MPAGS astrophysical techniques assignment 1

Elizabeth Stanway (e.r.stanway@warwick.ac.uk

Please e-mail me your answers within a week (can be scans or photographs of hand-written answers as long as these are clear). Don't worry if you can't work them out; the aim is that you engage with the topic. I will not be awarding marks, but will just keep note of whether you tried them.

1. The position of the Sun on the horizon at sunrise and sunset varies throughout the year. At the equator, it wanders $\pm 23.4^\circ$ North and South of due East and West. On the Arctic circle it varies by $\pm 90^\circ$ so that it is due South or North at the solstices.

   Somewhere between those points there is a latitude at which the Sun varies by $\pm 45^\circ$. At this latitude the positions of the sun at sunrise and sunset at the winter and summer solstices are exactly SE, SW, NE and NW, with the various directions lying at right-angles with respect to each other. Some have suggested that Stonehenge was built specifically at this latitude.

   Work out where this latitude is and hence evaluate the claim about Stonehenge. Carry through your work both allowing for and ignoring refraction. (Hint: use "stellarium")

2. "staralt" is a useful tool for plotting target altitudes. Use staralt to work out if and when (start and end dates) the targets listed below can be observed for more than 4 hours from (a) La Palma (Spain) and (b) La Silla (Chile).

   Targets: IP Peg, CL Oct, 3C 273 (all can be found on SIMBAD)

3. The STScI digitised sky survey at https://archive.stsci.edu/cgi-bin/dss_form can be used to obtain images of the sky. Download 1'x1' gif files ("finding charts") centred on **Barnard's star**, a high proper motion star. Do so for both the DSS1 (survey from the 1950s) and the more recent DSS2. Make sure Barnard's star actually appears, i.e. the coordinates you use should be appropriate to the epoch of the plate.

4. This question compares a diffraction-limited 2.4m telescope with a 10.6m seeing-limited telescope for object detection in the g-band. Data: (1) sky background $g = 22$ per square arcsecond for both telescopes, (2) zeropoint: assume that the 10.6m detects one photon per second for an object of $g = 29$, and scale the value for the 2.4m by collecting area. (3) Assume a seeing of 1" for the 10.6m, use the diffraction limit for the 2.4m.

   Assuming an aperture with a radius two times the seeing (or diffraction limit), calculate how long an exposure is needed for 5σ detections of objects of g magnitude 15, 20, 25 and 30 for each of the two telescopes, ignoring any readout noise of the detector.