

# **A PLEA FOR A MODERATE ANTI-JUSTIFICATIONISM**

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# Varieties of anti-justificationism

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- Radical anti-justificationism: inductive inference is (logically) unjustifiable in principle (D. Hume, K. Popper);
  - Moderate anti-justificationism: there is no need for a general justification of inductive inference, because induction, “as a fundamental mode of inquiry”, “must stand without further justification” (J. Norton). However, particular inductive generalizations might be justified by adding some “material postulates” to their premises.
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# IN THIS TALK:

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I am going to

- promote a stronger version of the moderate anti-justificationsim, such that holds an additional claim;
  - give examples in support of the additional claim
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# The claims shared with Norton's anti-justificationism

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- There is no need of general justification of inductive inference;
  - Local inductions allow strengthening by adding extra-assumptions to their premises;
  - Local strengthening of inductive inference is broadly used in scientific practice;
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# The additional claim:

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The strengthening of inductive generalizations by means of additional assumptions might have negative effects because:

Strengthened generalizations

- are resistant to empirical revision;
  - make scientists blind to important empirical evidence.
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# EXAMPLE 1: Are the swan-like black birds swans?

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The statement

(A) All swans are white.

is a generalization of the *factual* statement

(B) All *observed* swans are white.

The inference  $(B) \rightarrow (A)$  is logically invalid.

However,  $(B) + (C) \rightarrow (A)$  is a valid inference, if (C) is the following statement:

(C) Color is an essential property for swans, i.e. all swans must have the same color.

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# The resistance of strengthened generalizations to empirical revision

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The observation of a black swan-like bird cannot not lead to revision of the generalization

(A) All swans are white.

because (A) has been strengthened by

(C) Color is an essential property for swans  
(all swans have the same color)

and (A) + (C) implies that

(D) Black swan-like birds are not swans

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## **EXAMPLE 2:**

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**Are the cathode rays  
waves?**

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# The discovery of the cathode rays

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- 1857 – *Julius Plücker* reported that during the electrical discharge in a vacuum-tube a part of the glass wall near the cathode became phosphorescent. He also put on the record two important facts:
    - The observed glow could be deflected by magnetic force;
    - Particles of the platinum cathode were found on the glass of the tube near the cathode;
  
  - 1869 – Plücker's student *Johann Hittorf* added to these observations the following facts:
    - The observed rays follow straight lines;
    - They cast shadows;
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# The formation of two rival hypotheses

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- 1871 – the electrical engineer *Cromwell Fleetwood Varley* launched the first hypothesis about what the new rays might be. According to this hypothesis the rays are “*attenuated particles of matter, projected from the negative pole by electricity*”.
  - 1876 – *Eugen Goldstein* launched a different hypothesis – that the cathode rays were “*electromagnetic waves similar to light*”.
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# Attempts to prove the rival hypotheses

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- 1879 – in his Bakerian lecture *William Crookes* reported the results of experiments, which seemed to him to provide definitive proof of the corpuscular nature of cathode rays. These included obtaining a sharply defined shadow of a metal Maltese Cross on the wall of the glass tube behind the cross, and observation of the movement of a tiny paddle wheel put in the beam of the cathode rays. Crookes spoke of having discovered a fourth state of aggregation (“radiant matter”)
  - 1884 – *Heinrich Hertz* seemed to show that an electric field had no effect on the cathode rays. This he regarded as a crucial argument against the claim that the cathode rays consist of charged particles.
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# The 90's: the crucial decade for the debate on the cathode rays

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- 1892 – **Hertz** discovered another wave phenomenon – that “the cathodic rays are able to penetrate thin metallic leaves and they issue from them in a state of diffusion, like light passing through a turbid medium, e.g. opal glass”.
  - 1894 – **J.J. Thomson** succeeded to measure the speed of cathode rays and showed that they move much slower than light
  - 1895 – **Jean Perrin** showed that when cathode rays hit a metal plate the plate becomes negatively charged.
  - 1897 – **Walter Kaufmann** in Germany and **J.J. Thomson** in England succeeded to measure the ratio  $e/m$  for the alleged particles constituting the cathode rays.
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# The time-series in brief:

1857 – Plücker discovered the cathode rays (CR)

1864 – Maxwell's "Dynamical theory of the electromagnetic field"

1871 – Varley suggested that CR were "attenuated particles of matter"

1871 – Rayleigh's theory of scattering of light was published

1876 – Goldstein claimed that CR were "electromagnetic waves similar to light".

1892 – Hertz discovered that CR penetrate thin metallic leaves and issue from them in a state of diffusion

1894 – J. J. Thomson measured the speed of CR and discovered that it is about 1/3 of the speed of light.

1897 – Kaufmann and Thomson measured the ratio  $e/m$

# 1894: the crucial year?

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This is the claim of the mainstream historians of science:

- [Sarton, 1937]: “The Herzian or Lenardian conception of cathodic rays as aetherial waves became untenable when J. J. Thomson measured their speed by means of rotating mirror and found that it was variable but always materially smaller than the speed of light”
  - [Gribbin, 2002]: “Evidence that cathode rays could not simply be a form of electromagnetic radiation came in 1894, when J. J. Thomson, in England, showed that they move much more slowly than light (remember, Maxwell’s equation tell us that all electromagnetic radiation moves at the speed of light)”.
  - [Errede, 2005]: “1894: J. J. Thomson measures the speed of cathode rays and shows that they travel much more slowly than the speed of light. The aether model of cathode rays begins to die”.
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**The logic behind the claim that the measurement of the speed of CR showed that the wave view of CR was untenable is exactly the same as that forcing us to conclude on the basis of**

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(A) All swans are white.

and

(C) Color is an essential property for swans (all swans have the same color)

that

(D) Black swan-like birds are not swans

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**In order to see that we should just replace “swans” with “electromagnetic waves”, “color” with “speed”, “white” with “have a speed  $c$ ” and “black” with “have a speed much less than  $c$ ”.**

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(A) All electromagnetic waves (EMW) have a speed  $c$  in vacuum.

and

(C) The constant speed is an essential property for EMW (all EMW must have the same speed)

therefore,

(D) Cathode rays which have a speed much less than  $c$  are not waves

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# Thomson himself did not view his 1894 results as a crucial argument against the wave-aetherial conception of CR

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In the introduction of his 1897 paper J. J. Thomson wrote the following:

*"It would seem at first sight that it ought not be difficult to discriminate between views so different, yet experience shows that this is not the case..."*

The main advantage of electrified-particle theory over the wave-aetherial theory he saw in that

*"it is definite and its consequences can be predicted; with the aetherial theory it is impossible to predict what will happen under any given circumstances, as on this theory we are dealing with hitherto unobserved phenomena in the aether..."*

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**Those who were interested to defend the wave conception of CR and who had the evidence to do that, had taken the conclusions based on strengthened generalizations too seriously.**

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Philipp Lenard, the student of Hertz who confirmed the diffusion of CR passing through thin metallic sheets believed that he has crucial arguments for the claims that

- CR are an aetherial, not material, phenomenon
  - CR are not waves, they have a discrete character, i.e. they consist of quanta of pure electricity just as matter consists of atoms.
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# Lenard's arguments based on strengthened inductive generalizations

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All aetherial processes take place in vacuum.

(Strengthening assumption: being able to proceed in vacuum is an essential property of the processes in aether)

CR do pass through a vacuum-tube.

Therefore, they are an aetherial phenomenon.

Waves always interfere under certain conditions.

(Strengthening assumption: Interference is an essential characteristic of waves.)

Two beams of CR do not interfere.

Therefore CR are not waves

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## As a result, the scattering of CR by metal sheets was recognized as an evidence for the wave nature of electrons 30 years later.

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- 1924 – Luis de Broglie inferred theoretically the wave properties of the electron. According to his equations, electrons ought to have just the right wavelengths to be diffracted from crystal lattices.
  - 1927 – C. Davisson and L. Germer reported that the specific reflection and refraction phenomena, which have been observed when a homogeneous beam of electrons is scattered by a crystal of nickel could be explained in terms of wave mechanics.
  - 1927 – G. P. Thomson succeeded to obtain a picture of diffracted electrons, which confirmed the prediction of de Broglie.
  - 1937 – Davisson and G. Thomson shared the Nobel prize for the experimental proof of the wave properties of the electron.
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# CONCLUSIONS

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- ❑ Strengthened inductive generalizations are indeed broadly used by scientists but not by all of them. The comparison between J.J. Thomson and Ph. Lenard reveals that reliance on strengthened inductions is rather a matter of personal style of reasoning;
  - ❑ Strengthened inductive generalizations are resistant to empirical revision;
  - ❑ Strengthened inductive generalizations exert blinding effect on scientist who embrace them in respect to empirical data, which might falsify the generalization if it were not strengthened;
  - ❑ The revisability of inductive generalizations is their main value, it is not their main flaw;
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## The motto of this conference was:

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“what distinguishes science from all other human endeavors is that the accounts of the world that our best, mature sciences deliver are *strongly supported by evidence and this evidence* gives us the strongest reason to believe them”

## Now I am tempted to reformulate it in the following way:

“what distinguishes science from all other human endeavors is that the accounts of the world that our best, mature sciences deliver are *susceptible to empirical revision and the fact that they have survived so far* gives us the strongest reason to believe them”

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**Thank you!**

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