

# Einstein's "Swiss" Years

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## Why this title ?

Einstein's "Swiss" years, Einstein's "best" (scientific) years

The years when Einstein conceived relativity, special then general

Celebrating in 2015 the hundredth anniversary of Einstein's RG

You are in Switzerland: Einstein (early) became Swiss

You are in Geneva: Einstein's special connexion to Geneva

## Einstein, the "Swiss" years short biography

- (1879: Birth in Ulm, then family moves to Italy)
- 1895: First application to the Swiss Federal Polytechnic (ETH)
- 1896: Argovian cantonal gymnasium, Swiss Matura, second (successful) application to the ETH; resigns his "German" citizenship
- 1900: End of Einstein's ETH curriculum, obtains teaching diploma
- 1901: Einstein's Swiss citizenship
- 1892: Clerk at the Federal Office for Intellectual Property
- 1905: The "Annus Mirabilis"
- 1906: Ph.D. (Zurich university)
- 1908: Lecturer at Bern University
- 1909: Associate professor at Zurich University
- 1911: (April) Ordinary professor at Prague University
- 1912: (August) Ordinary professor at ETH
- 1914: Ordinary professor at Humboldt university, director of the KW institute for physics, Berlin

# The 1905 "Annus Mirabilis" and beyond

Molecular, atomic, statistical physics:

- Statistical treatment of Brownian motion
- Foundations of statistical mechanics
- Various applications

Quanta:

- The corpuscular aspects of light (in the Wien  $\frac{\nu}{T} \rightarrow \infty$  regime)
- The quantum theory of specific heats
- The wave-particle duality for light

Relativity:

- Electrodynamics of moving bodies
- The mass-energy equivalence
- "Relativization" of acceleration

Observe: Relativity is not Einstein's only concern!

# From Relativity to General Relativity I

1907; Delivering more than expected: the review paper for Stark's *Jahrbuch*

- First statement on "equivalence"
- Red shift

A break: Einstein's busy with quantum theory

1911; Getting back to gravitation: equivalence and consequences

- The equivalence: from a statement to a principle
- Red shift revisited
- Non-constant light velocity  $\rightarrow$  deflection of light rays

1912; Light velocity as potential: the scalar theory

- Light velocity as measure of gravitational potential
- A modification of the Poisson (newtonian) equation

## From Relativity to General Relativity II

- 1912; A study with inconspicuous consequences: motion in a static field
- Motion in a static homogeneous field: the Euler-Lagrange form
  - The action element as geometrical "line element":

$$ds^2 = dx^2 + dy^2 + dz^2 - c(x, y, z)^2 dt^2$$

- 1913; Getting the maths right: the Einstein-Grossmann collaboration
- From static homogeneous to general fields, need general transformations  $\rightarrow$  most general form of the line element

$$ds^2 = dx^2 + dy^2 + dz^2 - c(x, y, z)^2 dt^2 \longrightarrow ds^2 = g_{\mu\nu} dx^\mu dx^\nu$$

- 1913; Last minute (but lasting) doubts: general covariance "too much"?
- The *Lochargument*: an undeterminacy of GR equations?

1915; Bye to Switzerland, hello to GR: Berlin's winter 1915 "final rush"

## Einstein's crucial "Swiss" GR papers

Über das Relativitätsprinzip und die aus demselben gezogenen Folgerungen, *Jahrbuch der Radioaktivität und Elektronik*, vol. 4, 411-462, and vol. 5 (1907), 98-99 (corrections).

Über den Einfluss der Schwerkraft auf der Ausbreitung des Lichtes, *Annalen der Physik*, vol.35 (1911), 898-908.

Lichtgeschwindigkeit und Statik des Gravitationsfeldes, *Annalen der Physik*, vol.38 (1912) , 355-369

Zur Theorie des Statischen Gravitationsfeldes, *Annalen der Physik*, vol.38 (1912) , 443-458 (march 1912) and addendum

Entwurf einer verallgemeinerten Relativitätstheorie und einer Theorie der Gravitation, *Zeitschrift für Mathematik und Physik*, vol. 62 (1913), 225-244

# Einstein and SR: need of proper assessment

In the first decade, the meaning of SR yet unclear:

Just a clever reformulation of Lorentz theory  
or  
A much bigger picture?

Symptomatic: SR often dubbed, at the time,  
the "Lorentz-Einstein" theory!

A case of the reception of SR: Ch.-E. Guye experiments in Geneva



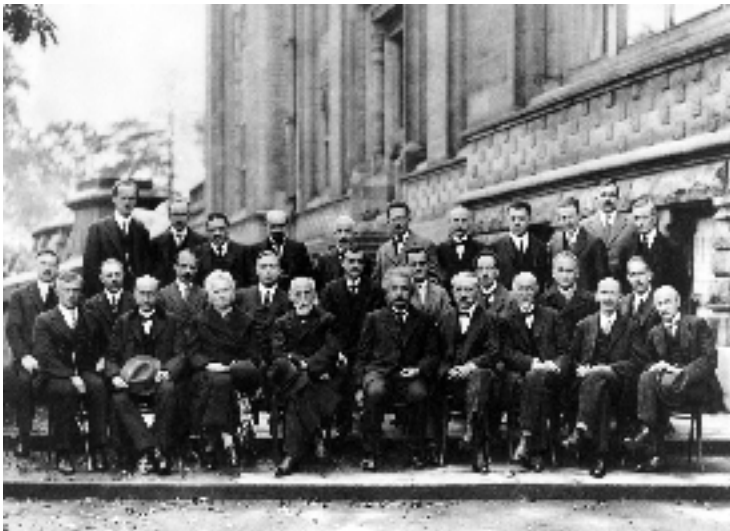


Figure: The Solvay 1927 Conference



Figure: Guye and his Team around 1912

# From "Lorentz-Einstein" theory to SR: the case of Guye

Turn of the century: The Lorentz-Einstein "electron" theory, a candidate for the "electromagnetic world view" (EWW)

The electromagnetic origin of mass: experiments from Kaufmann to Guye (1901-1915)

1909; Guye's partial vindication of the *Lorentz-Einstein* theory: ruling out Abraham's

1915; Guye's full vindication of *Einstein's* theory: more than just an EWW theory

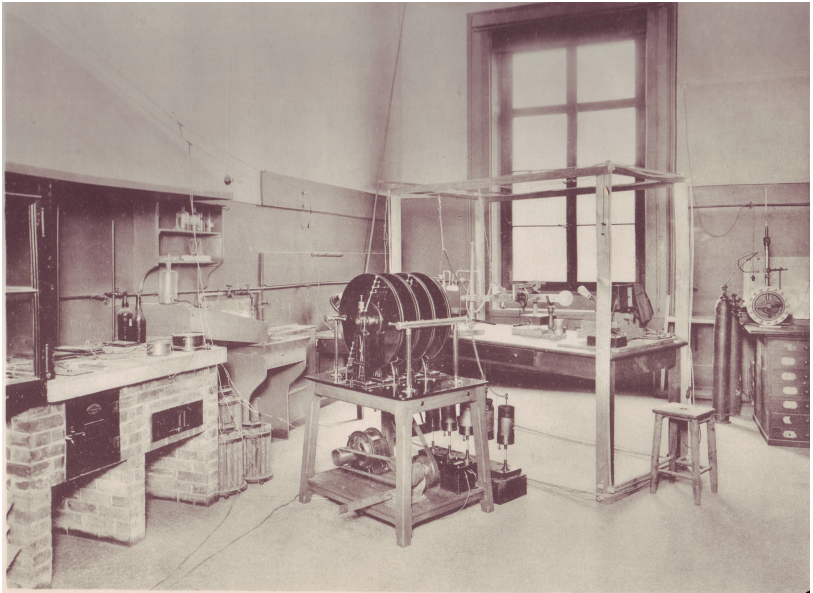


Figure: Guye's experimental setup (Bastions premises)



Figure: Guye's feat remembered

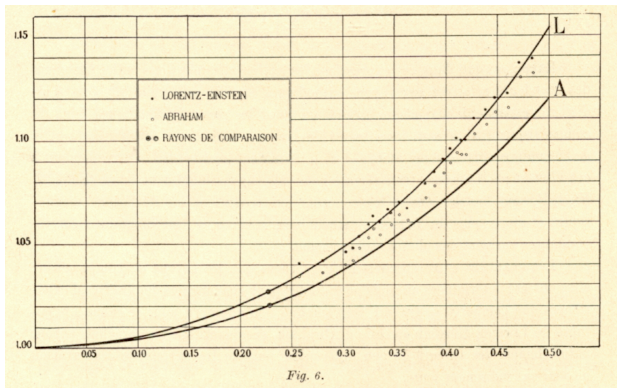


Figure: Vindicating Lorentz-Einstein

Prof. Dr. A. Einstein

Berlin W. 30, den 12. Jan. 20.  
Haberlanstr. 5.

Herrn

Prof. Dr. C. E. Guye

Genf.

Lieber Kollege!

Ihre freundliche Aufforderung hat mich sehr gefreut. Sobald ich wieder in die Schweiz komme, was sich wohl im Laufe des nächsten halben Jahres ermöglichen lassen wird, werde ich Ihrem Wunsche gern nachkommen. Es wird mir eine grosse Freude sein, nach so vielen Jahren Genf wiederzusehen, das zu der glücklichen Rolle auserkoren ist, Sitz des Völkerbundes zu werden.

Ihre Untersuchung über die Elektronenbewegung gehört nach meiner Ansicht zu den wichtigsten Bestätigungen der speziellen Relativitätstheorie. Ich erinnere mich nicht, ob ich Ihnen jemals meine Freude über das Gelingen dieser feinen Untersuchung ausgesprochen habe.

In der Vorfreude Sie und die andern Genfer Kollegen bald wiederzusehen, bin ich mit herzlichen Grüssen

Ihr

A. Einstein



Einstein to Guye, January 12th, 1920

Your gracious invitation made me very happy [...] It will be a great joy to see Geneva again since all these years, the City which was chosen to host the Society of Nations.

Your investigations on the motion of the electrons rank, to my opinion, among the most important confirmations of special relativity. I do not remember anymore if I told you the joy that your success brought to me. Looking forward seeing you and your Genevan Colleagues, with my best wishes, A. Einstein.



## Einstein's (public) fame: started in Geneva?

1909: Celebrating the 350th anniversary of Calvin's Academy

Many Honoris Causa nominees

The issue of nationalities: need to keep balance

Guye nominates "Mr. Einstein, physicist from Bern"

Einstein's very first Honoris Causa!

Guye and Einstein, a lasting relation

Thank you

and

My best wishes for a successfull

28th Texas Symposium