Announcements

- Quiz 1: available on Canvas, due @ 11:59pm tonight (01/22)
  - 25 pts; 30 mins to complete from starting time

- Today begins “The Nature of Space and Time”
  - Chapter 2 of the textbook
  - Problem 1 is due 01/24 @ 11:59pm
    - 5 pts for on-time submission
    - 20 pts for correct solution

Reference Frames

Inertial

Constant speed and direction

—> no acceleration

$a_{gravity} = 9.8\ m/s^2$

scale matters

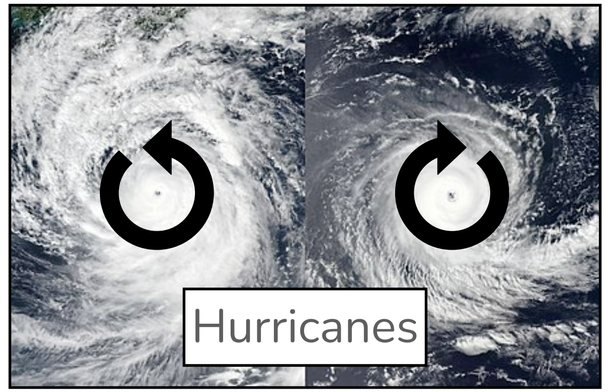
Non Inertial

Changing speed and/or direction

—> acceleration

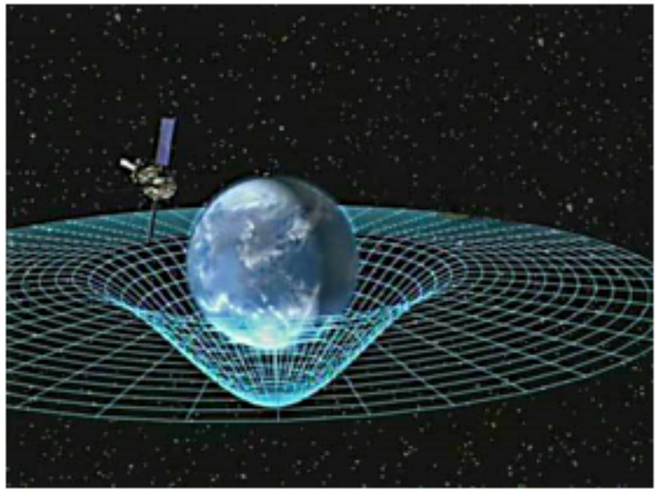
Northern Anti-clockwise

Southern clockwise



$a_{coriolis} = 0.03\ m/s^2$

Chapter 2: 01/22 - 02/09



What is the nature of space and time?

Classical Physics

Modern Physics

Future Physics

Star Trek: The Next Generation

“Descent Part 1”
Written:
Alexander Singer
Paramount
(1993)

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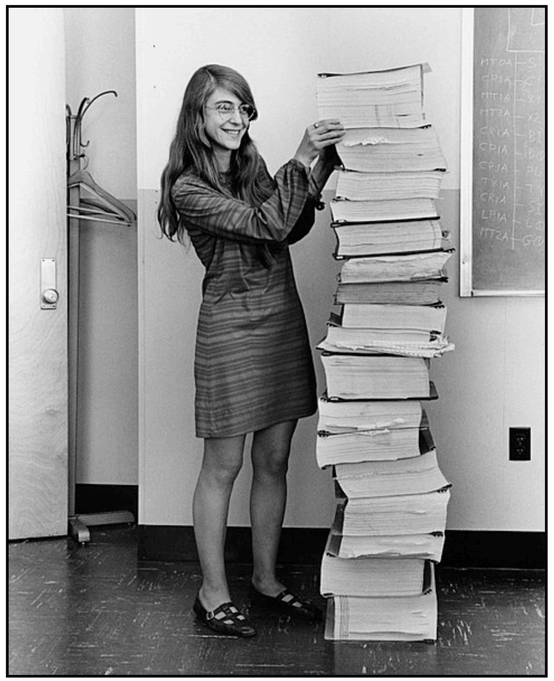
Classical Physics

Newton's Laws

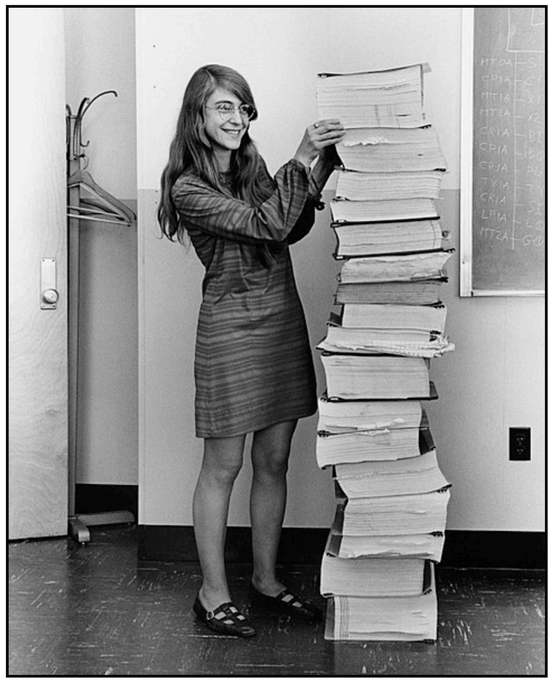


Margaret Hamilton

Accurate enough to get to the Moon!

Classical Physics

Newton's Laws



Margaret Hamilton

Not fast enough

Not tiny to get to the Moon!

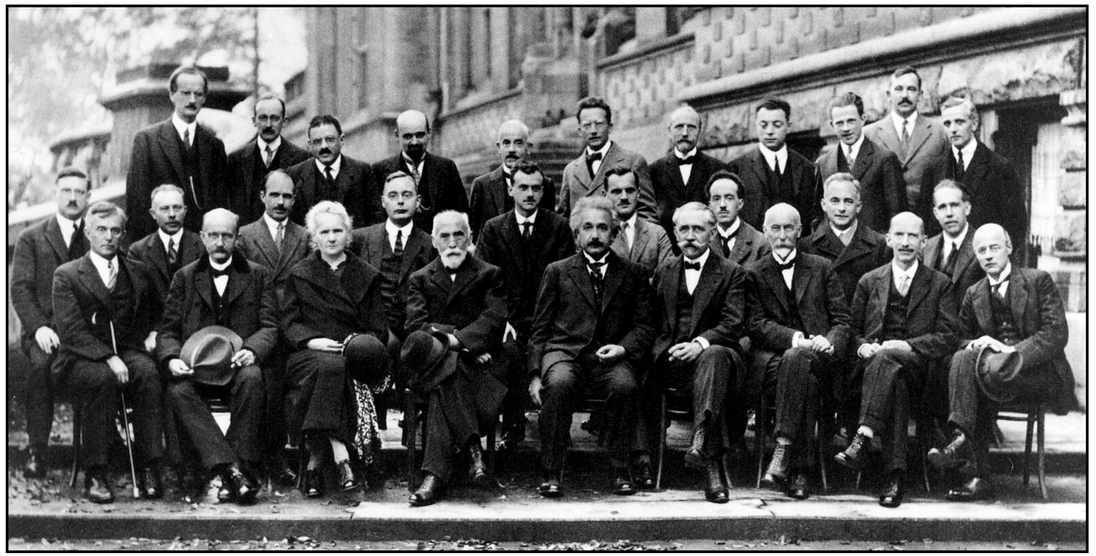
Not highly energetic

Modern Physics

Special Relativity: fast

Quantum Mechanics: tiny

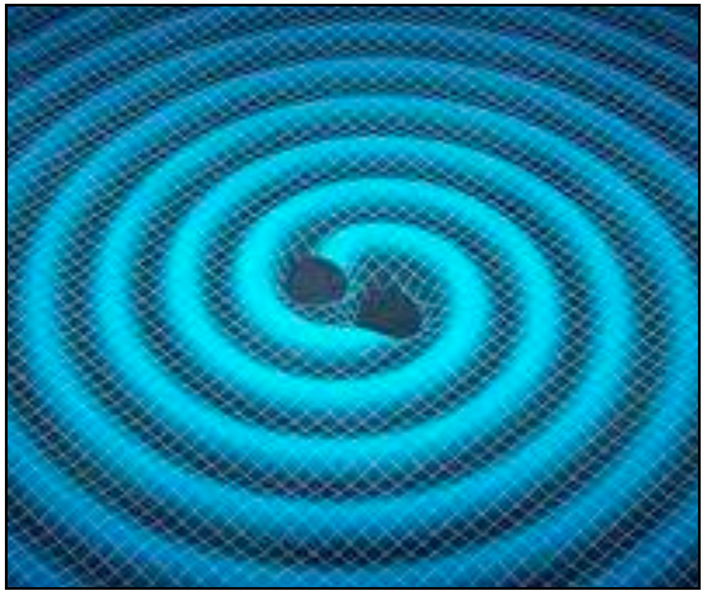
General Relativity: energetic



Solvay Conference 1927

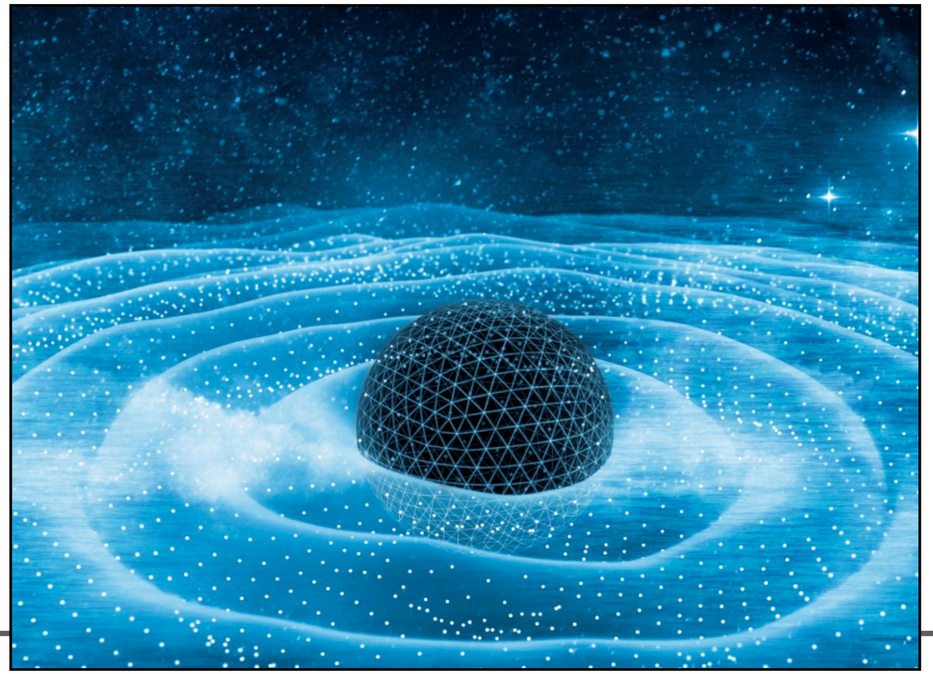
Modern Physics

- Time dilation & distortions of space/time
- Black holes
- Gravitational waves
- Warp drive — “faster than light” travel



Future Physics

- Quantum Gravity / Quantum foam
- Time travel
- The multiverse hypothesis



Newton's Laws of Motion (in an inertial reference frame)

I: Inertia - an object in motion stays in motion under no external forces

II: Force - the force on an object is equal to its change in its momentum with time

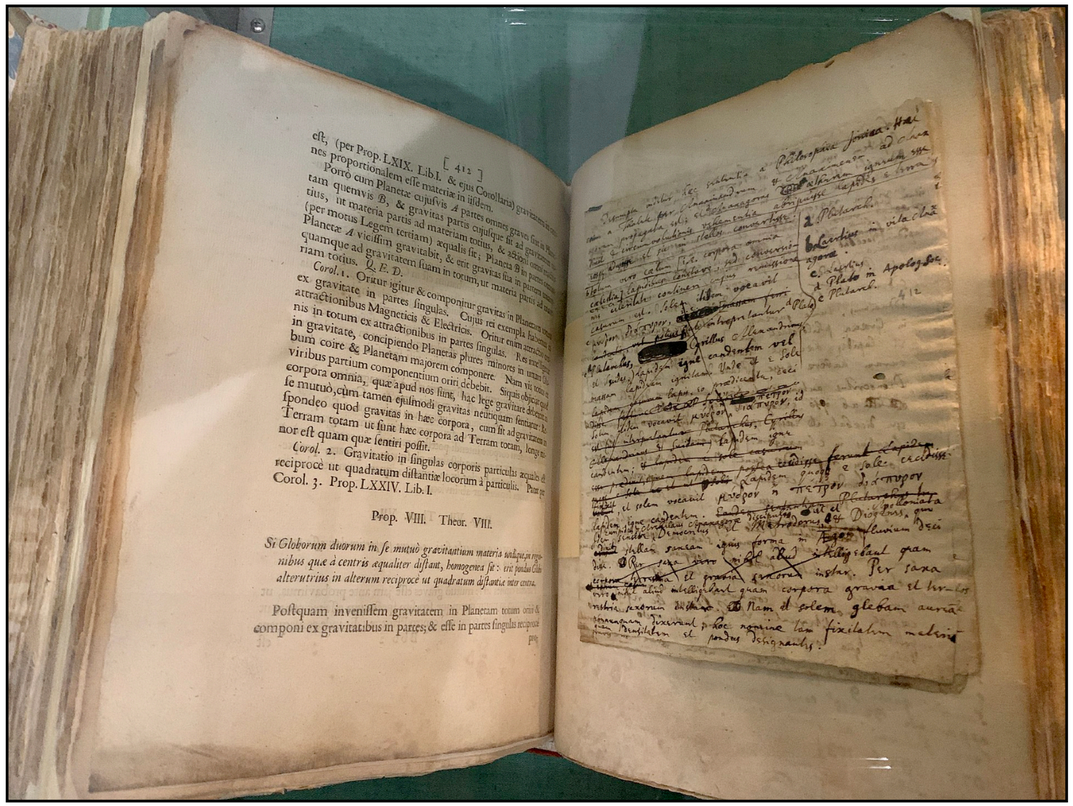
III: Action & Reaction - A force exerted by an object on another object is met with an equal and opposite force

I: Inertia -

"Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it."

- Isaac Newton;

Principia Mathematica (1687)



Cambridge University Library

I: Inertia -

"Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it."

- Isaac Newton;

Principia Mathematica (1687)

An object will continue in its state of uniform motion or rest, unless acted upon by an external force.

- *uniform* motion
- *external* force

X-Men III: The Last Stand
Director: Brett Ratner
20th Century Fox (2006)

Watch for examples of Newton I in action:

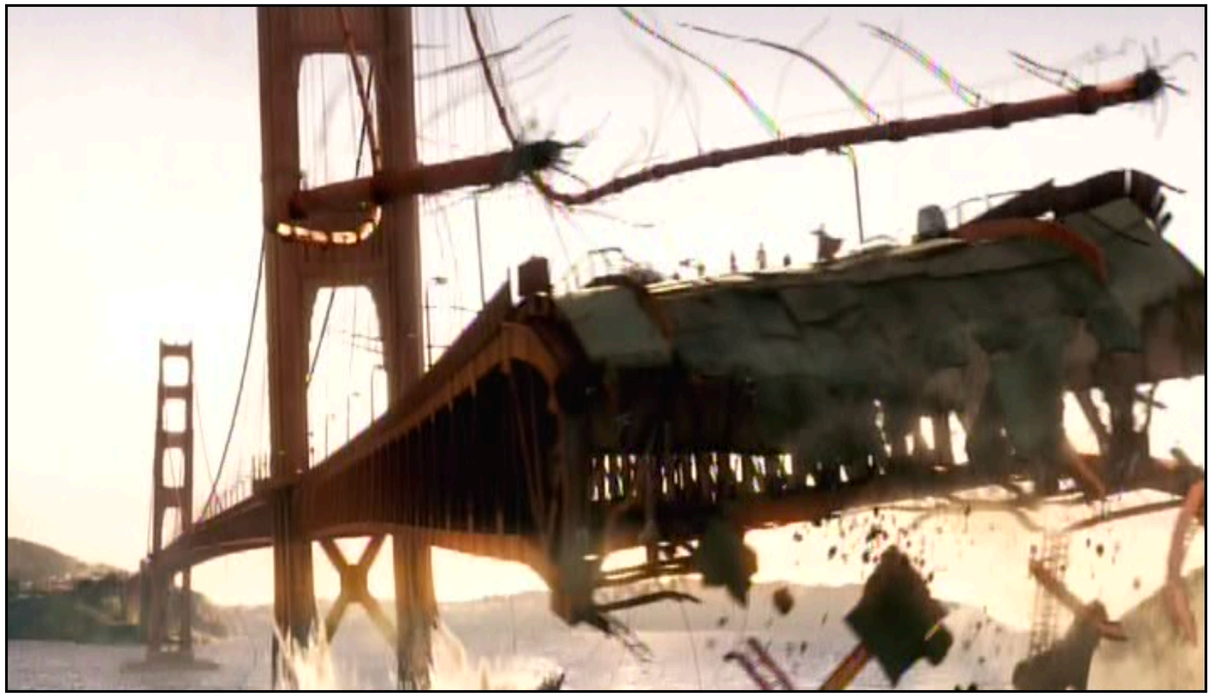
- *uniform* motion
- *external* forces

Is it realistic?

~~Is it realistic?~~

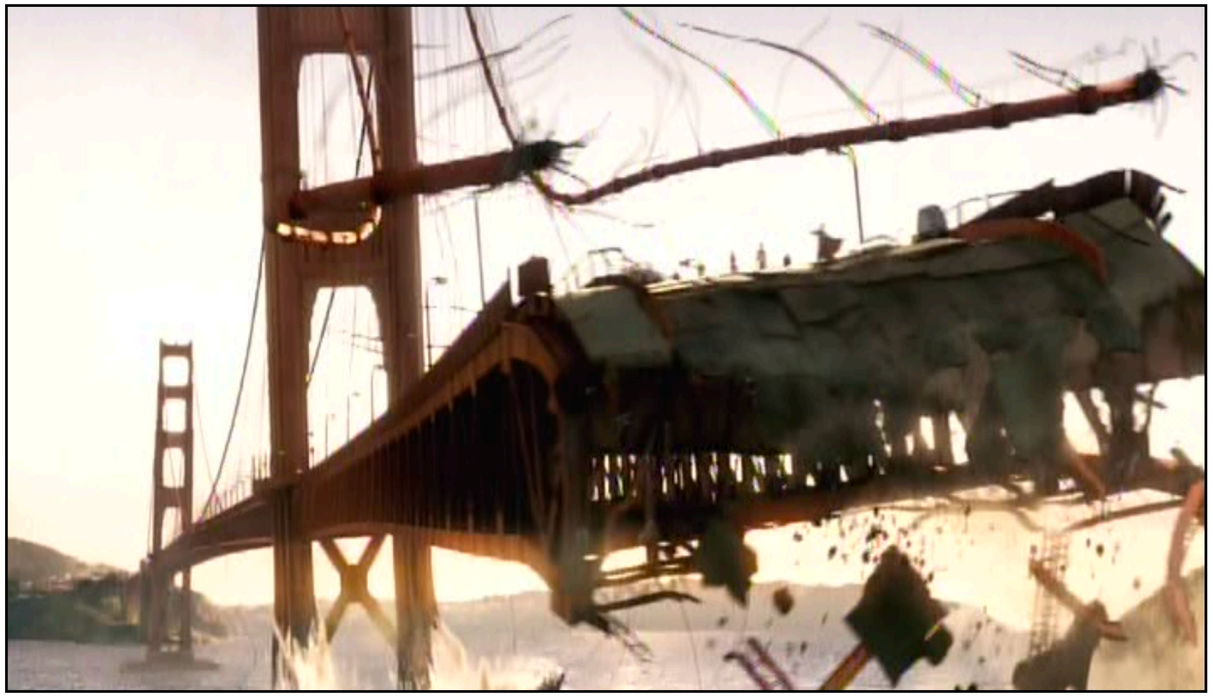
Is it consistent with Newton I?

Magneto exerts an *external force* to move the cars out of the path



~~Is it realistic?~~

Is it consistent with Newton I?



~~Is it realistic?~~

Is it consistent with Newton I?

Magneto exerts an *external force* to pull the bridge off the land

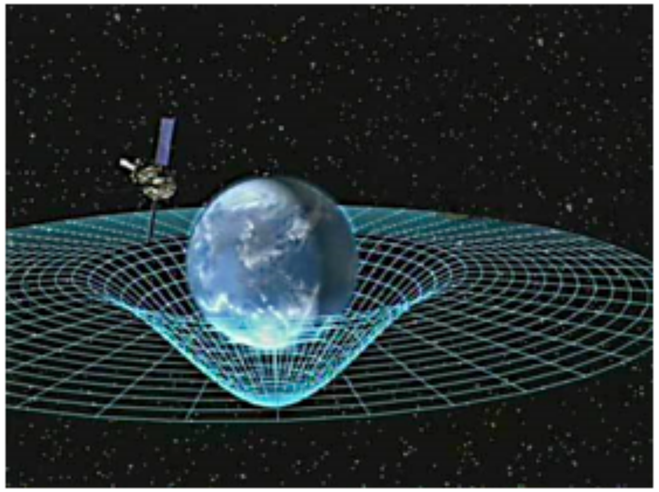
~~Is it realistic?~~

Is it consistent with Newton I?

Magneto can only exert his external magnetic force against Earth's magnetic field

Next time:

- Newton II, III
- Begin special relativity



What is the nature of space and time?

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