

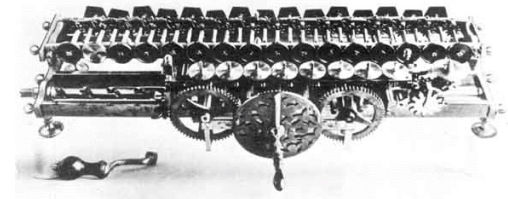
**Philosophy 203**  
***History of Modern Western Philosophy***



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**Hamilton College**  
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**Class #12**  
**Leibniz and Newton on Space and Time**

# Leibniz's Achievements



Mathematical (calculus, adding machine)

The concept of possible worlds and its utility for dealing with modality

- ▶ Necessity and possibility
- ▶ Modal logic
- ▶ Kripkean semantics (stipulation)
- ▶ Lewisian semantics (counterpart theory)

Analysis

- ▶ Frege, Russell, Logical Wittgenstein,
- ▶ Logical empiricism (positivism)

The primacy (irreducibility) of our mental lives

- ▶ More than Descartes, actually

Relationalism about space and time



# Space and Time

# Absolute and Relational Notions of Space and Time

- Theories of space and time have their roots in our observations about change.
- Change is due to some sort of motion.
- Motion is ordinarily measured relative to some external object.
  - ▶ Traveling on the highway, I am moving, with respect to the world outside the car, and sitting with respect to the car itself.
  - ▶ The Earth itself is moving, spinning on its axis.
  - ▶ The axis of the Earth is shifting in the annual revolution of our planet around the sun.
  - ▶ The solar system is moving relative to our Milky Way Galaxy, and the Milky Way is moving within our local system of galaxies.
  - ▶ I am driving 50 mph west, while the Earth is spinning at 650 miles per hour East, and the whole system is flying through space in its revolution around the sun at around 66,000 miles per hour, etc.
- Is there some fixed point, some privileged reference frame, to which all motion can be measured?
- Is there an absolute sense in which we can be said to be moving or not?
- Can we measure this motion relative to some special body or substance, like absolute space?
- Is there space, in addition to places?

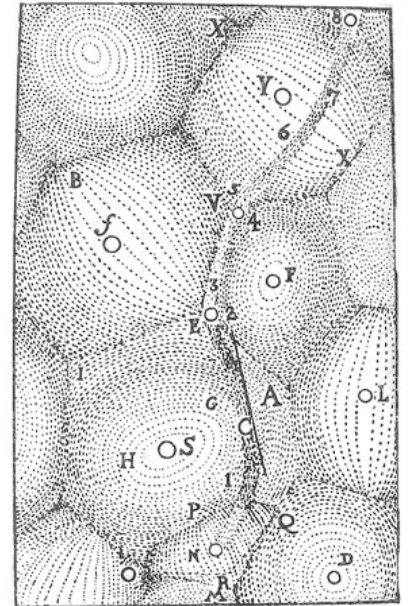
# Newton and Leibniz

Do space and time have absolute reality, or are they merely relational concepts?

- Newton's view is absolutist.
  - ▶ Space is something distinct from the bodies that occupy it.
  - ▶ Time is something that passes uniformly without regard to events in the world.
  - ▶ Space is an empty container, and time marches inexorably forward.
  - ▶ Though we measure space and time using bodies and events, these are only indicative of relative motions.
- Leibniz is a relationalist
  - ▶ Space and time are idealizations.
  - ▶ They are abstractions from the realities of the material world.
  - ▶ "I hold space to be something merely relative, as time is...an order of coexistences, as time is an order of successions" (LIII.4, AW 297b).
  - ▶ Phineas and Ferb

# Cartesians and the Void

- Descartes's physics denied the possibility of a void, or vacuum.
  - Aristoteleians who believed that a void is nothing, and what is nothing does not exist.
- Descartes took the world to be a plenum, in which space is not distinct from the bodies which fill it.
  - “All places are full of bodies... Each body can move only in complete circle of matter, or ring of bodies which all move together at the same time: a body entering a given place expels another, and the expelled body moves on and expels another, and so on, until the body at the end of the sequence enters the place left by the first body...” (Descartes, *Principles of Philosophy*, II.33).
- Leibniz adopts Descartes's views on the completeness of the material world.
  - “Let us fancy a space wholly empty. God could have placed some matter in it without derogating, in any respect, from all other things; therefore, he has actually placed some matter in that space; therefore, there is no space wholly empty; therefore, all is full” (LIV.PS, AW 303a).
- The Cartesians defined motion in terms of the translation of a body relative to its surrounding objects in the plenum.



# Atomists and the Void

- Gassendi, the intellectual heir of the Greek atomists, had argued that the places between objects are empty.
- Objects are placed in a transcendent void.
- When we move, we change our place relative to the objects around us, and we change our location in absolute space.
- “What exists outside the universe?”
  - Leibniz, with the Cartesians, answers that the universe extends infinitely, so that there is no outside.
  - Newton, with the atomists, answers that there is an empty void.
- Today, the debate between relationalist and absolutists continues between space-time relationalists, who believe that space-time is an artificial, or nominal, construct out of particular bodies, and substantivalists, who believe in the existence of space-time points or regions.

# Newton's Views on Space and Time

- Absolute time passes steadily without relation to anything external, and thus without reference to any change or way of measuring of time.
- Absolute space remains without relation to anything external.
  - Relative spaces are measures of absolute space defined with reference to some system of bodies.
- Absolute motion is the translation of a body from one absolute place to another.
  - Relative motion is the translation from one relative place to another.
- There is a fact of the matter whether a given body moves and what its true quantity of motion is.
- The true motion of a body does not consist of, or cannot be defined in terms of, its motion relative to other bodies.
- Space is the sensorium of God, the seat of divine cognition.



# Arguments from Properties and Causes

- Newton argues that the definition of motion as translation of a body relative to its surrounding objects will not allow us to arrive at a measurement of absolute motion.
- Bodies that are truly at rest are at rest with respect to one another.
  - ▶ Imagine that there is a distant star which is absolutely at rest.
  - ▶ We might wonder if something in our vicinity is also at rest.
  - ▶ But, if we measure it relative to the motions of things around it, we can not know whether it is moving or at rest relative to the distant star.
  - ▶ Thus, true rest cannot be defined simply in terms of position relative to bodies in the vicinity.
- If a part of a body maintains a fixed position with respect to the body as a whole, then it participates in the motion of the whole body.
  - ▶ Imagine that I am sleeping in the back of the car.
  - ▶ My femur is at rest with respect to me.
  - ▶ I am at rest with respect to the car.
  - ▶ But, my femur and I are both moving.
  - ▶ Thus, absolute motion cannot be defined as a translation from the immediately surrounding bodies.
- A body participates in the motion of its place when it moves away from that place.
  - ▶ You can change the relative motion of a body by changing the motion of the bodies to which you are comparing it.
  - ▶ But, you can only change the true, or absolute, motion of a body by applying some force to it.
  - ▶ The absolute motion of a body cannot be defined except by means of stationary places.

# Classifying Space

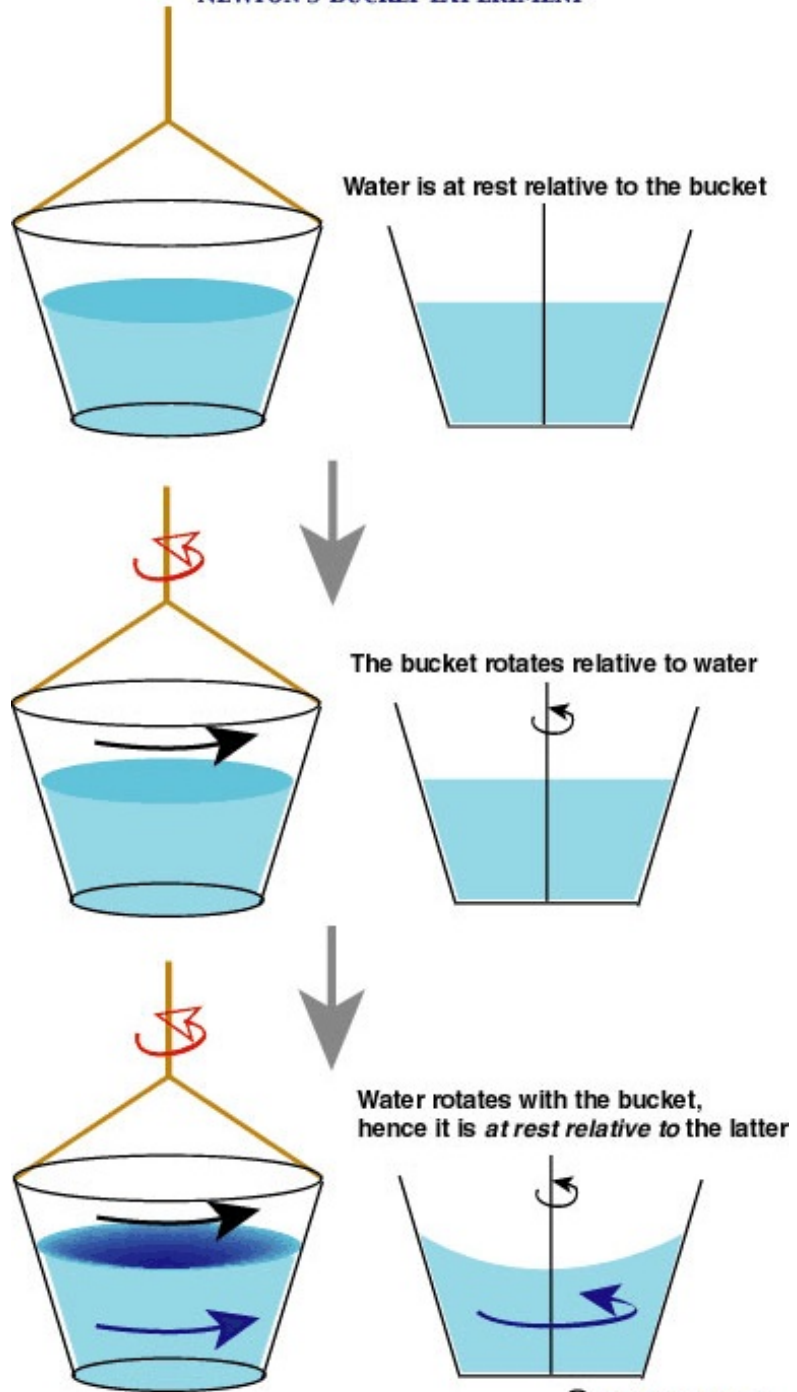
Is it a substance or an attribute?

- Newton does not take space to be a substance, for it lacks causal powers.
- But, it is also not an attribute, since its existence transcends the existence of any things.
- Unlike, say, redness, it doesn't need a thing to be predicated of.
  - “If space is a property or attribute, it must be the property of some substance. But of what substance will that bounded empty space be an affection or property, which the persons I am arguing with suppose to be between two bodies?” (LIV.8, AW 300a).
- So, space is real, but hovers in between substance and attribute.
- Perhaps the classification of all objects into substances and attributes is incomplete.

# Measuring Velocity

- The absolute speed of a body is the rate of change of its position relative to an arbitrary point of absolute space.
- According to Newton's account, absolute velocity is a well-defined quantity.
- But consider, as Galileo did, riding in a ship at a constant velocity.
- We cannot determine from observations inside the cabin whether the boat is at rest in harbor or sailing smoothly.
- Absolute velocity cannot be experimentally determined, unlike absolute rotation.
  - ▶ "Yet the thing is not altogether desperate; for we have some arguments to guide us, partly from the apparent motions, which are the differences of the true motions, partly from the forces, which are the causes and effects of the true motions" (Scholium to Definitions in *Principia*, AW 288a).

# NEWTON'S BUCKET EXPERIMENT



# Newton's Bucket

- We know that the motions are different in the two states, but we can not differentiate them in terms of local changes of place.
- In both state 1 and state 3, the water and the bucket are at relative rest.
- But state 3 is measurably different to state 1.
- The relationalist seems unable to describe the difference between the two states.
- The absolutist needs merely to point out that in state 3, the system is in absolute motion, while in state 1, the system is at absolute rest.
- Absolute acceleration (change in motion) is thus a measurable quantity.

# Leibniz, Against Newton

- “Our dispute consists in many other things. The question is whether God does not act in the most regular and most perfect manner; whether his machine is liable to disorder, which he is obliged to mend by extraordinary means; whether the will of God can act without reason; whether space is an absolute being; also concerning the nature of miracles; and many such things, which make a wide difference between us” (LIII.16, AW 299a).
- We are focusing only on the question of whether space is relational or absolute.

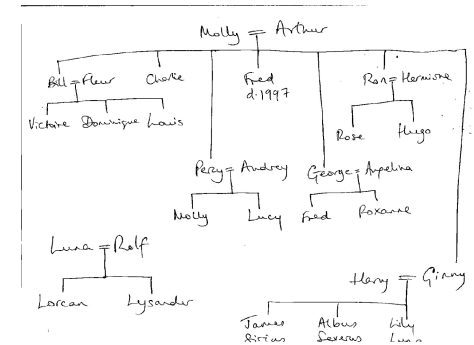


Sir Isaac Newton (left) and Gottfried Wilhelm von Leibniz (right)

# Revenge of the Great Principles

- “Those great principles of sufficient reason and of the identity of indiscernibles change the state of metaphysics. That science becomes real and demonstrative by means of these principles, whereas before it did generally consist in empty words” (LIV.5, AW 299b).
- Could the universe, for example, have been created at a different time?
- Could it be moved three inches to the left?
  - Or east changed for west?
- There would be no way to distinguish two universes that were identical in all their relations among objects, but put into a different space or reoriented.
- “Those two states, the one such as it is now, the other supposed to be the quite contrary way, would not at all differ from one another. Their difference therefore is only to be found in our chimerical supposition of the reality of space in itself. But in truth, the one would exactly be the same thing as the other, they being absolutely indiscernible, and consequently there is no room to inquire after a reason for the preference of the one to the other” (LIII.5, AW 297b-298a; see also LIV.13, AW 300a-b).

# Leibnizian Space and Time



- Space is a set of relations among bodies.
- Time is an abstract relation among events (or perceptions).
- Those systems of relations might be thought of as abstract, but they should not be reified.
- The family tree analogy
- No really existing thing could be infinitely divisible.
  - ▶ We must take space and time to be ideal, or imaginary constructs derived from the appearances of bodies.
- Bodies, for Leibniz, are just appearances.
  - ▶ Space and time turn out to be abstractions on what is already only a mere appearance.
  - ▶ The only reality is monadic.
  - ▶ Monads have temporal properties, but not spatial properties, except in a thin, derivational sense.



GOTTFRIED

Leibniz

AT **LAST**—MY COMPUTATIONAL MACHINE IS FINALLY FINISHED — IT'S THE FIRST OF ITS KIND ON THE EUROPEAN CONTINENT!

I'D LIKE TO SEE THAT THIEVING BASTARD NEWTON TRY TO TOP **THIS!**

☹️sigh☹️ AH WELL... EVERYTHING IS A PART OF GOD'S PLAN, SUFFERING AND ENVY SIMPLY A PHENOMENON OF PERCIPIENT BEINGS...IT CAN ONLY BE THE BEST OF ALL POSSIBLE WORLDS, AS SUCH...

THOUGH IT'D BE A HELLUVA LOT BETTER WITHOUT DIRTY PLAGIARIZING ENGLISH SCIENTISTS

# End Continental Rationalism

- Return to our senses