

ASTR469: Homework #3.

Due Feb. 3 at beginning of class.

1. The star Arcturus (J2000 RA = 14h15m39.7s, Dec = +19°10'57'') is the fourth brightest star in the sky. You're lost at sea on a sailing ship and observed one clear night that Arcturus rose at 9:00 pm.
 - (a) (3 pt) If you wanted to observe this star rise again 3 days later, assuming your ship has not moved significantly, at what clock time (with precision within one minute) should you expect to see Arcturus rise?
 - (b) (3 pt) Over the night, Arcturus got to a maximum elevation of 40°. At what terrestrial latitude is your ship (within one degree)? [*Hint: try drawing the path Arcturus would appear to take on the sky compared to the north celestial pole.*]
 - (c) (3pt) What is your LST when Arcturus transits?
 - (d) (3 pt) If Arcturus is on your meridian, then what is the hour angle of Deneb (J2000 RA = 20:40:00)?
2. You have decided the following list of objects is scientifically interesting:

| | J2000 R.A | J2000 Dec |
|--------------------------------------|------------------|------------------|
| Name | (deg) | (deg) |
| Andromeda Galaxy, M31 | 10.685 | 41.269 |
| NGC 869 star cluster | 34.750 | 57.128 |
| Ring nebula | 283.396 | 33.029 |
| Centaurus A | 201.365 | -43.019 |
| Carina Nebula, NGC3372 | 161.079 | -59.889 |
| Sagittarius A (center of our galaxy) | 266.417 | -29.008 |
| Crab nebula | 83.633 | 22.015 |
| Pleides star cluster | 56.750 | 24.117 |
| NGC7001 galaxy | 315.282 | -0.195 |

You need to observe one of the above objects **for 3 consecutive hours** to perform your experiment correctly. You can ask for time on one of two awesome telescopes:

- Keck telescope, in Hawaii; latitude 19.83, longitude -155.47 (also written 19.83 N, 155.47 W)
- Gemini South telescope, in central Chile; latitude -30.24, longitude -70.74 (also written 30.24 S, 70.74 W)

Your job is to plan out your observations. Assume for simplicity that both telescopes can in principle see down to the horizon.¹ In the end, you will need to fill submit the

¹Note: in reality this isn't true for many telescopes, because of telescope housing in the case of optical telescopes, or because of large dish size for radio telescopes. The edge of the 64m Parkes Radio Telescope will actually hit the ground if it tries to observe beyond $z = 60^\circ$!

following grid of information to the telescope for scheduling:

| | |
|---|--|
| Telescope | |
| Your target object | |
| J2000 RA, Dec (RA hh:mm:ss.s, Dec ° ' " formats) | |
| Telescope alt, az when target at meridian | |
| Observation start time (LST) | |
| Preferred observation date (a range is fine) | |

Here are some specific questions for you to answer. These are all valuable questions to ask yourself when planning an observation! Please remember to show your work. This includes writing the equations you're using and what values you're using for which variables.:

- (a) (2 pt) Which objects (if any) are observable from Gemini South telescope (for any amount of time)?
- (b) (2 pt) Which objects (if any) are observable from the Keck telescope (for any amount of time)?
- (c) (2 pt) What is the hh:mm:ss RA, and the $^{\circ} ' ''$ declination, of the Crab Nebula?
- (d) (2 pt) What is the LST when the Crab Nebula (Hereafter "Crab") transits?
- (e) (2 pt) What is the hour angle of Crab when it sets at Gemini South (assume the horizon is represented by a zenith angle of $z = 90^{\circ}$)?
- (f) (1 pt) Based on your previous answer, for how many hours is Crab above the horizon at Gemini South?
- (g) (2 pt) What is the maximum *elevation* of Crab from Gemini South? (Don't think too hard! You don't need any fancy equations!)
- (h) (2 pt) What is the *minimum airmass* (and hence the least impact of seeing, atmospheric extinction) for Crab from Gemini South?
- (i) (2 pts) Without using an LST calculator, approximate the date when Crab will transit near midnight—00:00 wall-clock time—at Gemini South (ignore daylight savings). Clearly explain your thinking. Recall our in-class exercise, which is reprinted in the lecture notes. At what approx. date does the Sun transit at noon for the RA of Crab?
- (j) (2 pts) Double check your answer to the previous question with this LST calculator:
<https://www.iiap.res.in/people/personnel/reks/software/javascript/calclst.php>
Note the time zone of Gemini South is UTC -4.
- (k) (2 pt) At the time from your previous answer, what will be the HA of Pleides?
- (l) (4 pts) Fill in the grid on the previous page, choosing a target for observation that is not Crab. Briefly but clearly justify your choice, considering airmass and general observability above the horizon for the required amount of time. Note: any target is valid for this question as long as you justify it!