

Introductory Astronomy

Week 6: Relativity and Black Holes

Clip 1: Introduction

Galileo 1632

“Shut yourself up with some friend in the largest room below decks of some large ship and there procure gnats, flies, and such other small winged creatures. Also get a great tub full of water and within it put certain fishes; let also a certain bottle be hung up, which drop by drop lets forth its water into another narrow-necked bottle placed underneath. Then, the ship lying still, observe how those small winged animals fly with like velocity towards all parts of the room; how the fishes swim indifferently towards all sides; and how the distilling drops all fall into the bottle placed underneath. And casting anything towards your friend, you need not throw it with more force one way than another, provided the distances be equal; and jumping broad, you will reach as far one way as another. Having observed all these particulars, though no man doubts that, so long as the vessel stands still, they ought to take place in this manner, make the ship move with what velocity you please, so long as the motion is uniform and not fluctuating this way and that. You shall not be able to discern the least alteration in all the forenamed effects, nor can you gather by any of them whether the ship moves or stands still. “

Principle of Relativity

- Laws of Physics are the same measured at **rest** or moving at **constant velocity**
- $\vec{F} = m\vec{a}$ determines **accelerations** which are the same in both **frames**
- At **rest** is **meaningless**. Only **relative** velocities are **physical**

This Week

- Follow Principle of Relativity as far as it takes us
- Electromagnetism will force some modifications – Special Relativity
- Find that Newtonian gravity is not invariant after all
- Describe General Relativity and some Astronomically important consequences
- Black Holes

Credits

- Animation created with Mathematica
<http://www.wolfram.com/mathematica>