

The Eye of the Beholder

It's the year 2050. Two green spaceships, 100m wide together, are speeding toward the Earth. Luckily, you are ready, having spent the past few decades scanning the night sky for signs of trouble with your homemade telescope.

(a) As you look through the telescope, would the spaceships be likely to appear (a) green, (b) blue, (c) white, or (d) red?

(b) Will the light reflecting off the spacecraft be able to make it through the Earth's atmosphere? Why or why not?

(c) The diameter of your eye is about 6 mm, while the diameter of your telescope is 18 m (you've invested a lot of money in astronomy...go you!). How many times brighter could the spacecraft look in your telescope than through just an eye, assuming that we're still viewing the entire craft?

(d) Your friend brings her bionic eye to your house. She boasts that she doesn't need to invest in a telescope because her bionic eye is just as good as a telescope. Is she justified in her boasting? Why or why not?

(e) **(Challenge)** The U.S. government, knowing of your backyard telescope and your interest in alien spacecraft, asks you how many spaceships are approaching. Based on the limitations of your telescope, what's the farthest distance to the spacecraft at which you'll be able to tell that there are two of them? If the spacecraft are moving at $0.15c$, how much time does this give the government to prepare for a potential invasion? What color will the spaceships actually appear?

Aw, Flux!

Betelgeuse is the ninth-brightest star in the night sky, even though it is roughly 643 light-years away from the Earth.

(a) Star Oski has a temperature that is 10 times that of Betelgeuse. How does its flux compare to Betelgeuse's?

(b) How does the luminosity of Star Oski compare to that of Betelgeuse if they have the same stellar radius? What if Star Oski has a radius twice as large as Betelgeuse's?

(c) Stars are (mostly) spherical. How would the luminosity of a star change, however, if the star were a cube of side length R as opposed to a sphere of radius R ? What about the flux?

Lightmapping (Optional)

Draw a bubble diagram with the following concepts in bubbles and annotated arrows relating their connections:

- Light
- Photon energies
- Telescopes
- Doppler shift
- Spectra
- Discrete atomic energy levels