

Key points from Lecture 4 of ASTR 350

1. In our normal experience, velocities add linearly. That is, if someone sees a ball (for example) moving with velocity \vec{w} and we see that someone moving with velocity \vec{v} , then we see the ball moving with velocity $\vec{v} + \vec{w}$. In Newtonian physics (in particular, using Galilean transformations), this applies to everything.
2. But the understanding of light we get from Maxwell's equations tells us that every observer sees the *same* speed of light in a vacuum, regardless of the observer's motion. This is inconsistent with Galilean transformations; instead, we need to use Lorentz transformations.
3. This was codified by Einstein into what we now call *special relativity*. There are two postulates: (1) the laws of nature are the same in all inertial frames of reference (i.e., ones where observers feel no acceleration), and (2) the speed of light in a vacuum is the same as measured by anyone in an inertial frame of reference.
4. One strange consequence is that time seems to run differently in different frames: if you pass by me at a high speed, I see your clock running slowly and you see my clock running slowly. This is called time dilation.
5. **Very importantly:** each of us sees our own clock running at a normal rate! In fact, no inertial observer can determine that they are moving; remember, all laws of nature are the same in any inertial frame.
6. In a frame that is non-inertial, because it is accelerating, then *fictitious forces* are introduced. Examples include centrifugal force and the Coriolis force.