Astro 121, Spring 2014
Research Techniques in Observational Astronomy

Week 4 (February 13, 2014): On-line tools and astronomical nomenclature

Snacks: Rebeka or Sara (?? I don't have the list with me right now.)

Resources and reading:

- The main goals this week are: (1) to learn more about the varied and sometimes arcane ways in which astronomical objects are named; (2) to become familiar with some on-line tools that we will use throughout the semester; and (3) to do some astronomical imaging with a CCD.

- Reading: Chromey, *To Measure the Sky*, Chapter 4.

- You can find the relevant web sites discussed below just by Googling; when you find them, you may want to bookmark them if you're using your own computer, as they will be useful throughout the semester. In addition to exploring these sites on your own just to see what they can do, please complete the tasks below as well in order to stretch your knowledge a bit.

Important concepts:

Understanding how to use the following on-line tools:

- ADS, NASA's Astrophysics Data System
- The SIMBAD database
- Vizier, a collection of and search engine for many astronomical catalogs
- NED, the NASA Extragalactic Database
- Skyview, a tool for viewing/plotting many astronomical datasets
- In addition, during seminar we'll discuss the basics of the (sometimes confusing) system(s) of astronomical nomenclature.

Problems/exercises

Note: For many of these problems, you are trying to track down a particular piece of information. As you do this, I'd like you to note down *how* you ultimately found it, i.e. what settings or search strategy did you have to employ to get these tools to do what you want?

1. ADS, NASA's Astrophysics Data System: Below are some types of searches one might want to do in the astronomical literature. The first few searches should be relatively easy, and you can probably figure out to do them without reading any documentation. But as you go down the list, you'll be pushing a bit farther into the more advanced capabilities of ADS, so you will probably need to read some of the documentation on-line. For each search, note how many papers you find (once you actually figure out how to do the right search), and also *note what you had to do to create that search*.

    a) A colleague mentions "That paper on HK Tau by Stapelfeldt et al." Find it.

    b) How many papers mentioning the star 51 Peg were published in refereed journals in the years 1984–1994, inclusive? How many in the years 1995–2005? (Why are these numbers so different? Is it solely that the pace of astronomical publication is increasing? [How would you check that hypothesis?])

    c) Find papers by me (Eric L. N. Jensen or Eric L. Jensen) but not by all the other E. Jensens of the astronomy world. (Almost all papers that are listed only under "E. Jensen" in ADS with no middle initial are by someone else; all of mine have one or more of my middle initials in the record. *Update 2012: I let one slip through on which I'm Nth coauthor without my middle initial, but ignore it for this problem.*) Note: it *is* possible to do this search in a single step in ADS rather than doing it by hand. That is, you shouldn't compile the list by combing through a longer list returned by ADS and manually picking out the right papers. The goal here is to make ADS return *only* what you want; you may have to dig through the documentation (or just poke around the site) somewhat to figure out how to do this.

    d) Find only papers on which some astronomer of your choice is the *first* author, and which appeared in refereed journals. (As above, the goal is to make ADS return only this set of papers in a single search, not to pick through a longer list by hand.)

2. Skyview: I'd recommend using the "Advanced" interface.

    a) Create and print out images of the galaxy Cygnus A in the optical (you might try both the red and blue bands of 2nd Digitized Sky Survey), the near-infrared (2MASS), and the radio (the NVSS survey at a frequency of 1.4 GHz). Make the scale about 0.1 degree on a side, and use a black and white colormap. Can you explain why the images look so different? (Browse around on the web to find some spectacular images of this galaxy.)

    b) Create and print out (in color) a color-composite image, 20" on a side, of the 2MASS survey near-infrared emission from L1689SNO2 that shows J-band in blue, H-band in green, and K-band in red. (Hint: this system is discussed in Haisch et al. 2002, AJ 124, 2841). Given that all infrared light is invisible to the human eye, why did I choose that particular mapping of colors to photometric filters (i.e. to wavelengths)?

    c) Apply the same technique as in (b) to create a different color-composite image of some other object, at whatever scale, and in whatever combination of colors and bands, you think is interesting/illuminating. Try to choose something where the color composite is telling you something astrophysically interesting.

3. Simbad:

    a) What is the distance to the star HIP 33455? Include an error bar on your answer.

    b) What is the radial velocity of the star HD 155555?

    c) What well-known celestial object is located near the equatorial coordinates 14 29 40 -62 40 50 (J2000)?

    d) What is the HD number of θ^1 Ori C (one of the O stars that forms the Trapezium in the Orion Nebula)?

    e) What is the origin of the name "DoAr 21"?

4. NED:

    a) Plot the spectral energy distribution (SED) for Cygnus A. (Bonus question: can you explain its overall trend with wavelength?)

    b) What is the redshift of 3C 273?

    c) (Another real research example, courtesy of Chris Burns, who works at the Carnegie Institution in Pasadena on a team that uses Type Ia supernovae to measure the Hubble constant and other cosmological parameters.) Your team detects a Type Ia supernova explosion at equatorial coordinates of 12h01m52.8s -18d58m22s (J2000).

        i. Use NED to figure out the name of this supernova.

        ii. Search for galaxies within about 10 arcmin of this position in order to determine the host galaxy for the supernova.

        iii. The peak V magnitude of the supernova is V = 12.79. What is the absolute V mag of the supernova? (Explain your calculation including what data you used, and why.)

5. Related to our discussion of nomenclature, here's a scavenger hunt. I'll give a (small) prize for the best answer to each of these:

    a) What is the highest-numbered variable star name you can find? (A few minutes' thinking will help you narrow down which constellation it's likely to be in.)

    b) Which star (or other object) has the largest number of names listed in Simbad or NED?

    I have no idea what the answer to (b) is, and a rough idea of the answer to (a).

6. Use Vizier to generate a table of all the stars in the Hipparcos catalog that are closer than 20 parsecs, with a parallax error of less than 10%. Then use the link to the VOPlot utility (at the bottom of the results page) to plot the resulting data. (Note: you'll have to figure out how to

get Vizier to give you more than 50 results.) Make a color-magnitude diagram, e.g. B-V vs. V mag, with brighter stars toward the top. Explain how you selected your sample, and how you generated the plot.

7. What is the equivalent width of the H-alpha line in the spectrum of the star HIP 75187? (*Equivalent width* is a measure of the strength of a spectral line, and is generally given in wavelength units, e.g. Ångstroms.) Is the line seen in emission or absorption?

8. Observing! Now that you know about coordinates and time, let's put those to use to plan some observations. This week we'll observe an asteroid, to get some experience planning, executing, and analyzing observations. Your pre-seminar assignment is to plan and execute the observations, and we'll spend some time in the second half of seminar going through the analysis.

    a) Find a reasonably bright, observable asteroid. Go to http://iasc.scibuff.com/osiris-rex.php and choose the "Target asteroids" tab to get a list of asteroids. Sort the list by magnitude so that brighter asteroids are at the top. Choose an asteroid that is i) brighter than 18th mag; ii) observable in the first half of the night at this time of year.

    b) Once you have the name of your asteroid, then you need to get a more detailed list of coordinates for it; a set of coordinates vs. time for an object is called an *ephemeris*. Use JPL's Horizons system to figure out the ephemeris. Go to http://ssd.jpl.nasa.gov/horizons.cgi and set the "Target Body" to be your chosen asteroid, and generate an ephemeris for Tuesday night of next week.

    c) Generate a finding chart (an image of the target field that you can use for comparison) and an airmass plot (a graph of how high the object will be in the sky as a function of time) using the tools linked from the top of the page at http://astro.swarthmore.edu/~jensen/tapir.html .