UNIVERSITÄT LEIPZIG

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Cosmology Problem Sheet 1

Problem 1.1 - Parallaxis distance measurement [12 Points]

In parallax distance measurement from Earth, a stellar object is observed for at least one year, and from the recorded track of its images against the far more remote fixed stars, forming an ellipse, a largest and a smallest parallax angle can be determined (referring to the large and small semi-axis of the ellipse). For simplicity, it is assumed that Earth's orbit is circular.

(a) Suppose that the inclination angle α of the line of shortest distance d from the Sun to the stellar object against Earth's orbital plane is (significantly) different from $90°$. Find a formula relating α to d and the smallest parallax angle under which the stellar object is seen from Earth during one year.

(b) The human eyes have an angular resolution of about $30''$. Suppose a human observer watches the sky with bare eyes. If the observer stares at a pair of stars (assumed point-like) which are $10^{14}m$ apart (perpendicular to the line of sight), what is the maximal distance d (in pc) of the pair of stars such that the observer can still see the pair of stars as two separate objects?

(c) Assuming that it was a good proposal – could one use the Hubble Space Telescope (HST) to observe the remainders of the Apollo program's Moon landing devices and confirm that the landing of men on Moon wasn't just made up as a movie in Hollywood? The angular resolution of the HST is $0.08''$, aperture is approx. 2.4 m and the focal length up to around 55 m. In order to be sure that the thing you see on the moon is not just a fancy shaped rock, one would have to resolve down to 0.5 m sized objects on the surface of the Moon.

Problem 1.2 - Magnitudes [12 Points]

(a) Verify the relation between L (absolute luminosity) and M (absolute brightness) given in Lecture 05, page 29.

(b) Suppose a star has a distance d from the observer. Derive a formula (dependent on d) for $m - M$ where m is the apparent magnitude, M is the absolute magnitude of the star.

(c) Calculate the distance to Alpha Centauri, assuming its absolute luminosity is the same as that of our Sun. Use the following data: Apparent magnitudes seen from Earth, $m_{\alpha C} = -0.01$, $m_\odot = -26.74$. Distance of Sun to Earth, $d_\odot = 1.496 \cdot 10^{11}$ m.

Please see information on next page! /...2

The solutions to the problems are to be handed in by Thu, 30 April 2020, 4 pm, using the moodle-tool for the Cosmology course, see

https://moodle2.uni-leipzig.de/course/index.php?categoryid=2765

You should upload your solution as pdf file. It is perfectly ok if you work out the solutions in hand-written form and scan/photograph them and convert the files into a single pdf file. However, please make sure that the result is very well readable, and that the pdf files aren't excessively large. Please leave some margin space for marking. The marked solutions will be made available in the moodle-tool.