Workshop 5: Random catalogs for real observations.

During the week we computed the clustering of two simulated galaxy sample. Since we use a simulation, the sky distribution of sources and the angular selection function were trivial. However, in real observations that is never the case. Images can be affected by defects due to the observation process, or can be flux contaminated by bright stars. We usually have to mask the regions on the image in which the photometry is not reliable. That means that we cannot use those regions of the image to make science, and then we remove any posible galaxy located on masked regions. If we want to measure the clustering of sources on te image, we need to also mask these regions when creating the random catalog. Today we will work with a real image of a quasar field at z~4, with a masked region, and we will learn how can we create the random catalog over the area.

1. Download the image of the quasar field from https://home.strw.leidenuniv.nl/~garcia/astrotwincolo/Workshop5/SDSSJ1138_R.fits. This is the field of a quasar at z~4 that was observed with VLT in the band R, to detect galaxies around the quasar. Galaxies may be detected over the entire area.

2. Open the image with ds9, and check the information in the header.

3. Check the image and identify some regions that you think the photometry is not reliable (for example regions with shades or other defects. Would you masked those regions?

4. Download the masked image that I created for this field From https://home.strw.leidenuniv.nl/~garcia/astrotwincolo/Workshop5/SDSSJ1138_mask.fits. This is an image with values=0 in regions where the photometry is not reliable, representing the regions in which we cannot detect galaxies. The image contain values=1 over the area that we effectively used to detect galaxies, representing the final sky coverage of the survey. Open the image in ds9 and see if the masked regions coincide with what you thought should have been masked.

5. We need to create a random catalog with sources randomly distributed over the effective area that we used to detect galaxies. How would you create a random catalog in this case?

6. Write a code to open the mask image and store the data in a 2D array.

7. In the image, check what are the maximum and minimum Ra and Dec coordinates in the field, and use these values to generate random points.

8. Generate 10,000 random sources over the area but avoiding mask regions. For that you need to generate the random positions (RA, dec) and for each position you need to check if the position fall over a masked area or not. If the position is over a masked area, you need

to re-generate a random position. Note that you also need to check if the position is within the edges of the image. To perform this task, you will need to convert the RA,Dec positions to pixels. All the relevant information to make that conversion is in the image header. Make some research to find which function in python can be used to convert from coordinates to pixels, for a given header (for example the function wcs.all_world2pix)

9. After you finish your random catalog, make a plot showing the sky distribution of the random catalog that you created. Are the random sources following the same sky coverage as the masked field?

10. One useful way to check that all your random sources are on the "allowed" positions is to create a ds9 region, and display the regions on the image. For that you need to create a text file containing the 3 following lines:

```
# Region file format: DS9 version 4.1
global color=green dashlist=8 3 width=1 font="helvetica 10 normal roman" select=1
highlite=1 dash=0 fixed=0 edit=1 move=1 delete=1 include=1 source=1
fk5
```

And then each following line need to contain the ra, dec position that you generated, and the size of the region that you want to plot. For example, if you want to display a circle of 30" of radius, you need to write:

```
circle(14:32:08.618, +34:31:40.48, 30")
```

Include the positions for the 10,000 random points that you created.

11. Finally, open in ds9 the mask image and display the regions that you created by clicking on the main menu: Regions > Load regions.

12. Are all the random points within the edges of the image and out of the masked regions?