A. Whitehead's *Principle of Relativity*

Ronny Desmet

Paris, 21 oct. 2011

Introduction

- A. N. Whitehead: 1861-1947
- Einstein's general theory of relativity: 1916
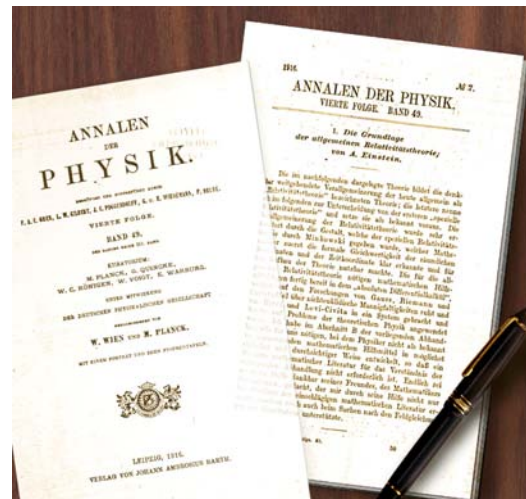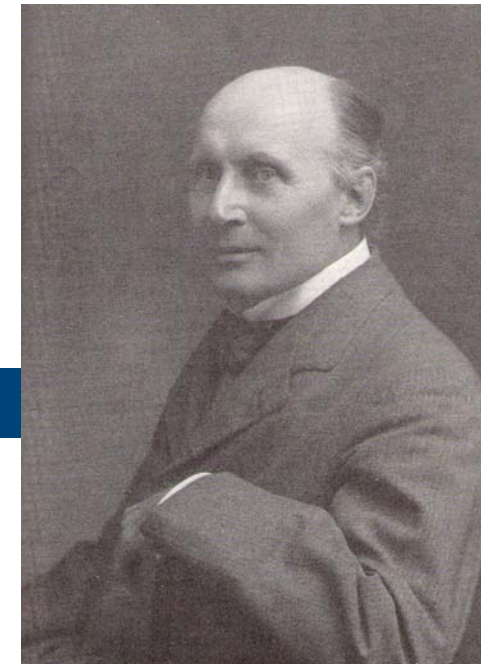
The
Principle of Relativity
with applications to
Physical Science

BY

A. N. WHITEHEAD, Sc.D., F.R.S.
Hon. D.Sc. (MANCHESTER), Hon. LL.D. (ST ANDREWS)
Fellow of Trinity College, Cambridge, and Professor of
Applied Mathematics in the Imperial College
of Science and Technology

CAMBRIDGE
AT THE UNIVERSITY PRESS
1922

- Whitehead's alternative theory of relativity: 1922

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Overview of the presentation

- Whitehead's critique of Einstein = **philosophy**, no physics

  ==> common sense

- Whitehead's distinction between pure **mathematics** and interpretation

  ==> interpretative freedom

- Whitehead and the British **physics** context

  ==> conceptual reorganisation

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1. Whitehead's philosophical critique of Einstein

"In all I have written, I have been trying to express common sense."

A.N. Whitehead

Indeed:

"L'impératif qui a fait exister Whitehead comme philosophe spéculatif n'est autre que celui-là: apprendre à résister aux pouvoir des théories qui font taire le sens commun."

I. Stengers

Notice: common sense is NOT gesunder Menschenverstand BUT Gemeinsinn (cf. Arendt), it is NOT bon sens BUT sens commun (cf. Stengers)

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Harmonisation with common sense
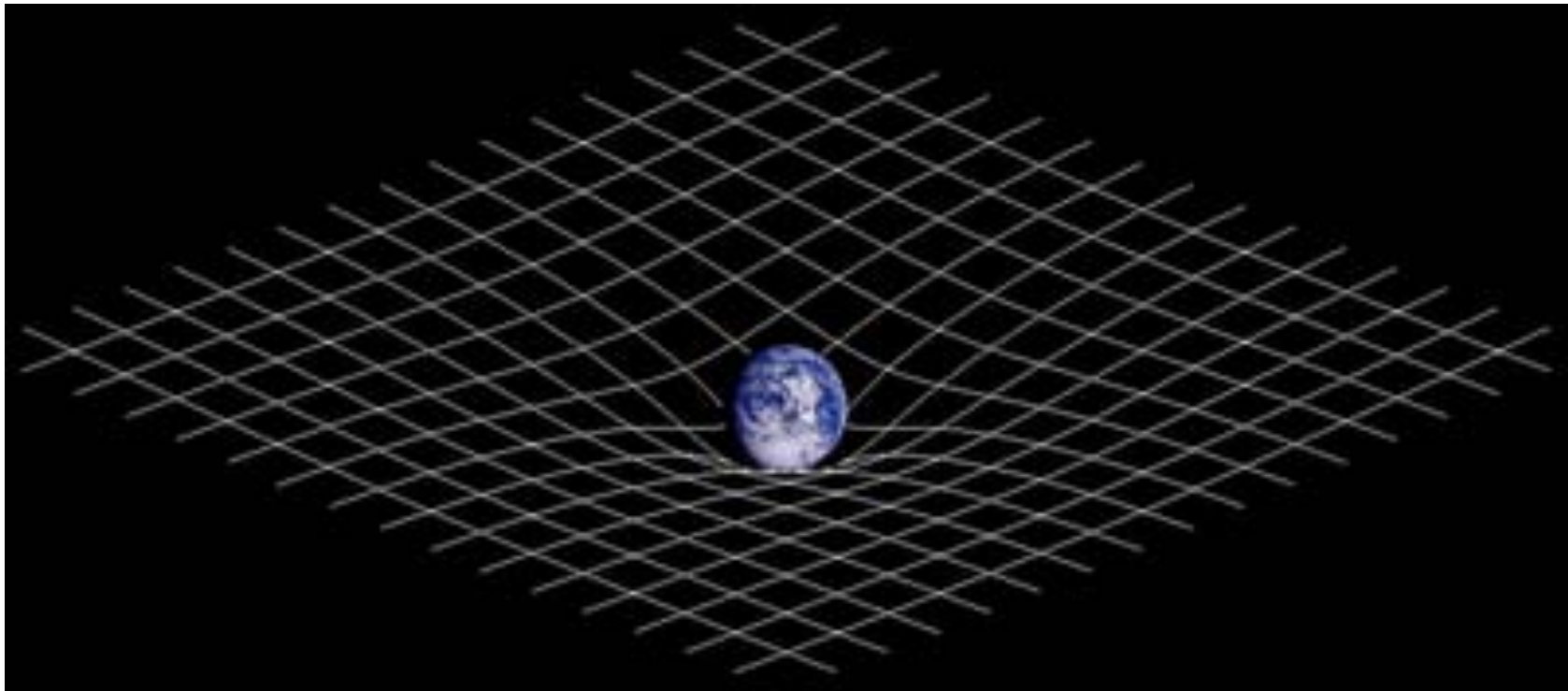
- Not with contingent beliefs
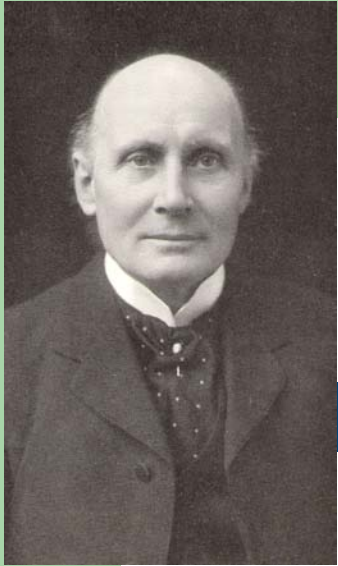- But with inevitable presuppositions

==> common sense = compass:

If a theory explicitly denies what is implicitly and inevitably presupposed in practice

then that theory should be revised

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Interludium 1

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Whitehead >< Einstein

- Einstein explicitly denies that space-time is independent from gravitation, and that it is uniform

- BUT Whitehead shows that the practice
  - of solving Einstein's equations
  - of measuring Einstein's predictions

  implicitly presupposes that independency and uniformity

- HENCE: Einstein's theory should be revised

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Interludium 2a : solving

Einstein's equation:
$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -\frac{8\pi\gamma}{c^4} T_{\mu\nu}$$

- In case of dust: $T_{\mu\nu} = \rho_0 v^\mu v^\nu$

- In case of perfect Fluid: $T_{\mu\nu} = \left(\rho_0 + \frac{p}{c^2} \right) v^\mu v^\nu - g_{\mu\nu} p$
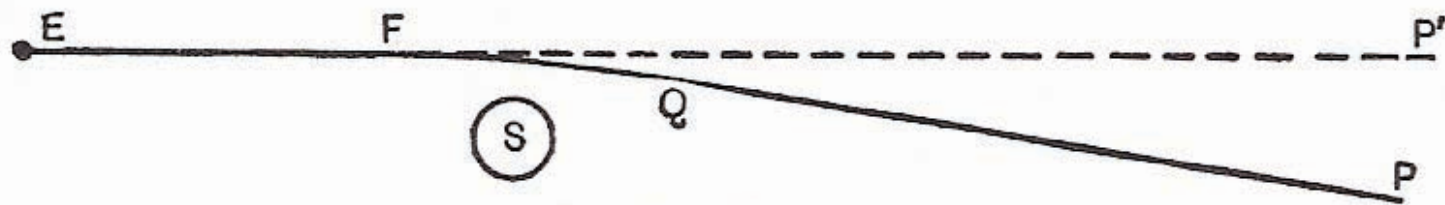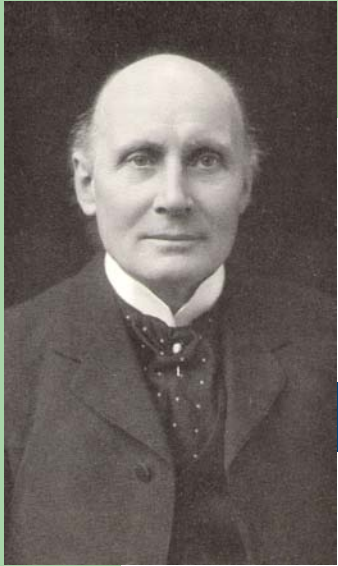
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Interludium 2b : measuring

FIG. 16.

Whitehead >< Einstein

- Einstein's bifurcation: the <u>theoretical</u> world of objective science >< the <u>practical</u> world of subjective perception and common sense

- Whitehead's protest in his words: "we must bow to those presumptions, which, in despite of criticism, we still employ for the regulation of our lives," and in the words of I. Stengers: "Il s'agit de résister aux théories qui font violence à ce que nous ne pouvons nous empêcher de croire."

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2. Whitehead's distinction between pure math and interpretation

- Pure mathematics = the study of relational patterns (or structures) in abstraction of the particularity of the relata

  - Whitehead's *Universal Algebra*:

  instrument of pure mathematics = algebra

  - Whitehead's *Principia Mathematica*:

  instrument of pure mathematics = logic

- Interpretation = indication of particular things, which together embody (or instantiate) a relational pattern (or structure)

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Pure geometry >< spatial interpretation

- Pure geometry = study of geometrical patterns in abstraction of all particularity of the things studied, and hence, also in abstraction of their spaciness, shape-iness, etc. In Whiteheads words: "The 'spaciness of space' and the 'shapi-ness of shapes', *e.g.*, circularity, sphericity, and cubicality ... do not enter into the geometrical reasoning."

- The spatial interpretation, "for all its overwhelming importance, is but an example." HENCE: other interpretations are possible
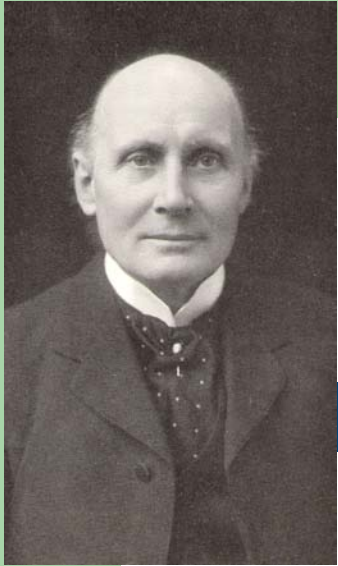
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Interludium 3 : shapi-ness

- Pythagorean distance function ==> sphericity

$$\sqrt{(x-u)^2 + (y-v)^2 + (z-w)^2}$$

- Maximum distance function ==> cubicality

$$\max\left\{\sqrt{(x-u)^2}, \sqrt{(y-v)^2}, \sqrt{(z-w)^2}\right\}$$

Whitehead >< Einstein

The geometrical pattern of the gravitational field

- is given a spatial interpretion by Einstein:
  gravitation = variably curved space-time

- is given a physical interpretation by Whitehead:
  gravitation = action or impetus different from, but
  against the background of, uniform space-time

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3. The British physics-context: special theory of relativity (STR)

1905   ==>   1908   ==>   1914   ==> 1919-1920
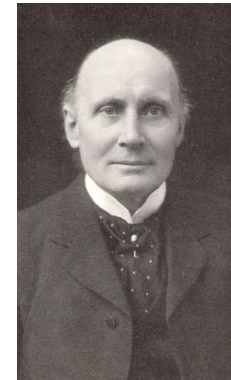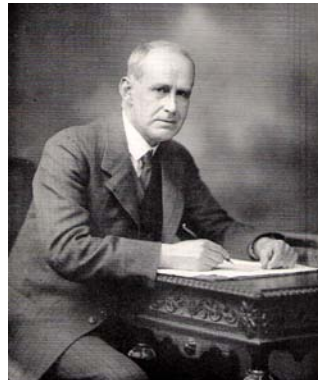Einstein ==> Minkowksi ==> Silberstein & Cunningham ==> Whitehead

Principles of Natural Knowledge (1919) & *Concept of Nature* (1920):

uniform spatio-temporal texture of experience ==> space-time of STR

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The British physics-context: general theory of relativity (GTR)

| 1916 | ==> | 1916 | ==> | 1916 | ==> | 1922 |
| Einstein | ==> | de Sitter | ==> | Eddington | ==> | Whitehead |

Principle of Relativity (1922) = alternative GTR:

conceptual reconstruction ==> gravitation = action or impetus

in the space-time of STR

Ingredients of the conceptual reconstruction

- Routh & Niven: analogical application of retarded potentials and of the principle of least action in various branches of physics
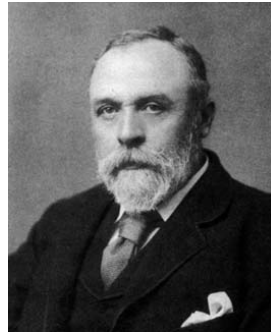
- Minkowski & Cunningham: the analogy between gravitation and electomagnetism

- Silberstein: failed attempt to undo Einstein's identification of gravitation and space-time

- Einstein's GTR as the theory to approach

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Result of the conceptual reconstruction

Whitehead's theory =

- empirically almost equivalent to E's GTR
  (cf. Gary Gibbons & Clifford Will)

- coherent with common sense
  (cf. Richard Feynman & Ilya Prigogine)

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Interludium 4a : ANW's space-time line element (metric tensor)

$$ds^2 = \eta_{\mu\nu}\, dx^\mu\, dx^\nu$$

Interludium 4b : ANW's gravitational wave equation

$$\Delta \varphi_M - \frac{1}{c^2} \frac{\partial^2 \varphi_M}{\partial t^2} = 0$$

Interludium 4c : ANW's gravitational potential

$$\varphi_M = \frac{\gamma M}{\left(1 - \frac{\vec{v}_M^2}{c^2}\right)^{-\frac{1}{2}}\left(r - \frac{\vec{v}_M \cdot \vec{r}}{c}\right)_{ret}}$$
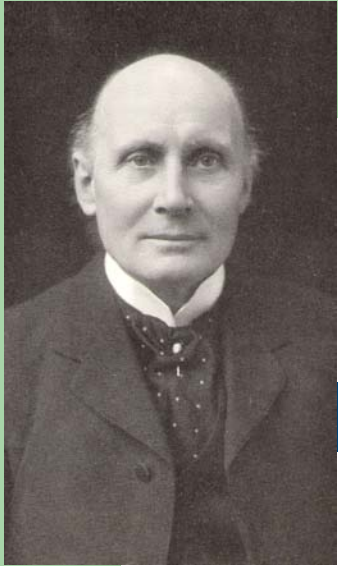
Interludium 4d: ANW's impetus line element (impetus tensor)

$$dI = m\left(ds^2 - \frac{2}{c^2}\sum_M \varphi_M dS^2 \right)^{\frac{1}{2}}$$

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Interludium 4e : ANW's gravitational equation of motion

$$\delta \int dI = 0$$

Whitehead >< Einstein

HALDANE AND EINSTEIN, 1921

Whitehead - Haldane - letter of May 26, 1921