# ASTR340 (Fall 2018) Homework 4

# GR, black holes and the basics of cosmological models

### (Due at the start of class on Tue 16th October 2018)

1. Describe the difference between a Schwarzschild and a Kerr black hole, defining the meaning of the terms: singularity, event horizon and ergosphere
2. FMC Q9.1
3. FMC Q9.4
4. FMC Q9.11
5. Suppose that it is a clear night and that you are looking up at the night sky; there is a beautiful full Moon, several planets are shining (Mars and Jupiter) and there are hundreds of stars visible. At that moment, at exactly midnight, Dr. Evil turns the Sun into a black hole (keeping its mass constant). Describe what you would feel and see as a result of this dastardly act. When would you see/feel these consequences? Explain.
6. FMC Q10.7
7. It was recently reported that astronomers had discovered a galaxy with a redshift of z=8.55.
    a. Suppose that this galaxy has an optical emission line with an emitted wavelength of 500nm. At what wavelength would we (on Earth) observe this emission line, and to which part of the spectrum does this wavelength correspond?
    b. Let's define the scale factor of the Universe at the current time to be $R_0$=1. What was the scale factor of the Universe at the time that we are seeing this galaxy?
    c. Prof. Ned Wright at UCLA has produced an extremely useful web-based tool for calculating interesting cosmological quantities. Use his website to calculate the age of the Universe at the time we are seeing this galaxy. Assume a Hubble constant of 70 km/s/Mpc and default values for $\Omega_M$ and $\Omega_\Lambda$. This tool is at: http://www.astro.ucla.edu/~wright/CosmoCalc.html
8. Suppose that the Universe were not homogeneous, i.e., different parts of the Universe had different average properties and, in particular, densities. Explain why this would affect the concept of "cosmic time". How would this be related to gravitational redshift?