INTELLIGIBILITY AND METAPHYSICS: UNDERSTANDING GRAVITATION

Henk W. de Regt
Department of Philosophy
VU University Amsterdam

Workshop *Scientific Reasoning in Action – From the Early Modern Period to 1900*
Ghent, 10-12 October 2018

Outline

Question: How does metaphysics relate to scientific understanding?

1. My philosophical theory of scientific understanding
2. Historical episode: debates about intelligibility of Newton's theory of gravitation
3. Two interpretations of the episode: Frank vs. Cushing
4. Conclusion: metaphysics and the limits of understanding

Understanding phenomena requires intelligible theories

If scientists **S** wants to understand a phenomenon on the basis of theory **T,** she needs appropriate skills to use **T**

➔ **T** should be *intelligible* to **S**

Intelligibility = value that scientists attribute to qualities of theory **T** that facilitate its use.

- Not an intrinsic property of theories, but a context-dependent value related to scientists' skills
- Example: visualizability

Understanding and intelligibility

CUP: Criterion for Understanding Phenomena

- A phenomenon P is understood scientifically iff there is an explanation of P that is based on an intelligible theory T and conforms to the basic epistemic values of empirical adequacy and internal consistency.

Intelligibility of theories

- Intelligibility is contextual – scientists in different contexts value different theoretical qualities as ‘tools’ for understanding.

Metaphysics & understanding

Traditional views:

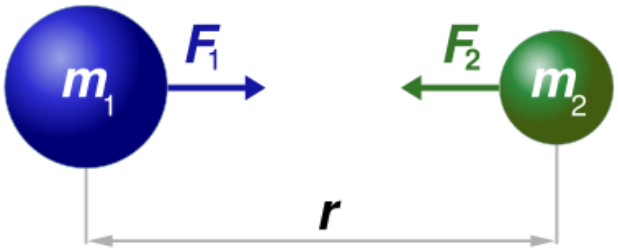
- Descartes' rationalism: metaphysics provides intelligible first principles.
- Salmon's ontic conception: explanatory understanding is gained by uncovering the causal structure of the world.

From the perspective of my account:

- How do metaphysics and scientific understanding relate?
- Does metaphysics pose a limit to understanding?

HISTORICAL CASE: UNDERSTANDING NEWTONIAN GRAVITATION

Newton's theory of gravitation (1687)



$$F_1 = F_2 = G\frac{m_1 \times m_2}{r^2}$$

- Suggests action at a distance
- A relapse into magical worldview with occult qualities?
- Criticized as unintelligible by Cartesians, and even by Newton himself…

Christiaan Huygens on understanding gravity

"I search for an intelligible cause of gravity, as it seems to me that it would be saying as much as nothing when attributing the cause why heavy bodies descend to the earth to some attractive quality of the earth or of these bodies themselves."

(1669)

Intelligibility = accordance with Cartesian metaphysics

Newton on understanding gravity

"It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon, and affect other matter without mutual contact." (1693)

Inconceivability = ?

Was Newton a Cartesian like Huygens?

Newton's road to his theory

- **Early Newton** followed Descartes but was not a hardcore Cartesian – also interested in alchemy, magnetism, etc.
- **1666 work on gravitation**: he derived inverse-square law, but no centripetal force or mutual attraction
- ***Principia* (1687)**: full-fledged theory of gravitation – gravity is a centripetal force that exists in all bodies universally and obeys inverse-square law.
  - However: *hypotheses non fingo* ("I feign no hypotheses") as to the cause of gravity.
  - But this does not imply that Newton wasn't interested in this cause, on the contrary!

Newton on the cause of gravitation

Cartesian mechanical explanation is impossible

> "[Gravity] arises from some cause that penetrates as far as the centers of the sun and planets, without any diminution of its power to act, and that acts not in proportion to the quantity of the *surfaces* of the particles upon which it acts (as mechanical causes are wont to do), but in proportion to the quantity of *solid* matter […]." (*Principia*, 2nd ed. 1713).

But gravity cannot be an inherent property of matter

> "That gravity should be innate, inherent and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else [...] is to me a great absurdity, and I believe that no man who has in philosophical matters a competent faculty of thinking, can ever fall into it." (1693 letter)

Newton on the cause of gravitation

Speculations: “very subtle spirit”, “rare elastic ether”

Did Newton consider action at a distance unintelligible?

- No, he only rejected the idea of gravity as an essential property of matter – instead he saw God as metaphysical cause of gravitation (“the mediation of something else, which is not material”)

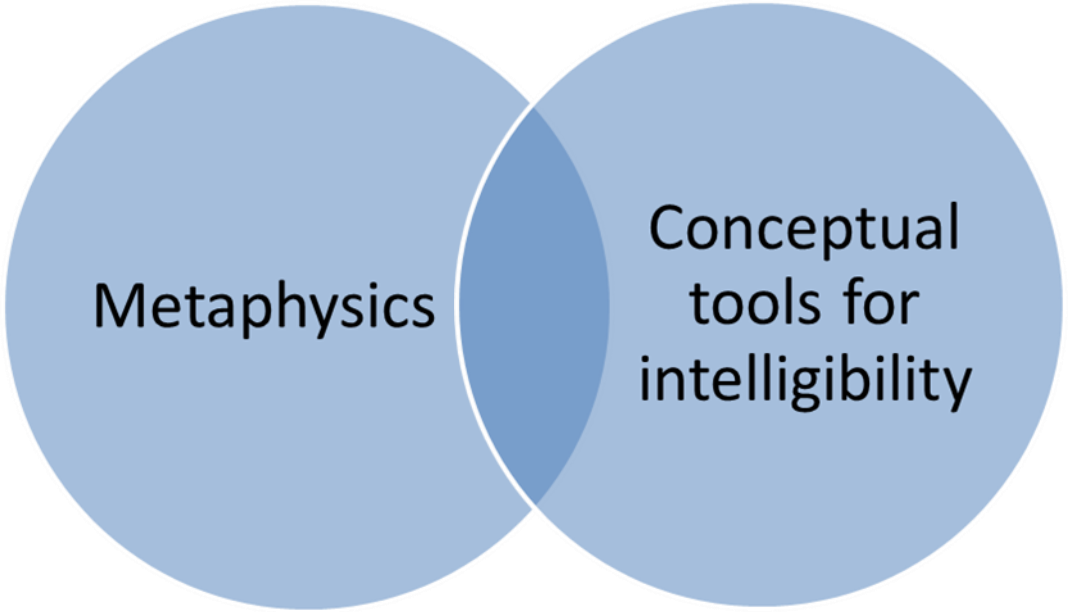
Newton, like the Cartesians, interpreted ‘intelligibility’ as

- **metaphysical intelligibility** = ‘harmony with accepted metaphysics”

which differs from

- **scientific intelligibility** = value attributed to theoretical qualities that facilitate use of the theory

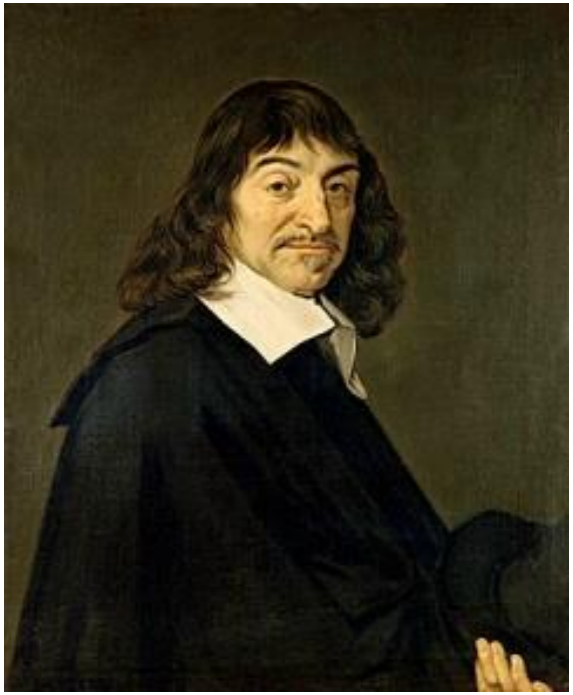
Metaphysical & scientific intelligibility



- Metaphysics can provide tools to render a theory scientifically intelligible
- Successful application of tools can in turn bolster metaphysics → canonization (as happened with Huygens)

Huygens as a (critical) Cartesian

"One understood what M. Descartes said, instead of the other philosophers who gave us words that made nothing comprehensible, [and] he dared to substitute for it causes which one can comprehend of all there is in nature" (1693).



Huygens and the mechanical philosophy

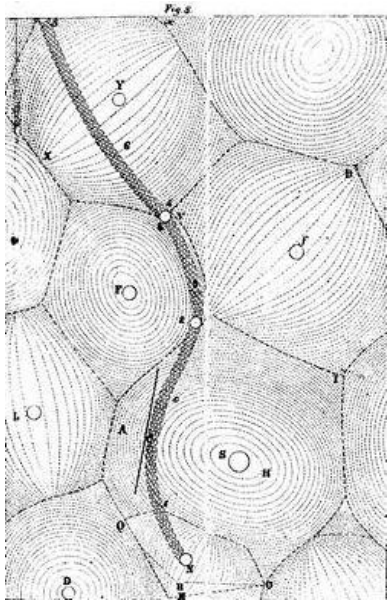
"… the true Philosophy, in which one comprehends the cause of all natural effects by reasons of mechanics. This is what must be done in my view, or else give up all hope of ever comprehending anything in physics." (1690)

Fertility of Cartesian mechanical philosophy:

- Huygens: whatever cannot be expressed in terms of size, shape & motion escapes mathematical treatment
- Huygens' laws of mechanics (1656), ether theory of gravitation (1669), and wave theory of light (1690)

➔Conceptual tools for understanding

➔Scientific intelligibility



Metaphysics & understanding gravitation

Huygens:

- Cartesian mechanical philosophy as source of tools for scientific understanding
- Successes led to canonization into metaphysics

Newton:

- Less committed to Cartesian metaphysics
- His alternative ‘divine metaphysics’ didn’t supply tools
- Scientific intelligibility: qualitative reasoning with action at a distance (tides, moon test)

18th-century: action at a distance canonized in metaphysics

Intelligibility around 1800

- Action-at-a-distance ideal of intelligibility: Kant, Laplace, Helmholtz
- John Leslie: “to maintain *that no body can act where it is not*, is in fact to assert that the same body can be in two places at the same time; which is a contradiction in terms, and therefore completely absurd.”
- Successful tool for scientific understanding, e.g. Coulomb’s law of electrical attraction and repulsion.

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$$

Two interpretations of this development

Positivists (Ernst Mach, Philipp Frank):

"The Newtonian theory of gravitation, on its appearance, disturbed almost all investigators of nature because it was founded on an uncommon unintelligibility. People tried to reduce gravitation to pressure and impact. At the present day gravitation no longer disturbs anybody: it has become a common unintelligibility (Mach 1872)

→ The demand for intelligibility is merely a hindrance to scientific progress.

James Cushing (1994)

"Newton's law gives us no understanding of what physical process causes the planet to follow an elliptical orbit."

"Action at a distance was "a failed attempt at intelligible explanatory discourse" and was "essentially bracketed as a problem for two hundred years or so."

→ There exist universal standards of intelligibility (causality, visualizability, locality)

Both interpretations are incorrect

- Metaphysics not merely a hindrance to scientific progress, as the positivists think – it can supply tools to render theories intelligible.
  - Positivists wrongly regard the production of empirical success as unproblematic – it requires intelligible theories that can be used by skilled scientists.

- Cushing neglects the contextuality and historical variation of intelligibility criteria.
  - He fails to see that Newton's theory of gravitation rightly acquired the status of a scientifically intelligible theory, and that action-at-a-distance tools generated novel explanations of phenomena.

Conclusion: metaphysics and scientific understanding

Scientific understanding is contextual:

- The (historical, social, disciplinary) context determines the limits of understanding.
- What can be understood depends on the skills of scientists and the available tools for rendering theories intelligible.
- Metaphysics is part of this context, and supplies conceptual tools.
- As the context changes, the limits of scientific understanding will change as well.