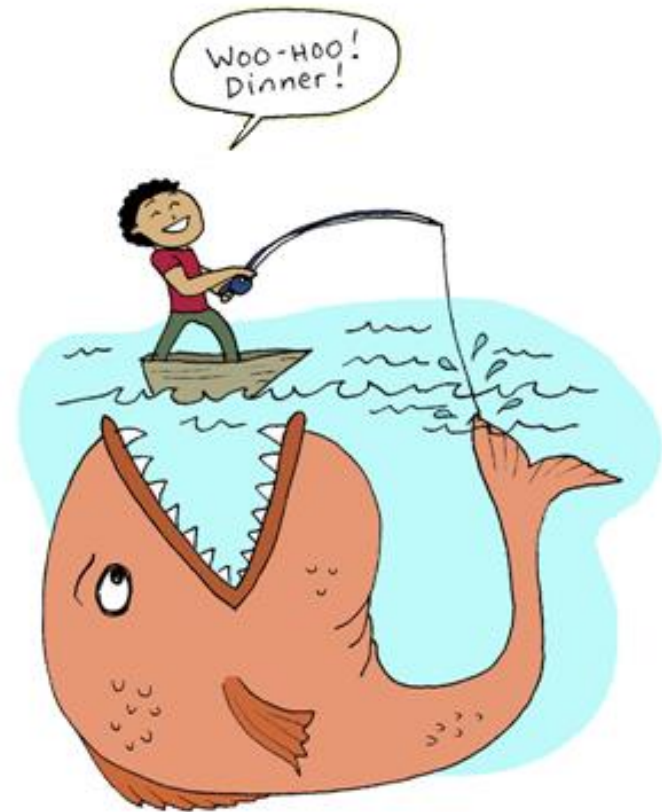


Rationalism and Empiricism

Is observation
enough?



Rationalism

- Rationalists hold at least one of the following:
 1. Rational intuition
 - Humans know some *substantial* facts about the external world by a non-perceptual faculty of “rational intuition”
 2. Innate knowledge
 - Some human *knowledge* is innate (present at birth) or *a priori* (known prior to experience)
 3. Innate concepts or “ideas”
 - Some human *concepts* are innate, or *a priori*
 4. The universe *itself* is rational

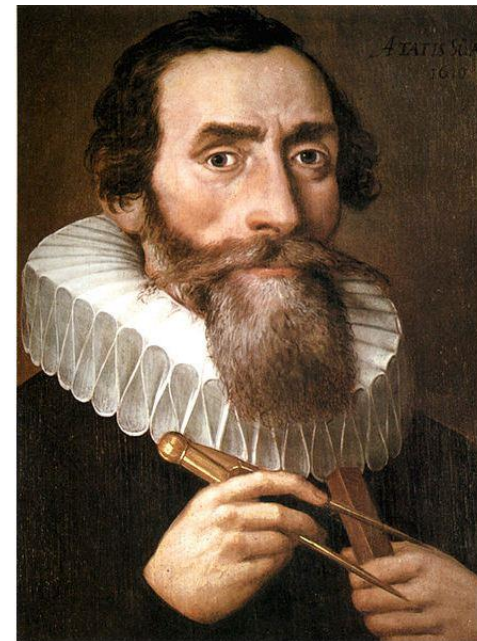
4. The universe *itself* is rational

- Rationalism says that the world itself contains conceptual structures such as “states of affairs”, possible worlds, objective probabilities, etc.
- Rationalism also says that our minds have been made to fit the world we are in.
- Even at birth, our minds have some pre-installed cognitive structures (put there by God, or by our evolutionary history) that are required for knowledge of the external world.
- Therefore, our intuitive feelings about how the world *must be*, or *ought to be*, are often correct.

“Geometry, which before the origin of things was coeternal with the divine mind and is God himself (for what could there be in God which would not be God himself?), supplied God with patterns for the creation of the world, and passed over to Man along with the image of God; and was not in fact taken in through the eyes.”

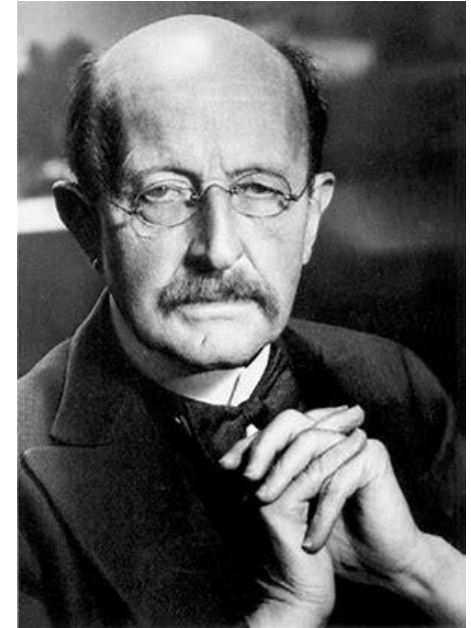
Johannes Kepler

(Harmonice Mundi, The Harmony of the World (1619), book IV, ch. 1. Trans. E. J. Aiton, A. M. Duncan and J. V. Field (1997), 304)



“What led me to my science and what fascinated me from a young age was the, by no means self-evident, fact that our laws of thought agree with the regularities found in the succession of impressions we receive from the natural world, that it is thus possible for the human being to gain enlightenment regarding these regularities by means of pure thought ...”

Max Planck, *A Scientific Autobiography*
(1948)



Max Planck, a
(Christian)
physicist

This is how rationalists talk

“One has a great confidence in the theory arising from its great beauty, quite independent of its detailed successes ... One has an overpowering belief that its foundations must be correct quite independent of its agreement with observation.”

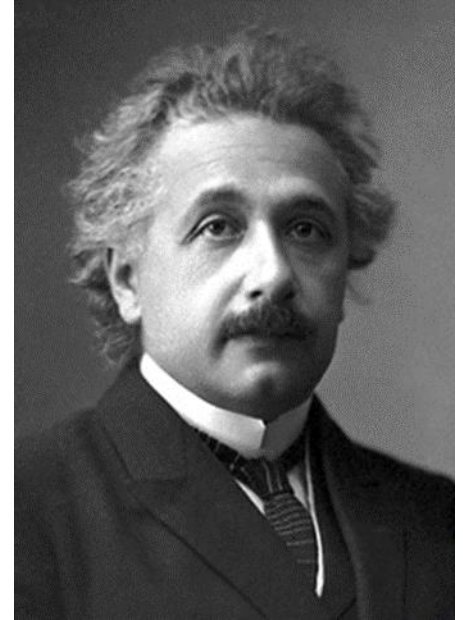
Paul Dirac (physicist) 1980.
(Not a believer in God.)



$$\left(\beta mc^2 + \sum_{k=1}^3 \alpha_k p_k c \right) \psi(\mathbf{x}, t) = i\hbar \frac{\partial \psi(\mathbf{x}, t)}{\partial t}$$

- ‘I have no better expression than the term “religious” for this trust in **the rational character of reality and in its being accessible, at least to some extent, to human reason.** Where this feeling is absent, science degenerates into senseless empiricism’

Einstein, letter to Maurice Solovine,
January 1, 1951



Empiricism

- In philosophy, empiricism is the claim that **all of our knowledge and concepts come from experience**. There is no substantial *a priori* knowledge, or *a priori* concepts.
- Rational intuition only supplies **trivial**, tautological facts, “relations of ideas”, “analytic truths”, e.g. “ $a = a$ ”, “bachelors are unmarried”, etc.
 - “necessity resides in the way we talk about things, not in the things we talk about” (Quine, 1966, p. 174)
- (In the context of scientific knowledge, “empiricism” is used a little more loosely. It can just mean an emphasis on empirical rather than theoretical methods.)

Francis Bacon, *Novum Organon*, 1620.

Interpreting nature vs. anticipating nature

26. To help me get my ideas across, I have generally used different labels for human reason's two ways of approaching nature: the customary way I describe as *anticipating nature* (because it is rash and premature); and the way that draws conclusions from facts in the right way I describe as *interpreting nature*.

How empiricists do science

36. There remains for me only one way of getting my message across. It is a simple way, namely this: I must lead you to the particular events themselves, and to the order in which they occur; and you for your part must force yourself for a while to **lay aside your notions** and start to familiarize yourself with facts.

45. The human intellect is inherently apt to suppose the existence of more order and regularity in the world than it finds there. Many things in nature are unique and not like anything else; but the intellect devises for them non-existent parallels and correspondences and relatives. That is how it comes about that all the heavenly bodies are thought to move in perfect circles.

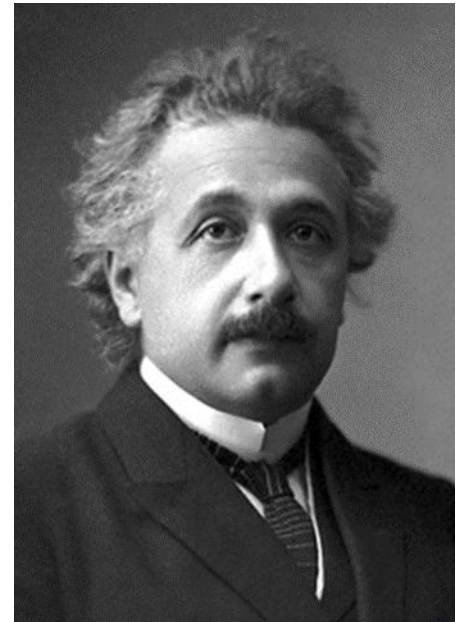
...

- Or ellipses?

Einstein Disagrees

‘I have no better expression than the term “religious” for this trust in **the rational character of reality and in its being accessible, at least to some extent, to human reason.** Where this feeling is absent, science degenerates into senseless empiricism’

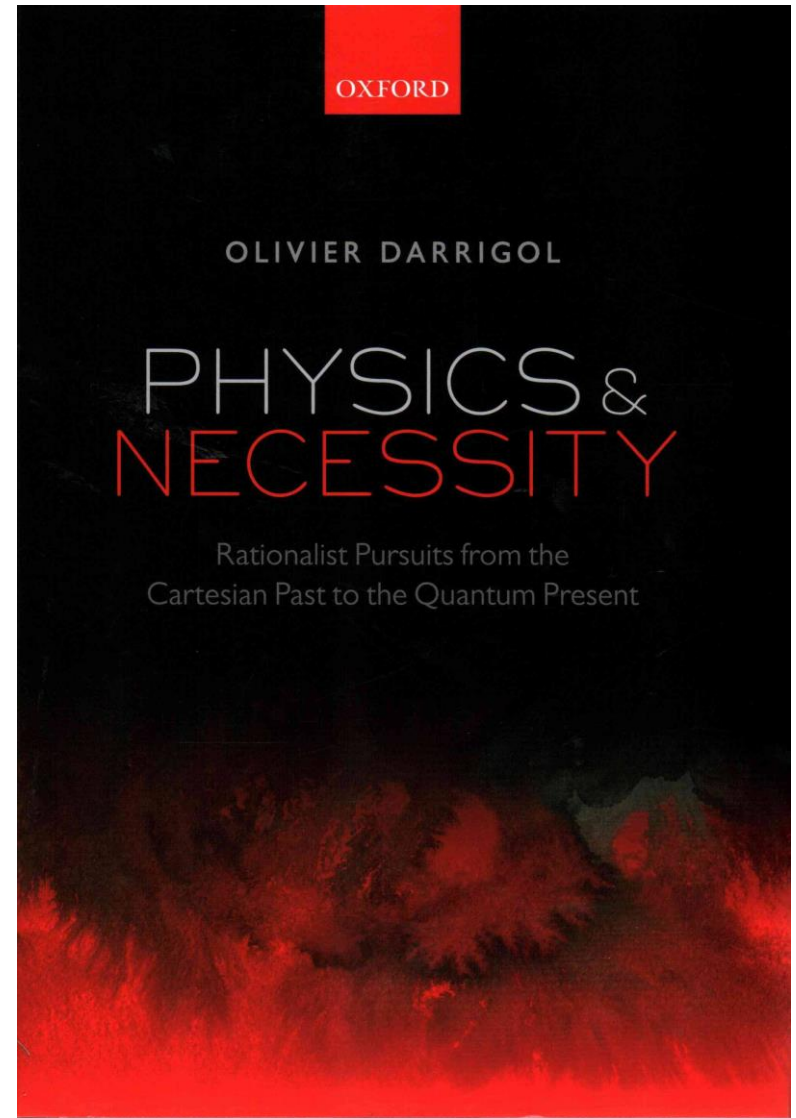
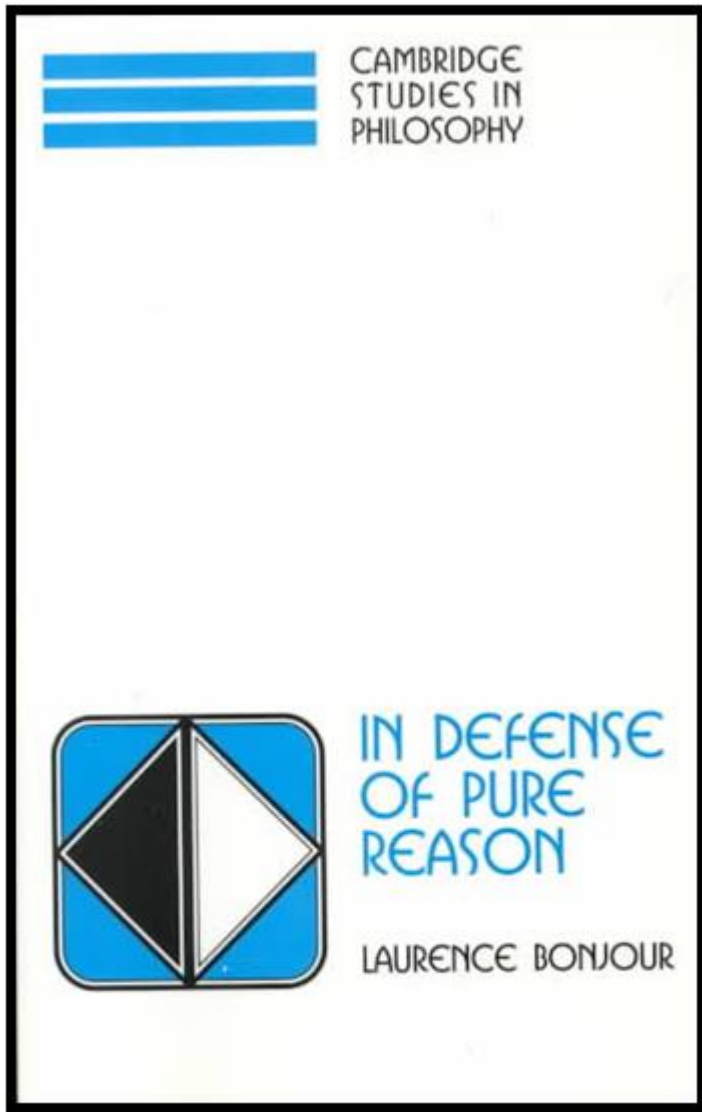
Einstein, letter to Maurice Solovine,
January 1, 1951



What about logic and mathematics?

- It seems clear that experience is at least a *necessary* condition for much of our knowledge.
 - E.g. can we know, *a priori*, what pineapple tastes like?
- But knowledge of logical and mathematical truths seems to be rather different. What do empiricists say about it?
 - Moderate empiricists (e.g. Hume) say that mathematics is *a priori*, but also trivial and tautological. (Relies on the analytic / synthetic distinction.)
 - Radical empiricists (e.g. Quine) say that mathematics isn't *a priori*, but highly theoretical science.

- “Both of these views are argued to be entirely unsatisfactory. Moderate empiricism evaporates under scrutiny, turning out, if I am right, not to have been even a fully intelligible position, while radical empiricism collapses into a pervasive skepticism.”
- BonJour, *In Defense of Pure Reason*, p. xii



(Unusual) books arguing for rationalism

Rationalism and Theology

There can be theological grounds for rationalism:

“The reason for this second rule [2nd law of motion] is the same as the reason for the first rule, namely the unchangingness and simplicity of the operation by which God preserves motion in matter.”

(Descartes, *Principles of Philosophy*)

And also for empiricism:

“Without all doubt this World, so diversified with that variety of forms and motions we find in it, could arise from nothing but the **perfectly free will of God** directing and presiding over all. From this fountain it is that those laws, which we call the laws of Nature, have flowed; in which there appear many traces indeed of the most **wise** contrivance, *but not the least shadow of necessity*. These therefore we must not seek from uncertain conjectures, but *learn them from observations and experiments ...*”

- [Italics added] Roger Cotes, preface to the 1713 edition of Newton's *Principia*.

British rationalism?

“It is inconceivable that inanimate Matter should, without the Mediation of something else, which is not material, operate upon, and affect other matter without mutual Contact...That Gravity should be innate, inherent and essential to Matter, so that one body may act upon another at a distance thro’ a Vacuum, without the Mediation of any thing else, by and through which their Action and Force may be conveyed from one to another, is to me so great an Absurdity that I believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it.”

—Isaac Newton, *Letters to Bentley*, 1692/3

Strong rationalism

Strong rationalism says that *a priori* knowledge is *certain/incorrigible/infallible*, and also gives knowledge of (metaphysically) *necessary* truths.

“And the demonstrations [of the rules of collision] are so certain, that even if experience seemed to show us the contrary, we would nonetheless have to trust our reason more than our senses”

(Descartes, *Principles of Philosophy*, 1644)

“As [the principles of mechanics] have heretofore been insufficiently established, I demonstrate them in such a manner that they will be understood to be not only certain but even necessarily true”

Leonhard Euler, *Mechanica*, 1736.

BonJour's "moderate rationalism"

- BonJour sees no reason why *a priori* knowledge should be *certain*.
- “What emerges is what may be reasonably described as a moderate version of rationalism, one that rejects the traditional claim that *a priori* insight is infallible, while nevertheless preserving its status as a fundamental source of epistemic justification.”
- (Yet BonJour possibly still holds the view that *a priori* knowledge concerns only necessary truths.)

A priori knowledge concerns necessary truths?

- “According to *rationalism, a priori* justification occurs when the mind directly or intuitively sees or grasps or apprehends (or perhaps merely seems to itself to see or grasp or apprehend)⁷ a **necessary** fact about the nature or structure of reality.”
- “7. As we shall see in Chapter 4, the rationalist must concede, contrary to the main historical tradition, that what appears subjectively to be such a seeing or grasping or apprehending may fail to be one, most strikingly in the case where the proposition that seemed to be necessary turns out to be false.”

But maybe not!

- “The immediate moral to be drawn is that the two distinctions in question, the *a priori-a posteriori* distinction and the necessary-contingent distinction, though related in important ways (including some that have yet to emerge), *are quite distinct* in both meaning and application, a very long philosophical tradition to the contrary notwithstanding.”
- (N. B. Bonjour’s examples of *a priori* knowledge all concern necessary truths.)

Leibniz's "semi-moderate rationalism"

Leibniz on the other hand thought that we can have *a priori* knowledge of *contingent* facts as well.

“Leibniz also differed from Descartes in his higher tolerance of final causes (what we would now call aim or purpose). He believed that such causes, for instance the principle that light takes the easiest path in a series of transparent bodies, were often more accessible to human inquiry and that they offered a pleasant demonstration of **God's wisdom**: God selects the best of all possible worlds.”

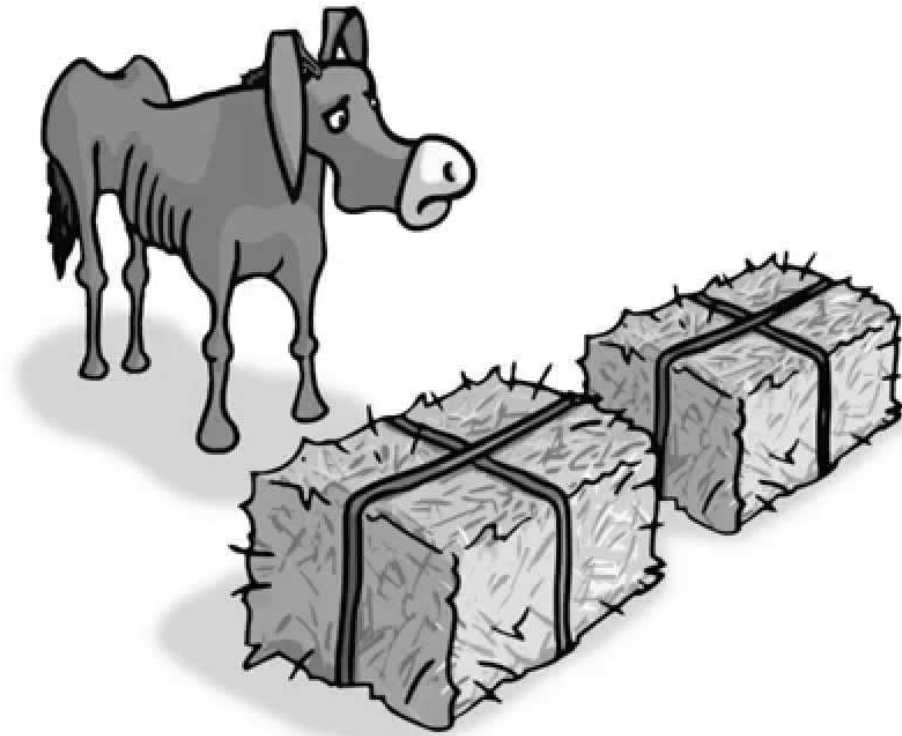
Olivier Darrigol, *Physics and Necessity* (2014), p. 21.

Principle of Sufficient Reason

“When two incompatible things are equally good, and when neither in themselves, nor by their combination with other things, has the one any advantage over the other, God will produce neither of them.”

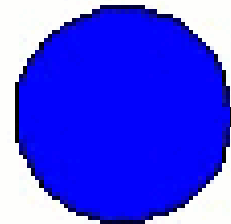
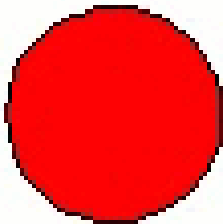
Leibniz, *Essay in Dynamics*, 1695.

- E.g. a symmetric lever, with equal forces on both sides, at equal distances, *cannot move in either direction*. (Illustrated by Buridan’s ass.)

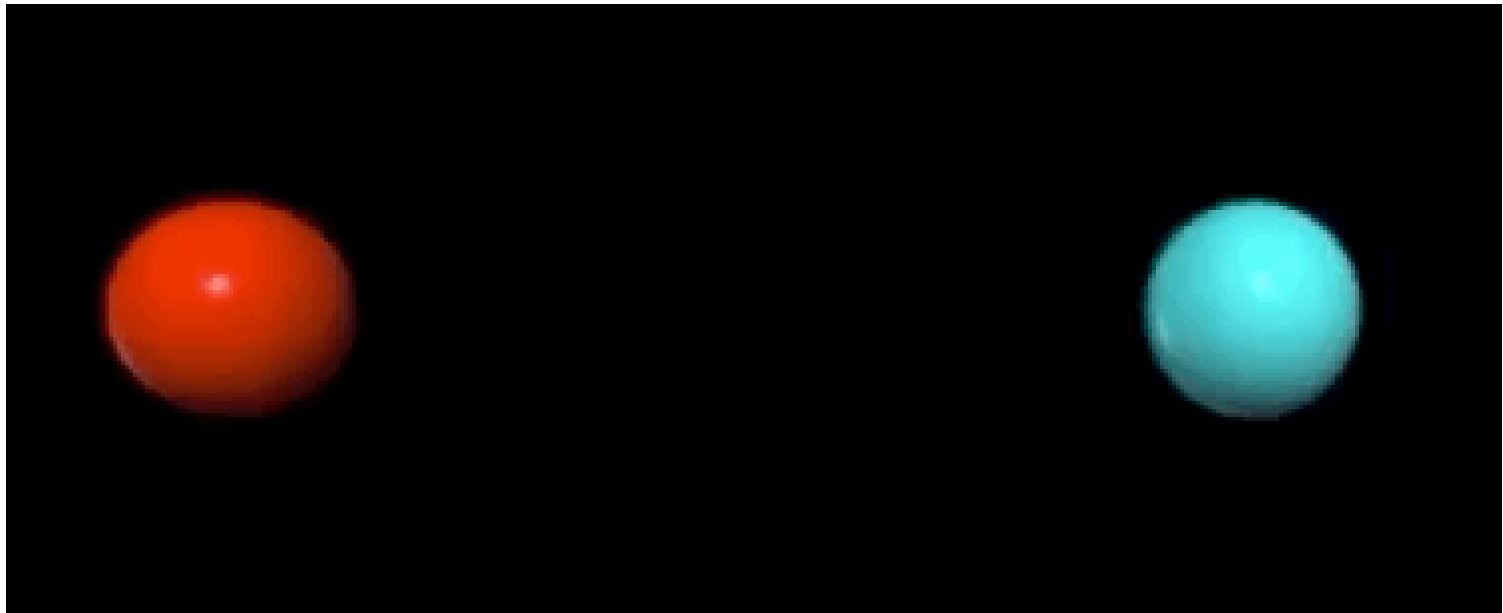


- Buridan's ass (donkey) lacks a sufficient reason to eat one bale (first) rather than the other, and so starves.

Symmetry is conserved in rational inferences ...
... and also in causal processes.

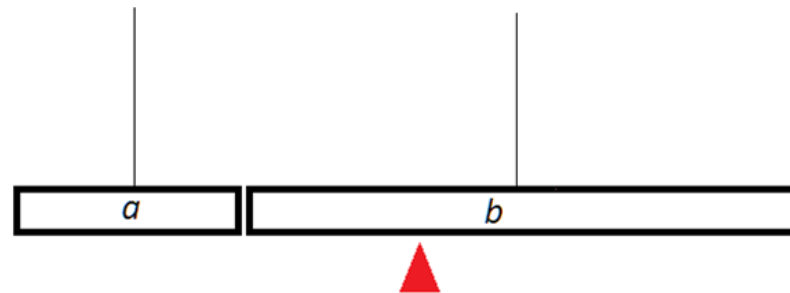
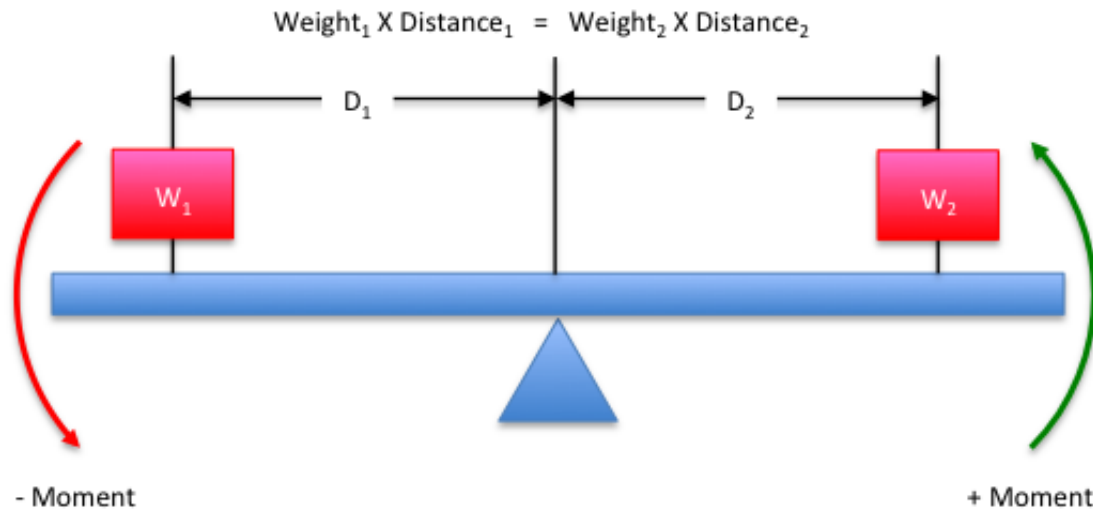


Is *this* rationally possible?



- This is irrational, unless the red ball has many times the mass of the blue one.
- In that case, *there is no initial symmetry.*

Principle of the lever

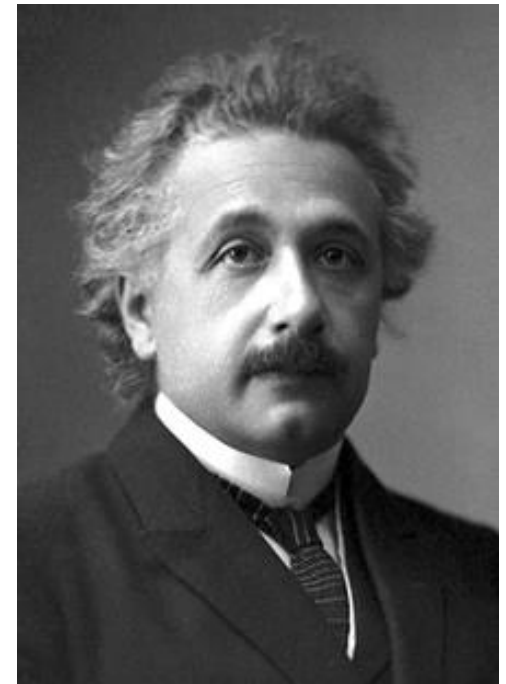


God is *free*, but also *wise* ..

“As we will see in a moment, this usage of the principle of sufficient reason became very popular in eighteenth-century natural philosophy. It lends a sort of rational necessity to some contingent truths, even though they do not result from the principle of contradiction. According to Leibniz, **some other contingent truths have a “moral” necessity: they find their reason in God’s wisdom.** This is the case for the conservation of live force and for the optical principle of the easiest path.”

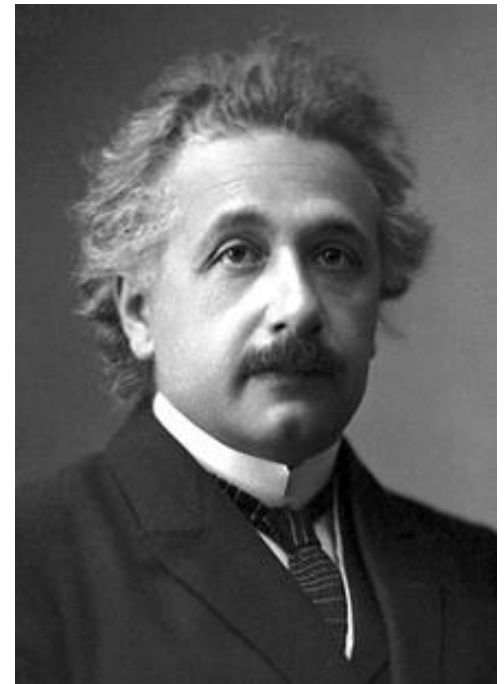
Darrigol, p. 22.

- Einstein's rationalism was similar in this regard to Leibniz's.
- In 1919, after an experiment confirmed Einstein's theory of general relativity, a reporter asked Einstein what would it have meant if his theory was wrong. He replied:
“God would have missed a great opportunity.”
- (Not: “God would have created a contradiction”)



“What really interests me is whether God could have made the world any differently: in other words, whether the demand for logical simplicity leaves any freedom at all.”

(Albert Einstein, late 1940s, as remembered by his assistant Ernst Straus)



Hume's famous argument against rationalism

“[relations of ideas] can be discovered purely by thinking, with no need to attend to anything that actually exists anywhere in the universe ...

... Matters of fact, which are the second objects of human reason, are not established in the same way; and we cannot have such strong grounds for thinking them true. **The contrary of every matter of fact is still *possible*, because it doesn't imply a contradiction and is conceived by the mind as easily and clearly as if it conformed perfectly to reality.**

- Is this true?

Hume's famous argument against rationalism

“... *That the sun will not rise tomorrow* is just as intelligible as—and no more contradictory than—the proposition *that the sun will rise tomorrow*. It would therefore be a waste of time to try to [logically] *demonstrate* its falsehood. If it were demonstratively false, it would imply a contradiction and so could never be clearly conceived by the mind.”

- Is Hume right?
 - Yes. But semi-moderate rationalism *circumvents* this argument by not claiming logical necessity in the first place!

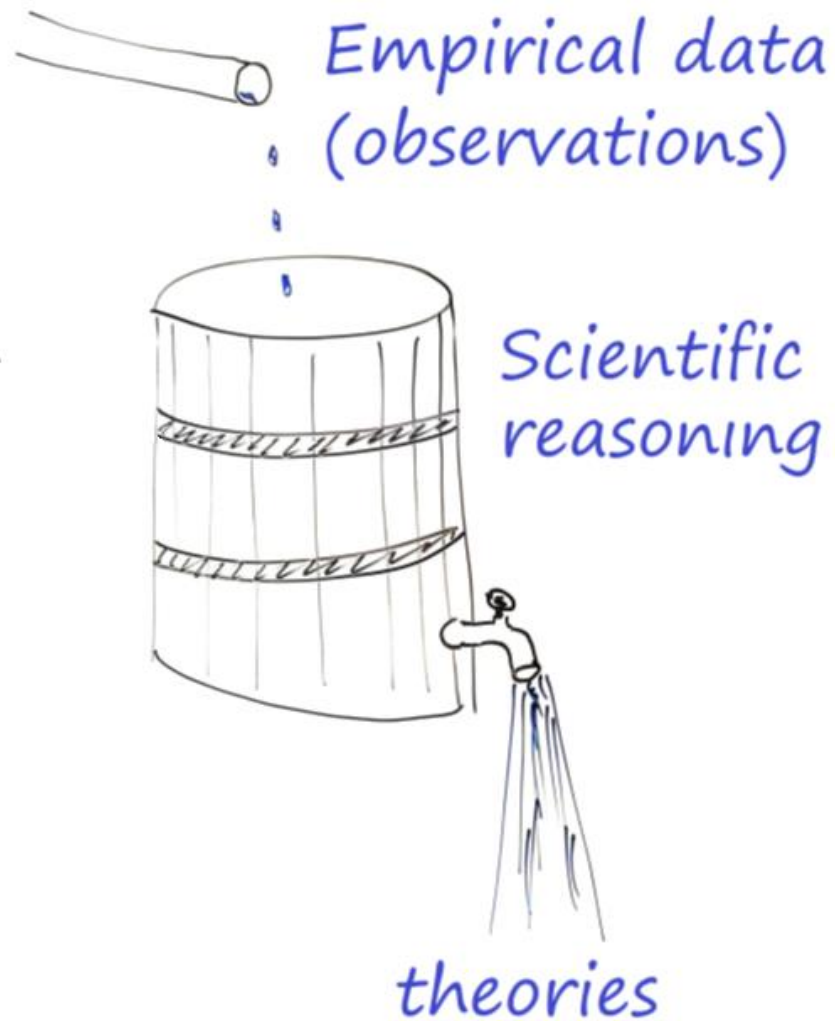
Main arguments for rationalism

1. There are great examples.

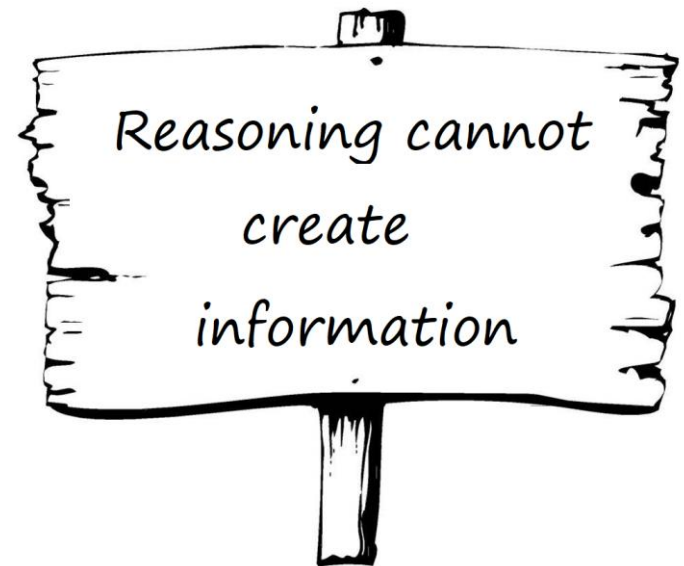
- A large number of historically-important scientific arguments, employed by the best scientists, appear to be both cogent and at least partly *a priori* in character.

2. Science is irrational otherwise.

- Scientific theories are inferred from experience, yet have content that goes beyond immediate experience. Hence scientific theories are based on information that is non-empirical.
- The “problem of induction” is only a problem for empiricism. The solution is to accept rationalism!



N.B. Quine refers to observations as “the meager input”, and the theories we infer from them as “the torrential output”.



Objections to Rationalism

Hume, Carnap, Quine, etc.

Just illusion, error and bias?

“When historians of physics encounter rationalist arguments, they tend to regard them as **short-lived illusions implying unconscious assumptions, cultural biases, and even errors of reasoning**. At best they recognize that these arguments function as useful motors of research. Today’s physicists have a more ambiguous attitude. They may profess empiricism and yet secretly flirt with rationalism.”

- Olivier Darrigol, *Physics and Necessity* (2014), Preface.

Darrigol's view of *a priori* arguments used in physics:

“... in a few felicitous cases the rational deduction can be mended to provide a **genuinely convincing proof** of necessity. These cases fall under the category of what I call *comprehensibility arguments*, in homage to Helmholtz's idea that **nature, if it is at all comprehensible, must *a priori* comply with certain theoretical structures ...**

... these [rationalist arguments] are not completely rigorous, and there is always a remnant of subjectivity in judging the premises of comprehensibility. They nonetheless make it very difficult to imagine, in given domains of experience, theories different from or not equivalent to those already known to be successful.”

Extravagant hubris? Occult?

“... the idea of [rational insight] has been widely rejected in recent epistemology. It will strike many, perhaps most, contemporary philosophers as **unreasonably extravagant, a kind of epistemological *hubris*** that should be eschewed by any sober and hard-headed philosophy.

Once it is accepted that this sort of insight cannot be accounted for in any epistemologically useful way by appeal to the allegedly unproblematic apparatus of definitions or linguistic conventions, a standard reaction is to disparage it as **objectionably mysterious, perhaps even somehow occult**, in character, and hence as incapable of being accepted at face value – no matter how compelling the intuitive or phenomenological appearances may be, or how unavailing the search for an alternative epistemological account.”

- Bonjour, pp. 17-18 in the reading

e.g. Kurt Gödel on mathematics

“The truth, I believe, is that [mathematical] **concepts form an objective reality of their own**, which we cannot create or change, but only perceive and describe” (320).

“Thereby I mean the view that **mathematics describes a non-sensual reality**, which exists independently both of the acts and the dispositions of the human mind and is only perceived, and probably perceived very incompletely, by the human mind” (323).

(Gibbs lecture, 1951)

“But, despite their remoteness from sense experience, **we do have something like a perception also of the objects of set theory**, as is seen from the fact that the axioms force themselves on us as being true. I don’t see any reason why we should have less confidence in this kind of perception, i.e., in mathematical intuition, than in sense perception ...”

Gödel, *What is Cantor's continuum problem?*, 1964

- Or are mathematical facts just trivial “relations between ideas”?

Is mathematics trivial, or 'deep'?

- Some mathematical facts don't seem to be true merely "by definition".
 - They engage some sort of mathematical reality?
- E.g. define a 'loop' as a set of points with an 'arrow' function that is anti-symmetric.
 - For any 2 points A and B on the loop, you can follow arrows from A to B.
 - Then the definition of 'loop' says nothing about the set of points being finite. ("Finite" = greater than all its proper subsets.)
 - *But we can prove that every loop is finite.*
 - A string can be infinite, but a loop cannot be.

Carnap disagrees

- “Quine wrote that Carnap had found “the way out of the jungle” by claiming that “not only logic and mathematics; but all that is not meaningless in philosophy ... speaks ... not of things or ‘reality’ but rather of syntax”

Tarski vs. Etchemendy on logical consequence

- I want to define a sentence P as analytic when P is a **logical consequence** of $\{\}$.
- This isn't correct, however, using Tarski's (standard) theory of logical consequence.
- But it works using Etchemendy's theory
 - (*The Concept of Logical Consequence*, 1990).



Alfred Tarski



John Etchemendy

Is rationalism even an *option*?

- “As already noted, rationalism has been generally repudiated in recent times, and indeed has often not been regarded as even a significant epistemological option.” (BonJour, p. 16 in the reading.)
- (... in Chapter 7, I will argue that only an *a priori* justification can even hope to solve the problem of induction; but it is a striking fact that discussions of induction **often fail to even list such a justification** as one of the dialectical alternatives.)

(Epistemic) Arguments against rationalism

1. Supposed “Rational insight” is too opaque and subjective to count as rational or justified. (E.g. the familiar challenge: “obvious to whom?”)
2. If we allow people to just say they know something *a priori*, this will be abused by dogmatists.
3. A priori knowledge would require meta-justification.
4. A priori analysis can only tell us about our own concepts (possibly shared with all humans), not about mind-independent reality. (e.g. Dummett)

(Metaphysical) Arguments against rationalism

- “...rationalism is incompatible with allegedly well-established theses about the nature and limitations of human beings and human intellectual processes. These theses may take the form of sweeping, general claims, such as **the vaunted theses of materialism (or physicalism) and naturalism**, or they may be much more specific in character.”
- (p. 28 in the Bonjour reading)

E.g.

1. Causal Objection.

- Supposed *a priori* knowledge concerns Platonistic entities like Forms, which are abstract and non-causal. How can such entities cause belief?

2. Symbolic view of thought

- Human thought merely involves the formal processing of symbolic representations. This rules out rational insight.

BonJour's "too easy" response

- Ruling out rationalism, on the grounds that it is incompatible with (e.g.) physicalism, would be *self defeating*.
- Such an argument uses physicalism as a premise. But how do we know that physicalism is true?
 1. Physicalism is clearly 'synthetic' (not a logical truth).
 2. Physicalism is a highly abstract claim, not knowable by direct observation.
 3. Ampliative inferences rely, at least implicitly, on additional information.

∴ 4. Belief in physicalism can only be justified by an ampliative inference, from experience. (from 1, 2)

∴ 5. Belief in physicalism relies on non-empirical knowledge. (from 3, 4)

Hume on *a priori* knowledge

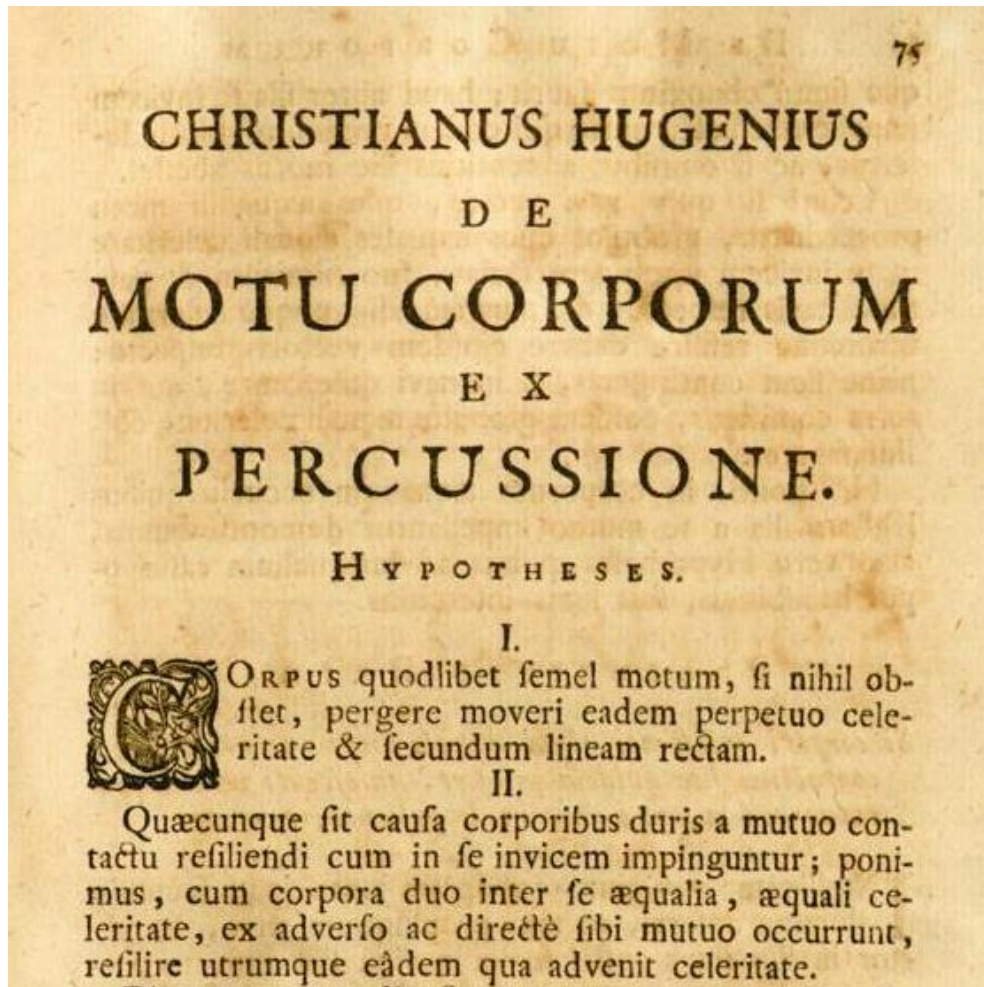
“I venture to assert, as true without exception, that knowledge about causes is never acquired through a priori reasoning, and always comes from our experience of finding that particular objects are constantly associated with one other.”

- Hume argues for this by *examples*. Adam taking a bath, gunpowder, magnets, slabs of marble, digestive systems, etc.
- But these all involve complicated systems, with hidden interior mechanisms. (Not fair.) What about simple systems? E.g. what about colliding billiard balls?

Hume on the collision problem

“We are apt to imagine that we could discover these effects purely through reason, without experience. We fancy that if we had been suddenly brought into this world, we could have known straight off that when one billiard ball strikes another it will make it move—knowing this for certain, without having to try it out on billiard balls. Custom has such a great influence!”

What about Huygens?



Hume wrote the Enquiry in 1748, about 45 years *after* Huygens' (correct) solution to Descartes' collision problem, was published: "On the Motion of Bodies Resulting from Impact".

What about Huygens?

- Huygens' solution was almost entirely *a priori*! Everything was mathematically derived from highly intuitive principles, or “hypotheses”, including:
 1. Natural motion is rectilinear, constant speed
 2. Symmetry is conserved during collisions
 3. The laws of collision are the same in all uniformly-moving reference frames (“Galilean relativity”)

“If you’re not yet convinced that absolutely all the laws of nature and operations of bodies can be known only by experience, consider the following. If we are asked to say what the effects will be of some object, without consulting past experience of it, how can the mind go about doing this? **It must invent or imagine some event as being the object’s effect; and clearly this invention must be entirely arbitrary.** The mind can’t possibly find the effect in the supposed cause, however carefully we examine it, for the effect is totally different from the cause and therefore can never be discovered in it.”

- Hume doesn’t criticise Huygens’ work on the collision problem, or even mention it (according to Paul Russell).
- Is this a reasonable argument against rationalism?

Reasoning can *eliminate* possible laws?

- The claim that Huygens established collision laws, with certainty, using **entirely** *a priori* reasoning, is surely incorrect.
- But what of the weaker claim that *a priori* reasoning might eliminate many putative laws (e.g. those of Descartes!) thus narrowing the field of possibilities?

Hume: “... clearly this invention must be entirely arbitrary”

- Is any reasoning that isn't purely logical thereby “entirely arbitrary”? Must one “invent or imagine” the effect?
 - A wise God might freely choose between several possible sets of physical laws, but most possible laws would be unwise, or incomprehensible.

Another objection to rationalism

- What about Euclidean geometry?
 - From time immemorial, Euclidean geometry was supposed to be purely *a priori*, certain, necessary, etc.
 - Later (around 1820-30) Bolyai, Lobachevsky and Riemann showed that alternative geometries were mathematically possible.
 - Then (1916) Einstein showed that physical space is Riemannian rather than Euclidean!

Kant and Euclidean Geometry

“The apodeictic [i.e., clearly established or beyond dispute] certainty of all geometrical propositions, and the possibility of their a priori construction, is grounded in this a priori necessity of space. Were this representation of space a concept acquired a posteriori, and derived from outer experience in general, the first principles of mathematical determination would be nothing but perceptions. They would therefore all share in the contingent character of perception; that there should be only one straight line between two points would not be necessary, but only what experience always teaches.”

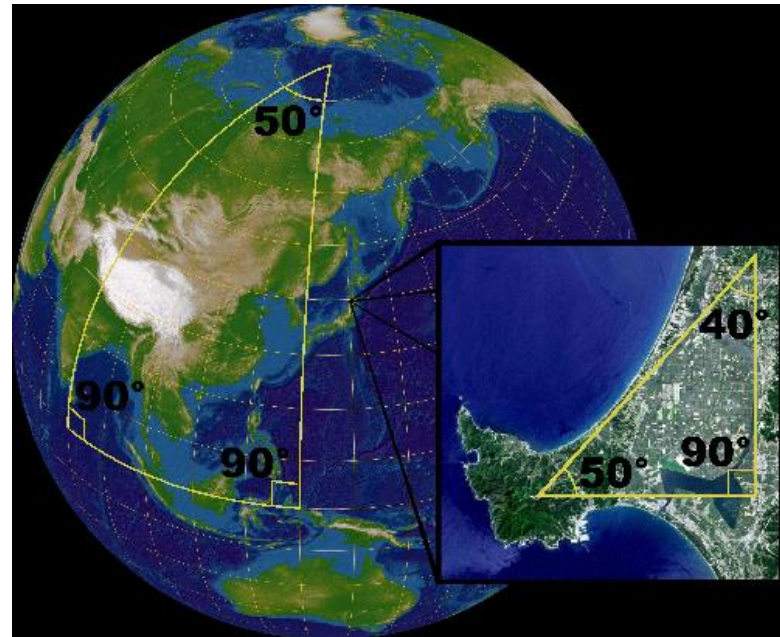
Kant, *Critique of Pure Reason*, A24.

Euclid's axioms (or "postulates")

1. A straight line segment can be drawn joining any two points.
2. Any straight line segment can be extended indefinitely in a straight line.
3. Given any straight line segment, a circle can be drawn having the segment as radius and one endpoint as centre.
4. All right angles are congruent.
5. Given any straight line and a point not on it, there exists one and only one straight line which passes through that point and never intersects the first line, no matter how far they are extended.

- These axioms entail that the internal angles of a triangle sum to 180° . But is this certain? Do we need to measure it, just to be sure?
- Kant says there's no need to measure it.
- Physicists say that, with a large triangle, the angles *don't* sum to 180° .
- 'curved space'

An *analogy* of
'curved space'



Rationalist response?

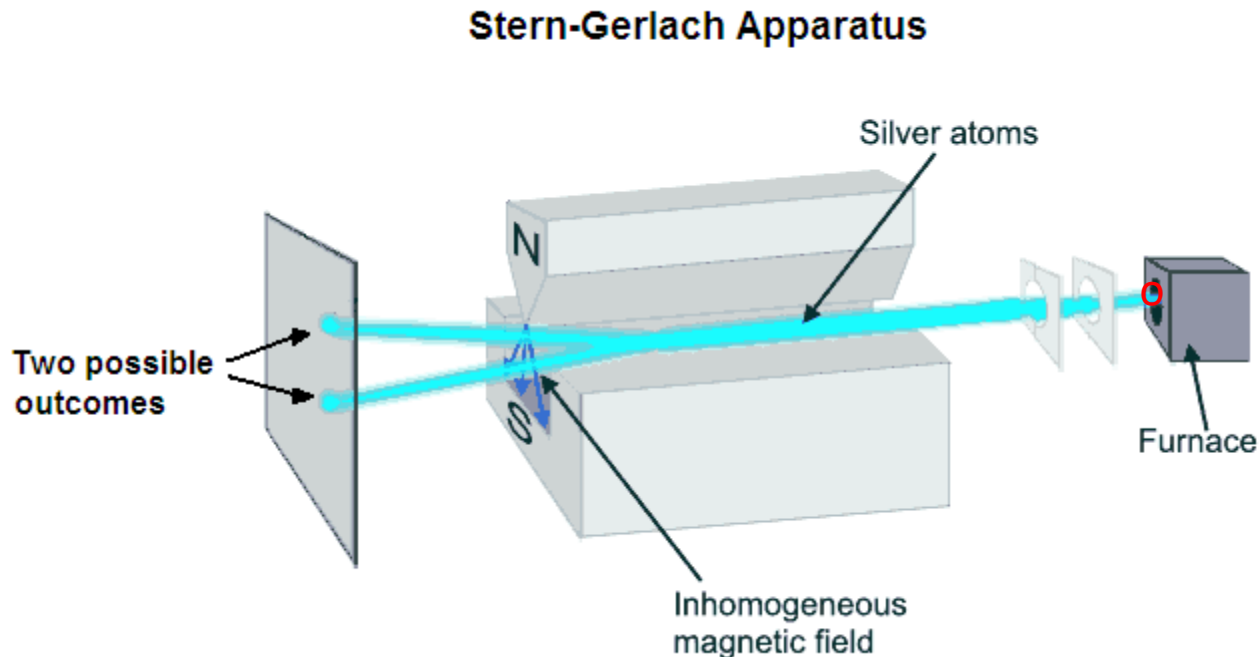
- Moderate rationalists don't find this case as embarrassing as a strong rationalist would.
 - “We admit that rational intuition can be wrong, so why be surprised by such cases?”
 - Alternatively, one can say that Euclidean geometry *is true of the human visual field*, intuition of space, etc. (Sounds a little Kantian, I know.)
 - If you were designing the human visual system, wouldn't you base it on Euclidean geometry?
- Also, Axiom 5 (the one that is false for non-Euclidean geometries) was long regarded as less intuitively certain than the other four.

Rationalism and chance

- One fundamental idea of rationalism is:
 1. Effects can be logically inferred from their causes, (i.e. from a suitably complete description of the total cause).
- This seems to entail determinism. (Historically, many rationalists have regarded determinism as *a priori*.)
- But the advent of quantum mechanics (arguably) shows that determinism is false.

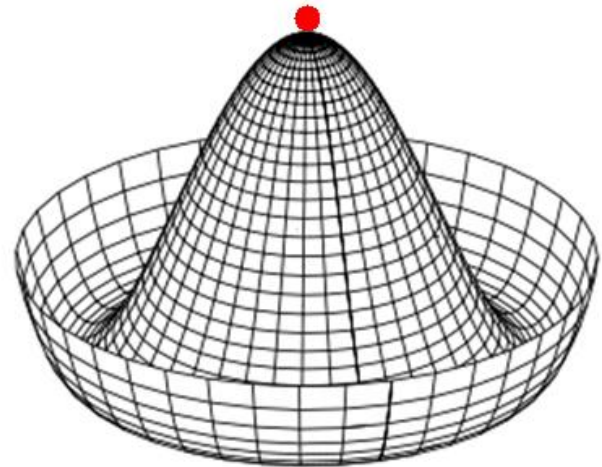
E.g. the Stern-Gerlach apparatus

- Suppose a physicist sets up an experiment and observes the outcome (e.g. *up* or *down*).



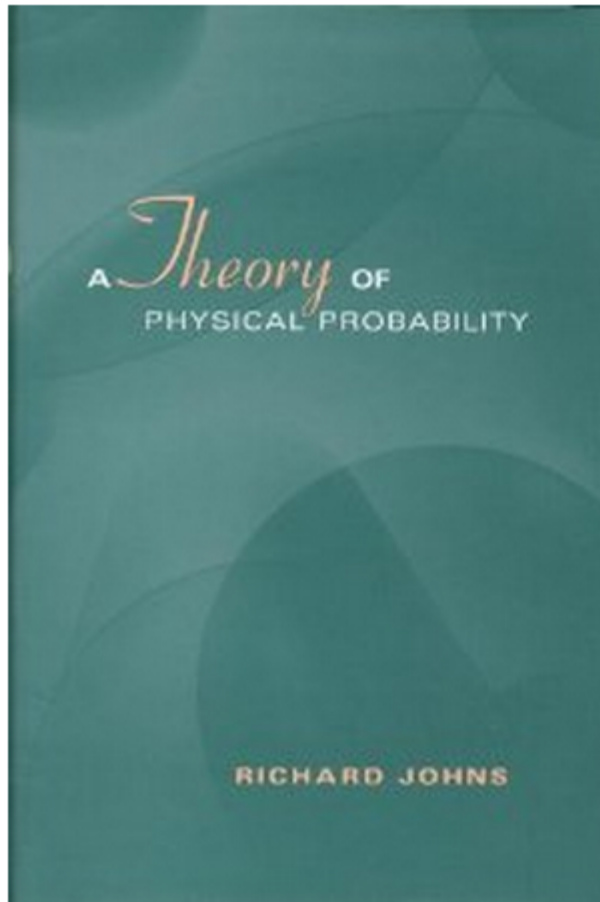
“Spontaneous symmetry breaking”

- Many physical theories allow the possibility of “spontaneous symmetry breaking”, where a system that is initially symmetric evolves – all by itself – to an asymmetric state.



Can the ball roll down the slope?

A rationalist's theory of chance



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A rationalist's theory of chance

- The idea of a 'complete description' of a concrete physical system is perhaps fishy.
- Propositions are mental, abstract, etc. Perhaps there are inherent limitations to how completely a physical system can be represented in such terms?
- Hence the *maximal* description of a cause may be *incomplete*. In such cases, **the maximal description of the cause may not entail the effect.**
- Instead, rationality dictates only a certain *degree* of belief in a possible effect, given the cause.
- This is in fact the *physical chance* of the effect.

A rationalist's theory of chance

- Spontaneous symmetry breaking is possible, on this view.
- The preservation of symmetry under logical inference then requires only that symmetric alternatives have *equal probability*.
- Buridan's ass need not starve!
- Note that physical reality is not *entirely* rational and comprehensible on this view. It's a small retreat for rationalism.