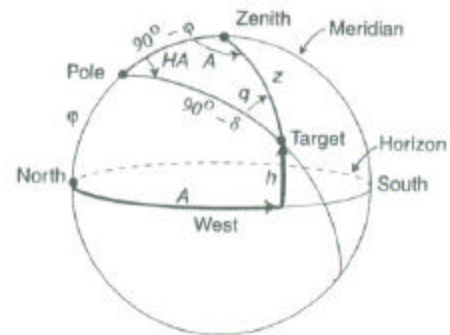
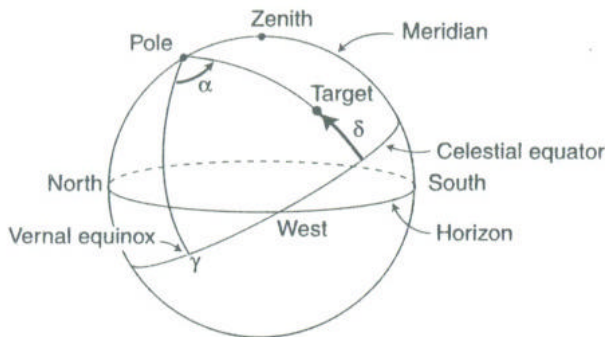


General considerations for observations

Systems of coordinates

- **Equatorial system:** usual system to use for selecting objects according to ephemerid comparing with **Local Sidereal Time (LST)**;

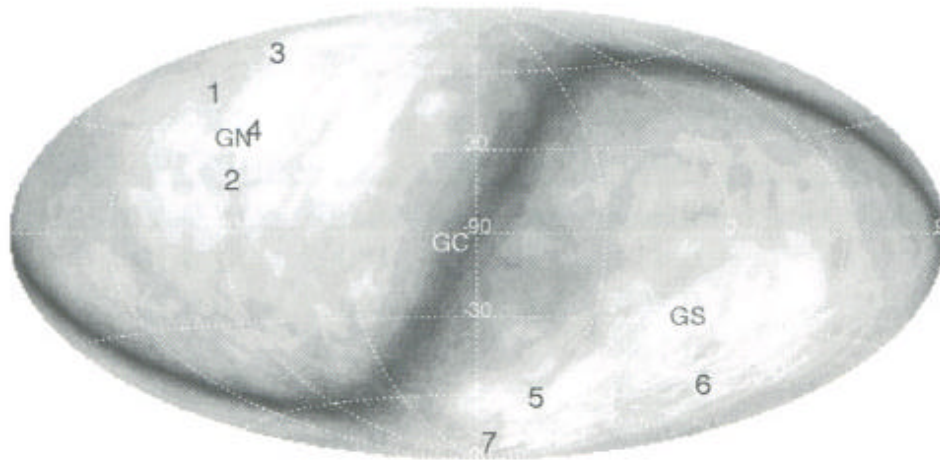


- **Hour angle:** $HA = LST - RA$; negative hour angle, the object did not pass the meridian (eastward) and positive it already passed it (westward);
 - to minimize **air mass**, optimal observations are performed 1 or 2 hours before and after passage to the meridian;
- **Alt-Azimuthal system (alt-az):** system used today with major size telescopes (usual coordinate system used in Radio astronomy);
 - Conversion between equatorial to alt-az is necessary → because FOV rotates, one needs to know how the orientation of the field varies as the telescope tracks;
 - This is defined by the **parallactic angle** (q); parallactic angle is zero for object on the meridian;

Selecting objects

Observations gain from being optimized by the proper choice of:

1. **Time of the year** (minimizing **air mass** \Rightarrow transit at local meridian); need to compare equatorial coordinates of object with Local Sidereal Time at the date planned for the observation;
2. **Moon Phase** (new moon for dark sky) \Rightarrow important for imaging
3. Selecting regions with **reduced background** from **zodiacal light** and **galactic dust**



Important directions in the sky

1. **Lockman hole** (a region of low far-infrared galactic emission)
2. **Virgo cluster of galaxies**
3. **Hubble Deep Field** (HST long exposure target area)
4. **Coma cluster of galaxies**
5. **Small Magellanic Cloud**
6. **Fornax cluster of galaxies**
7. **Large Magellanic Cloud**

Choosing observation date

- **Local Sidereal time (LST):** sidereal day is the time interval between two successive passage of a celestial object at the local meridian (23h 56min 4s)

→ Optimal observation dates is done by comparing the ST at the date planned for observation with the equatorial coordinates of the target;

HORA SIDERAL

Hora Sideral, 2006

A las 0^h del meridiano 90° W.G.

Abreviaturas:
dj: día juliano

d	dj	h	m	s	d	dj	h	m	s	d	dj	h	m	s
enero					febrero					marzo				
1	2453736.75	6	43	0.7	1	2453767.75	8	45	14.0	1	2453795.75	10	35	37.5
2	2453737.75	6	46	57.2	2	2453768.75	8	49	10.5	2	2453796.75	10	39	34.0
3	2453738.75	6	50	53.8	3	2453769.75	8	53	7.1	3	2453797.75	10	43	30.6
4	2453739.75	6	54	50.3	4	2453770.75	8	57	3.6	4	2453798.75	10	47	27.2
5	2453740.75	6	58	46.9	5	2453771.75	9	1	0.2	5	2453799.75	10	51	23.7
6	2453741.75	7	2	43.4	6	2453772.75	9	4	56.7	6	2453800.75	10	55	20.3
7	2453742.75	7	6	40.0	7	2453773.75	9	8	53.3	7	2453801.75	10	59	16.8
8	2453743.75	7	10	36.5	8	2453774.75	9	12	49.8	8	2453802.75	11	3	13.4
9	2453744.75	7	14	33.1	9	2453775.75	9	16	46.4	9	2453803.75	11	7	9.9
0	2453745.75	7	18	29.7	10	2453776.75	9	20	43.0	10	2453804.75	11	11	6.5
11	2453746.75	7	22	26.2	11	2453777.75	9	24	39.5	11	2453805.75	11	15	3.1
12	2453747.75	7	26	22.8	12	2453778.75	9	28	36.1	12	2453806.75	11	18	59.6
13	2453748.75	7	30	19.4	13	2453779.75	9	32	32.6	13	2453807.75	11	22	56.2
14	2453749.75	7	34	15.9	14	2453780.75	9	36	29.2	14	2453808.75	11	26	52.7
15	2453750.75	7	38	12.5	15	2453781.75	9	40	25.7	15	2453809.75	11	30	49.3
16	2453751.75	7	42	9.0	16	2453782.75	9	44	22.3	16	2453810.75	11	34	45.8
17	2453752.75	7	46	5.6	17	2453783.75	9	48	18.8	17	2453811.75	11	38	42.3
18	2453753.75	7	50	2.1	18	2453784.75	9	52	15.4	18	2453812.75	11	42	38.9
19	2453754.75	7	53	58.7	19	2453785.75	9	56	11.9	19	2453813.75	11	46	35.4
20	2453755.75	7	57	55.2	20	2453786.75	10	0	8.5	20	2453814.75	11	50	32.0
21	2453756.75	8	1	51.8	21	2453787.75	10	4	5.0	21	2453815.75	11	54	28.6
22	2453757.75	8	5	48.4	22	2453788.75	10	8	1.6	22	2453816.75	11	58	25.1
23	2453758.75	8	9	44.9	23	2453789.75	10	11	58.2	23	2453817.75	12	2	21.7
24	2453759.75	8	13	41.5	24	2453790.75	10	15	54.7	24	2453818.75	12	6	18.2
25	2453760.75	8	17	38.0	25	2453791.75	10	19	51.3	25	2453819.75	12	10	14.8
26	2453761.75	8	21	34.6	26	2453792.75	10	23	47.8	26	2453820.75	12	14	11.4
27	2453762.75	8	25	31.2	27	2453793.75	10	27	44.4	27	2453821.75	12	18	7.9
28	2453763.75	8	29	27.7	28	2453794.75	10	31	41.0	28	2453822.75	12	22	4.5
29	2453764.75	8	33	24.3						29	2453823.75	12	26	1.0
30	2453765.75	8	37	20.9						30	2453824.75	12	29	57.5
31	2453766.75	8	41	17.4						31	2453825.75	12	33	54.1

- **Julian date:** useful for observations which are continuous or do not depend on human-based schedule (ex. variable stars, space observatories);

Telescope pointing and tracking

- Once calibration is done (usually one center a bright star with known coordinates each beginning of nights), pointing to a source is accurate at 1 arcsecond for ground-based to 10 arcseconds for space telescopes;
- Small FOV or spectrograph may require **target acquisition** techniques;
- **Target acquisition:**
 - **blind pointing:** when not demanding (several arcseconds) the telescope is pointed using attitude sensors, then pointing is refined by identifying the target in the field;
 - **offsetting:** when the target is too faint, a reference star (for which the position relative to the object is known) is pointed and the position is corrected by the difference in position;
 - **peak-up** method: when higher precision is required; consists of making slight pointing changes in a prescribed pattern, determining the position that maximize the flux (important in NIR ex. UKIRT);
 - **blind offset:** when the target is too faint for the peak-up procedure, a precise offset should be used, determined from previous long exposure images of the target FOV;
- Once pointed, the telescope must **track** to compensate for **inertial drifts** (space telescope) or **rotation of the Earth** (ground observation);
 - tracking is an open-loop procedure relying on attitude sensors and encoders; for improving tracking the pointing loop is close on the field itself using bright stars for **guiding**;
- **Guiding:** the procedure consists in using a dedicated focal plane instrument (**guider**) to image one or possibly two bright stars and correct the pointing accordingly;
 - although guiding stars can be chosen opportunistically, the process can be automated using special guide stars catalogues (ex: Hubble Space Telescope Guide star Catalogs);
- Note: during target acquisition the telescope must already be tracking and guiding;

The art of tracking

Table I: Integrated Star Distribution

V	*/sq deg	10x10 arcmin	*/sq deg	10x10 arcmin
m	Gal eq.	Gal eq.	Gal Pole	Gal Pole
8	1.95	0.05	0.5	0.01
9	6.03	0.17	1.38	0.04
10	17.8	0.49	3.55	0.10
11	54	1.5	9.1	0.25
12	151	4.2	21	0.59
13	398	11	49	1.4
14	1050	29	102	2.8
15	2630	73	186	5.2
16	6025	167	350	9.6
17	13500	375	600	17

Dramatic dependence of number of stars on Galactic latitude:

- Faint stars are more than ten times more closely packed near the Galactic equator than near the poles
- Since these are average numbers, any particular patch of sky may have more or fewer stars.

In order to always have a guiding star (or nearly always) one must have three to five stars on average

- If a guider's FOV is roughly ten by ten arcminutes, it must be able to detect stars down to about 14-15 magnitudes in order to work reliably near the Galactic Poles.

Clearly, a large FOV will include brighter stars than a small one

- However, for a given detector that larger FOV causes the image scale to change, so that each unit of detector area covers a larger patch of sky
- In turn, that means that any centering algorithm will become less precise and any guiding corrections will become more coarse

Table II. S/N vs V for CCD with RN=30 electron

Mag. in V	8	10	12	15	18
Exp. Time (s)					
0.1	40/38	7.4/7	1.2/1.1	0.08/0.07	0.005/0.005
1.0	200/180	57/33	11/7.7	0.73/0.5	0.05/0.03
10	700/620	250/160	69/30	5.2/2	0.34/0.13
100	2200/2000	840/530	260/99	23/6.5	1.5/0.41

In the table, there are two values per entry separated by a slash

- the first is the S/N for observations made under a dark sky (20 magnitude per square arcsecond)
- the second for observations under a bright sky (17 magnitude per square arcsecond).

For guiding purposes a S/N of several is required to keep the guider from moving the scope frequently in the direction of some statistical noise peak.

- Simulations show that S/N =5 is a good lower limit.
- A system shown in Table III would therefore be limited to guiding on stars brighter than tenth magnitude if it used a video-rate CCD or brighter than thirteenth if it could integrate for a second or two.

Telescopes with accurate drives which only need tweaking several times per minute could guide on stars as faint as 15 by integrating for ten seconds or more.

First Project: Star formation distribution in late-type spiral galaxies

The goal of this project is to study the distribution of star forming regions found in late-type spiral galaxies.

Background: It is usually believed that the star formation in disk spirals is a result of density waves. There must be consequently a very tight connection between star formation and spiral patterns. By studying the distribution of star forming regions in the disk of nearby spiral it should be possible to put in evidence such a connection. This would constitute a sort of “signature” of the phenomenon, which could be used to recognize spirals at higher redshifts, where only star forming regions are visible, confirming, there forth, there existence.

Observations : (U)BVRI images of a sample of nearby late-type spiral galaxies

Different colors trace different type of stars – allows to determine region of dust extinction

Task one: Find in literature the different exposure times for the different filter

Task two: Make a list of late-type spiral galaxies observable from La Luz

Condition 1- position – 2-3hours on each side of meridian

Condition 2- small redshifts + exposure time

Condition 3- the galaxies must fill the FOV

FOV of CCD (in second of arc): #pixel of CCD × plate scale

Plate scale (arcsecond/pixel): Plate scale = $\frac{206265 \times \text{size of pixel (mm)}}{1000 \times f / \# \times D (mm)}$

Where: $D = 570 \text{ mm}$, $f / \# = 13.5$ or 7.5 and pixel size is 9 mm