X-ray data: The Chandra Source Catalog (Evans+ 2010, 2019)

A catalog of all sources detected in observations by the Chandra X-ray satellite. It is not an all-sky survey, it is simply a list of X-ray sources detected in various Chandra observations over the years.

The catalog contains lots of information, we will only be interested in the following:

- Sky position (RA, Dec): `RAIRCS, DECIRCS`
- Positional uncertainty (in arcsec): `r0`
- Signal to noise of the detection: `S/N`
- X-ray Flux and upper/lower limits, measure by the Chandra ACIS detector: `F90b, b_F90b, B_F90b`
- X-ray hardness: `HRhs`

We will get this info only for objects that are X-ray point sources and that have been detected in the Chandra ACIS imaging.

We will do this by doing using astropy's `astroquery` function to pull the catalog from the Vizier website.

(Note: astroquery is an astropy affiliated package and must be installed on your computers:

- *via anaconda:* `conda install -c astropy astroquery`
- *via pip:* `pip install --pre astroquery`

Matching catalogs by coordinates

We have two datasets: SDSS (optical) and CHANDRA (X-ray). We want to cross-match them into one dataset that contains the optical and X-ray data for all X-ray sources. We do this by matching on position.

```
# make a sky coordinate object for all the objects in the SDSS catalog....
sdss_coord=SkyCoord(SDSS['ra'],SDSS['dec'], unit='deg', frame='icrs')

# ....and for all the objects in the Chandra catalog
chandra_coord=SkyCoord(CHANDRA['RAICRS'],CHANDRA['DEICRS'], unit='deg', frame='icrs')

# now for each chandra_coord, match it to the nearest sdss coord using sky coords (ra,dec)
# idx lists (for each chandra source) the row number in the SDSS table that contains the
#      closest match.
# d2d is the 2D seperation between the sources (angle on the sky)
# d3d is the 3D seperation, which is meaningless for us, since we dont have distances
idx, d2d, d3d = chandra_coord.match_to_catalog_sky(sdss_coord)
```

SDSS[idx] will be a data table where each row of data is the optical properties of the object ***closest to*** the X-ray sources listed in the CHANDRA table, in the proper row order to match the CHANDRA table.

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So we can now do a horizontal stack of the CHANDRA and SDSS[idx] to make our final data table.

```
# now make a merged list by "horizontally stacking" the two tables: CHANDRA and SDSS[idx]
from astropy.table import hstack
CROSSMATCHED=hstack([CHANDRA,SDSS[idx]])
```

CROSSMATCHED is a new data table containing our final combined/matched X-ray and optical data for all X-ray sources.

One important thing: we matched on the closest objects. The closest object may still be far away, and not the proper match! So we will add a column to our crossmatched dataset that says how far away the closest optical object was:

```
# add a column that shows the separation in arcsec
CROSSMATCHED['match_sep']=d2d.arcsec
```