

# Forced Photometry

# Forced photometry versus cross-matching surveys

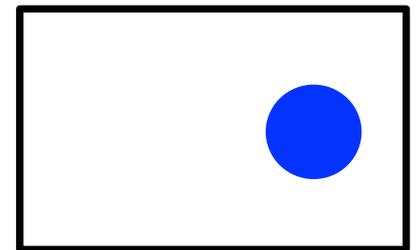
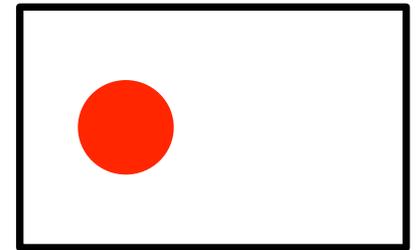
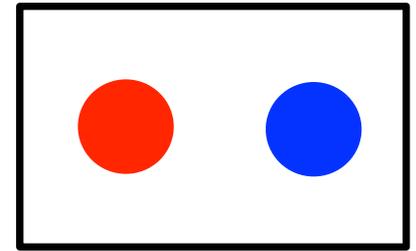
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- Cross-matching sources between different imaging surveys, and assuming that you're looking at the same source in both surveys, inevitably discards information
  - To understand why we have to think about how a “source” (a star, galaxy, quasar etc.) ends up being recorded in a sky survey catalog
  - To catalog a source, sky surveys want to be certain that they've actually detected it, so they set some threshold of significance above the general sky background
    - to see why, study an image in the *SDSS Navigator Tool* and think about whether faint sources are *real*
  - Often, this threshold is set at a signal-to-noise ratio of 5, which I will refer to as a “ $5\sigma$  detection”
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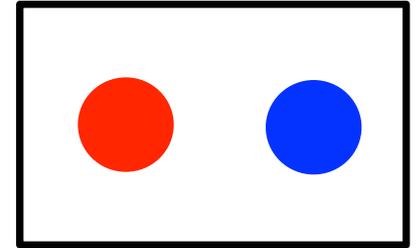
- Consider the “true” image of a small part of the sky to the right, in which there is a very red galaxy and a quite blue galaxy
- In an infrared survey of the sky, the red source is detected at  $6\sigma$ , but the blue source is only detected at  $4\sigma$ 
  - So, a ( $> 5\sigma$ ) catalog of sources from the infrared survey just “sees” the red source
- In an optical survey of the sky, the blue source is detected at  $6\sigma$ , but the red source is only detected at  $4\sigma$ 
  - So, a ( $> 5\sigma$ ) catalog of sources from the optical survey just “sees” the blue source



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- In the “true” image the two different galaxies are very close together, separated by only, say 1”

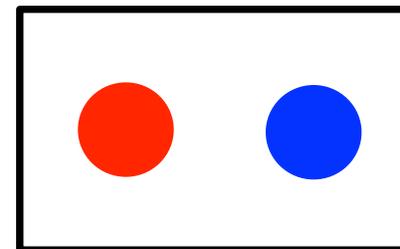


- So, when the two surveys are cross-matched, the red and the blue galaxy are likely to be confused as a single source
  - Before large surveys of the sky, this wasn't a problem, as people would look at the images and determine which galaxy was which by visual inspection
  - But, in sky surveys that contain hundreds-of-millions of astronomical sources, this confusion between sources can become a problem
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- The solution is not to store astronomical surveys at the  $5\sigma$  source level, but instead to store the raw images
  - the actual information that telescopes collect, which are the pixels of the survey
- A more correct approach to finding sources in surveys that circumvents issues with cross-matching would be:
  - find the positions of all sources that are detected in any survey or in any combination of surveys
  - Sink an aperture at that position in *all* sky surveys
  - Measure the flux at that position in *all* sky surveys using the native images of the survey



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- This process is sometimes called *forced photometry*
    - “forced” because a detection of a source (say  $>5\sigma$ ) in one survey is used to measure fluxes of that source in other surveys, even if *the source isn't detected in those other surveys* (say  $<5\sigma$ )
  - This is an example of how better use of information can be used to improve our understanding of data
    - The information that a source exists (because it is detected in one survey or combination of surveys) is used to infer that it must exist in other surveys
  - Forced photometry of a survey can be complex. We will study its results using existing forced photometry of GALEX images at SDSS source positions
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# Python tasks

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1. The DR8 “star” sweeps at */d/quasar2/dr8/301/calibObj\** match files at */d/quasar2/galex\_dr8/301/aper\_calibObj\** which are GALEX files photometered at SDSS positions (by Hogg et al. 2011; see the syllabus link for more information)
    - read in a DR8 sweep file and a matching GALEX file and check they contain the same number of objects
  2. Find the closest SDSS object in the sweep files (of type “star”) to the position  $(\alpha, \delta) = (143.209^\circ, 36.701^\circ)$  and record that object’s SDSS *PSFFLUX* measurements
    - use my *sdss\_sweep\_data\_index.py* code from week 7 to determine which sweep files contain objects near the position  $(\alpha, \delta) = (143.209^\circ, 36.701^\circ)$
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# Python tasks

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3. Find the matching GALEX object and record the *NUV* and *FUV* flux measurements for this object
    - The GALEX and sweep files match row-by-row
    - So, object 99 in the sweep file of interest corresponds to object 99 in the matching GALEX file
  4. Repeat 2. and 3. for  $(\alpha, \delta) = (199.783^\circ, 43.8613^\circ)$ ...but keep your existing work for  $(\alpha, \delta) = (143.209^\circ, 36.701^\circ)$ 
    - plot the 7 fluxes (5 SDSS and 2 GALEX) for both objects as a function of wavelength. *PSFLUX* corresponds to *ugriz* at 3543, 4770, 6231, 7625 and 9134 Å, *FUV* and *NUV* are at about 1600 and 2400 Å
    - The  $(\alpha, \delta)$  represent two different sources. Which is bright in the optical? Which is bright in the UV?
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