How Do I…
Find optical data for 2MASS galaxies?

SkyServer allows you to cross-match your own data with SDSS data. This is particularly useful for finding optical counterparts for objects seen in other wavelengths. For example, you can find optical counterparts for galaxies seen in photometric data of other surveys, such as the 2MASS infrared survey.

The tool to do this is the Imaging Cross-Identification tool. This guide will tell you specifically how to use the tool to cross-match galaxies with 2MASS. For more general tips on how to use the cross-identification tool, see the guide called **How do I cross-match my own dataset with the SDSS?**

1. The first step is to get 2MASS infrared data, using whatever tools you are most comfortable with. The only constraint is that the RA and dec must appear *last* in the list. I used the NVO's OpenSkyQuery tool (www.openskyquery.org) to get the 2MASS object ID, the j, h, and k magnitudes, and the positions. Here are the first three objects from my data:

twomass_objid	twomass_j_m	twomass_h_m	twomass_k_m	twomass_ra	twomass_dec
563751268	15.247	14.513	14.028	0.163748	-0.01341
563751176	16.087	15.262	15.046	0.168484	0.027418
563751452	12.394	12.014	11.952	0.137534	-0.090995

2. Next, go to SkyServer's Imaging Cross-Identification tool. To get there from the astronomers' home page, click on the **Imaging Cross-ID** link in the *Search Tools* menu.

3. The tool will look like this:
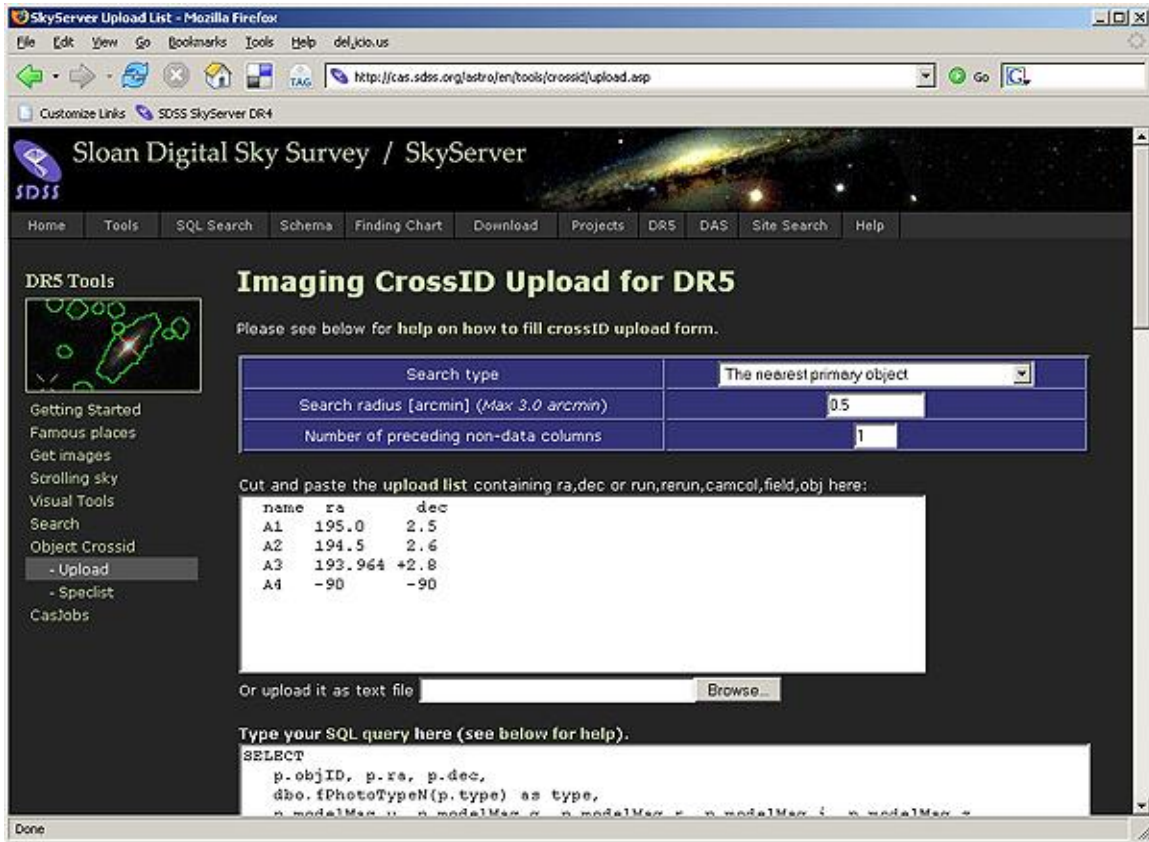
4. In the Search Type dropdown menu, choose whether the type of search you want to do. Because you want to find the single best observation of the single SDSS object that corresponds to each 2MASS object, select *The nearest primary object*.

5. Enter a search radius (in arcminutes) in the *Search Radius* textbox. This is the radius around each of your objects that the tool will search as it looks for a matching SDSS object. The maximum radius you can enter is 3 arcminutes.

6. Enter the number of columns that precede your RA and dec in the textbox labeled *Number of preceding non-data columns*. In the example of my dataset above, there are 4 columns preceding the RA and dec, so I would enter *4* here.

7. You can either cut and paste the 2MASS data into the textbox or type the name of the data file in the *Or upload it as a text file* box. When there is data in the textbox and a file specified in the upload box, the file takes priority.

8. You can change the data that the tool returns by changing the SQL query displayed in the bottom textbox. The default query will return the following SDSS data for each matching object: object ID, positions, types, and magnitudes (u, g, r, i, z).

9. Choose the format you would like results returned in. HTML will return results as a table in your browser. CSV will return results as a comma-separated value file, which can be opened by many graphing programs.

10. If you want to limit returned results just to galaxies (excluding the stars), add the following line to the WHERE block of the query in the textbox:

```
AND p.type = 3
```

The full query will look like this:

```
SELECT
   p.objID, p.ra, p.dec,
   dbo.fPhotoTypeN(p.type) as type,
   p.modelMag_u, p.modelMag_g, p.modelMag_r, p.modelMag_i, p.modelMag_z
FROM #x x, #upload u, PhotoTag p
WHERE u.up_id = x.up_id and x.objID=p.objID
   AND p.type = 3
ORDER BY x.up_id
```

11. Click *Submit* to run the query. If you followed the instructions above, the results will look like this:

ObjID	j	h	k	objID	ra	dec	type	modelMag_u	modelMag_g	modelMag_r	modelMag_i	modelMag_z
563751268	15.247	14.513	14.028	587731186204016720	0.163804	-0.013391	GALAXY	19.099	17.077	16.108	15.669	15.3
563751176	16.087	15.262	15.046	588015509269446824	0.168493	0.027409	GALAXY	20.444	18.548	17.577	17.142	16.847
563751098	16.043	15.688	15.247	588015509269447133	0.162512	0.062793	GALAXY	22.465	20.753	23.147	26.198	21.48

The first four columns are the 2MASS data that you uploaded: the object ID and the j, h, and k magnitudes. The rest of the columns of data come from the SDSS: the object ID, RA and dec, type (STAR or GALAXY), and the 5 magnitudes.

12. Click on the link for each object ID to see go to the **Explore** tool entry for that object. The tool looks like this:

13. You will see the object's identifier, ra and dec, and SDSS long object ID at the top of the page.

14. Below the name and position data, you will see a close-up image of the object, with a scale. The object's photometric data is to the right of the image. The magnitudes are the second row.

15. If the SDSS did not measure a spectrum for this object, the tool will say, "No scienceprimary SpecObj linked to this PhotoObj." If the object does have an SDSS spectrum, the tool will show the spectrum below the photometric data.

16. Click on the picture of the spectrum to see a larger view. Spectral lines are marked on the spectrum by green and pink dotted lines, as well as labels. The redshfit and error are shown at the bottom of the spectrum.

17. To see FITS images of the object, click on the **FITS** link below the *PhotoObj* heading in the left-hand menu. *Corrected Frames* are the final step of processing for SDSS images. There is one image for each filter. Right-click on the label for the filter you want to download the image.