Laser Physics (Physics 464)
Homework I, due Wednesday, September 4, 2024

Transverse Doppler shift

Year 202?, the Artemis NASA mission is on the moon with a high resolution wavemeter. Jan Hall's one micron wavelength laser with one Herz bandwidth is beamed at that detector. Is that sufficiently narrow bandwidth? If not, what is the minimum bandwidth required? How long do you have to track the detector on the moon with your laser beam in order to do this measurement? Assume a circular orbit of radius L_0 for the moon around the earth.

Longitudinal Doppler shift

The orbit of the moon is not circular, but has a fairly large eccentricity of 13%. The moon-earth distance varies periodically. Take that variation to be sinusoidal. What is the Doppler shift at the point(s) where the longitudinal component of the velocity is maximum?
The earth is at a focus of the ellipse. If e is the eccentricity, s the shortest distance, the longest distance is $e+s$ The amplitude of the distance oscillation is $e = 0.13R$.

The duckling transverse Doppler shift

Find an expression for the transverse Doppler shift of the duckling (see class notes)