

Astrophysics Problem Set #5 (Journal Reading)

Due Friday, Oct. 9 at 4pm

1. **Journal Reading:** Please download “Measurement of the Diameter of Alpha Orionis with the Interferometer” (Michelson, A.A. and Pease, F.G. 1921, *Astrophysical Journal*, 53, 249) from the electronic handouts page on our course website. In this article, Michelson measures the diameter of Betelgeuse using an interferometer of his own design, something that hadn't been done before and wasn't pulled off by anyone else for over 20 years. This is a relatively short paper (11 pages), but again, my goal is not for you to memorize the paper, but for you to pay attention to how Michelson and Pease pulled off the measurement of the diameter of a star. After reading the article answer the following questions:
 - a. What is interferometry? Why is it difficult to set up an interferometer? To answer these questions, you may have to look this outside of the article. Be sure to cite your sources. **NOTE:** Wikipedia or any other website is NOT an acceptable source, but using it to find “refereed sources,” such as textbooks or peer-reviewed articles, is acceptable.
 - b. The smallest detail a telescope can make out in ideal conditions is governed by the “Airy disk” equation

$$\sin \theta = 1.22 \frac{\lambda}{D}.$$

where λ is the wavelength of the observation, D is the diameter of the telescope's primary mirror/lens, and θ is the angular size of the smallest detail that can be seen. We assume wavelength and diameter are in the same units. For small angles, this can be written:

$$\theta \approx \sin \theta \longrightarrow \theta \approx 1.22 \frac{\lambda}{D}.$$

Use this expression to determine the diameter of a telescope with enough resolution to measure the diameter of Betelgeuse using an optical telescope centered in the red ($\lambda = 700 \text{ nm} = 7000\text{\AA}$). Based on your answer, does it make sense to use an interferometer instead of a large telescope¹? **NOTE:** Remember that to measure the diameter of Betelgeuse, you need to have an angular resolution sufficiently smaller than Betelgeuse to make out its diameter.

- c. Write up of a question Michelson and Pease answered in their article and your best attempt to understand their answers based on the paper.

¹ The largest optical telescopes at the time of Michelson and Pease's work were about 2.5 meters in diameter. The largest today have 10 meter mirrors, although some exploit interferometric techniques with multiple mirrors to achieve greater resolution.