# NYU Physics I—Problem Set 13

Due Thursday 2018 December 6 at the beginning of lecture.

**Problem 1:** Get a sense of the speed of light by computing two things:

*(a)* How many times could light go around the equator of the Earth in a time interval of 1 s?

*(b)* How long (in ns) does it take light to go 1 ft?

**Problem 2:** From the notes at `http://cosmo.nyu.edu/hogg/sr/`, Problem 3–4. Note that there is a typo in this part *(d)* of this problem: It is the Earth that replies, not the station.

**Problem 3:** From the notes at `http://cosmo.nyu.edu/hogg/sr/`, Problem 2–14.

**Problem 4:** *(a)* What is $\gamma$ to first order in $\beta^2$ for $\beta << 1$? That is, construct a Taylor Series for $\gamma$ in terms of $\beta^2$ and give the zeroth-order term (1) and then the first-order term.

*(b)* What are $\beta$ and $\gamma$ for a person walking (relative to the sidewalk), a driver on the freeway (relative to the road), a commercial jet (relative to the air), and an astronaut in the ISS (relative to the center of mass of the Earth)? Use the first-order expression from part *(a)* to compute the $\gamma$ values.

*(c)* Computing the full time dilation effect in gravity is complicated! However, the pure kinematic part of the time dilation only depends on $\gamma$. Two twins part. One gets on the ISS for a year, and one stays on Earth. When they are reunited in a year, how much younger is the astronaut than the homebody?

**Extra Problem (will not be graded for credit):** If the total energy (rest mass plus kinetic) of a point particle is $\gamma\, m\, c^2$, use the result from Problem 3 above to get an approximate expression for the kinetic energy at low speeds.