The Young Astronomer's Briefcase
小天文学家的工具箱

Rosa M. Ros

International Astronomical Union
Technical University of Catalonia, Spain

Goals 目标

- Understand the importance of careful observations
- 理解仔细观察的重要性
- Understand the use of various instruments through the student's construction of the instruments
- 让学生在自己制作工具的过程中去理解如何运用各种工具。

The Young Astronomer's Briefcase
小天文学家的工具箱

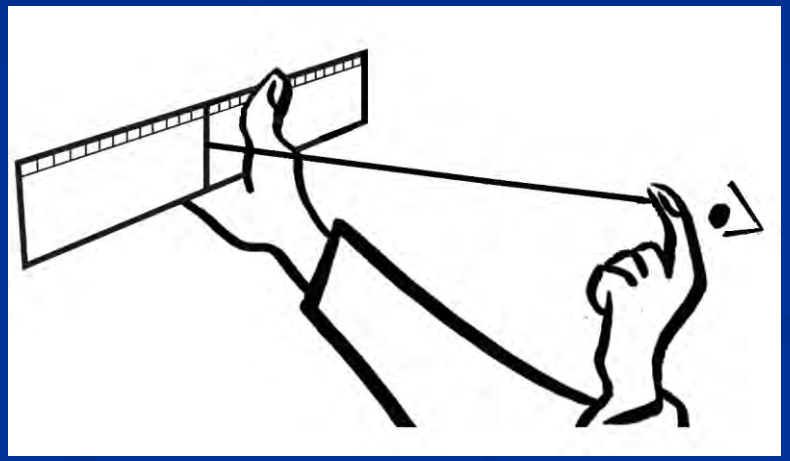
- All instruments built and organized in a box.
- 所有工具都在箱子里

Components of the kit 工具清单

- “Ruler to measure angles” “测量角度的尺子”
- Simplified quadrant 简易象限仪
- Simple horizontal goniometer 简易方位角测量仪
- Planisphere 活动星图
- Map of the Moon 月面图
- Spectroscope 光谱仪
- Equatorial Sundial 赤道式日晷
- Red light flashlight 红光手电
- Compass 指南针
- Wristwatch 手表
- Paper, pencil, camera … 纸、铅笔、相机等

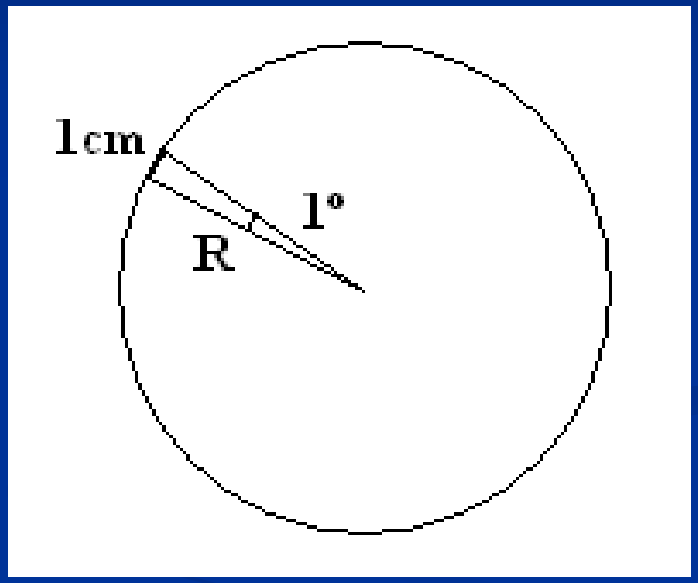
1) “Ruler to measure angles«
“测量角度的尺子”

- To provide the angular distance between two stars.
- 用于测量两颗星间的角距离。
- Simple to use if we do not want to use coordinates.
- 简单易用，无需从坐标推算。



1) “Ruler to measure angles”
测量角度的尺子

- "What is the distance (radius R) needed to obtain a device which is equivalent to 1 º to 1 cm?”
- 半径R为多大时，角度1度所对应的弧长为1厘米？



$$\frac{2\pi R \text{ cm}}{360^\circ} = \frac{1 \text{ cm}}{1^\circ} \Rightarrow R = 180 / \pi = 57 \text{ cm}$$

1) “Ruler to measure angles«
测量角度的尺子

- To build: We set a string of length 57 cm to a non-flexible ruler
- 制作：用一根57厘米长的绳子和一把硬质尺子。

1) “Ruler to measure angles”
测量角度的尺子

- We observe with the end of the string almost touching our eye (on the cheek below the eye)
- 用眼睛抵近观察绳子的一端(在眼睛下方的脸颊上)。
- With string stretched: 1 cm = 1º
- 将绳子拉直:1厘米= 1º

Activity 1: To measure the angular distance between two stars or two points

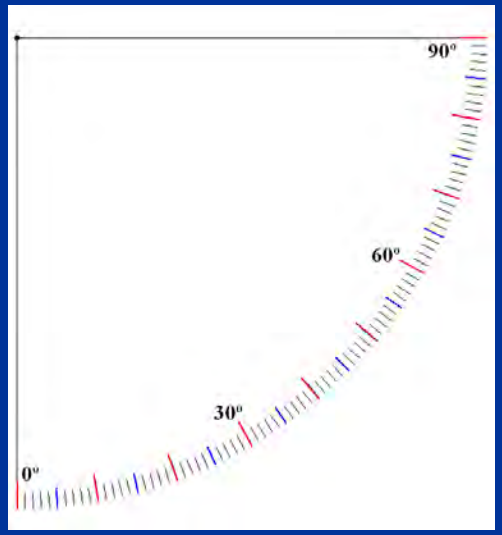
活动1：测量两颗星或两点之间的角距离

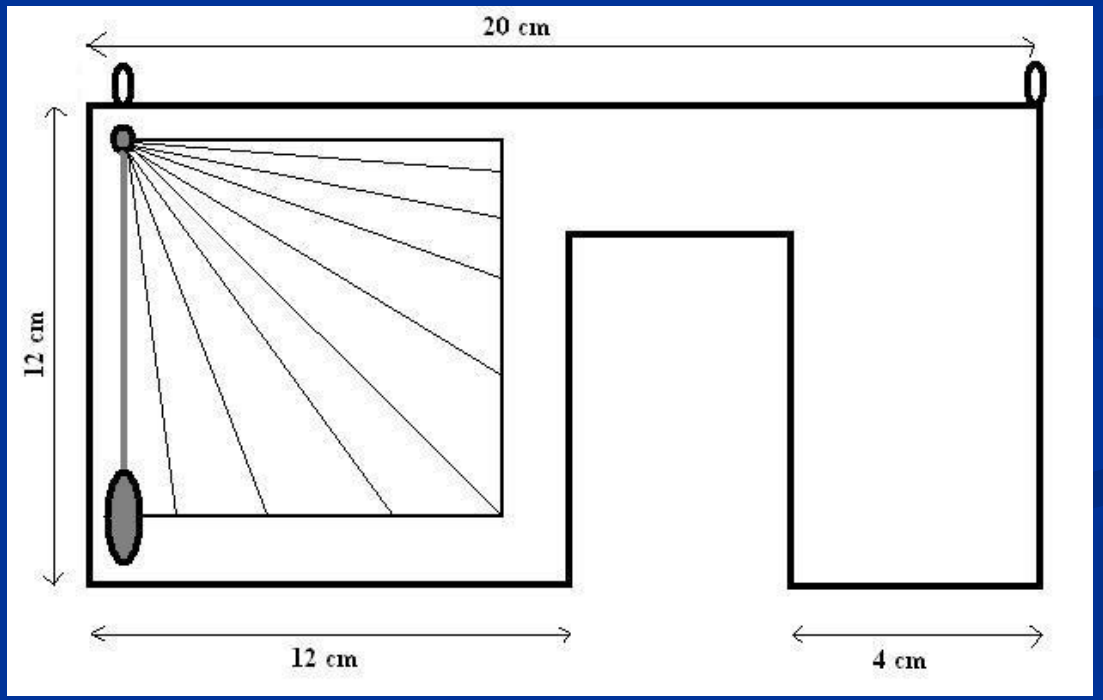
2) Simplified quadrant
简易象限仪

- To find the altitude of the stars.
- 测量天体的地平高度。
- Work in groups of two students: one looking through the viewfinder and the other making the readings.
- 两人一组：一人通过窥管找到天体，另一人读取数值。

2) Simplified quadrant (gun type)
简易象限仪（枪式）

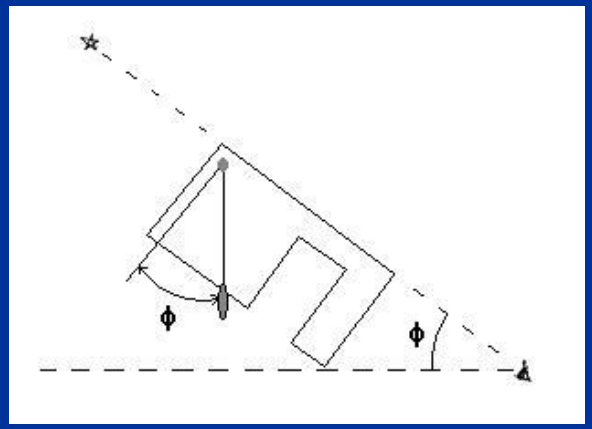
- Rectangular piece of cardboard (approx. 12 x 20 cm). 长方形硬纸板
- Two round hooks on the upper side. 上边装有两个圆圈型挂钩





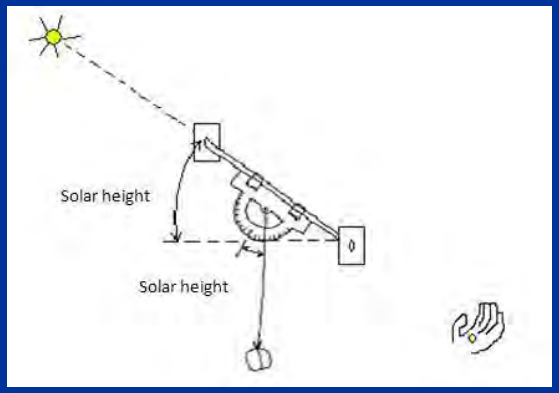
2) Simplified quadrant (gun type)
简易象限仪（枪式）

- If you see the object through the two hooks, the string indicates the altitude above the horizon.
- 如果您通过两个圆圈型挂钩看到目标，此时通过铅垂线能够读出该目标的地平高度。



2) Simplified quadrant (gun type)
简易象限仪（枪式）

- A straw with a carton located across the hooks is an excellent viewfinder for measuring the altitude of the Sun by projecting the image onto a piece of white cardboard.
- 测定太阳高度的好方法：将吸管固定在上述挂钩的位置上，吸管后方放置一块白色卡纸。当白色卡纸上出现太阳亮斑时，即可读出太阳高度。（不可肉眼直视太阳）



- **ATTENTION:**

NEVER LOOK DIRECTLY AT THE SUN!

Activity 2: To find the altitude of the Sun, a star or a point in the corridor

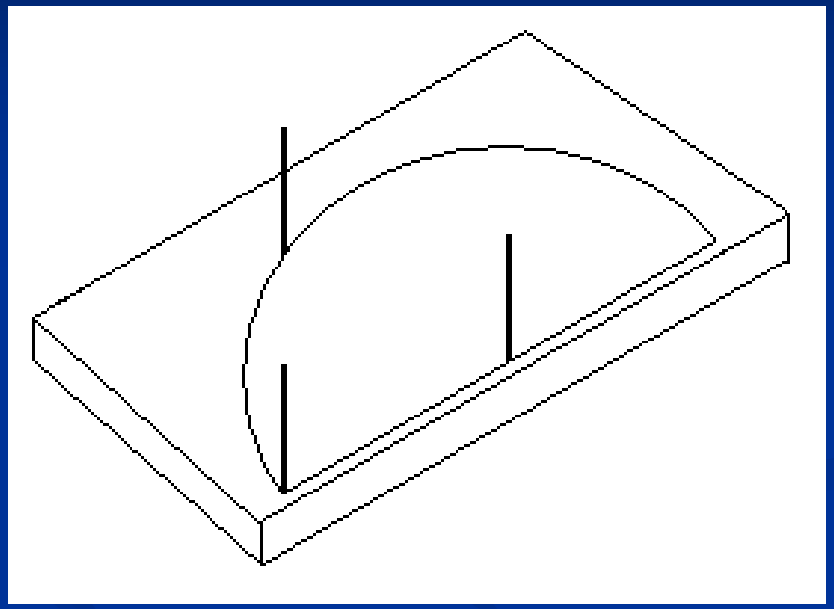
活动2：测量太阳、一颗星或者某一点的地平高度

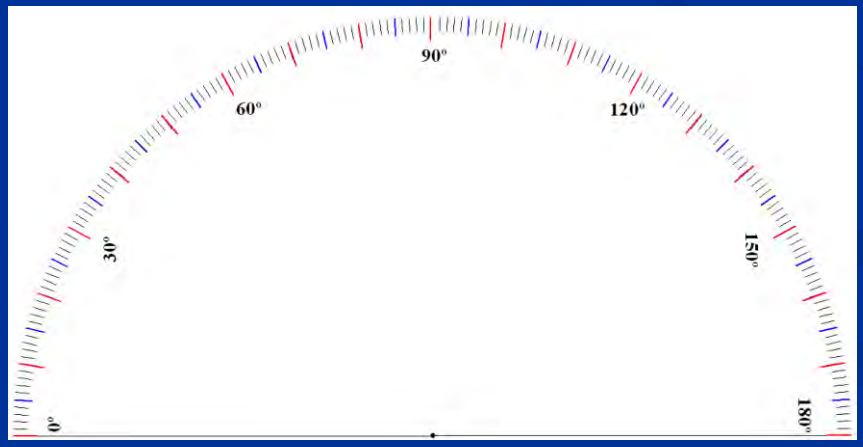
3) Simple horizontal goniometer
简易方位角测量仪

- To determine the azimuth of the stars.
- 测定天体方位角 。
- You need to use a compass to align the instrument in the North-South direction.
- 需要用指南针为测量仪确定南北向。

3) Simple horizontal goniometer
简易方位角测量仪

- Cardboard 12x20 cm.
- 纸板 12x20 cm.
- Using 3 "needles" you can set two directions.
- 用3根针确定两个方向。
- Read the angle between them.
- 读出两个方向的夹角。





3) Simple horizontal goniometer
简易方位角测量仪

- To measure the azimuth of a star, place the origin of the semicircle in the North-South direction.
- 要测量一颗恒星的方位角，把半圆的直径边放在南北方向上。
- Azimuth is the angle from the North-South line through the centre of the circle and the direction of the star.
- 方位角是南北向与恒星方向的夹角。

Activity 3: To determine the azimuth of a star or the angular distance between two stars or two points in the classroom

活动3:测定一颗星的方位角或两颗星的角距离或教室中两点间的角距离

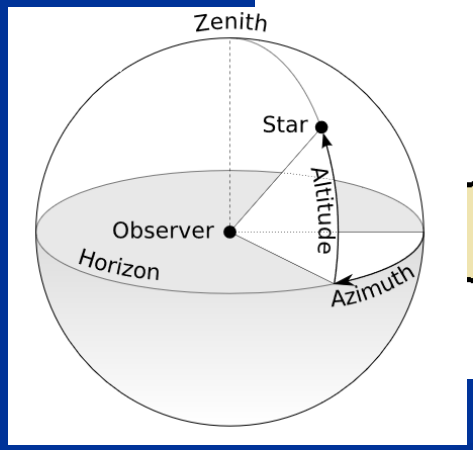
Horizontal coordinates (LOCAL)
水平坐标系（本地）

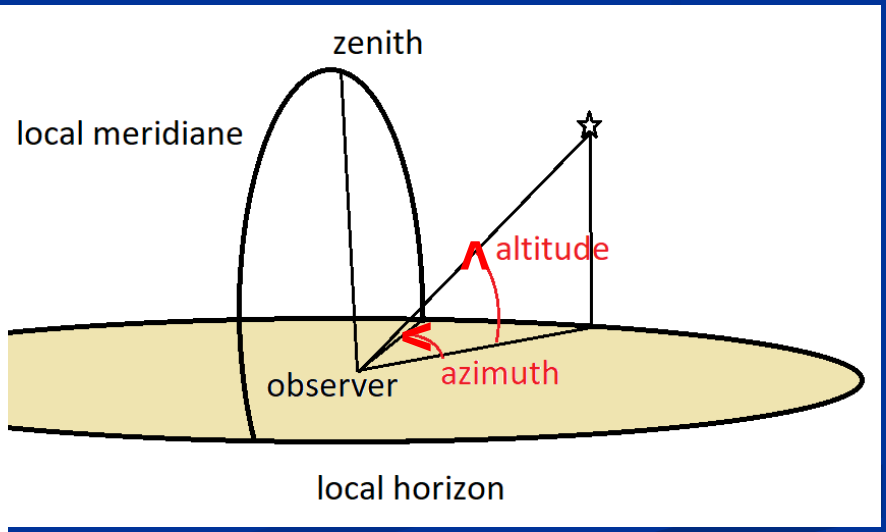
Using the altitude (quadrant) and azimuth (goniometer) of a star we can place it on the local horizon

(depending on the observer)

利用一颗恒星的高度(象限仪)和方位角(测角器)，我们可以在本地地平线圈上确定它的位置(取决于观测者)

altitude from 0° to 90° from the horizon
azimuth from 0° to 360° from the local meridian (S in Europa, N in USA)

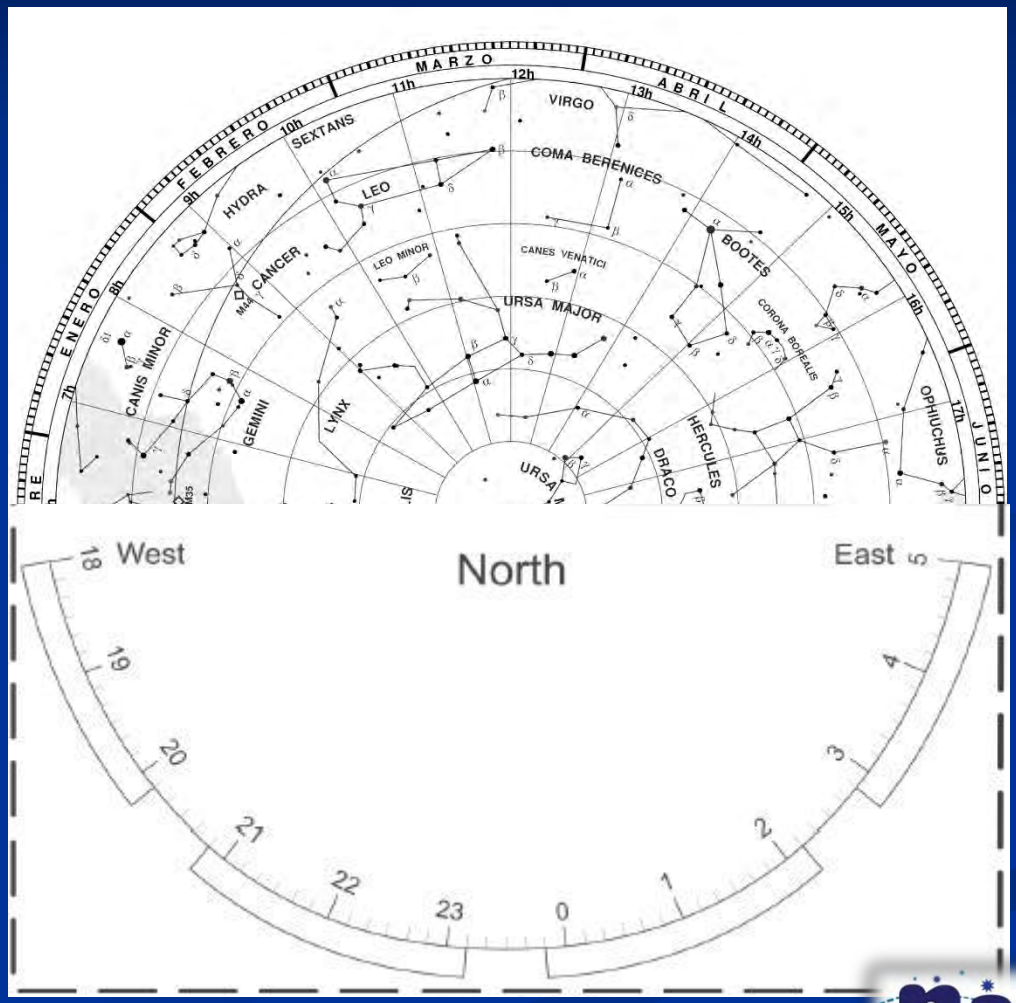




高度从地平起算，范围0°至90°
方位角本地子午圈起算，范围0°到360°(欧洲以南点为起点，美国以北点为起点)

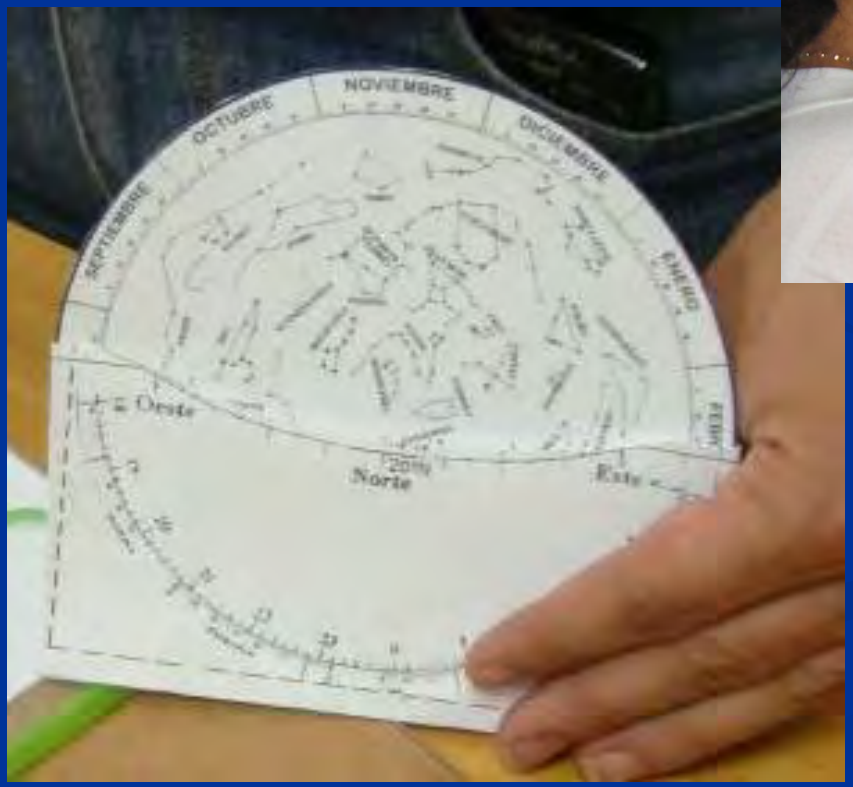
4) Planisphere 活动星图

- To learn what constellations are visible at your latitude, knowing the date and time of the observation.
- 了解什么星座在你的纬度上是可见的，知道相应的观测日期和时间。



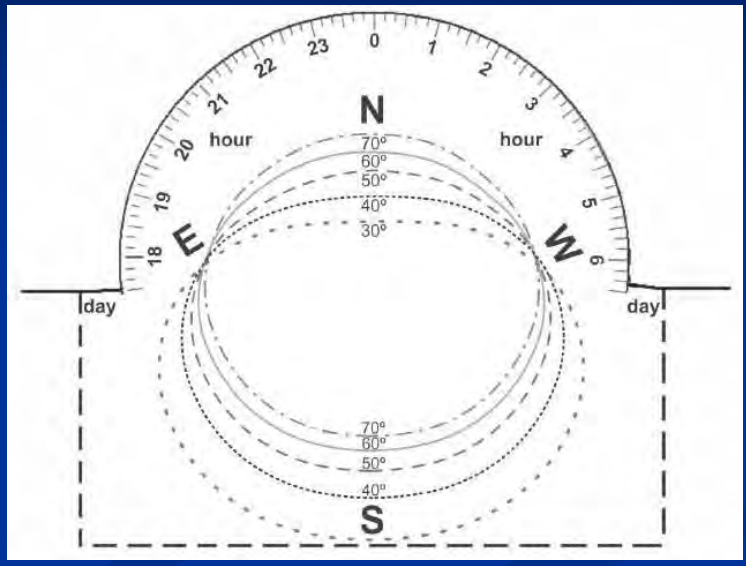
4) Planisphere 活动星图

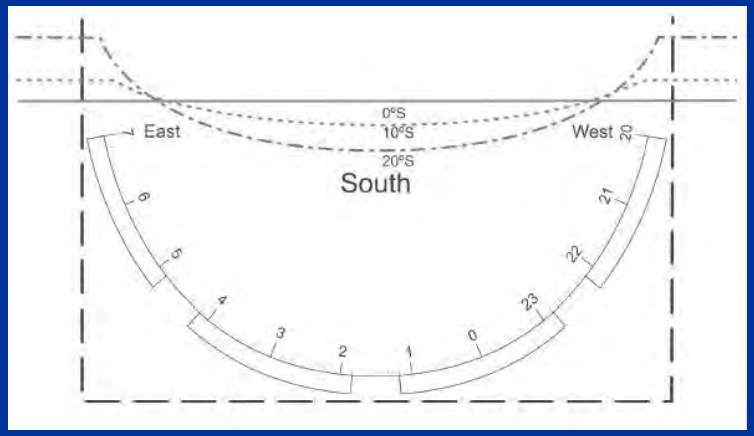
- Constellations disc photocopied onto white paper.
  星座盘印制在白纸板上

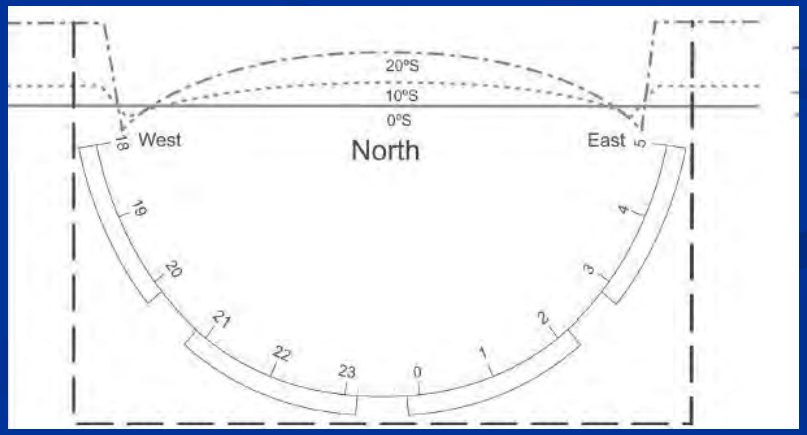


4) Planisphere活动星图

- Inside a pocket whose cut-out area depends on the local latitude.
- 根据当地纬度制作活动星图时间、方向底盘。







Activity 4: Rotate the disk until it matches the date and time of observation

活动4:根据观测日期和时间旋转星座盘

To use the planisphere in the classroom or in observation sessions

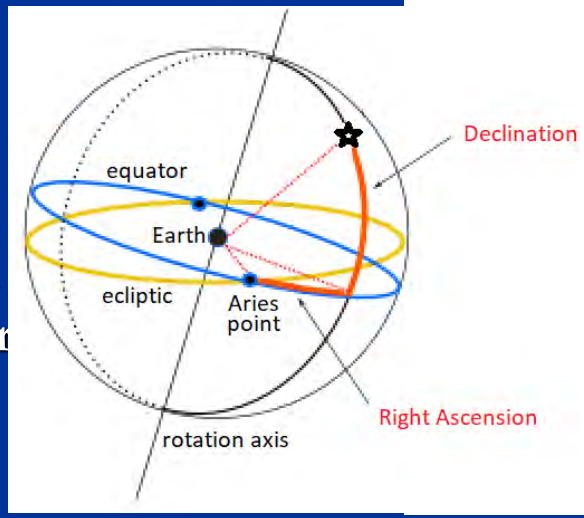
在课堂或观测环节使用活动星图

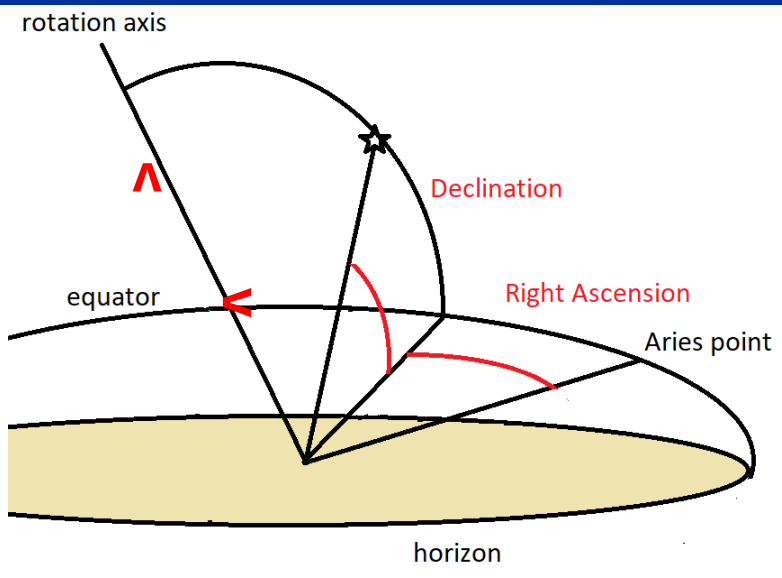
Equatorial coordinates (UNIVERSAL)
赤道坐标系（通用）

Using the declination and the right ascension of a star we can place it anywhere (it does not depend on the observer)

利用恒星的赤纬和赤经，我们可以在天球上确定它的位置（不依赖于观测者）

Declination from 0º to 90º N, or from 0º to 90º S
Right Ascension from 0h to 24h from Aries point (Ecuador with ecliptic)

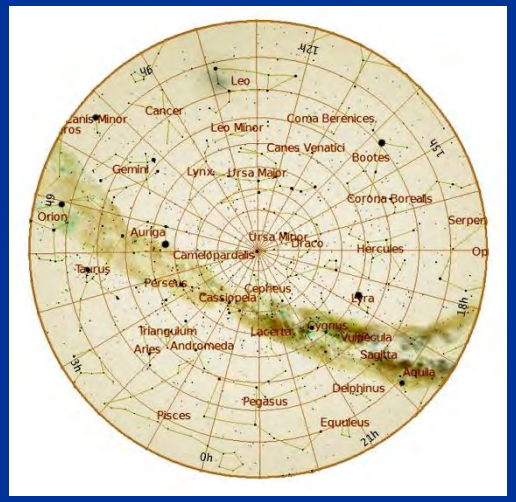


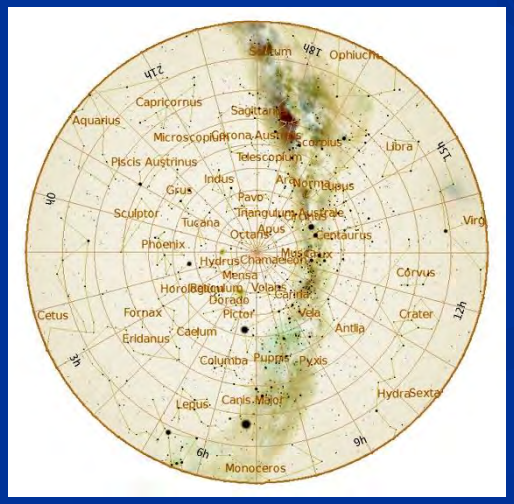


赤纬的范围包括北纬0º到90º，以及南纬0º到90º
赤经从春分点起算，范围从0h到24h

Activity 5: Equatorial coordinates
活动5：赤道坐标系

Placing in the planisphere the following candidate stars to host exoplanetary systems
将下列拥有系外行星系统的恒星放在星图的正确位置



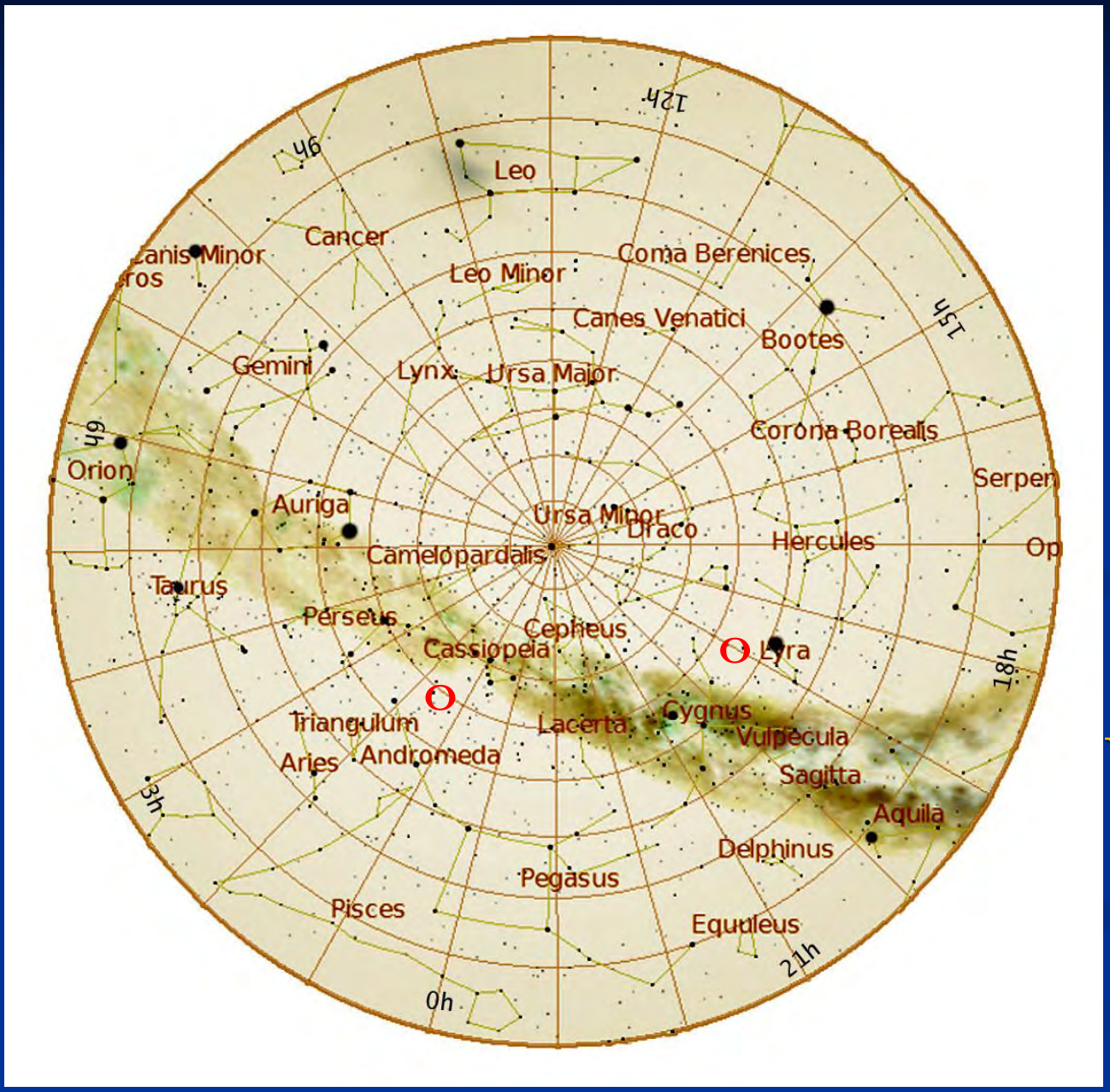


Ups And (Andromeda)
AR 1h 36m 48s
D +41º 24′20′′

581 Gliese (Libra)
AR 15h 19m 26s
D -7º 43′20′′

Kepler 62 (Lyra)
AR 18h 52m 51s
D +45º 20′59 ′′

Trappist 1 (Aquarius)
AR 23h 6m 29s
D -5º 2′28′′

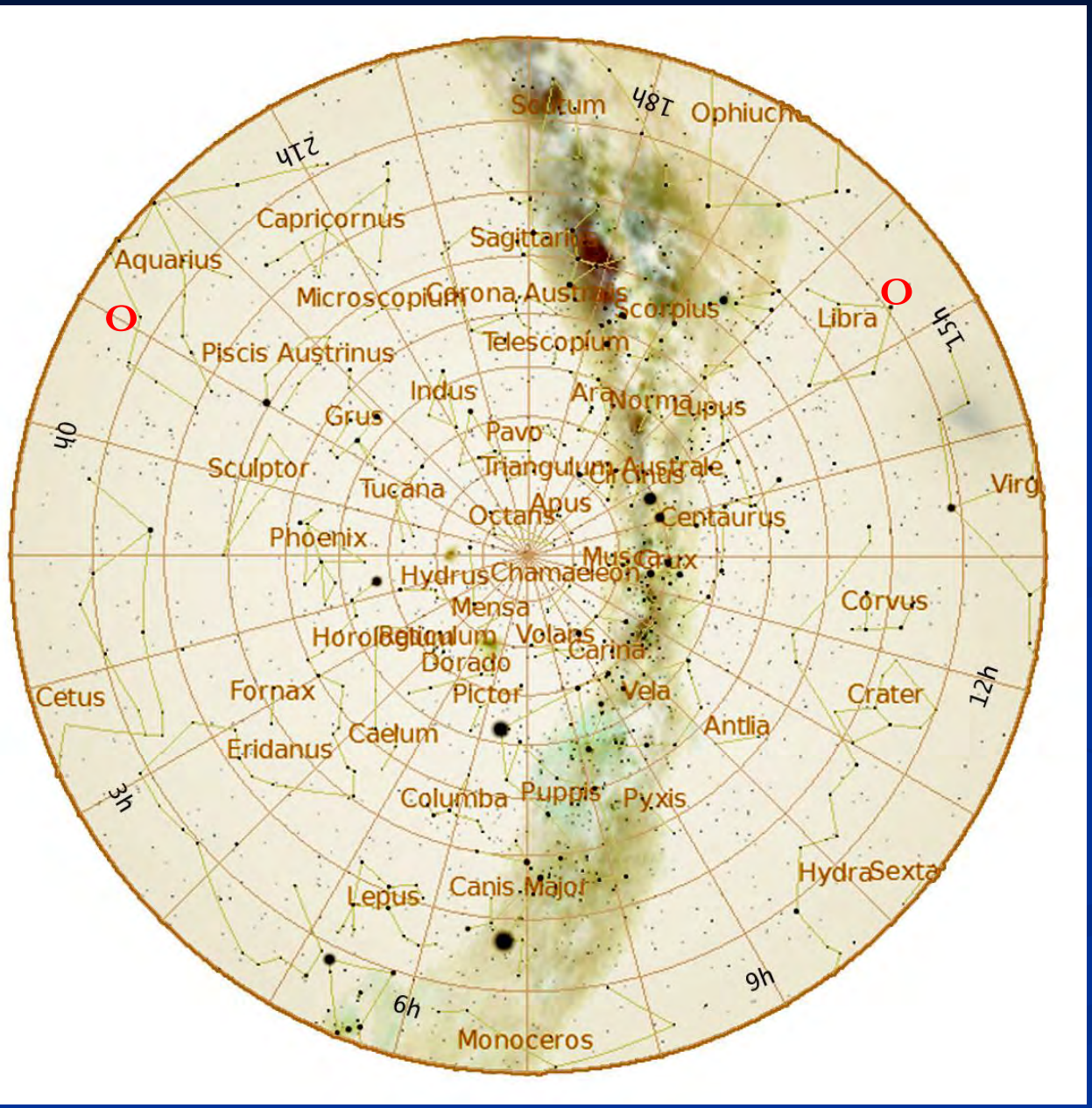


Kepler 62 (Lyra)
AR 18h 52m 51s
D +45º 20´59 ´´

If we cover it with the latitude window, we can see that the distance to the horizon (altitude) varies with the latitude window

如果我们用纬度窗口覆盖住星图，会发现恒星的高度随着纬度的不同发生变化

Ups And (Andromeda)
AR 1h 36m 48s
D +41º 24´20´´



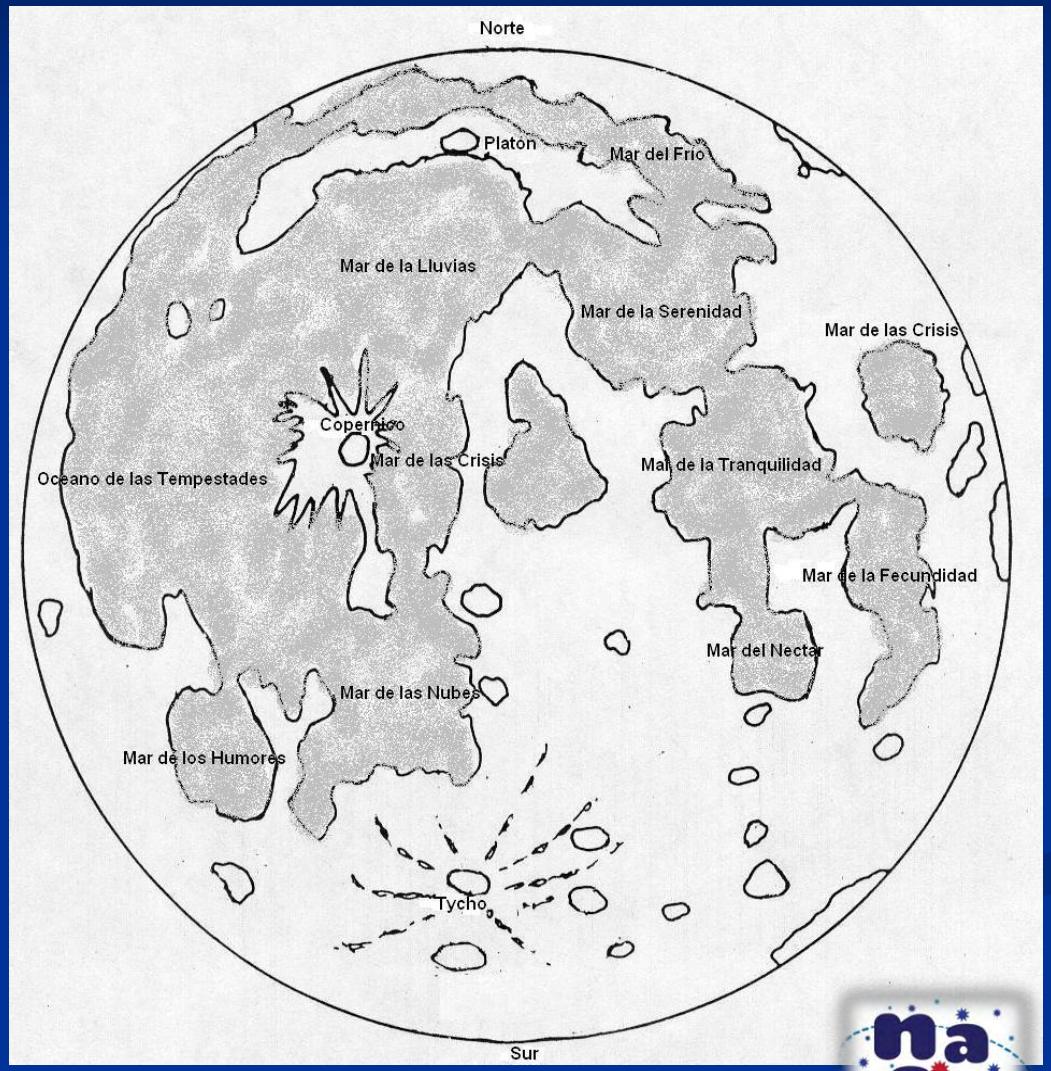
581 Gliese (Libra)
AR 15h 19m 26s
D -7º 43´20´´

Trappist 1 (Aquarius)
AR 23h 6m 29s
D -5º 2´28´´

6) Moon map 月面图

- To locate seas (maria), craters and ridges.
- 找出月海、环形山、山脉。

Activity 6: Start by identifying the maria
活动6：从认识月海开始



Activity 6: Continue to identify craters and other features

活动6：然后认识环形山和其他月貌特征

7) Spectroscope 光谱仪

- To display the spectrum of sunlight
- 展示太阳光谱

7) Spectroscope光谱仪

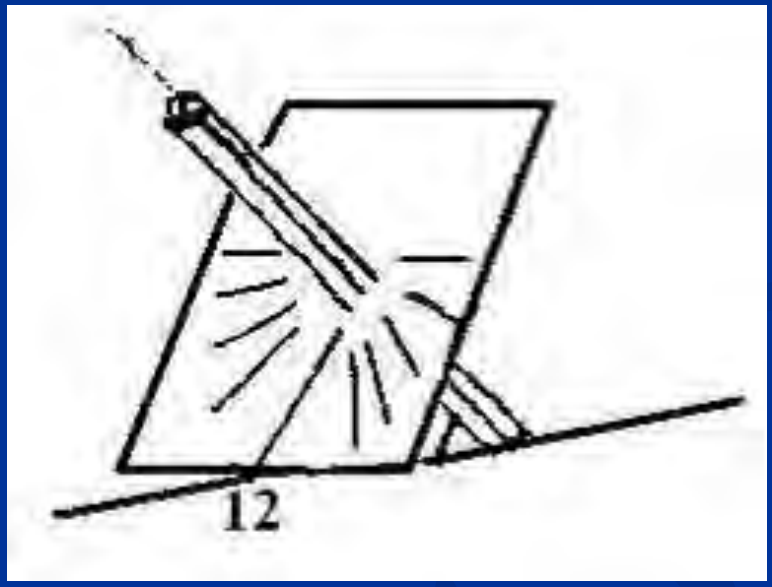
- Paint the inside the box black.
- 将盒子内壁涂黑。
- Cut a flap to look at the spectrum within the box.
- 剪出一块折页开口用于观察盒子内的光谱。
- Paste a piece of CD on the bottom inside the box (with the recorded area facing up).
- 在盒子内壁底部粘贴一小片CD（录制区域朝上）。

Activity 7: Close the box leaving only a slit open in the area opposite the viewer.
活动7：关闭盒子，只在观测点对面留下一条小缝隙

- To use the spectroscope with the Sun or the lights of the classroom.
- 使用光谱仪观察太阳或者教室里的灯光。
- Photograph of the solar spectrum.
- 拍摄太阳光谱照片。

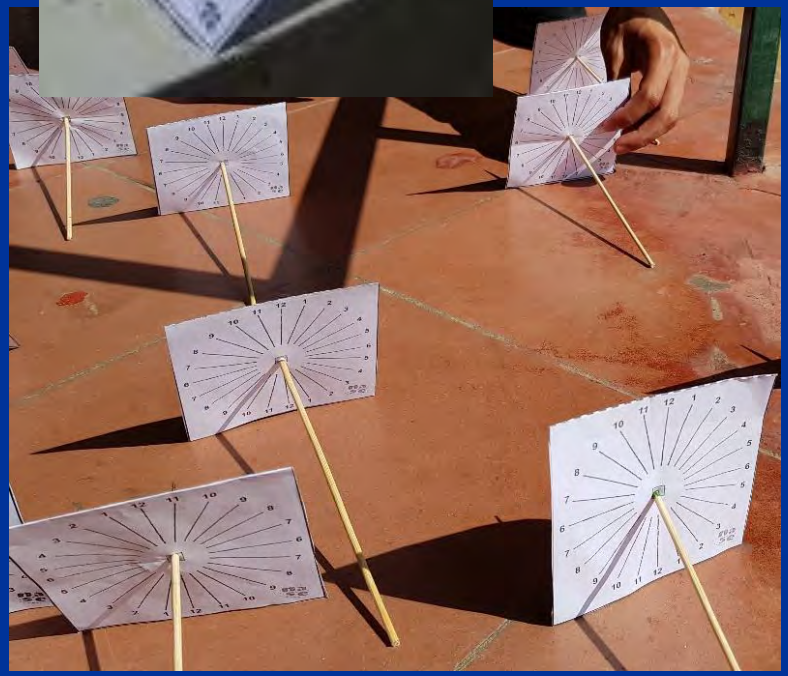
8) Equatorial sundial 赤道式日晷

- To determine the time.
- 测定时间。
- You need to use a compass to align the instrument in the North-South direction.
- 使用指南针为日晷确定南北向。
- Workshop Horizon and Sundials.
- 地平线工坊和日晷



Activity 8: To use the sundial with the corrections

活动7：使用日晷进行时间校正



Solar Time + Total Adjustment = wristwatch time

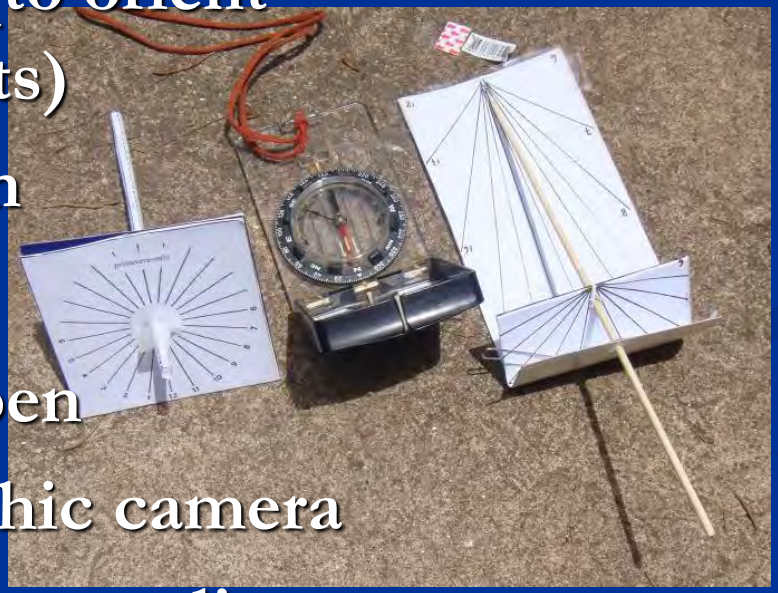
太阳时+总调整=手表时间

Total Adjustment:总调整

- Longitude Adjustment
- 经度调整
- Summer/winter Adjustment
- 冬夏调整
- ET Adjustment
- 时间等式调整

Activity 9: Supplementary material
Preparation of the briefcase
活动9：补充材料——为手提箱做准备

- Compass (to orient instruments)
- Wristwatch
- Notebook
- Pencil or pen
- Photographic camera
- Glasses to see eclipses
- Mobile
- Flashlight (red light)



- 指南针(确定方向的仪器)
- 手表
- 笔记本
- 铅笔或钢笔
- 照相机
- 观测日食专用的眼镜
- 手机
- 手电筒(红光)

Flashlight (red light) 红光手电

- Illuminate and study your maps before looking at real night sky.
- 在看真正的夜空之前，先研究一下你的星图。
- Light can disrupt observations.
- 光会干扰观测。
- You can attach red “cellophane” to your torch (or mobile phone) with adhesive tape.
- 你可以用胶带把红色的“玻璃纸”粘在你的手电筒(或手机)上，来做成红光手电。

Prepare the briefcase 准备公文包

- A bag-like folder and a bit of thick rope to make the handle.
- It is enough to make two cuts on the spine of the folder and insert the handle making after a couple of knots.
- 一个袋状的文件夹和一些粗绳子用来做提手。
- 只需在文件夹的书脊上切两个切口，然后在打几个结后插入手柄即可。

Conclusions 结论

- Is appropriate that students make their own instruments and use them in their organized briefcase 学员们能否正确制作并使用工具箱里的工具
- With this activity, students: 通过活动，学生可以：
  - gain confidence in their measurements 通过测量获得自信
  - take responsibility for their own instruments对自己的仪器负责
  - develop their creativity and manual skills开发自我动手能力和创造能力
  - understand the importance of systematic data collection了解系统地数据采集的重要性
  - facilitate their understanding of more sophisticated instruments
    帮助他们理解更为精密的仪器
  - recognize the importance of observation with the unaided eye, both in history and today.
    让他们理解历史上和现在，用肉眼观测的重要性

Thank you very much
for your attention!
谢谢！