

# Newton and Leibniz on Space and Time

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# Introduction

- Can you explain the concept of motion without the notion of space and/or time?
  - Both Leibniz and Newton's theories of space and time are rooted in observations of change (e.g. motion).
- What is space and time? Are they real substances in the world? Can a single object or event have an absolute space or time, or do space and time rely on relational properties between multiple objects or events?

# A Few Definitions

- **Relativism** - Leibniz's theory on space and time
- **Absolutism** – Newton's theory on space and time
- **Plenum** – a space every part of which is full of matter, which included air and ether
- **Void** – space that contains no matter
- **Sensory organs** – the tools with which we perceive the world.
- **Sensorium** – the seat of sensation where an organism experiences and interprets the environment within which it lives

# Relativism

- First, what are space and time? Are they real substances in the world or simply relational properties between objects and events?
- “I hold space to be something merely relative... as an order of coexistences, as time is an order of successions” (Leibniz, L111.4, AW 297b).
- For example: If the entire universe were moved 3 inches or 3 seconds from where it actually is, nothing in the universe would change in any significant (relative) way

# Absolutism

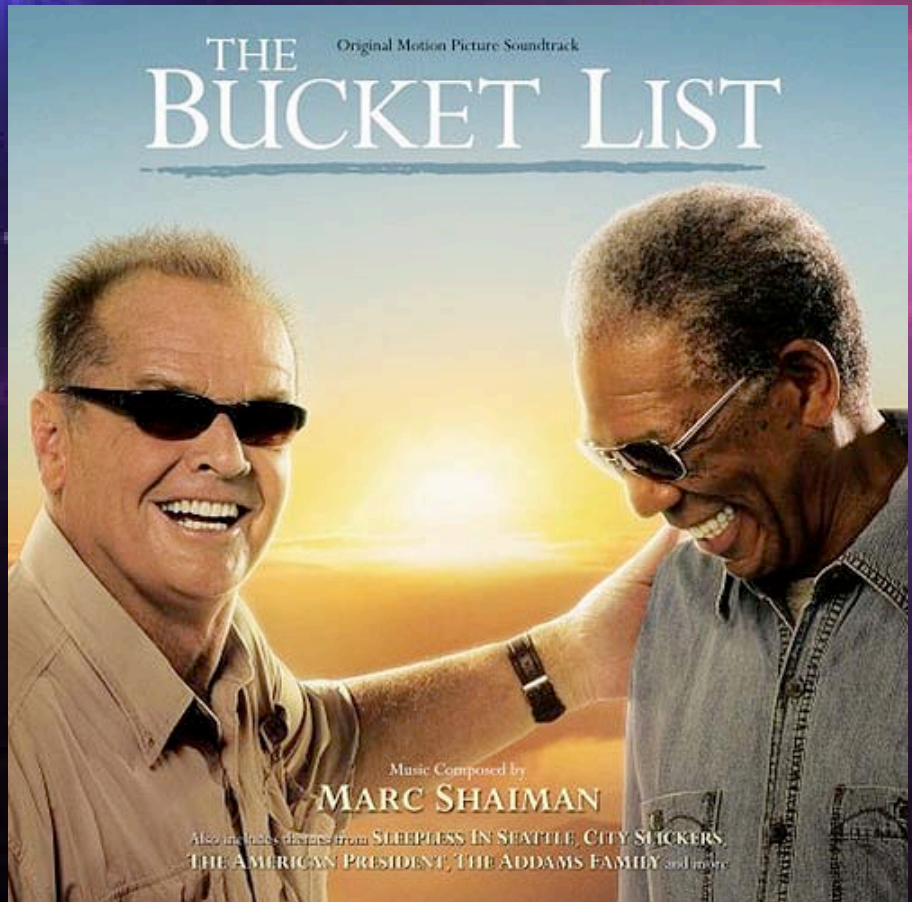
- “Absolute space, in its own nature, without relation to anything external, always remains similar and immovable” (Newton, AW 285)
- Humans can only observe relative space and time, but absolute space and time must presuppose the relative.
- “It may be that there is no such thing as a uniform motion by which time may be accurately measured.” (Newton, AW 285)



# Newton's Bucket Experiment

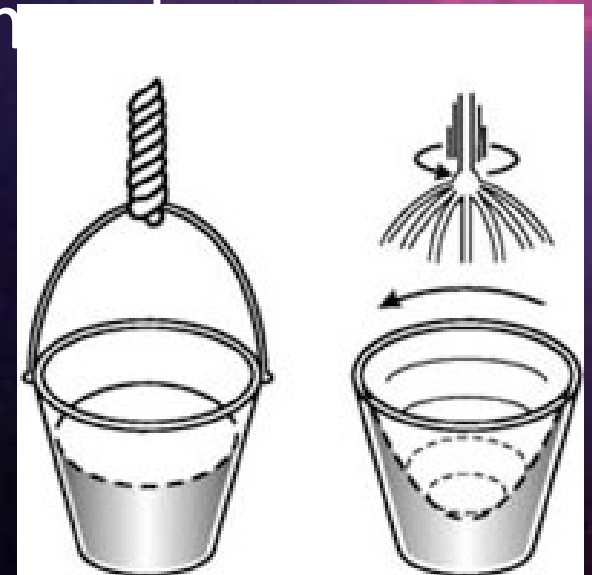
<http://www.youtube.com/watch?v=Zip9ft1PgV0>

- **State 1:** Bucket and water are at relative and absolute rest.
- **State 2:** Bucket is in motion, movement of bucket is transferred to water
- **State 3:** Bucket and water are in uniform motion



# Newton's Explanation

- “The ascent of the water shows its endeavor to recede from the axis of its motion, and the true and absolute circular motion of the water, which is here directly contrary to the relative, becomes known and measured by this endeavor.”  
(Newton, AW 287)



# Void vs. Plenum

- Absolutist argument:
  - If a vacuum (i.e. void) exists it poses a problem for relativists. Without matter, one cannot define distances in a vacuum using relative space.
- Relativist argument:
  - “In like manner, to admit the void in nature is ascribing to God a very imperfect work; it is violating the grand principle of the necessity of a sufficient reason” (Leibniz, AW 302)



# Sensory Organs and the Sensorium

- Newton: Humans can only perceive relative space and time using sensory organs while God, in a Spinozic sense, contains absolute space and time within, and through the sensorium, absolute space and time are known.
- “I find, in express words in the Appendix to Sir Isaac Newton’s *Optics*, that space is the sensorium of God. But the word “sensorium” has always signified the organ of sensation. He and his friends may now if they think fit, explain themselves quite otherwise; I shall not be against it.” (Leibniz, AW 295)

# Things to Ponder...

- “Space and time are relative in the sense that certain magnitudes such as duration and distance vary from one frame of reference to another. (This is implied by Einstein’s Theory of Relativity).” (Horwich, Noûs)
- Time dilation and length contraction
- Metric expansion of the universe
- Twin Paradox:
  - 2 identical twins are born
  - One flies at the speed of light for 20 years, then comes back to earth
  - His brother is 60 years old when he gets back

*Fin.*



# Kant's Response

- Maybe we're thinking about this all wrong....
  - Is it possible to distinguish between objects of coexistence or moments of succession without space and time? No says Kant
  - As humans, all we can know is that our sensibility requires space and time to perceive the world
  - “The representation of space cannot be obtained from the relations of appearance through experience, but this outer experience is itself *first* possible only through this representation” (*Critique of Pure Reason*, B38, emphasis mine)
  - Kant never really addresses the possibility or impossibility of the existence of absolute space and time, but he does say we can never know definitively or objectively