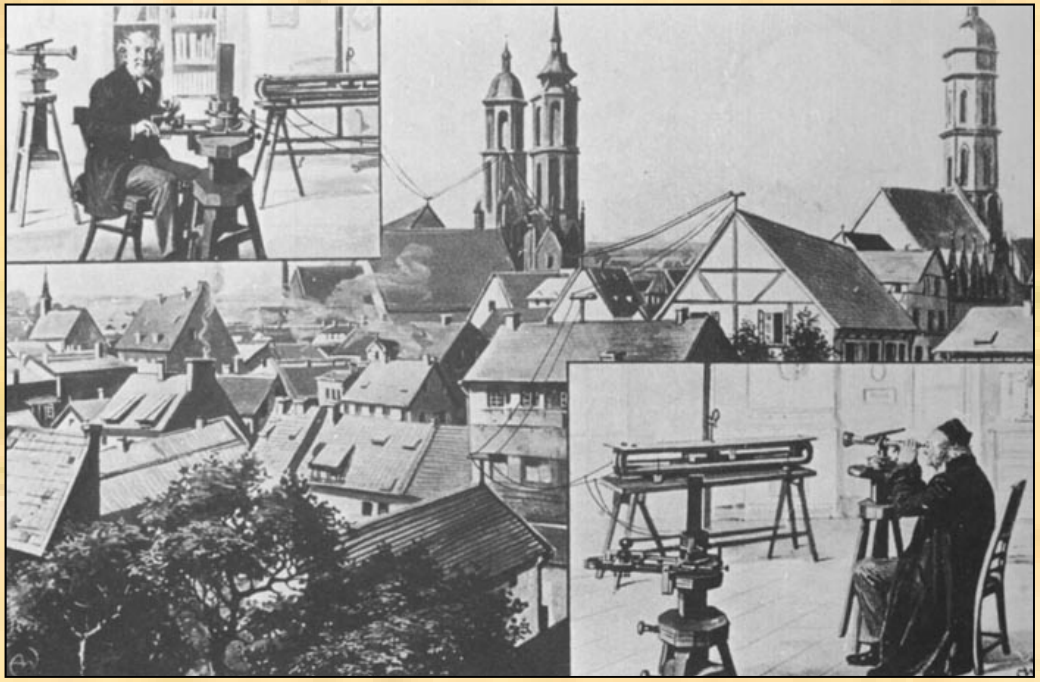
(Gauß lived here until 1855)

Since 2005, the
„University Observatory“
is the
Institute for Astrophysics

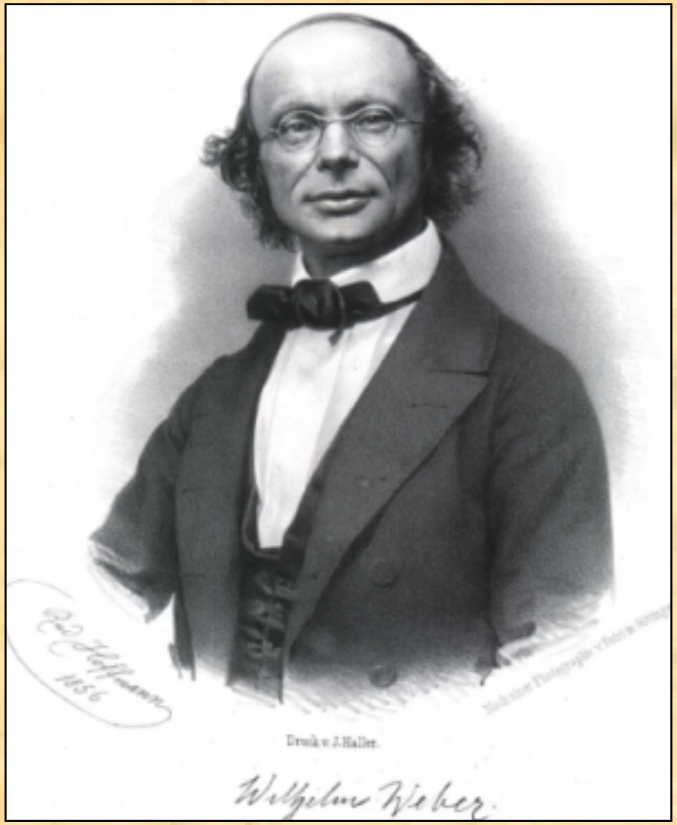
The new Physics of ~1820 was the electricity

Close Collaboration between a genial mathematician
(**Gauß**) and an experimentalist **(Weber)**

First Telegraph
(spring 1833 until 1845)



2,2 km long, double wire



Wilhelm Weber (1804 – 91)

Professor of physics: 1831-1837
1849-1891

one of the „Göttingen Seven"

Fired on December 14th, 1837

As a friend of C.F. Gauß
he returned in 1849

Era after Napoleonic Wars

Ernst August 1837-1851

ignored the Constitution,
dismissed the Parliament

Conflict:

absolute
versus
constitutional monarchy

Göttingen Seven:

7 out of 41 Professors protested,
were fired or banned,
among them also the
Grimm Brothers

Wilhelm IV. 1830-1837

a „liberal“ Constitution
1833

Fairy tales: Cinderella,…

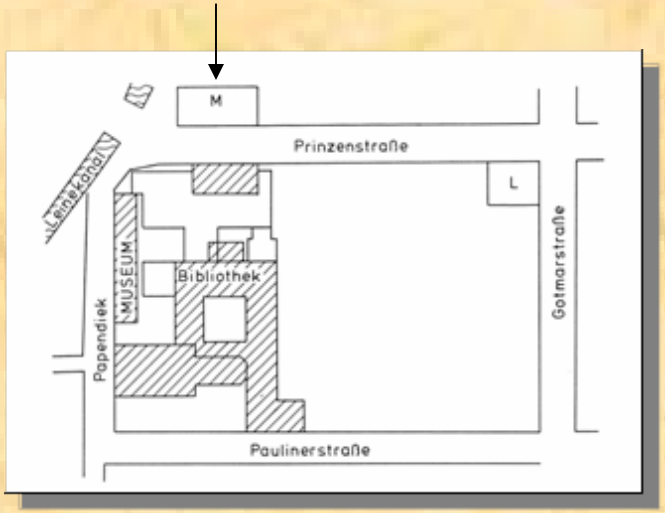
Physics Institute - Weber at „Michaelis-house“

Research on Electricity:

force between charges, magnetism,
absolute unit-system, …

Maxwell‘s Equations (1861–64)

were more general than
Weber‘s description



Weber always understood current as a big number of charged particles

1881 / 83: Reorganisation:

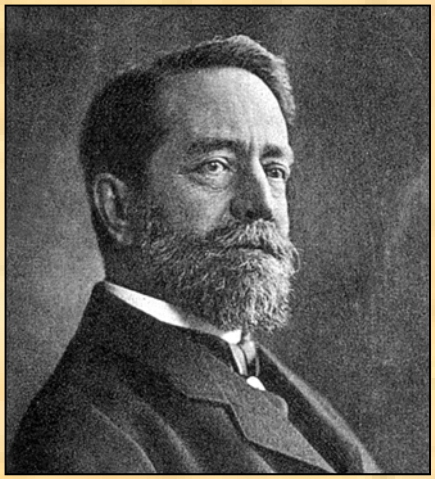
experimental + mathematical department

Electron, found 1897 in Cathode Rays

Emil Wiechert, J.J.Thomson

Göttingen Mathematics got worldwide reputation

Successors of **Carl Friedrich Gauß**:



Peter G. Lejeune-Dirichlet,, 1855 – 1859

Bernhard Riemann, 1859 – 1866

(theoretical assistent of W.Weber since 1849)

Felix Klein, 1866 – 1913

David Hilbert, 1895 – 1930

(„Physics is too hard for the Physicists“)

Hermann Minkowski, 1902 – 1909

Richard Courant, 1922 - 1933

1893, under Felix Klein‘s efforts Göttingen began admitting women

2009: still to be finished…

Amalie Emmy Noether

(1882 -1935)

- In the winter 1903 - 04 she attended lectures in Göttingen by **Schwarzschild, Minkowski, Blumenthal Klein and Hilbert.**

- In 1904, Bavaria granted the right for women to attend university.

- She enrolled officially in Erlangen and made her Ph.D. in 1907

In spring 1915, **D. Hilbert** and **F. Klein** invited her to return to Göttingen

but a professorship was blocked in the Philosophical Faculty:

No women as University lecturers!

Hilbert's answer:

„I do not see, that the sex of the candidate is an argument against her admission./… / After all, we are a University not a bath house."

Habilitation of a woman

After lengthy discussions, in Prussia a habilitation of women was legally (29. 5.1908) **not allowed**

The habilitation of Emmy Noether took from 1915 – 1919 (in 3 attempts)

First habilitated woman at the Göttingen University

(but no wage before 1923, minor position, one-year-contracts)

Noether Theorems (1918)

The mathematics of the general relativity was difficult, even for Einstein.
Hilbert and Klein were active in relativity work – they wanted Noether to help:

Every symmetry of nature yields a conservation law and vice versa:

symmetry in time	enery conservation
symmetry in spatial translation	momentum conservation
symmetry in rotational motion	angular momentum conservation
symmetry of special wave functions	charge, colour, …

New Institutes, triggered by Felix Klein,

highly gifted organizer, friend to **F. Althoff**, Head of department in Prussian Ministry of Education

1894:	**Physical Chemistry**	**Walter Nernst**
1896:	**Department for Applied Elctricity**	**Herman Theodor Simon**
1901:	**Institute for Geophysics**	**Emil Wiechert**
1904:	**Institute for Applied Mathematics**	**Carl Runge**
1904:	**Institute for Applied Physics**	**Ludwig Prandtl**

State + private sponsors: (*Göttinger Vereinigung…)*

1905: „Pure“ Physics Institute Bunsenstrasse

New Physics around 1900

Atomic - Physics:

Goldstein cathode-rays (1886)
Röntgen x-rays (1895)
Bequerel radioactivity (1896)
Planck Constant (1900)
Einstein's explanation Photo-effect (1905)
Rutherford experiment (1909)
Bohr's model of the atom (1913)
Franck – Hertz experiment (1911 – 1914)

Einstein's general relativity theory (1907 – 1915)

Bertha Röntgen's hand 1895

- **a bulk of unexplained data in atomic spectra**
- **empirical rules**
- **new phenomena**

3 new professors in the Bunsenstrasse

started the **Golden Era of Göttingen Physics : „Göttingen Spirit"**

Born Franck Pohl

All three at the age of 38,
friends since their studies in Heidelberg

1920: New structure of the Institute for „Pure" Physics

Institute for Theoretical Physics:

Max Born, 1921 – 1933
(1882 – 1970)

II. Physical Institute:

James Franck, 1920 – 1933
(1882 – 1964)

I. Physical Institute:

Robert Pohl, 1920 – 1953
(1884 – 1976)

Research Topics

- **James Franck** studied the interaction between electrons and atoms or molecules in gases. During his whole life he was interested in the role of electrons in chemical – or later – biological processes.

The famous „Franck-Hertz-experiment“ (1914) was seen as a proof of Bohr‘s model of the atom.
In **1925** they got the **Nobel-Prize** for these experiments

- **Robert Pohl** worked on diffraction of x-rays and the photoelectric effect, later he used this effect with inner electrons in insulating crystals, pioneering experiments to modern solid state physics.

Many experiments were performed, to understand the influence of discrete energy-quanta

The Quantum Mechanics

- **Max Born** startet 1923 a program to find a mathematical description of the quantum-theory of the atom. He developed with **Werner Heisenberg and Pascual Jordan** the **Matrix - representation** of the quantum-mechanics in **1925**.

Only months later **Erwin Schrödinger (Munich)** had a different approach, the **wave - mechanics.** He showed the equivalence of both methods

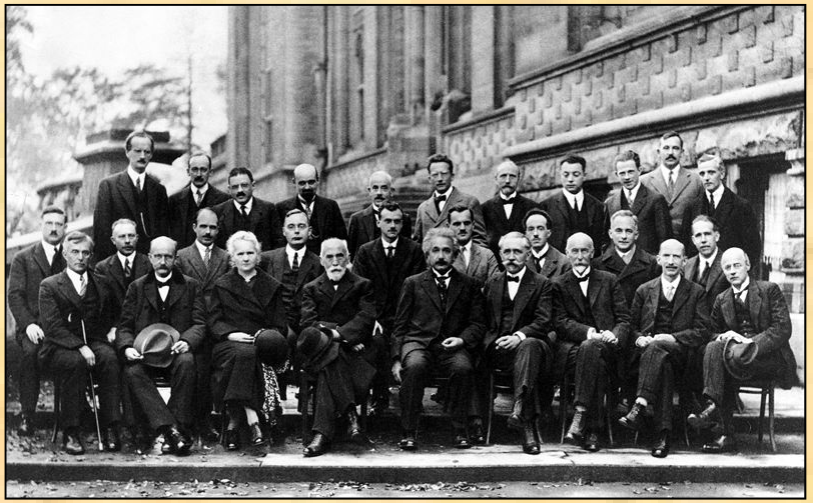
1927: „Kopenhagen Interpretation“ by Bohr and Heisenberg:

$|\psi|^2$ = Probability density

Nobel Prizes:

1932: **Werner Heisenberg**
1933: Erwin Schrödinger
Paul Dirac
1954: **Max Born**

Fifth Solvay Conference, 1927



The „Max Born School" in Göttingen

Ph.D. students:	Max Delbrück	NP
	Walter Elsasser	
	Friedrich Hund	
	Pascual Jordan	
	Maria Goeppert-Mayer	
	Wolfgang Nordheim	
	Robert Oppenheimer	
	Victor Weisskopf	
Assistants:	Enrico Fermi	NP
	Werner Heisenberg	NP
	Gerhard Herzberg	NP
	Friedrich Hund	
	Maria Goeppert-Mayer	NP
	Pascual Jordan	
	Wolfgang Pauli	NP
	Leon Rosenfeld	
	Edward Teller	
	Eugene Wigner	NP =

II. Physical Institute:

Hans Dehmelt	NP
Wolfgang Paul	NP

30.1.1933:

Adolf Hitler came to power „Reichskanzler“

1. 4. 1933, general boycott of Jewish shops

Gesetz zur Wiederherstellung des Berufsbeamtentums
Law for the restauration of the Professional Civil Service
7. 4. 1933

„political enemies“, jewish judjes and civil servants have been expelled from **all public institutions**
On Universities a maximum of only 1.5% jewish students was admitted

Jewish = at least one of your grandparents was a jew

From **1935** on, a marriage with a jew was forbidden

Public Protest

James Franck in Göttingen, 17.4.1933

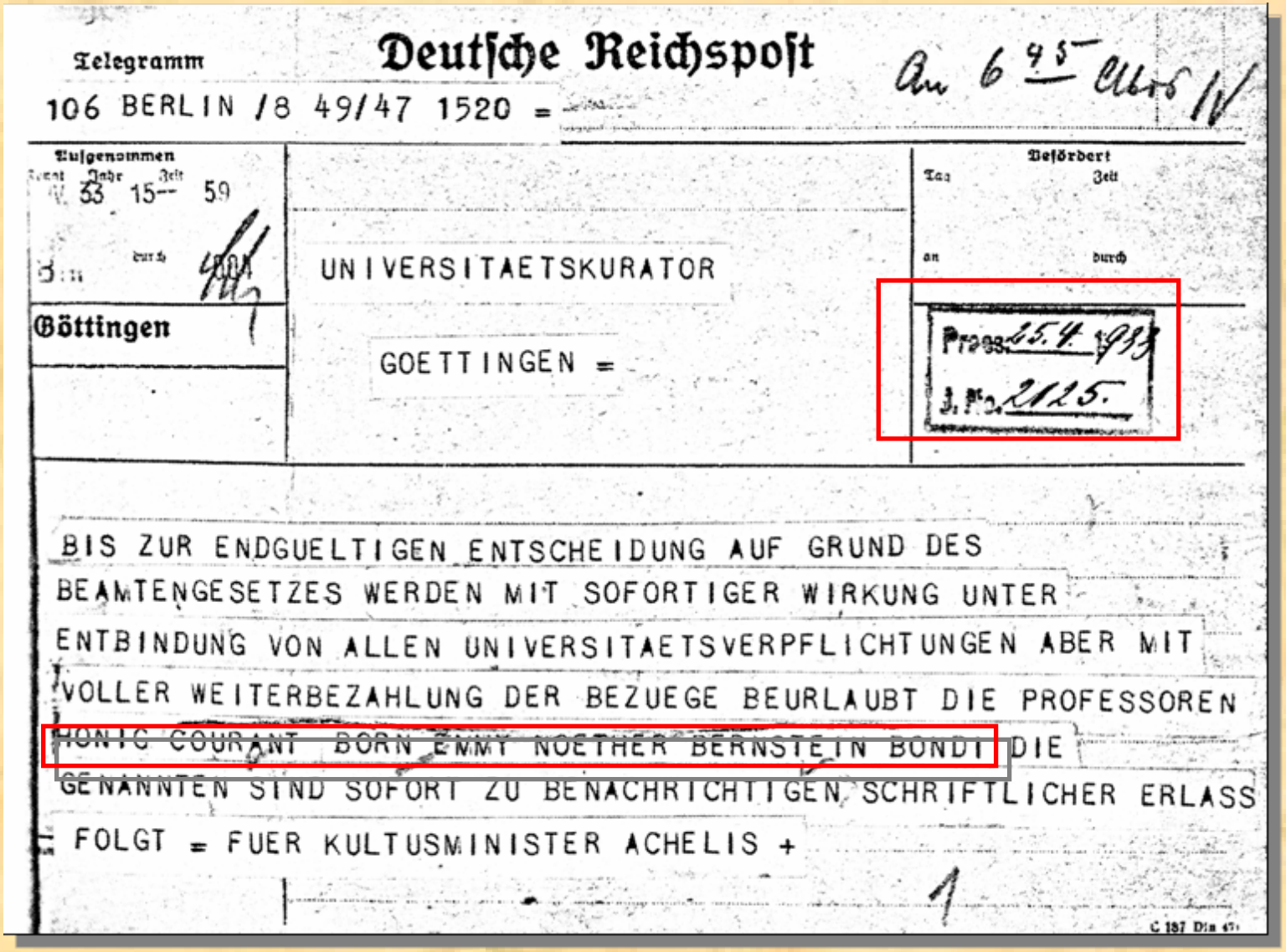
cancelled his position in a letter to the Rector and the Minister, he gave parts open to a newsletter

42 out of **219** **colleagues** **in Göttingen** claimed this letter **in public** as a **„Sabotage of… government“**

Paul Ewald in Stuttgart, 20.4.1933
stepped down from being Rector

Fritz Haber in Berlin, 30.4.1933
stepped down from director of the Kaiser Wilhelm Institute for Physical Chemistry

The End



Telegramm

Deutsche Reichspost

106 BERLIN /8 49/47 1520 =

Aufgenommen
Tag 53 Jahr 15-- Zeit 59
durch

Göttingen

UNIVERSITAETSKURATOR

GOETTINGEN =

Befördert
Tag Zeit
an durch

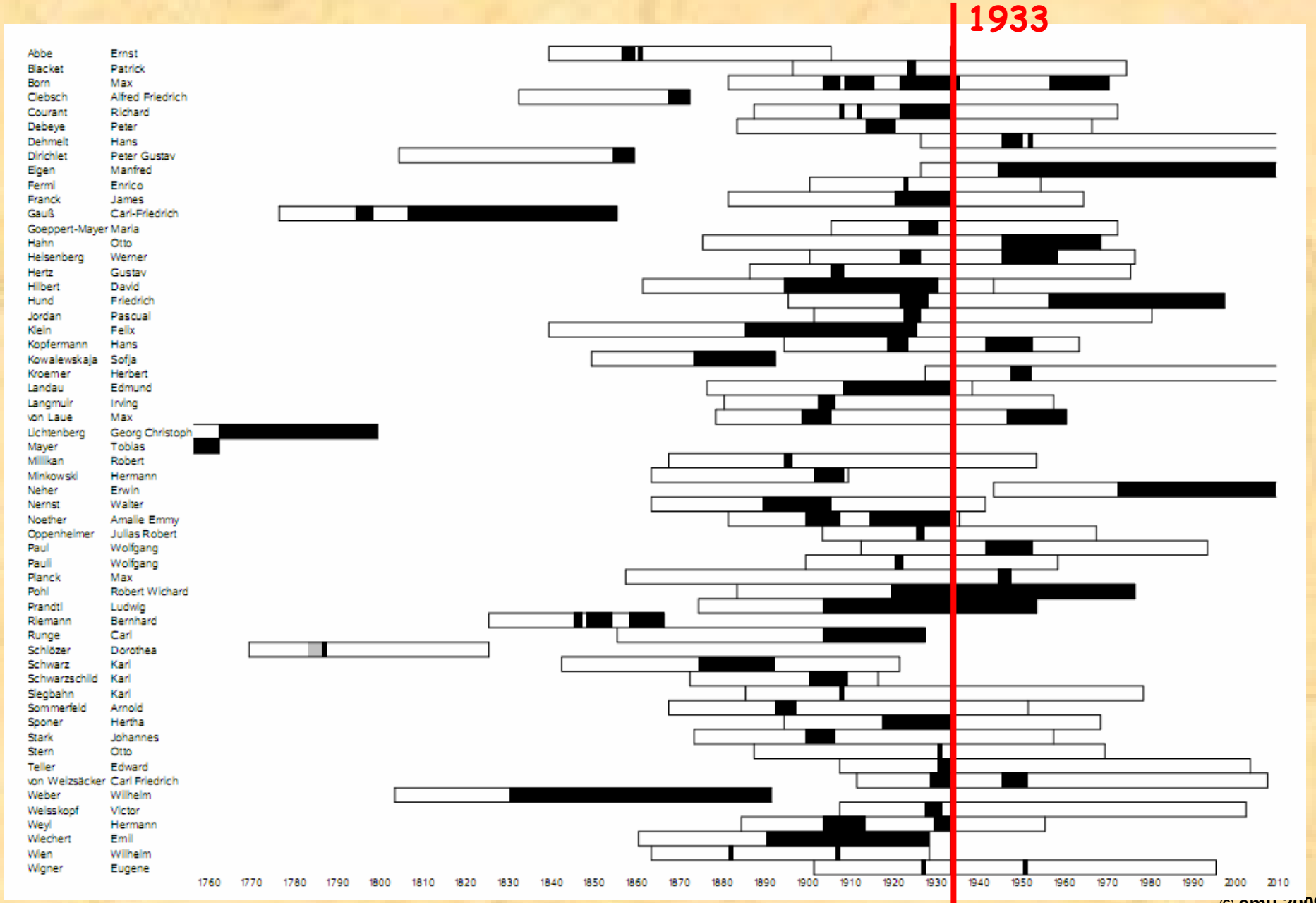
Prees. 25.4. 1933
J. Nr. 2125.

BIS ZUR ENDGUELTIGEN ENTSCHEIDUNG AUF GRUND DES BEAMTENGESETZES WERDEN MIT SOFORTIGER WIRKUNG UNTER ENTBINDUNG VON ALLEN UNIVERSITAETSVERPFLICHTUNGEN ABER MIT VOLLER WEITERBEZAHLUNG DER BEZUEGE BEURLAUBT DIE PROFESSOREN HONIG COURANT BORN EMMY NOETHER BERNSTEIN BONDI DIE GENANNTEN SIND SOFORT ZU BENACHRICHTIGEN. SCHRIFTLICHER ERLASS FOLGT = FUER KULTUSMINISTER ACHELIS +

1

C 187 Din 47

Timeline Famous Scientists



some Statistics

1933 - 1936: 1145 of 7979 teachers **on all Universities** fired = 14.3%
1377 of 10737 (assistents included) = 12.8%

in **physics**: **50 out of ca. 200 = 25%,**
(80% of them emigrated)

in Berlin, **Göttingen,** Hamburg: **the loss was > 40%**

Who stayed and why ?

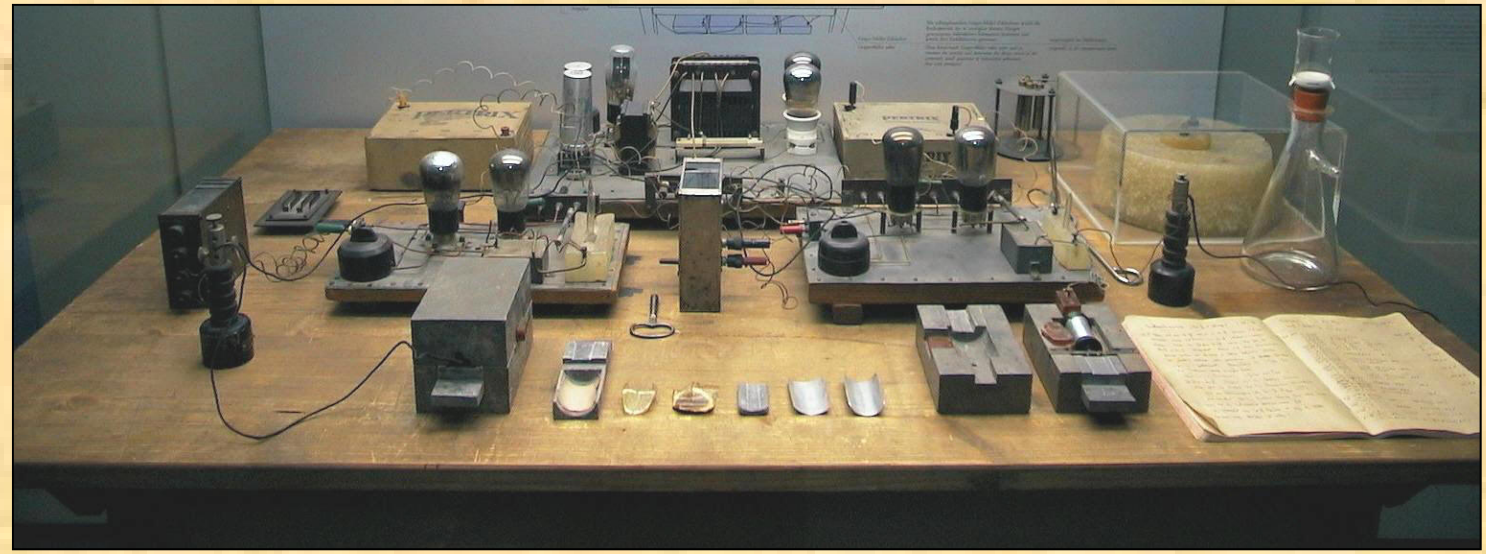
Max Planck
Otto Hahn
Werner Heisenberg
C.F.von Weizsäcker
Max von Laue

Robert Pohl
Friedrich Hund
Hans Kopfermann
Wolfgang Paul
Gustav Hertz

Philip Lenard
Johannes Stark
Georg Joos
Pascual Jordan
Ludwig Prandtl

1938 (Berlin): Nuclear fission, (Hahn + Straßmann)

(tried to produce Transurans by Neutron-capture, publ. 10.2.1939)



Emigrants from Germany feared a Nazi Atomic Bomb:

L. Szilard and **E.Teller** ⟶ A. Einstein ⟶ F. Roosevelt

decision: 2.8.1939 develop an atomic bomb
1944: Manhattan-project

most of„Max Born School“, many emigrants

Did Germany work on a Nazi atomic bomb?

The Army organized **scientists** and **institutes** in the ***Uranium Club***

In 1942 decision against a bomb (?)

9 nuclear physicists from the „Uranium Club“ and Max von Laue were arrested at Farm Hill

Erich Bagge
Walther Gerlach
Paul Harteck
Horst Korsching
Karl Wirtz
Kurt Diebner
Otto Hahn
Werner Heisenberg
Max von Laue
✶**Carl Friedrich von Weizsäcker**

✶ *„The history will remember that Americans and British made the bomb and that the Germans – at the same time – tried to build a reactor“*

Truth or „a version“ ?

End of World War II in Göttingen

24.November 1944:
Bombs destroy the Univ.-Library:
Pauliner-Church
(opening session!)

6.4.1945:
German Army cancels the order of total defence

8.4.1945:
Göttingen handed over to American troops

The University-Hospital and most of the institutes stayed intact and were allowed to operate already in the middle of May 1945

The University startet full service as the first one in Germany already at 14. September 1945

Max Born, James Franck, Robert Pohl:

„Legacy“:

use Quantum Mechanics to:

•

follow the matter to the core …

Atomic Physics ⟶ Nuclear Physics ⟶ High Energy Physics

II. Physikalisches Institut

•

see, how electrons determine macroscopic matter…

Solid State Physics, Metals, Magnetism, Supraconductivity, Low Temp.

I. + IV. Physikalisches Institut, Metallphysik

Can the „Göttingen Spirit“ return?