



Part II: Classification of galaxies using mid-IR colors





WISE The Wide-field Infrared Survey Explorer at IPAC

NASA's **Wide-field Infrared Survey Explorer** (WISE; [Wright et al. 2010](#)) mapped the sky at 3.4, 4.6, 12, and 22 μm (W1, W2, W3, W4) in 2010 with an angular resolution of 6.1", 6.4", 6.5", & 12.0" in the four bands.

The WISE Source Catalog contains the attributes for **563,921,584 point-like and resolved objects** detected on the Atlas Intensity images.

Catalog sources are required to have a measured **SNR>5** in at least one band, and to meet other criteria to insure a high degree of reliability.

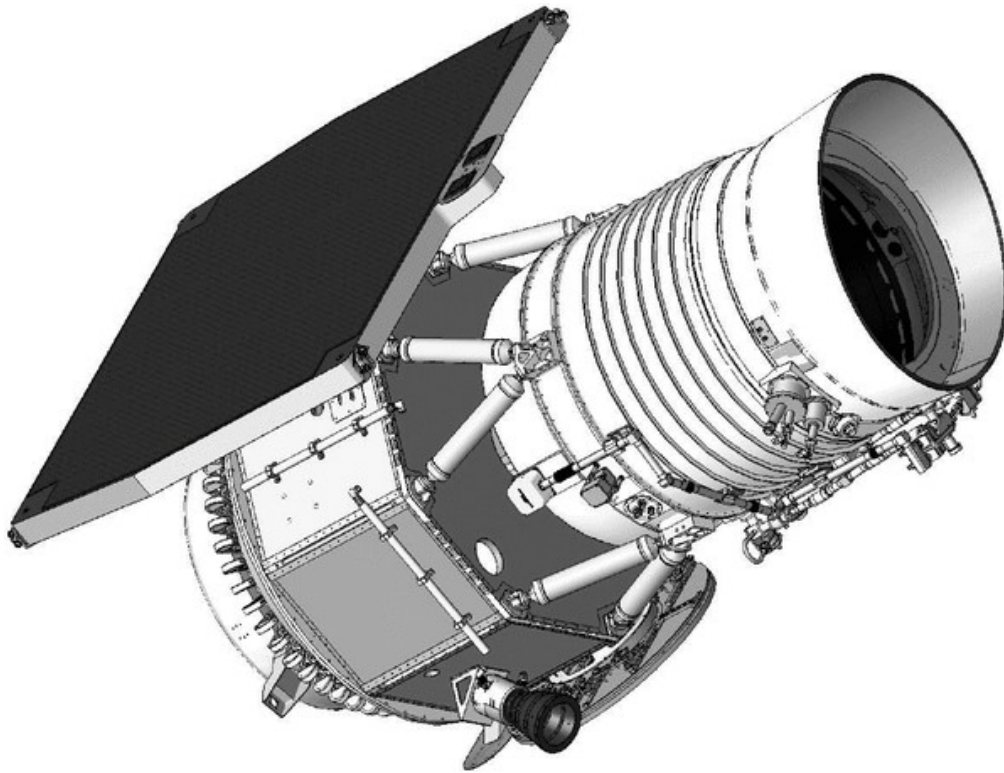
WISE Mission facts

The mission was planned to create infrared images of 99 percent of the sky, with at least eight images made of each position on the sky in order to increase accuracy.

The spacecraft was placed in a 525 km, circular, polar, Sun-synchronous orbit for its ten-month mission, during which it has taken 1.5 million images, one every 11 seconds.

The produced image library contains data on the local Solar System, the Milky Way, and the more distant universe. Among the objects WISE studied are asteroids, cool, dim stars such as brown dwarfs, and the most luminous infrared galaxies.

WISE satellite



The WISE flight system in survey configuration with cover off.

NASA's Wide-field Infrared Survey Explorer, or WISE, spacecraft is situated on a work stand before launch



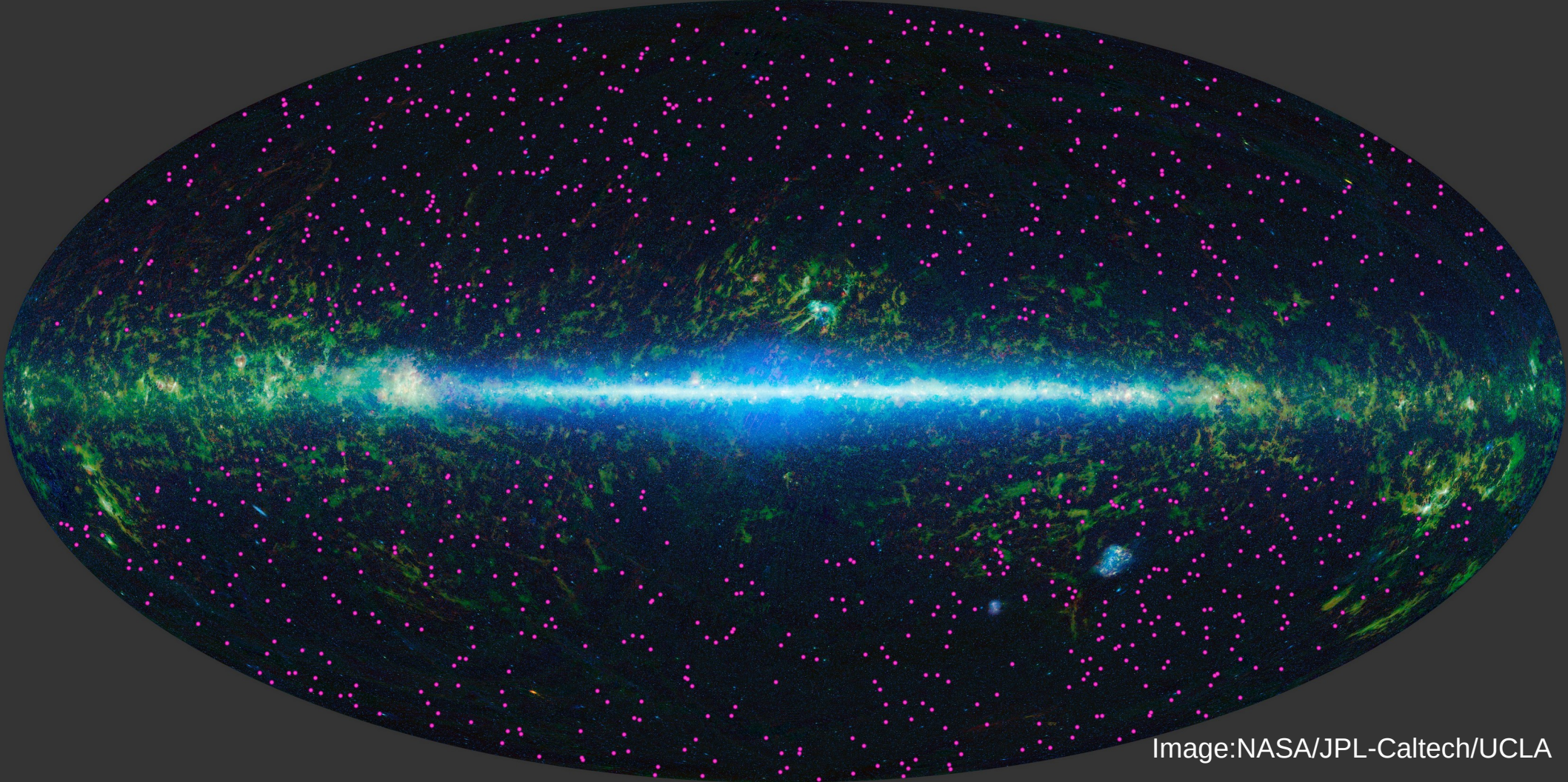


Image:NASA/JPL-Caltech/UCLA

NASA's Wide-field Infrared Survey Explorer (WISE) has identified about 1,000 extremely obscured objects over the sky, as marked by the magenta symbols. These hot dust-obscured galaxies, or "hot DOGs," are turning out to be among the most luminous, or intrinsically bright objects known, in some cases putting out over 1,000 times more energy than our Milky Way galaxy.

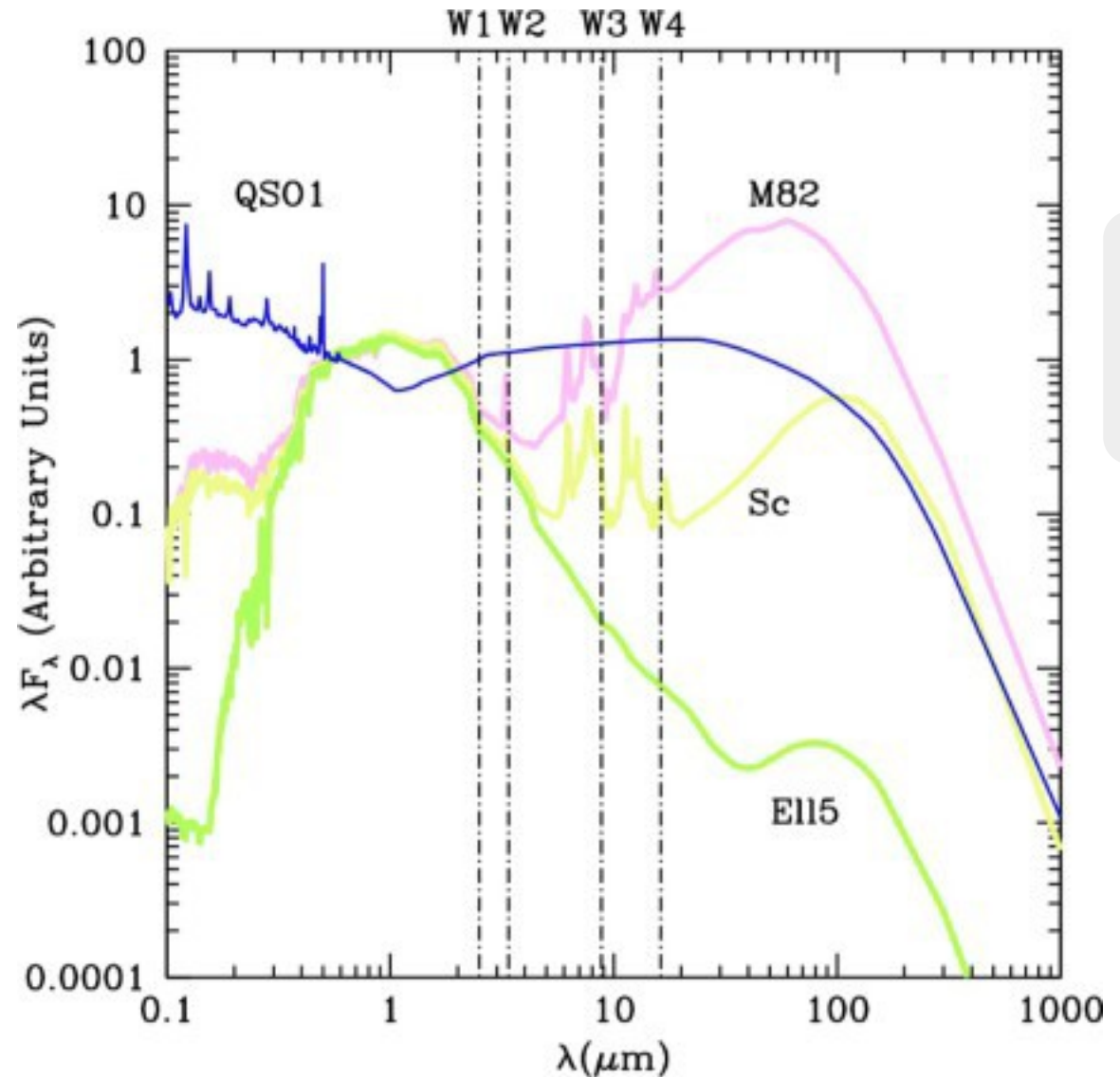
One example image



Wolf-Rayet wind bubble NGC 2359 in the infrared using W1 as blue, W2 as cyan, W3 as green, and W4 as red.

SED and W1, W2, W3 & W4

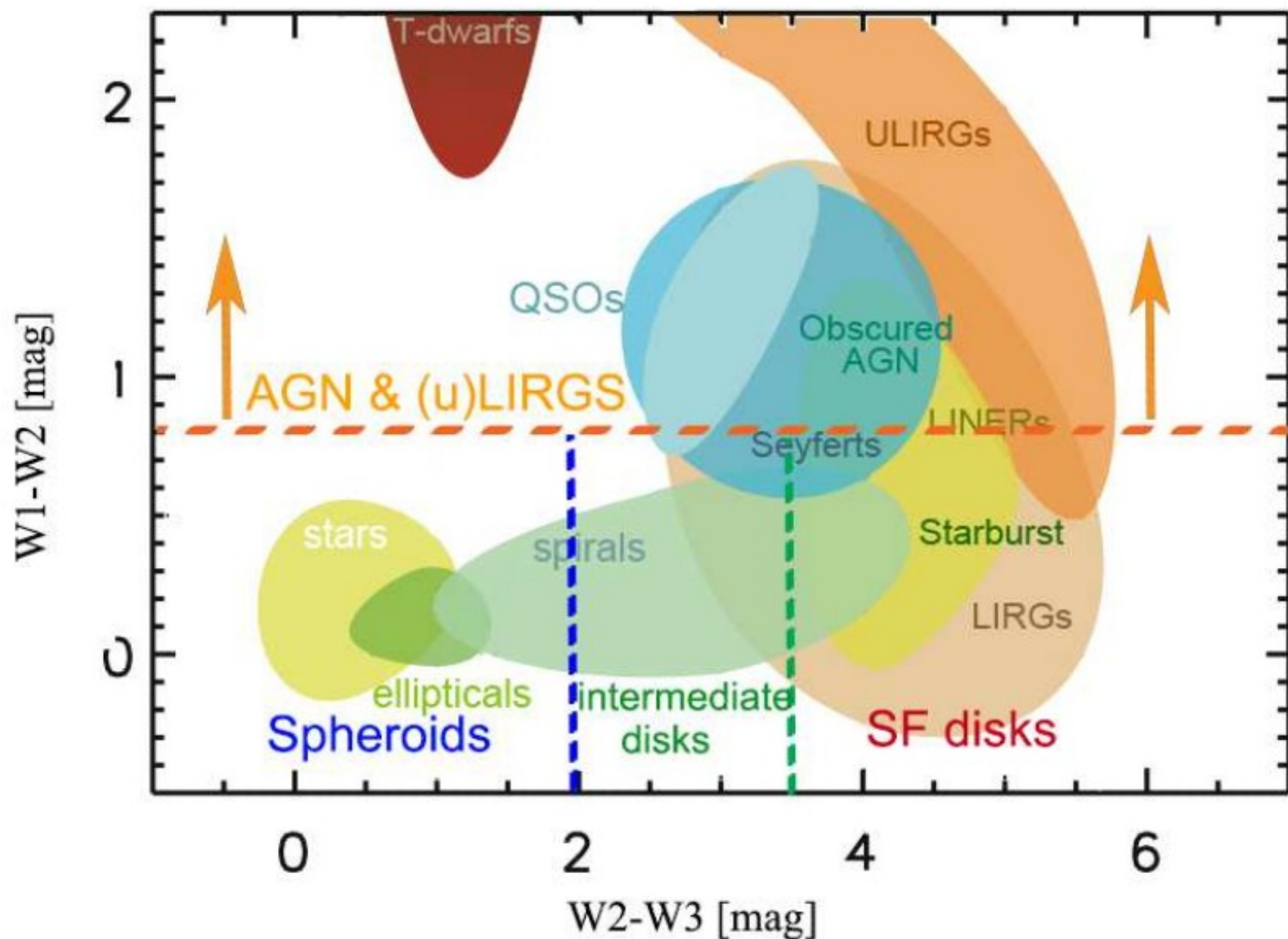
SEDs of typical galaxies, with the four WISE bands marked.



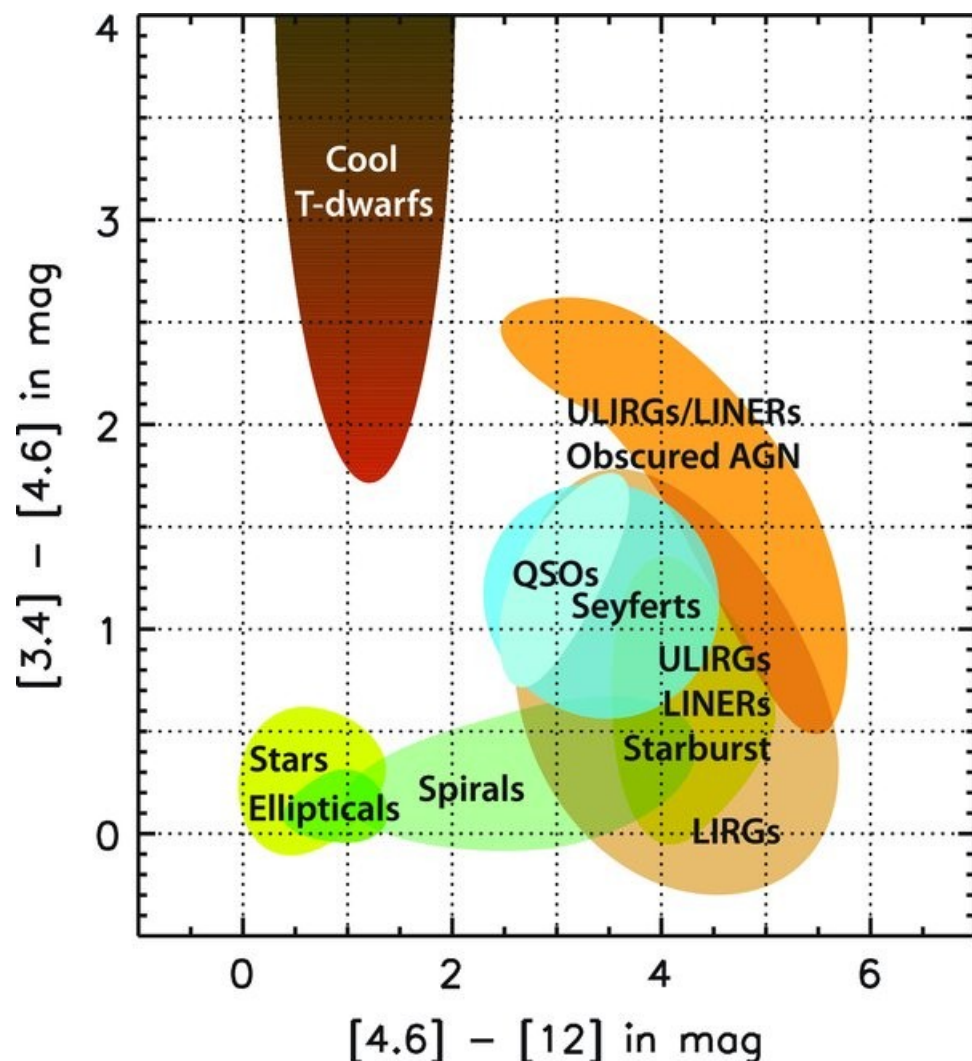


How can we use it?

WISE color-color diagram showing location of different galaxy types defined from Wright et al. 2010



WISE color-color diagram



Color–color diagram showing the locations of interesting classes of objects.

Stars and early-type galaxies have colors near zero, while brown dwarfs are very red in W1–W2.

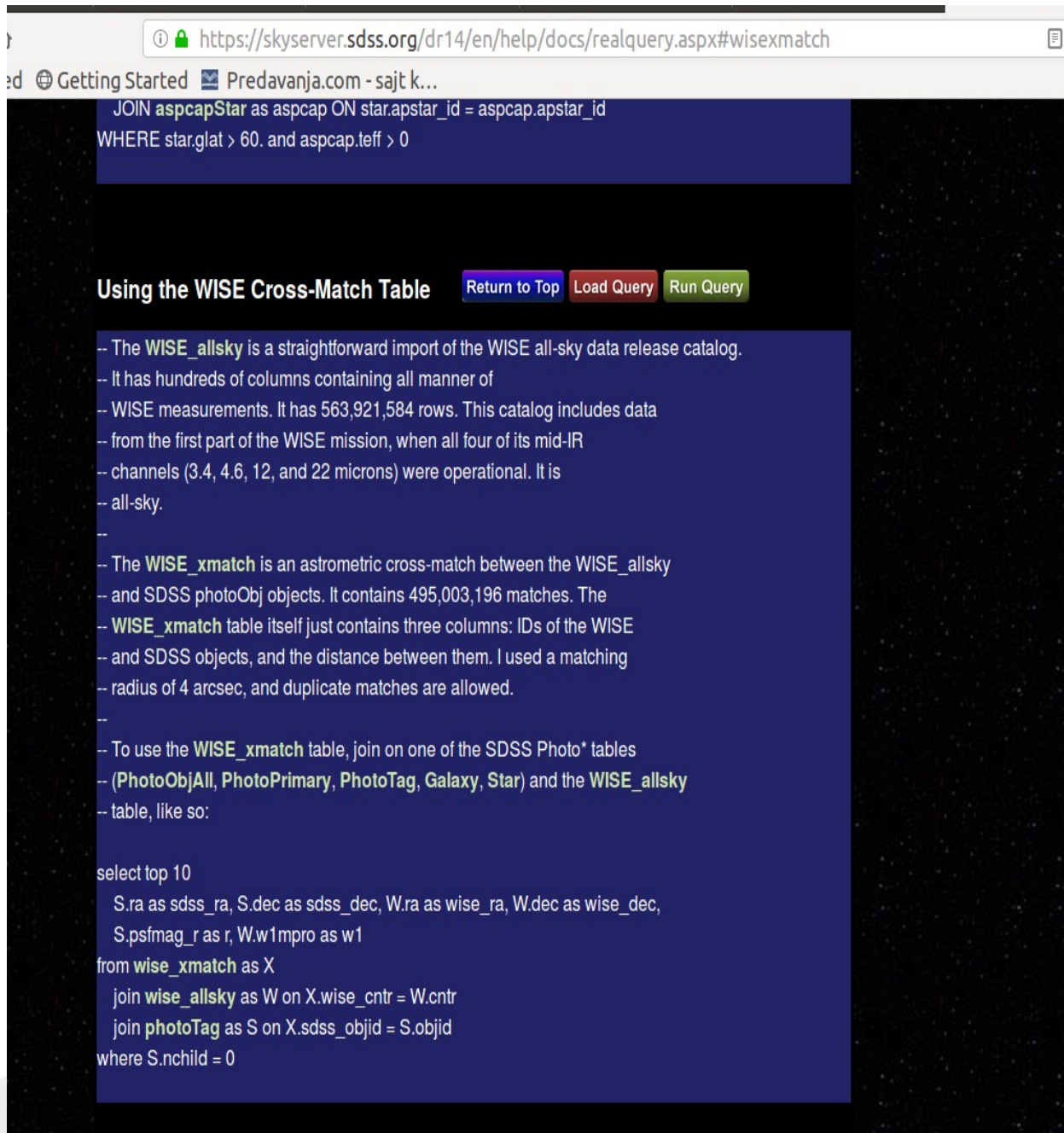
Spiral galaxies are red in W2–W3, and ULIRGS tend to be red in both colors.

Assignment: **WISE color-color diagram**

Due for report: 28.04.2023. (Friday)

1. For the sample of galaxies selected from SDSS database in Part I, find the corresponding WISE colors using WISE fluxes from Cross-identifications link:
<https://skyserver.sdss.org/dr14/en/help/docs/realquery.aspx#wisexmatch>
2. Assign classes (AGN & (u)LIRGS, Spheroids, Intermediate disks and SF disks) to all objects in the sample using the thresholds from the image on the bottom right (dashed lines). How do these classes compare to ones obtained using BPT diagram from Part I?
3. Locate one random object on the WISE color-color plot having $W1-W2 \geq 0.8$ (Assef et al. 2013) and address the following:
 - Where is the object located in this plot? Mark it clearly on the graph.
 - Does it agree with the optical classification from BPT diagram?
 - Draw some conclusions about the type of AGN using the WISE color-color plot.

<https://skyserver.sdss.org/dr14/en/help/docs/realquery.aspx#wisexmatch>



The screenshot shows a web browser window with the URL <https://skyserver.sdss.org/dr14/en/help/docs/realquery.aspx#wisexmatch>. The page title is "Getting Started" and the user is logged in as "Predavanja.com - sajt k...". The main content area is titled "Using the WISE Cross-Match Table" and contains a SQL query and a detailed explanation of the WISE tables.

```
JOIN aspcapStar as aspcap ON star.apstar_id = aspcap.apstar_id
WHERE star.glat > 60. and aspcap.teff > 0
```

Using the WISE Cross-Match Table [Return to Top](#) [Load Query](#) [Run Query](#)

-- The **WISE_allsky** is a straightforward import of the WISE all-sky data release catalog.
-- It has hundreds of columns containing all manner of
-- WISE measurements. It has 563,921,584 rows. This catalog includes data
-- from the first part of the WISE mission, when all four of its mid-IR
-- channels (3.4, 4.6, 12, and 22 microns) were operational. It is
-- all-sky.
--
-- The **WISE_xmatch** is an astrometric cross-match between the **WISE_allsky**
-- and SDSS photoObj objects. It contains 495,003,196 matches. The
-- **WISE_xmatch** table itself just contains three columns: IDs of the WISE
-- and SDSS objects, and the distance between them. I used a matching
-- radius of 4 arcsec, and duplicate matches are allowed.
--
-- To use the **WISE_xmatch** table, join on one of the SDSS Photo* tables
-- (**PhotoObjAll**, **PhotoPrimary**, **PhotoTag**, **Galaxy**, **Star**) and the **WISE_allsky**
-- table, like so:

```
select top 10
  S.ra as sdss_ra, S.dec as sdss_dec, W.ra as wise_ra, W.dec as wise_dec,
  S.psfmag_r as r, W.w1mpro as w1
from wise_xmatch as X
  join wise_allsky as W on X.wise_cnr = W.cnr
  join photoTag as S on X.sdss_objid = S.objid
where S.nchild = 0
```

This template SQL query can be your starting point.

Load this query and adopt it further.

Use Schema browser to explore WISE tables on SDSS

References

Assef et al. 2013, <http://adsabs.harvard.edu/abs/2013ApJ...772...26A>

Assef et al. 2017, <http://adsabs.harvard.edu/abs/2018ApJS..234...23A>

Jarrett et al. 2017, <https://iopscience.iop.org/article/10.1088/0004-637X/772/1/26/pdf>

Kauffmann et al. 2003, <https://ui.adsabs.harvard.edu/abs/2003MNRAS.346.1055K>

Kewley et al. 2001, <https://ui.adsabs.harvard.edu/abs/2001ApJ...556..121K>

Wright et al. 2010, <http://adsabs.harvard.edu/abs/2010AJ....140.1868W>

<http://wise2.ipac.caltech.edu/docs/release/allsky/>

<http://wise2.ipac.caltech.edu/docs/release/allwise/>

<http://wise.ssl.berkeley.edu/>



Artist concept of WISE spacecraft
Image: NASA/JPL-Caltech