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Physics 230 Section 001

Final Project Report

Visualizing Relativistic Aberration, or "What do Han and Chewie see from the Millennium Falcon's cockpit, and why?"

I've always like science fiction, and as I've learned true science I've liked either pointing out things that happened which were impossible, or explanations given that were either wrong or just totally bogus. As time has gone on, however, I've preferred considering what would happen if one impossible thing were to happen, what the following results would be. So I considered, what would a traveler see if he were aboard a ship that could safely accelerate to relativistic speeds?

Star Wars, Star Trek, and a lot of other science fiction all portray the traveler's view of the stars as a field of stars elongated into lines, streaking past. This is totally wrong, as a traveler would actually see their field of vision distort, converging towards a central point in the direction of travel. When I learned this, I had a hard time visualizing what was happening, so I decided some animations would be of use.

I started from very simple animations, a spaceship in the middle of six equidistant stars. Photons are emitted from the six stars at the same time, arriving at the ship at the same time. Then I added lines connecting the ship and the photons, which would show the angle at which the photons would hit the ship—and thus the direction in which the spaceship perceives the stars to be. When the ship is stationary, everything lines up.

Then I made a set of four animations showing the ship traveling at different speeds. In each instance, the photons converge upon the ship in the center. The angles at which the photons converge upon the ship change more and more the faster the ship is going, which causes an aberration for a traveler on the ship that is more and more extreme.

I included an animation that showed—while ignoring relativity—what would be seen by a ship traveling twice the speed of light. I included that to show that the fact that the model continued working for something moving twice the speed of light implies that the model is not totally accurate or correct.

I then moved to special relativity, starting from the stars' frame, which really revealed nothing special except to hint that we needed to consider everything from the ship's frame.

I had quite a tricky time getting the Lorentz transform all flushed out and working properly in the animation. For example, I couldn't figure out how to get time dilation animated properly. All photons were emitted at the same time and converged at the same time upon the ship, but with space distortion it meant that the speed of light wasn't constant in that animation.

Further development of this project would be to thoroughly flush out a correct animation including time dilation. However, as it stands, the animations do work together to give a more intuitive understanding of aberration for moving observers.

https://git.physics.byu.edu/carter62/relativistic-aberration