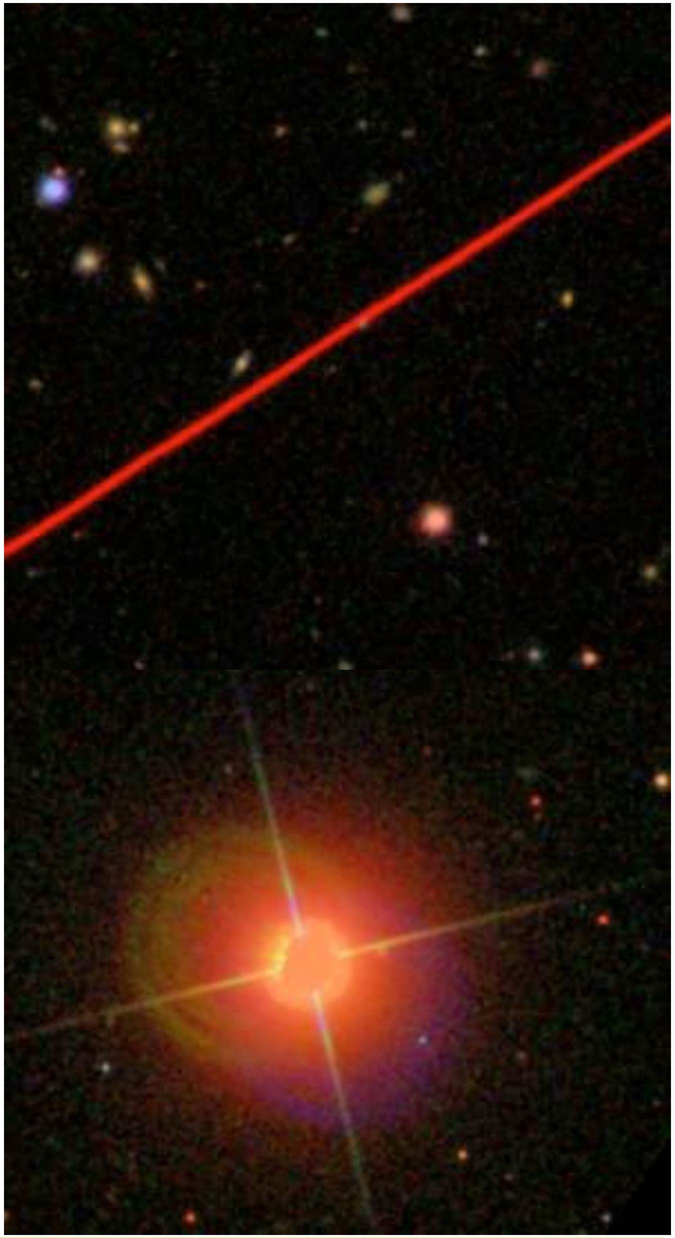
Flagging Bad Data

Flagging Bad Data in Imaging

- Observations are never perfect, due to observing conditions
  - e.g., bad seeing, moonlight, the solar wind, clouds, airplanes, cosmic rays, telescope malfunctions etc.
- Further, even good observations can be rendered unusable by astronomical sources
  - e.g., very bright objects can create diffraction spikes, double or "ghost" images saturated CCD pixels etc.



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- As many as half of the observations in the SDSS may be spurious because of these effects
- To attempt to allow users to correct for “bad” imaging data, most surveys have sets of “flags” that can be employed to discard spurious objects
- The common way to express flags is as a *bitmask*
- Say you have a collection of 4 flags that represent, respectively, a saturated pixel (0), a diffraction spike (1), terrible seeing (2) and a ghost image (3). For an object that contains a saturated pixel and ghosting:
  - $flag = (1\text{x}2^0)+(0\text{x}2^1)+(0\text{x}2^2)+(1\text{x}2^3) = 9$

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- In the SDSS sweeps files the flags are recorded in the columns "*OBJC_FLAGS*" and "*OBJC_FLAGS2*"
- A description of the meanings of the flags is in the file */ASTR8020/runnoe/week11/sdssMaskbits.par* under *maskbits OBJECT1* and *maskbits OBJECT2*
- Each flag is also described in the *SDSS Schema* (see the syllabus link and search for *photoflags*)
  - note that in the online SDSS catalog archive server, the two sets of flags are combined into one
- The sweeps files contain flag information both for the imaging combined across *all* filters (as *OBJC_FLAGS* and *OBJC_FLAGS2)* and for the imaging in each *individual* (*ugriz*) band (as *FLAGS* and *FLAGS2*)

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- To use the flags in the sweeps files, the following sequence of commands will be common:
  - *flag = 2**9*
  - *w = np.where((objs["OBJC_FLAGS"] & flag) == 0)*
  - *objs = objs[w]*
- Where, here, I've used *OBJC_FLAGS* but for the second set of flags I'd use *OBJC_FLAGS2*
- Here, I've assumed that we've read the sweeps file into a structure called *objs* and that we want to recover the objects that do *not* have the flag set (== *0*)
- The value of *"flag"* would be looked up for the flag of interest (e.g. *"CR"* for a cosmic ray would be *flag = 2**12* for the column *OBJC_FLAGS*)

Other useful bitmasks

- Beyond flags, the SDSS (and other current surveys) use bitmasks to capture a range of information
- Because the SDSS scans the sky multiple times, objects can be detected multiple times (or can be flagged as spurious due to only appearing in one scan)
- The *best* observation of each *real* object is stored as *SURVEY_PRIMARY* (*2**8*) in the *RESOLVE_STATUS* column of the sweeps. To recover *PRIMARY* objects, e.g.
  - *flag = 2**8*
  - *w = np.where((objs["RESOLVE_STATUS"] & flag) != 0)*
  - *obj = objs[w]*
- Often, it takes a great deal of trial-and-error to determine which flags should be applied, but *you will almost always want to restrict to SURVEY_PRIMARY*

Python tasks

1. Find the closest ***galaxy*** in the SDSS sweep files to the point $(\alpha,\delta) = (336.4388^{o},-0.8343^{o})$
   - When looking up only a few objects (and not matching to *WISE* forced photometry), it will be quicker to use the *sdss_sweep_circle.py* code in my week 10 directory rather than using *sdss_sweep_data_index.py*
   - Galaxy-like images can be retrieved by passing *(objtype='gal' to sdss_sweep_circle.py*)
2. Is this galaxy a set of *blended* images? Does it contain any pixels that are *saturated*? Is it *blended* or *saturated* in every band or just in the overall combined image?
   - Find the image of this galaxy in the *SDSS Navigator Tool*. Does it look saturated? Is it even a galaxy?

Python tasks

3. Last lecture, you wrote code to separate spectroscopically confirmed quasars and stars using *ugriz* color cuts. Let's see how well that would work in a real imaging survey

   - retrieve every point source ("*objtype=star*") in the SDSS sweeps files imaging that lie within a 3^{o} radius of the coordinate $(\alpha,\delta) = (180^{o},30^{o})$. We'll call these *objs*
   - For a circular area, you can use *sdss_sweep_circle* to retrieve the *objs*...but in this case, also send *all=True* so we can illustrate the use of *SURVEY_PRIMARY*
   - restrict the *objs* in magnitude to $i < 20$
   - coordinate-match the *objs* to the *qsos-ra180-dec30-rad3.fits* file in my week 10 git directory, to find which $i < 20$ objects in SDSS imaging are quasars

Python tasks

4. Apply the color-cut code you wrote last lecture to the *objs* to determine which of them are likely to be quasars

- What is the *area* of the circle of radius 3^{o} within which we are considering the *objs*?
- Given that spectroscopy is the only way to know for sure if an object is a quasar or a star, how many spectra would we have to obtain per sq. deg. to determine the number of quasars per sq. deg. that your code recovers?
- Find *flag* cuts on the *objs* that retain > 90% of known quasars (the quasars from my *qsos-ra180-dec30-rad3.fits* file) but that reduce the number of spectra per sq. deg. we'd have to obtain to confirm new quasars
- (*SURVEY_PRIMARY* would be a good place to start...)