

PHYS 1040: Solution

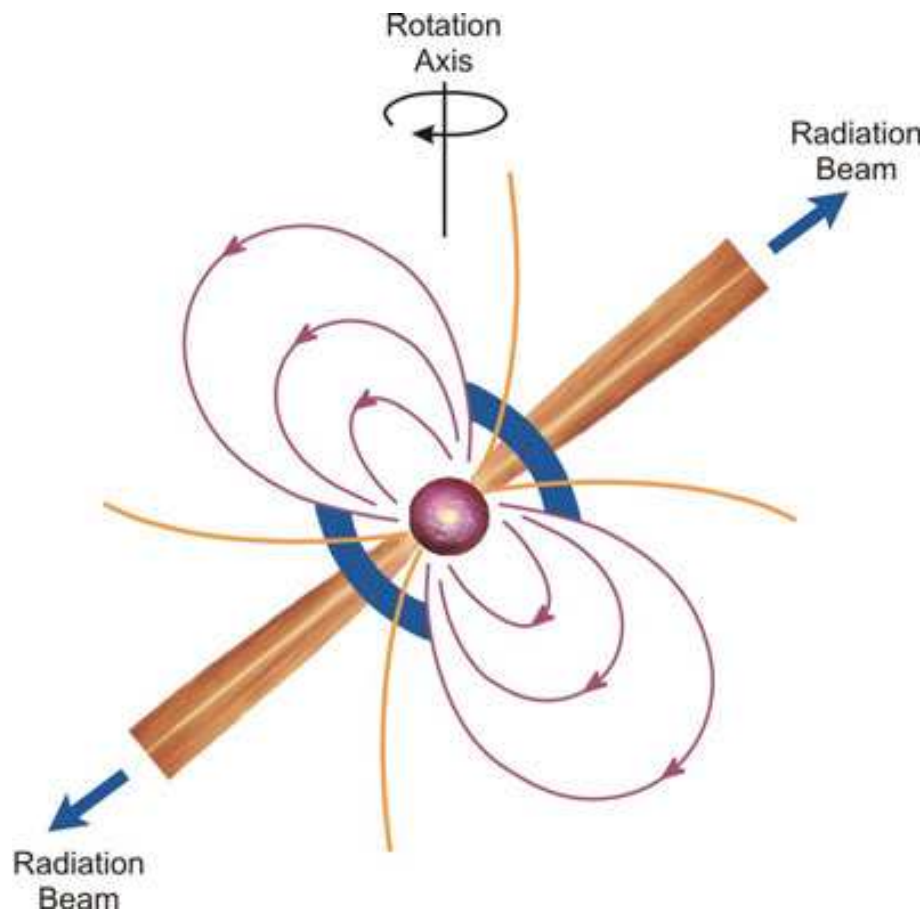
Assignment #4, Spring 2008

1: My semester project rules!

If I were going to make a poster with you, I'd make a poster about measuring the scale of the Universe from my backyard (a project I am working on with some amateur astronomy friends of mine). We all can look up the size of the Earth and the distance to the Moon, and the scale of Jupiter's orbit. But how were these measurements first made? It is possible, using simple devices you build in your kitchen and observations from your backyard, to measure the scale of the Universe yourself!

2: Why do pulsars pulse?

Pulsars "pulse" on and off from our viewpoint here on Earth. The pulsing is a consequence of the fact that the magnetic axis of the pulsar is not aligned with the spin axis. Most of the emission that can be detected with a telescope is directed along a tight beam of radiation along the magnetic axis. As the pulsar spins, the beam of radiation sweeps around pointing in a different place in the sky every moment. If you lie along a circle traced out by this beam, you see the pulsar. It is "on" when the beam is passing by you, and "off" while you are waiting for it to spin back around again.



3: Dark & Bright Nebulae

It is often the case, as with the Trifid Nebula (M20), that dark nebulae are attached to companion bright nebulae. In these cases, the bright emission part of the nebula is being energized by nearby stars, and glowing. Parts of the nebula which are far from the stars do not gather enough energy to become luminous, and they don't glow. If these non-glowing regions of nebular gas lie on the side of the nebula closest to Earth, then it blocks the luminous parts of nebula from our view. Dark nebulae are, in essence, "backlit" by the brighter nebula.

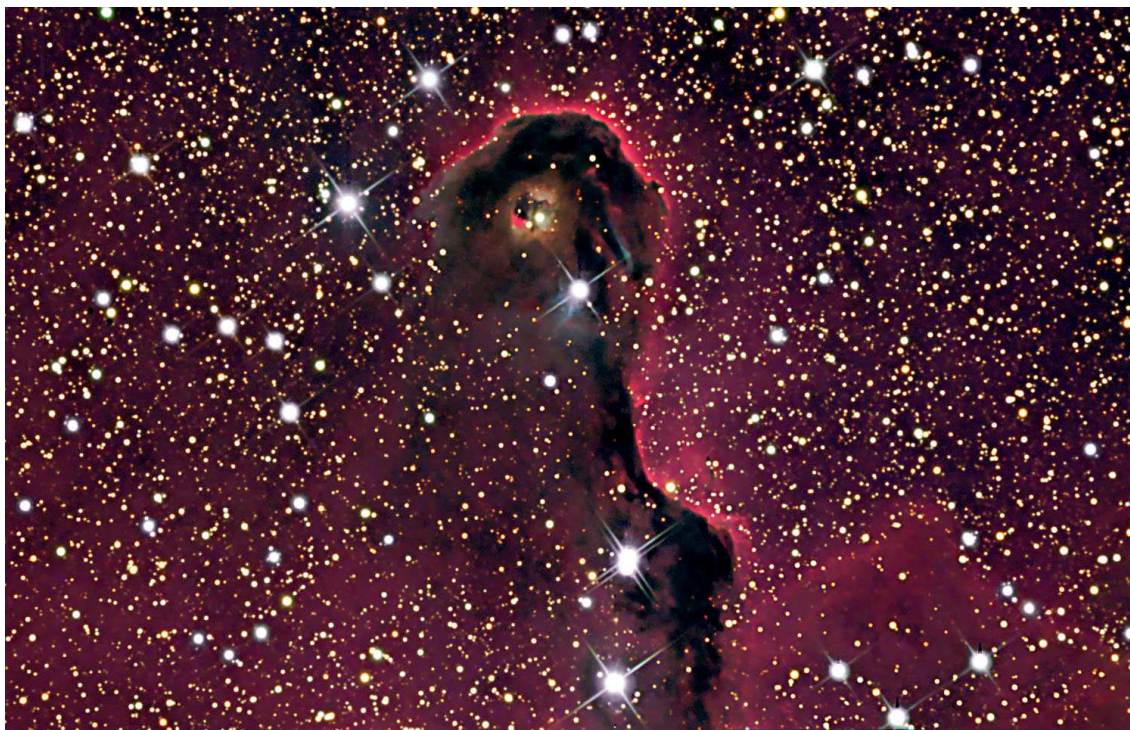


Figure 1: IC 1396, the Elephant's Trunk Nebula.

4: Extinction of Light...

Each parsec of travel reduces the intensity of light by a factor of 0.1 (10%). To find out the intensity after 10 parsecs, I simply reduce the amount of light I have by 10% (multiply by 0.9):

$$\begin{aligned} I_{final} &= I_{initial} \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \times 0.9 \\ &= I_{initial} \times (0.9)^{10} = I_{initial} \times 0.35 \end{aligned}$$

So only 35% of the original light remains.

5: Eclipsing binaries

In an eclipsing binary system, the brightness of the system goes *down* during any eclipse because the total area you can see radiating light is reduced. The question here is about what the relative dimming is when one star passes in front of the other.

In this case, the larger, brighter star is *A*. Since star *B* is dimmer, when it is eclipsed (behind star *A*) less light is lost than when *B* is in front of star *A*. When star *B* is eclipsed, the minimum in the light curve is shallower. When star *A* is eclipsed, the minimum is deeper.

6: Looking for other Earths

The primary method that is used to detect extrasolar planets is *astrometric surveys*, which rely on the gravity of a planet tugging on the parent star and making its position in the sky wobble. Since gravitational force depends

on the masses involved, smaller masses (like Earth sized planets) produce less force, which means the star won't wobble very much at all.

The current best technique for detecting Earth masses planets is using microlensing, as planets make a very distinctive "spiky" shape in the microlensing light curve.

