

Homework 2 - Areas on the Sphere

Don't forget to `svn up` before you issue any other commands in SVN—this is to guard against you changing a document that someone else is working on in the same directory¹.

Don't forget to `svn ci` (with `-m` comments) frequently as you work. This allows others to see how your work progressed, and it automatically backs your work up as you produce it so that you're less likely to lose any of your work and/or so that you can revert to earlier versions of your work.

Don't forget to log in using **your** personal username and password on the physics network. Remember to comment your code carefully with your initials beside every comment (as in `;ADM` an IDL comment). Remember to provide an informative header for **every** function and procedure that you write (see my IDL Primer linked from the syllabus for an example of such a header).

Throughout ASTR5160, try to make your plots look professional. You may wish to write (or find) an IDL procedure that can be called to initiate a set of parameters to make professional-looking plots.

1. Astronomers often survey “square” fields in the sky (i.e. *lunes*) that have corners (vertices) in Right Ascension and declination of $(\alpha_{\min}, \delta_{\min})$, $(\alpha_{\max}, \delta_{\min})$, $(\alpha_{\max}, \delta_{\max})$, $(\alpha_{\min}, \delta_{\max})$. Write a function to determine the area of such a general field in square degrees. Plot 4 areas that are progressively higher in declination for the same α_{\min} and α_{\max} and label the regions with their areas (`xyouts` facilitates general plot labeling). Confirm that your function returns the correct area for a spherical cap as well as for a lune.
2. Write a procedure to randomly populate a spherical lune. The procedure should take α_{\min} , α_{\max} , δ_{\min} , δ_{\max} and return a set of (α, δ) coordinates that correctly populate that lune randomly in area. Use your function from the first item, above, to confirm that the areas you are populating contain the correct number of random points relative to populating the entire sphere (hint: remember that the area of the entire sphere is $4\pi \text{ rad}^2$ and refer to my equations for randomly populating the sphere from lectures).

In my `week2` directory in SVN, there is a list of quasars called `HW1quasarfile.dat`². This is a list of 1,066 $i = 18$ (“18th magnitude”) quasars that I’ve drawn from the Sloan Digital Sky Survey. Provided in the file are the coordinates of the quasars in base-60 (`hms.ss o ' "`) format.

3. Write a procedure that determines the pixel number at level 5, level 6 and level 7 of the HEALpix (ring) hierarchy for these quasars. Create a structure with the tags `ra`, `dec`, and `pixnum` to store this information, where `pixnum` is a 3-array. Write your structure out to a `fits` file (don't forget to send `/create`).
4. Write a procedure that reads in the structure from the `fits` file created in the previous step, plots the location of all the quasars in (α, δ) , and over plots those quasars that lie in the 5 most over-dense³ pixels at level 5 of the HEALpix (ring) hierarchy in a different color and using a different symbol.

¹this shouldn't be a big deal until you start to work on the team project, but you should get into the habit *now*

²In general, it is **not** a good idea to store large data files in SVN as it slows down updates for all users, but this particular data file is very small

³i.e. the 5 pixels that have the largest number of quasars per square degree