PHYS 114 HWK 4 **Due: 4/2/24**

1. From text, Chap 3: 3.1, 3.2, 3.5

2. Professor G asks you to design a photometer to measure OI 630.0-nm nightglow emission with a PMT device. He has a PMT [with housing and cooling unit] that gives an overall effective QE of 11%. Professor G also has some spare optics [from his previous work on the Death Star] and a 630.0-nm interference filter, which all combined have a Transmission of 93%. You will be using a bare 4" diameter lens as the aperture, whose transmission is already included in the above system efficiency. Professor G believes that having an array of photometers, all measuring synoptically, will lend great insight into his ideas of magnetospheric storm formation that he has published on. Professor G also things that he will probably win a new NSF award in 4 months to also install 557.7-nm emission photometers [whose emission is much higher than 630-nm emission, about 3 times as much!] and is excited about having these systems. Professor G also has a 355-nm Quantel laser system of 10 Hz at 2.6 W, along with 2 o-scopes, a pet monkey that eats ice cream named Pete, and an optical housing to hold optics. Professor G also tells you that the typical thermospheric emission from the midlatitude trough at solar minimum from OI at 630.0-nm is about "10 Rayleighs." At solar max, that value can increase a little, but during geomagnetic storms the value can increase by a factor of 10!

[Having no idea what a "Rayleigh" is, you wisely ask Professor X's grad students [so as to not bother the very busy Professor G any more than is necessary] and they tell you that

$$1\ [\text{Rayleigh}] = 10^6\ [\text{photons}/(\text{m}^2 \bullet \text{sec})].]$$

TO THE BAT CAVE!

1. Design the forward model for this system. Assume a system noise equivalent to 0.1-Rayleigh.

2. Plot a curve of the number of photons received as a function of the integration period for "reasonable" ranges.

3. What is the optimal integration time assuming you want a 1%-error from each data realization?

4. Hold the phone! Professor G suddenly finds a better PMT [he stole it from the THz research group run by Professor F… they probably have too much money anyway ☺] with a QE of 19%. "Overplot" the new forward model curve on top of the previous curve of step 3.

5. Repeat step 3 using the better PMT.