ASTR 2401

Time & Planning Observations

Observational Astronomy

Agenda

- Splitting Observing Lab Nights
- Observing Logistics
- Any questions about last weeks lab / lab report?
- An Aside for the Visual Observing Lab
- Time
- Planning Observations
- Weather for Tonight

An aside for the visual observing lab.

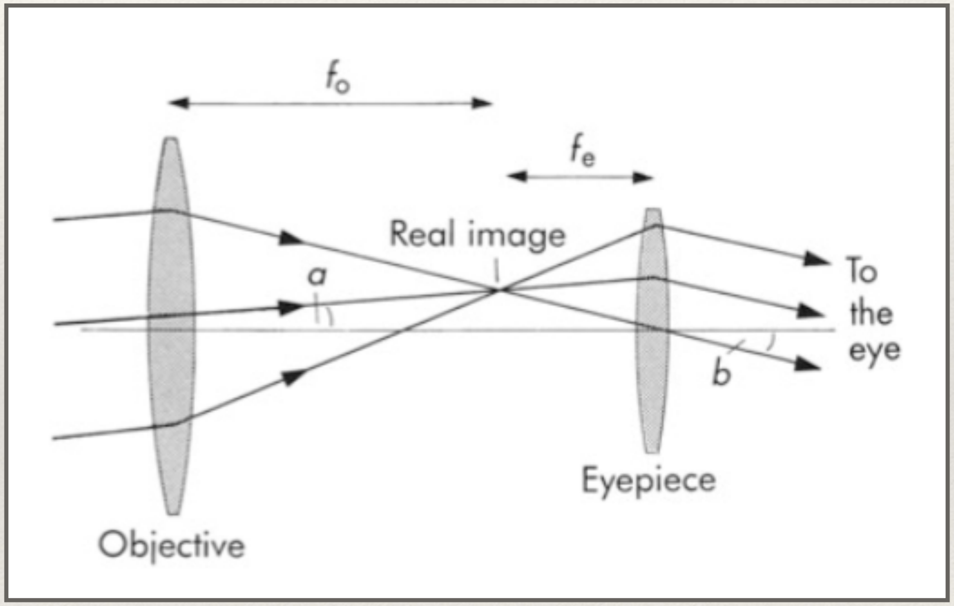
For visual observing with an eyepiece.

Magnification:

$$M = \frac{f_o}{f_e}$$

Field of View (FoV):

$$FoV = \frac{FoV_e}{M}$$

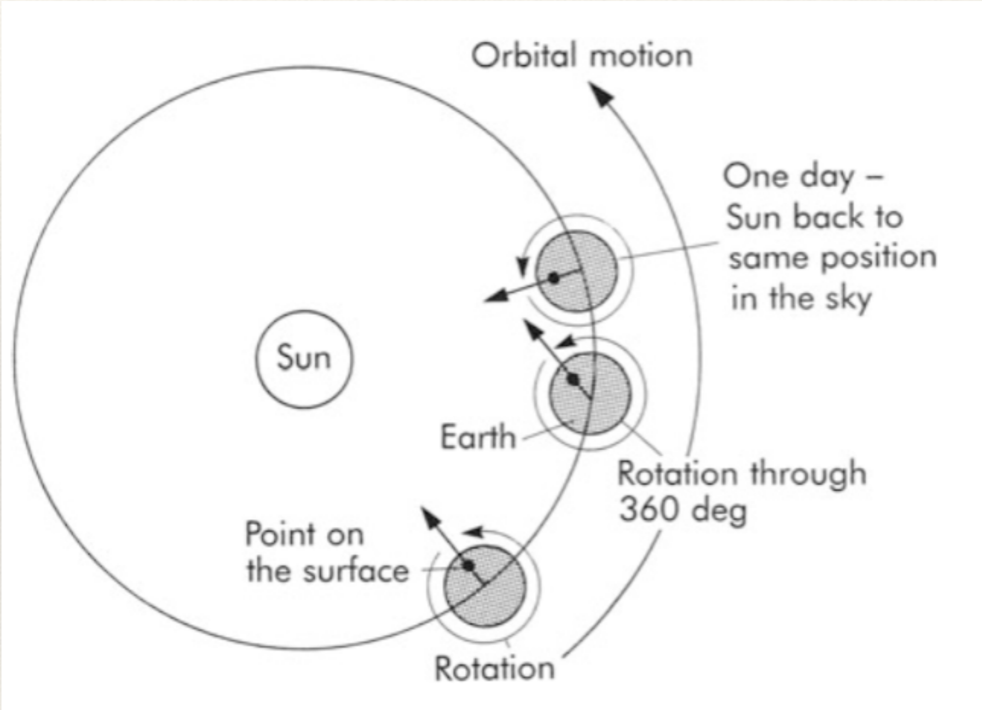


Time

Knowing the time is just as important as good coordinates. Otherwise, you can’t convert between RA, Dec and altitude, azimuth.

Sidereal Time

- The sidereal day is the true rotation period with respect to the vernal equinox
- 23 hours, 56 minutes, 4.0916 seconds
- The local sidereal time (LST), is HA of the vernal equinox
- **LST = the current RA of the local meridian**



Solar Time

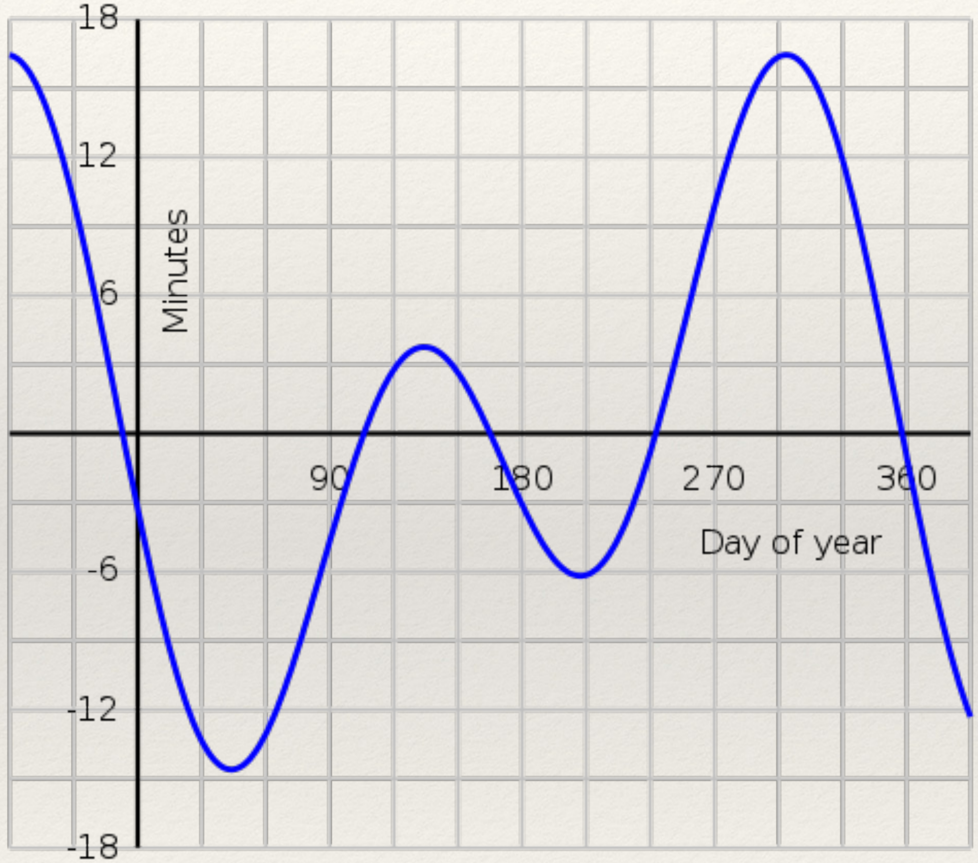
Mean Solar Time is the time of day based upon the mean solar day (i.e. 24 hours long). For mean solar time the sun is at zenith at noon.

Why is every solar day not exactly 24 hours long?

Greenwich Mean Time (GMT), or **Universal Time (UT)** is the mean solar time at the prime meridian. This serves as the reference for all local times.

You typically need to know the UT as well as the Local Sidereal Time, especially if the target is time variable.

The Equation of Time plotted over a year.



Astronomer's Headache

Civil time (what we use every day, also known as Standard Time) is based upon the 24 hour mean solar day, but is different from local solar time because of the use of time zones.

Time Zones
While everyone would probably like to have their clocks read noon when the sun is overhead, there are also some obvious practical difficulties with having time change continuously with location. For this reason, standard time is divided up into 24 time zones, each approximately 1 hr (15 degrees) in width…with a lot of quirkiness due to politics.

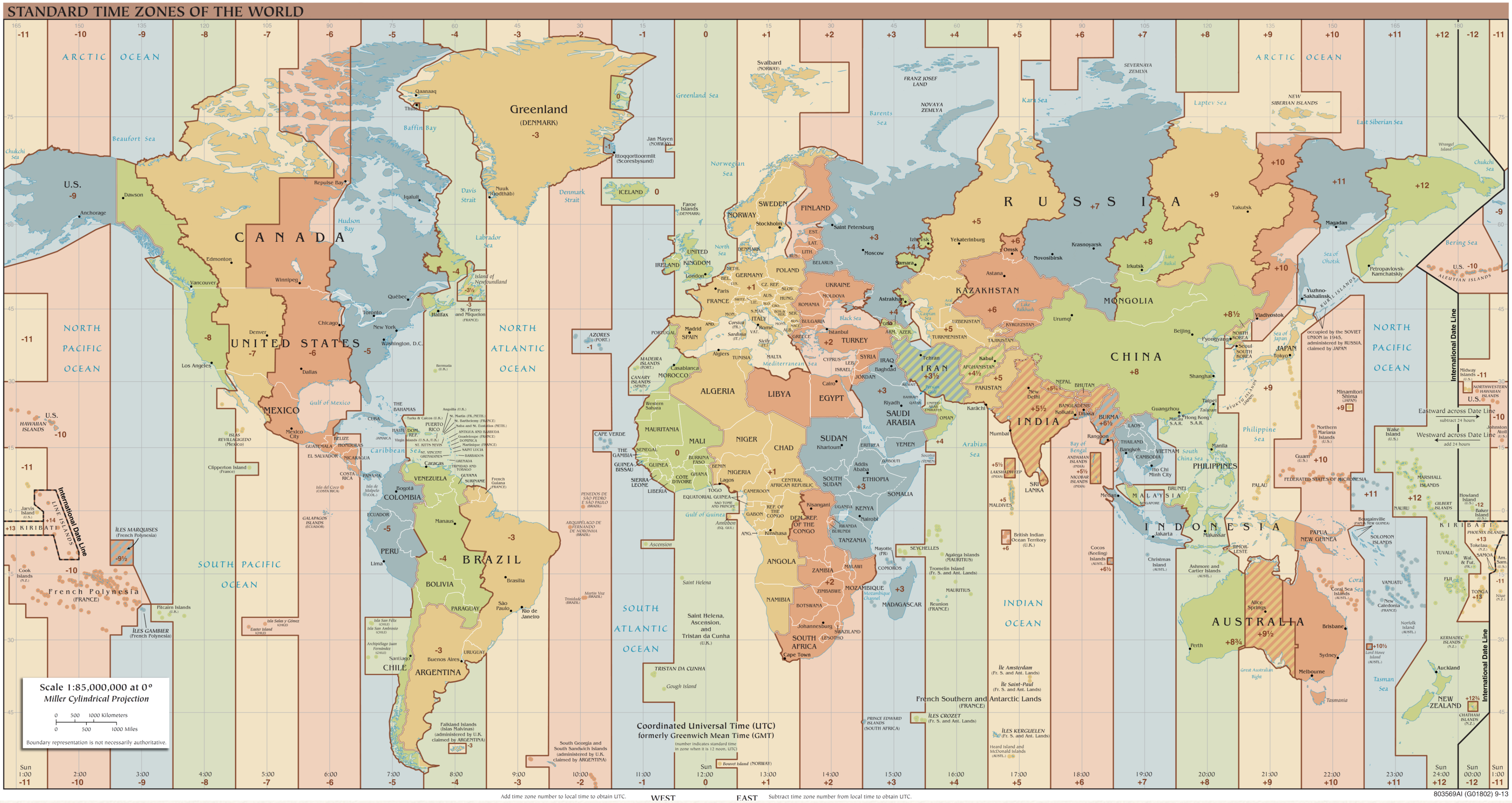
The point here to keep in mind is that standard (civil) time is not generally the same as local solar time!

Daylight Saving Time (DST)
Adding a bit of extra confusion, many locations observe some form of daylight saving time.

- In the U.S. the time changes occur on the second Sunday in March (spring forward) and the first Sunday of November (fall back) at 2am local time.
- In the EU, it runs from the last Sunday of March to the last Sunday of October.
- In the US, Arizona, Hawaii, Puerto Rico, the U.S. Virgin Islands, and American Samoa don't observe DST.

DST dates for this school year: Sunday, November 6, 2016 and Sunday, March 12, 2017

Time Zones


STANDARD TIME ZONES OF THE WORLD
Coordinated Universal Time (UTC)
formerly Greenwich Mean Time (GMT)
Scale 1:85,000,000 at 0°
Miller Cylindrical Projection
Boundary representation is not necessarily authoritative.
International Date Line
Add time zone number to local time to obtain UTC.
WEST
EAST
Subtract time zone number from local time to obtain UTC.
803569AI (G01802) 9-13

Julian Days

If you're dealing with observations over an extended time baseline (months, years, centuries), it is useful to have an means of keeping track without worry about leap years, days the month, changes in calendar systems in medieval times, etc. Julian days were introduced for this purpose. Julian days are a running count of days since noon UT, January 1, 4713 B.C.

Examples:

```
2pm, January 12, 2006   JD 2453748.20833
2pm, January 12, 1000BC JD 1356185.20833
12am, August 28, 2016   JD 2457630.500000
```

Name	Epoch	Calculation
Julian Date (JD)	12h Jan 1, 4713 BC	
Reduced JD (RJD)	12h Nov 16, 1858	JD - 2400000
Modified (MJD)	0h Nov 17, 1858	JD - 2400000.5

Julian Days (Date)

If you're dealing with observations over an extended time baseline (months, years, centuries), it is useful to have an means of keeping track without worry about leap years, days the month, changes in calendar systems in medieval times, etc. Julian days were introduced for this purpose. Julian days are a running count of days since noon UT, January 1, 4713 B.C.

Examples:

```
2pm, January 12, 2006   JD 2453748.20833
2pm, January 12, 1000BC JD 1356185.20833
12am, August 28, 2016   JD 2457630.500000
```

Name		Epoch	Calculation
Julian Date	(JD)	12h Jan 1, 4713 BC	
Reduced JD	(RJD)	12h Nov 16, 1858	JD - 2400000
Modified	(MJD)	0h Nov 17, 1858	JD - 2400000.5

****Beware, a number of non-astronomical software programs now use a "Julian Date", which is not generally the same as the astronomical Julian Date.**

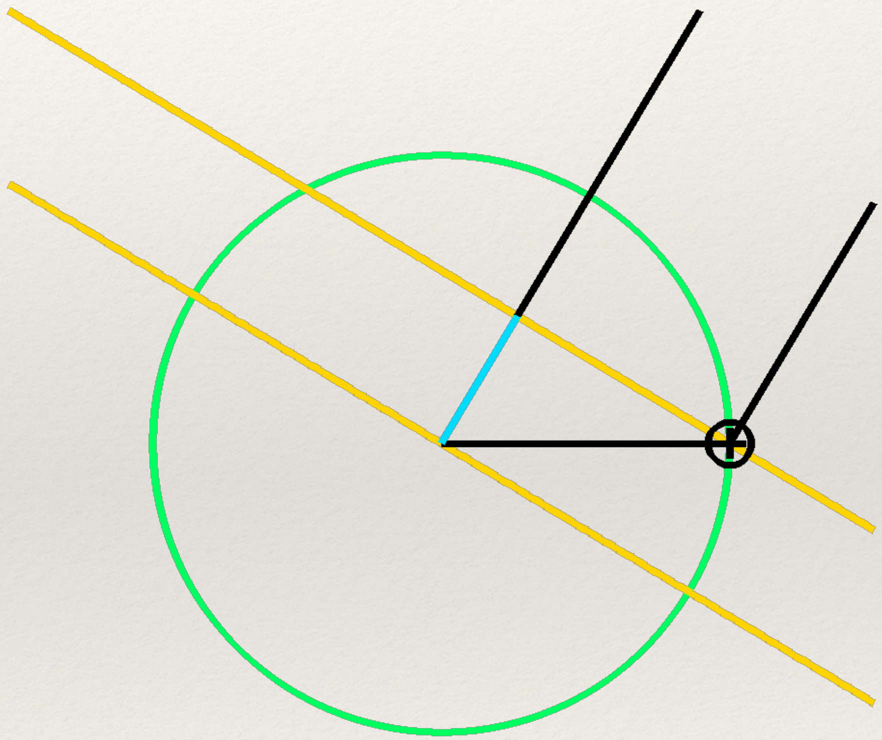
Heliocentric Julian Date

When need high temporal precision in your timing, you have to account for the light travel time across Earth's orbit (pulsar timing, for example).

It is convenient to use the frame of reference of hypothetical observer on the Sun, thus **Heliocentric Julian Date (HJD)**.

The conversion is complex, so it is best left to computers.

Also it has now been replaced.

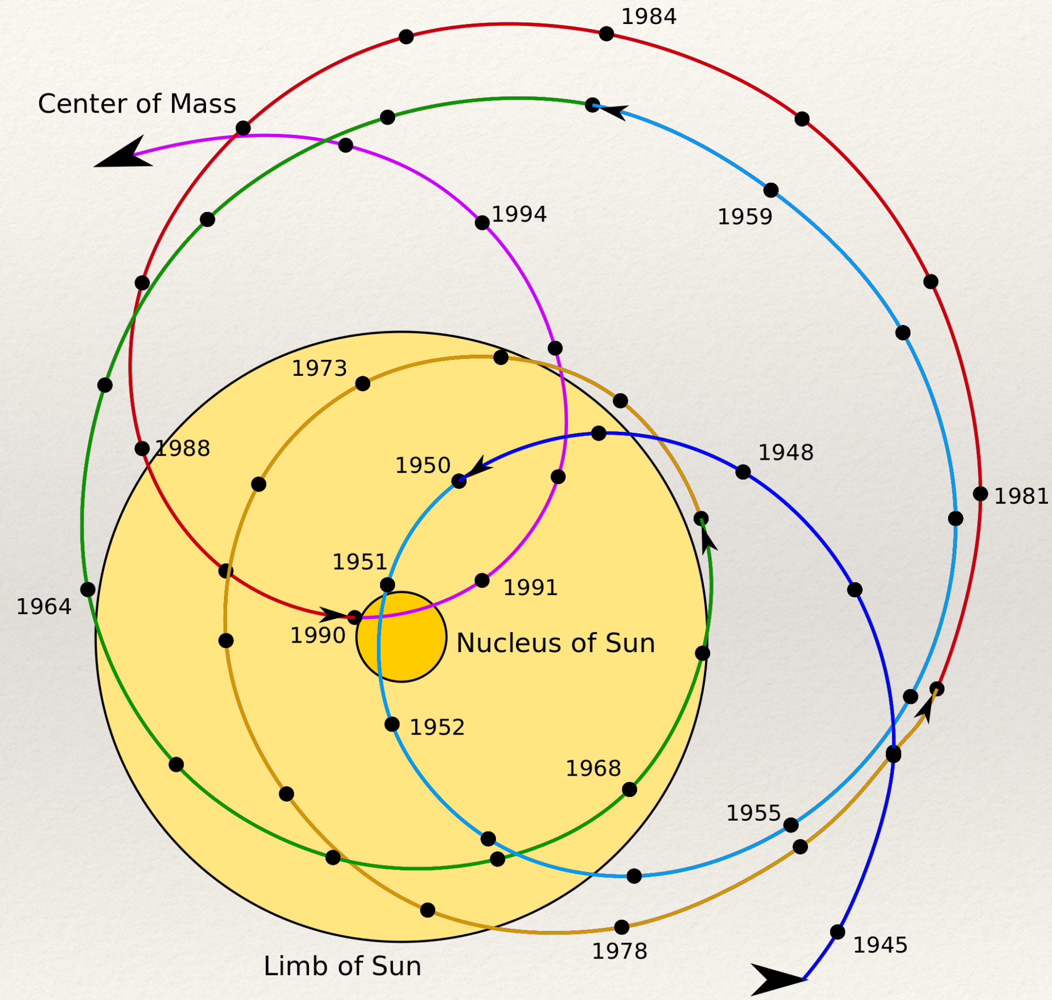


Barycentric Julian Date

The Sun is not stationary, it orbits around the barycenter of the Solar System.

In 1991, **Barycentric Julian Date (BJD)** replaces HJD as the standard reference.

BJD and HJD can vary but up ± 4s.



Planning Observations

Planning Observations

So you have a great idea for a research project and you want to go take some observations. Before requesting observing time, there are some basic things that you need to consider:

1. Target selection
2. Target visibility
3. Does the data you need already exist? Are new observations necessary?
4. What telescope?
5. What instrument and configuration?
6. How much time is required for the observations?

...today we'll focus upon the first three of these items.

Target Visibility

Factors to consider:

- Time of year (RA)?
- Declination?
  - Northern or southern target?
  - Hours of night that target will be observable from a given telescope
  - Altitude limits
  - Airmass considerations

Is the target above the horizon when you want to observe?

Now is a great time to observe M31 from Skyview!

Moon	Evening Date	HA.eve	airm.eve	HA.ctr	airm.ctr	HA.morn	airm.m...	hrs<3	hrs<2	hrs<1.5
New	2016 Jun 04	-10:56	(down)	-7:47	> 10.	-4:38	1.70	1.6	0.6	0.0
Full	2016 Jun 19	-9:49	(down)	-6:45	3.99	-3:40	1.38	2.6	1.5	0.4
New	2016 Jul 03	-8:54	(down)	-5:46	2.46	-2:39	1.18	3.6	2.5	1.4
Full	2016 Jul 19	-8:01	> 10.	-4:41	1.73	-1:22	1.05	4.8	3.8	2.7
New	2016 Aug 02	-7:20	6.22	-3:46	1.41	-0:13	1.01	6.0	5.0	3.9
Full	2016 Aug 17	-6:41	3.84	-2:50	1.21	+1:02	1.03	7.2	6.2	5.1
New	2016 Aug 31	-6:07	2.84	-1:58	1.10	+2:10	1.12	8.3	7.3	6.2
Full	2016 Sep 16	-5:28	2.19	-1:01	1.03	+3:27	1.32	8.9	8.6	7.5
New	2016 Sep 30	-4:53	1.83	-0:10	1.01	+4:33	1.66	9.4	9.4	8.2
Full	2016 Oct 15	-4:14	1.54	+0:45	1.02	+5:43	2.40	9.9	9.4	8.2
New	2016 Oct 30	-3:30	1.34	+1:42	1.07	+6:53	4.39	9.7	8.7	7.6
Full	2016 Nov 13	-2:44	1.19	+2:38	1.18	+8:00	> 10.	8.9	7.9	6.8
New	2016 Nov 28	-1:49	1.08	+3:41	1.38	+9:11	(down)	8.0	7.0	5.9
Full	2016 Dec 13	-0:48	1.02	+4:46	1.77	+10:20	(down)	7.0	6.0	4.9
New	2016 Dec 28	+0:19	1.01	+5:53	2.57	+11:27	(down)	5.9	4.9	3.8
Full	2017 Jan 11	+1:24	1.05	+6:54	4.42	-11:36	(down)	4.8	3.8	2.7

Forget Alpha Centauri though.

Moon	Evening Date	HA.eve	airm.eve	HA.ctr	airm.ctr	HA.morn	airm.m...	hrs<3	hrs<2	hrs<1.5
New	2016 Jun 04	-0:55	(down)	+2:14	(down)	+5:23	(down)	0.0	0.0	0.0
Full	2016 Jun 19	+0:11	(down)	+3:16	(down)	+6:21	(down)	0.0	0.0	0.0
New	2016 Jul 03	+1:06	(down)	+4:14	(down)	+7:22	(down)	0.0	0.0	0.0
Full	2016 Jul 19	+2:00	(down)	+5:19	(down)	+8:38	(down)	0.0	0.0	0.0
New	2016 Aug 02	+2:41	(down)	+6:14	(down)	+9:48	(down)	0.0	0.0	0.0
Full	2016 Aug 17	+3:20	(down)	+7:11	(down)	+11:02	(down)	0.0	0.0	0.0
New	2016 Aug 31	+3:54	(down)	+8:02	(down)	-11:49	(down)	0.0	0.0	0.0
Full	2016 Sep 16	+4:33	(down)	+9:00	(down)	-10:33	(down)	0.0	0.0	0.0
New	2016 Sep 30	+5:07	(down)	+9:50	(down)	-9:27	(down)	0.0	0.0	0.0
Full	2016 Oct 15	+5:47	(down)	+10:45	(down)	-8:17	(down)	0.0	0.0	0.0
New	2016 Oct 30	+6:31	(down)	+11:43	(down)	-7:06	(down)	0.0	0.0	0.0
Full	2016 Nov 13	+7:17	(down)	-11:21	(down)	-6:00	(down)	0.0	0.0	0.0
New	2016 Nov 28	+8:12	(down)	-10:18	(down)	-4:49	(down)	0.0	0.0	0.0
Full	2016 Dec 13	+9:13	(down)	-9:13	(down)	-3:39	(down)	0.0	0.0	0.0
New	2016 Dec 28	+10:20	(down)	-8:07	(down)	-2:33	(down)	0.0	0.0	0.0
Full	2017 Jan 11	+11:25	(down)	-7:05	(down)	-1:35	(down)	0.0	0.0	0.0

Airmass

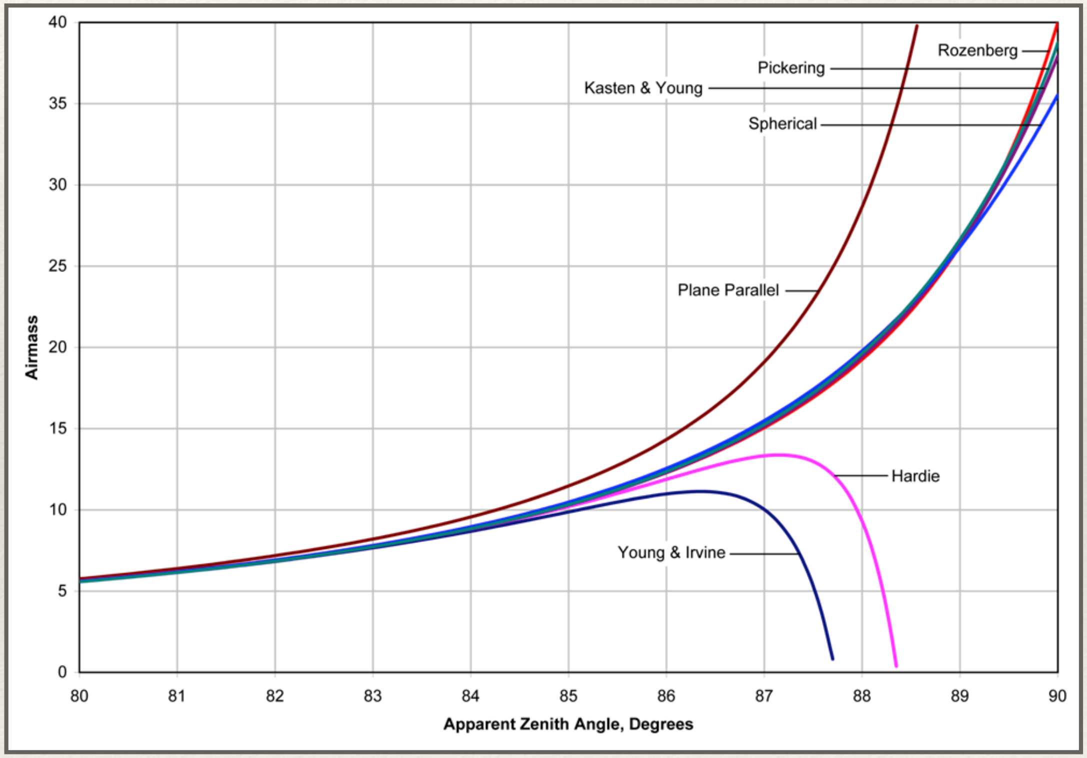
Airmass is the amount of atmosphere the light from the target passes through.

airmass ≈ sec(z)

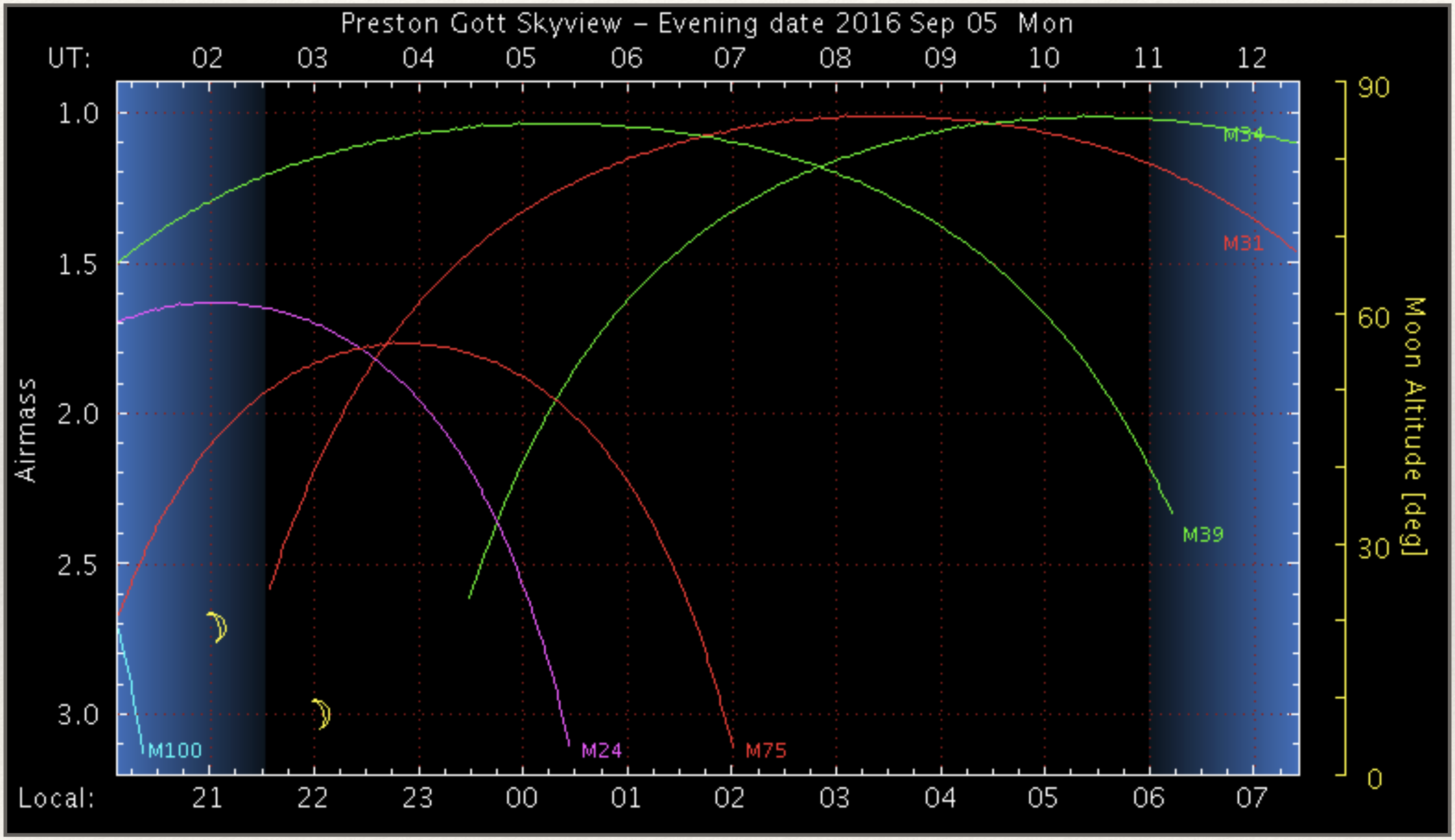
where *alt = 90° - z*

Airmass affects **extinction** and **seeing**.

Basically, the more atmosphere you look through, the worse things get!



Airmass charts are really useful.



Let take a look a JSkyCalc

URL HERE

Catalogs

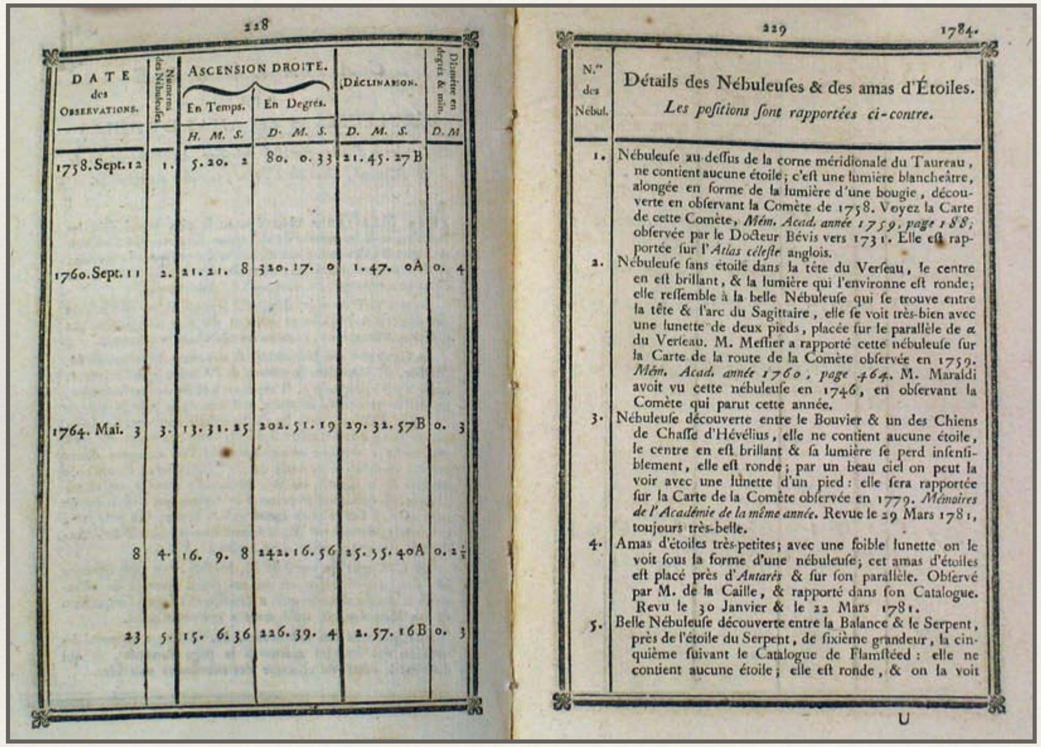
While not scientific ends in themselves, catalogs and atlases have traditionally served as key resources for astronomical programs.

Catalog - List of objects with positional information and other object properties

Atlas - A compilation of images of objects, often accompanied by catalog information.

Classic Examples:

- **Messier Catalog**
- **Hubble Atlas**
- **Henry Draper Star Catalog**



228

DATE des Observations.	Numeros des Nébuleuses	Ascension Droite. En Temps.	Ascension Droite. En Degrés.	Déclinaison.	Diamètre en degrés & min.
		H. M. S.	D. M. S.	D. M. S.	D. M
1758. Sept. 12	1.	5. 20. 2	80. 0. 33	21. 45. 27 B	
1760. Sept. 11	2.	21. 21. 8	320. 17. 0	1. 47. 0 A	0. 4
1764. Mai. 3	3.	13. 31. 25	202. 51. 19	29. 32. 57 B	0. 3
8	4.	16. 9. 8	242. 16. 56	25. 55. 40 A	0. 2½
23	5.	15. 6. 36	226. 39. 4	2. 57. 16 B	0. 3

229 1784.

N.os des Nébul.	Détails des Nébuleuſes & des amas d'Étoiles. *Les poſitions ſont rapportées ci-contre.*
1.	Nébuleuſe au-deſſus de la corne méridionale du Taureau, ne contient aucune étoile; c'eſt une lumière blancheâtre, alongée en forme de la lumière d'une bougie, découverte en obſervant la Comète de 1758. Voyez la Carte de cette Comète, *Mém. Acad. année 1759, page 188;* obſervée par le Docteur Bévis vers 1731. Elle eſt rapportée ſur l'*Atlas céleſte* anglois.
2.	Nébuleuſe ſans étoile dans la tête du Verſeau, le centre en eſt brillant, & la lumière qui l'environne eſt ronde; elle reſſemble à la belle Nébuleuſe qui ſe trouve entre la tête & l'arc du Sagittaire, elle ſe voit très-bien avec une lunette de deux pieds, placée ſur le parallèle de α du Verſeau. M. Meſſier a rapporté cette nébuleuſe ſur la Carte de la route de la Comète obſervée en 1759. *Mém. Acad. année 1760, page 464.* M. Maraldi avoit vu cette nébuleuſe en 1746, en obſervant la Comète qui parut cette année.
3.	Nébuleuſe découverte entre le Bouvier & un des Chiens de Chaſſe d'Hévélius, elle ne contient aucune étoile, le centre en eſt brillant & ſa lumière ſe perd inſenſiblement, elle eſt ronde; par un beau ciel on peut la voir avec une lunette d'un pied: elle ſera rapportée ſur la Carte de la Comète obſervée en 1779. *Mémoires de l'Académie de la même année.* Revue le 29 Mars 1781, toujours très-belle.
4.	Amas d'étoiles très-petites; avec une foible lunette on le voit ſous la forme d'une nébuleuſe; cet amas d'étoiles eſt placé près d'*Antarès* & ſur ſon parallèle. Obſervé par M. de la Caille, & rapporté dans ſon Catalogue. Revu le 30 Janvier & le 22 Mars 1781.
5.	Belle Nébuleuſe découverte entre la Balance & le Serpent, près de l'étoile du Serpent, de ſixième grandeur, la cinquième ſuivant le Catalogue de Flamſtéed: elle ne contient aucune étoile; elle eſt ronde, & on la voit

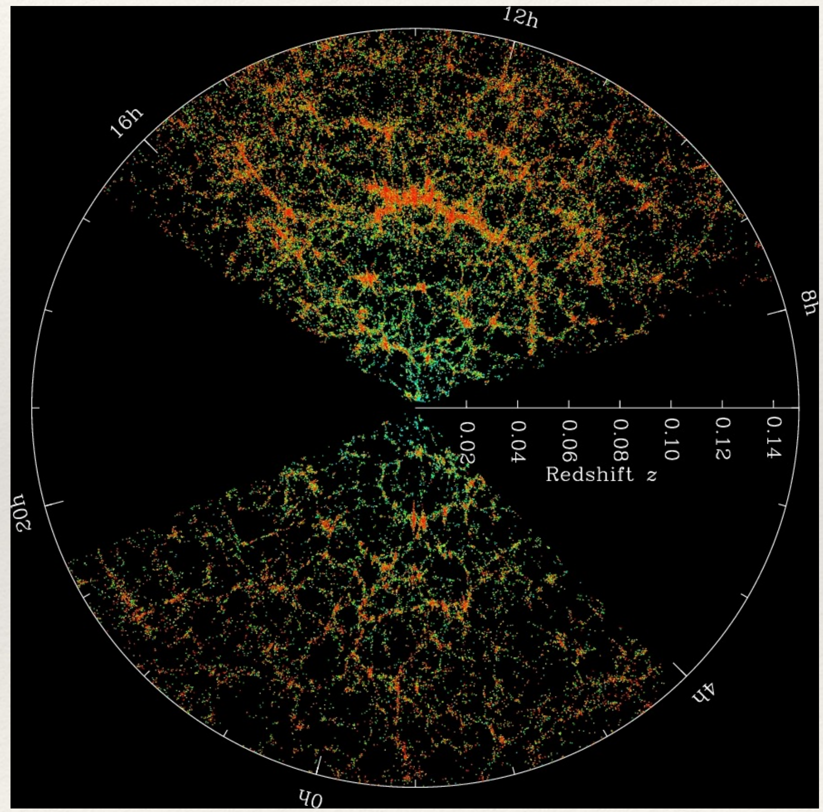
U

Modern Catalogs

The explosion of both observing and computing capabilities has led to a corresponding explosion in the size of astronomical data sets. The classic published catalogs and atlases have been superseded by online databases.

Examples of modern catalogs and atlases:

- **Two Micron All Sky Survey** (2MASS; 108 objects)
- **Sloan Digital Sky Survey** (SDSS; northern hemisphere)
- **Digitized Sky Survey** (atlas of full sky)
- **WISE All Sky Survey** (747 million objects)



Modern Databases

SIMBAD (7 million objects, simbad.u-strasbg.fr/simbad/)

> "The SIMBAD astronomical database, created and maintained by the CDS, Strasbourg, brings together basic data, cross-identifications, observational measurements, and bibliography, for celestial objects outside the solar system: stars, galaxies, and nonstellar objects within our galaxy, or in external galaxies."

NED (NASA/IPAC Extragalactic Database, ned.ipac.caltech.edu) 215 million objects

254 million multiwavelength object cross-IDs

1.4 million associations (candidate cross-IDs) 5 million redshifts

2 billion photometric measurements

31 million objects linked to 93,000 refereed journal articles

2.6 million images, maps and external links

VizieR - Catalog of catalogs (vizier.u-strasbg.fr/)

"VizieR provides access to the most complete library of published astronomical catalogues and data tables available on line, organized in a self-documented database. Query tools allow the user to select relevant data tables and to extract and format records matching given criteria. Specific care has been taken for optimizing access to some very large catalogues such as UCAC2, the USNO-B1, or the 2MASS last release."

These databases are more than just ways to find a target. You can do real science with the catalogs alone without ever going to a telescope!

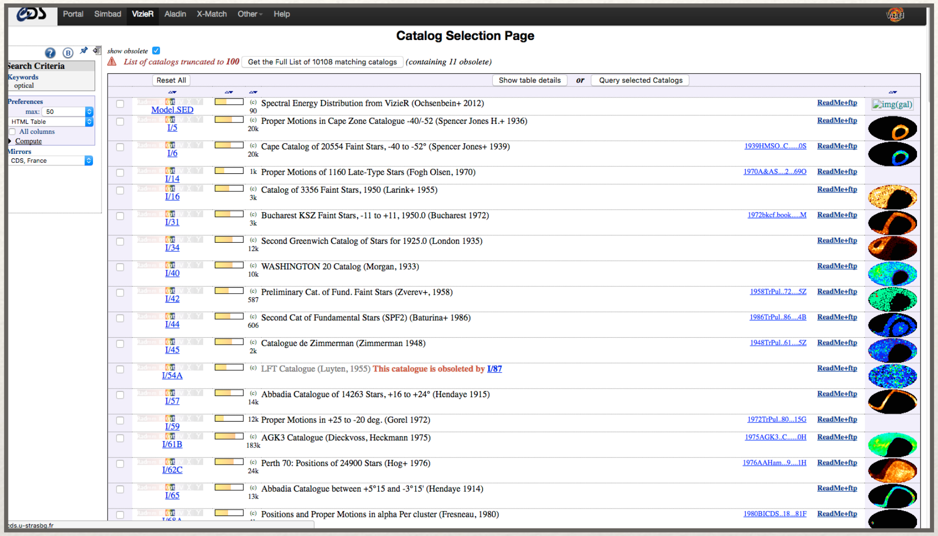


Image Servers

Some Important Modern Image Servers:

MAST (http://archive.stsci.edu/)

Data from assorted space missions (for example, HST, Kepler, WISE, Swift, GALEX, etc)

SDSS data

Digitized Sky Survey

Digitized Sky Survey (http://archive.stsci.edu/cgi-bin/dss_form)

"The Digitized Sky Survey comprises a set of all-sky photographic surveys in E, V, J, R, and N bands conducted with the Palomar and UK Schmidt telescopes. The Catalogs and Surveys Branch (CASB) is digitizing the photographic plates to support HST observing programs but also as a service to the astronomical community."

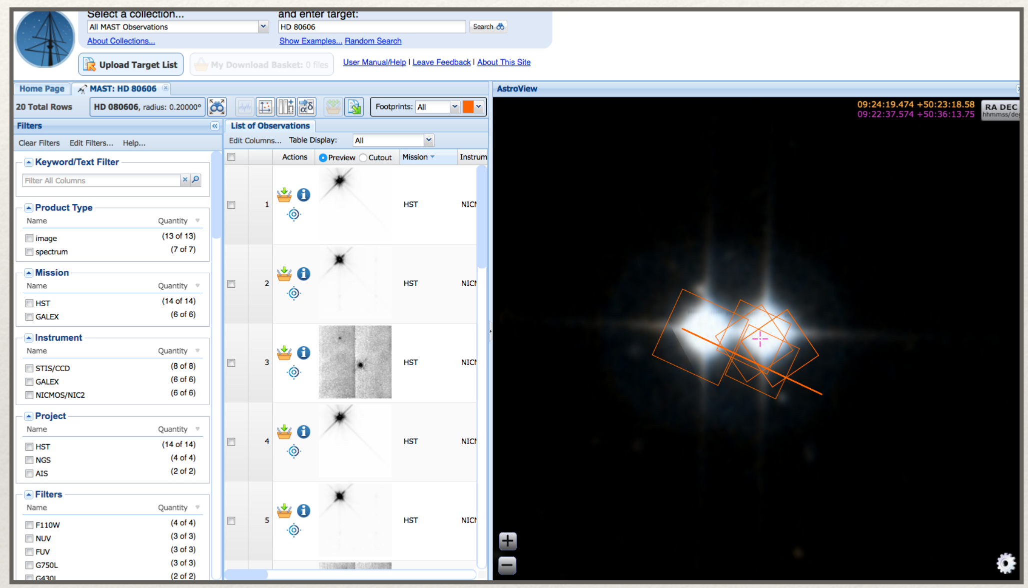
SkyView Virtual Observatory (http://skyview.gsfc.nasa.gov/)

"SkyView is a Virtual Observatory on the Net generating images of any part of the sky at wavelengths in all regimes from Radio to Gamma-Ray."

Can download images of multiple wavelengths with a single search

NOAO Science Archive (http://archive.noao.edu/nsa)

Data from large surveys at national observatories



Finding Charts

Before you go to the telescope, you should make yourself a finding chart

The finding chart should be similar too, but a bit larger than the FoV of the telescope

You want something like 15′ x 15′ view around your target

It's better to use an image database tool like **Aladdin (http://aladin.u-strasbg.fr/aladin.gml)** as opposed to planetarium software like the sky.

Inverted colors work best, it's easier to see faint things and better for printing