Photometry 1 Problem Set

By Nathanael Beta Budiman

1. A star with 4 solar radius and surface temperature of 8000 K is located 14 pc from the Sun. Calculate its apparent and absolute magnitude.
2. If the Sun has a sunspot at its surface with diameter of 50000 km and temperature of 3000 K, calculate the flux emitted by the sunspot. Also, calculate the change in solar luminosity due to this sunspot. Given the Sun's radius 696000 km and its surface temperature is 5800 K.
3. A 50 W green laser emits photon with wavelength 5250 Å and the beam width is 1°. In a detector is 10 m from the laser, calculate the received flux at the detector. If the detector is circular with diameter of 3 cm, calculate the number of photon detected by the device.
4. An observer is moving away from the Sun. As he moves, the Sun is getting dimmer and smaller as seen by him. Find the angular diameter of the Sun when the Sun is as bright as the full moon at the night sky ($m_{full\ moon} = -12.6$).
5. An observer at a spaceship sees the Sun has angular diameter of 0.2°, and the peak emission from the Sun is 5000 Å. A solar panel (4 m × 3 m) is installed to the spaceship to get the energy from the Sun. If the solar panel efficiency is 70%, find how much energy he gets in 4 hours.
6. From spectroscopic observation, the peak spectral emission of a star is at 6000 Å. From astrometric observation, that star's parallax is $0.04''$. From photometric observation, we get $5.61 \times 10^{-10}\ \mathrm{W/m^2}$ from that star. Calculate the star's radius.
7. A cluster consist of two types of star, that is class B5V ($L = 589\ L_\odot$) and class F2V ($L = 5L_\odot$). If at this cluster there are 400 stars and the combined absolute magnitude is -5.93, calculate the number of stars of class F.
8. A globular cluster with magnitude 7.35 has parallax angle of $0.0023''$ and angular diameter of 1°. If all of the stars at this cluster is solar-type stars (like the Sun), calculate the number of stars in that cluster, and also the number density of stars at that cluster
9. A star is moving radially away from the Earth with constant velocity. At $t = 0$, its magnitude is 0.21, and at $t = 2$ billion years its magnitude is 3.25. Find its magnitude on $t = 4$ billion years.

10. A star with magnitude 4.21 at the Earth's sky is a star system with an exoplanet orbiting that star. If the maximum angular separation between the star and the exoplanet as seen from the Earth is $5''$, and the star's parallax is $0.4''$, calculate the apparent magnitude of that star as seen by the observer at the exoplanet.
11. An alien is observing the Sun, and suddenly Jupiter is transiting in front of the Sun. Due to this transit, some of the Sun light got blocked so its observed magnitude change. Calculate the change of the apparent magnitude due to this transit.
12. Assume there is a star moving away from the Earth in a straight line. After billions of years, its distance had changed quite a lot, and also this star has evolved so that its radius and temperature also changes. Due to this changes, its angular diameter is just one third of the original angular diameter, and its peak emission wavelength is twice the original peak emission wavelength. Calculate the change of its apparent magnitude.
13. A satellite is orbiting the Earth with circular orbit, and it is emiting light isotropically to all direction. An observer at the surface of the Earth is observing this satellite, and when the satellite is overhead, its magnitude is 5.11^{m}, and when the satellite is at the observer's horizon, its magnitude is 7.94^{m}. Find the height of the satellite's orbit, and calculate the power emitted by the satellite.
14. A three star system (star A, B, and C), and it is known that the ratio of their radii $R_A : R_B : R_C = 5 : 3 : 2$, and the ratio of their surface temperature $T_A : T_B : T_C = 2 : 3 : 4$. At the sky, this three star system is seen as a single point source with magnitude 5.2. Calculate the magnitude of each star.
15. If the dimmest magnitude that can be seen by A and by B consecutively is 6 mag and 8 mag, calculate the ratio of number of stars that could be seen by B and A. Assume that the stars is distributed uniformly in our galaxy.