Lecture 1 Supplement: History of Space Concepts

Note Title 1/18/2011

What is space? 2 Historical Viewpoints
↳ Relational
↳ Entity

Aristotle: completely relational view → the place of an object is determined by the surrounding objects.

The question of space is equivalent to the meaning of the question "where is an object?"

This is because in the entity view, you can answer the question of where by refering to space itself as an entity.

But: Aristotle has it both ways: Aristotle's universe is highly structured. There is an absolute structure to where objects are and how they can move, so there is both a relational & absolute notion of location.

$\Rightarrow$ All of this is further developed by Ptolemy (and Church endorsed) where perfect motion (the heavens) is circular.

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2 Ideas of space give rise to 2 ways to think about motion:

(1) Objects move w/ respect to space (Newton)
(2) Objects move w/ respect to each other.
(Aristotle, Descartes, Galileo, ...)

Middle Ages: typical problems (philosophical)

(1) Can God move the universe 1 yard to the right? ← only has meaning in absolute view

(2) Is there meaning to the question: Is there a difference b/w fixing the earth and rotating the heavens or fixing the heavens and rotating the earth?

Always the relational view is dominant!

Contemporaries / Galileo: uniform motion is not detectable
(All inertial reference frames are equivalent)

\ Descartes: also emphasizes relational definition of motion

Huygens: works out elastic collision problems using Galilean relativity.

Newton: ditches relational view ⇒ mechanics requires space as an entity

↳ uses absolute space and absolute motion
(although actually only needs absolute acceleration and rotation)

Contemporaries of Newton object to two things:

(1) Action at a distance
(Newton doesn't explain how gravity works)

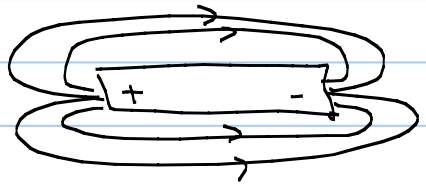
(2) Absolute space

(Both of these objections turn out to be correct!)

Relational view: Galilean Relativity

Absolute / Entity view: Newtonian Mechanics
↑ contains a distinction b/w matter (particles) and space ($\mathbb{R}^3$, Euclidean)

Road to SR:
conflicts in E+M



Are the Faraday lines real?
what are the $\vec{E}$ + $\vec{B}$ fields?
Why aren't Maxwell's eqns Galilean invariant?
Why can't we detect the ether?

(1905) Einstein: Accept Galilean relativity as an ok idea.
Accept Maxwell's equations as correct.
→ Problem is w/ simultaneity.

Galileo: There is no meaning to the "same spatial point" at different times independent of an observer.

Einstein Adds: There is no meaning to "at the same time" at different spatial points independent of an observer.

→ **Observer dependent simultaneity** leads to Lorentz transformations and a theory of special relativity that resolves the E&M paradoxes

⟹ So the entity picture of space is much more complex and difficult to work into physics than the relational view.