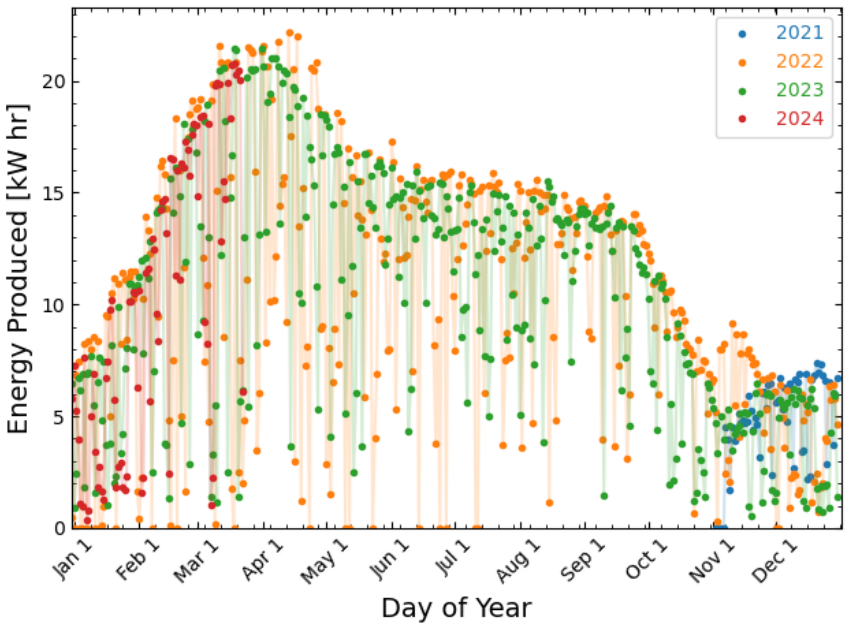
UNIVERSITY OF KANSAS
Department of Physics and Astronomy
Physical Astronomy (ASTR 391) — Prof. Crossfield — Spring 2024

Problem Set 7
Due: Friday, April 5, 2024, 10am Kansas Time
This problem set is worth **42 points**.

As always, be sure to: show your work, circle your final answer, and use the appropriate number of significant figures.

1. **Solar Energy [16 pts]**

   Figure 1 below shows the daily energy produced by Prof. Crossfield's rooftop solar panels over the past few years.



   (a) Describe the general trends you observe in this plot. [4 pts]

   (b) Calculate the Solar Constant, the typical flux of sunlight incident on the Earth, in W/m^2. [3 pts]

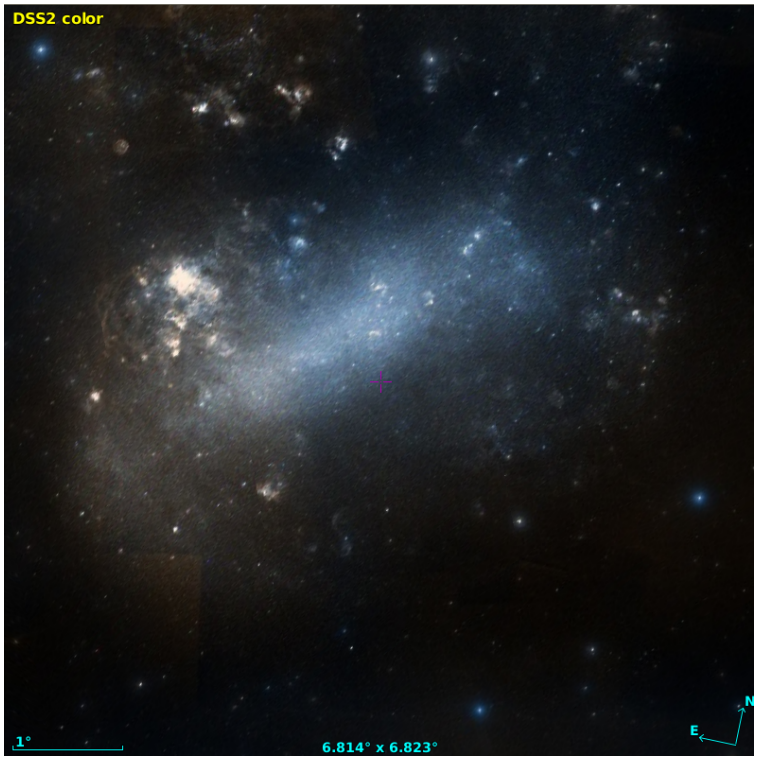
   (c) Prof. Crossfield's solar panel system has a total collecting area of roughly 20 m^2. Estimate the maximum power (in W) that you might expect the panels to produce. [2 pts]

   (d) Using your estimate of the maximum power, estimate the total energy (in kW-hr, killowatt-hours) that might be produced in a day. [3 pts]

   (e) In fact, the system never produces more than about 5 kW of power at peak, and rarely more than $\sim$20 kw-hr of energy per day, at maximum. Describe why these numbers are significantly lower than your rough estimates. [4 pts]

2. **A Galaxy (not so) Far, Far Away [26 pts]**

The Large Magellanic Cloud (LMC) is a dwarf/irregular galaxy fairly near to the Milky Way. Here is its selfie, in Figure 2:



(a) The total apparent brightness of the LMC at visible wavelengths is a visual magnitude of $\sim$0.1, corresponding to roughly 10^8 photons/sec/m^2/nm. Assume that all these photons are visible-wavelength, and then estimate the observed flux density, F_λ, from the LMC in W/m^2/nm. [5 pts]

(b) Assume further that all energy from the LMC is radiated at visible wavelengths, and then estimate the total flux observed from the LMC, in W/m^2. [4 pts]

(c) The parallax to the LMC is roughly 20 μas. Estimate the distance to the LMC, in pc. [2 pts]

(d) Use your value for the distance to estimate the total luminosity of the LMC, in both W and $L_\odot$. [4 pts]

(e) Given the image of the LMC, estimate its angular diameter (in deg), physical diamer (in pc), and angular area (solid angle, in $\square^o$). [6 pts]

(f) Use your estimate of the LMC's solid angle to estimate its average surface brightness, I_λ, in W/m^2/nm/$\square^o$. How does this compare to the value of $\sim 10^{-13}$ W/m^2/nm/$\square^o$ that we estimated for M31 (the Andromeda Galaxy) in class? [5 pts]