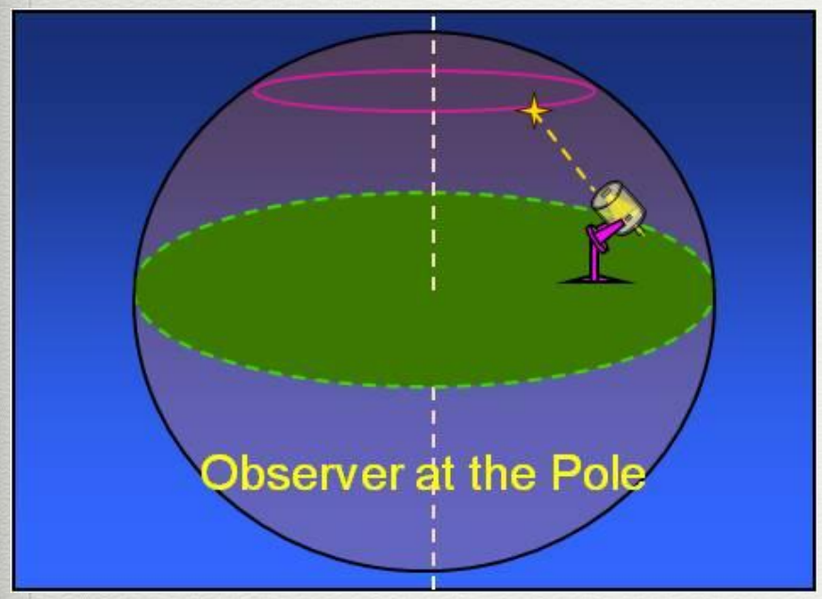
架設天文望遠鏡

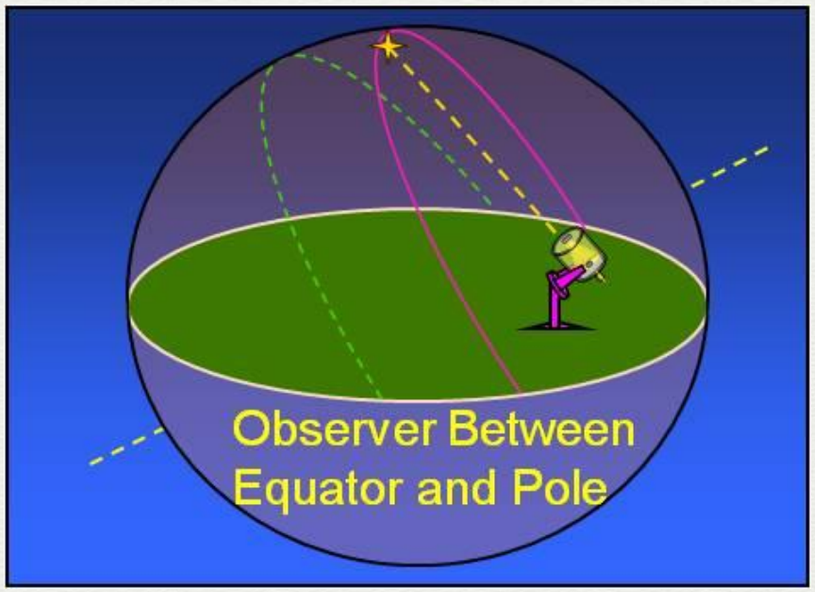
余甘楓

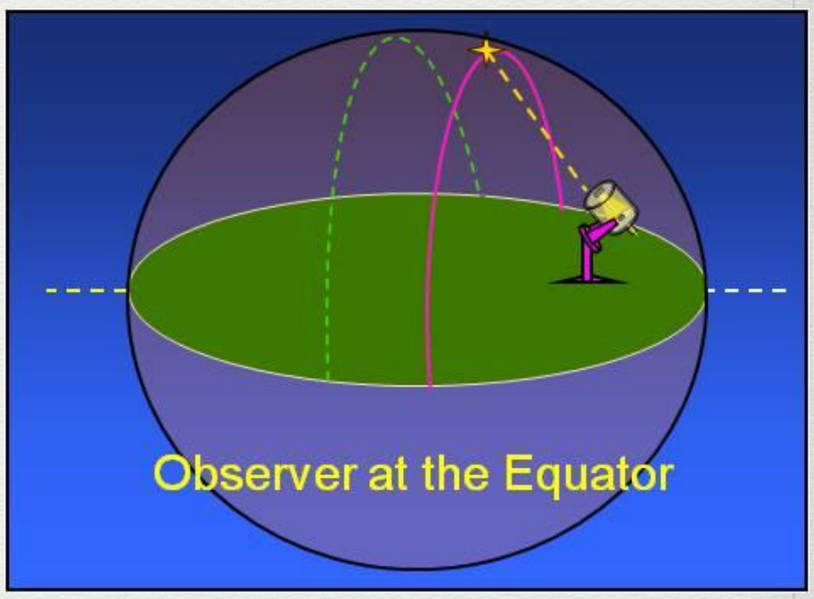
Simulation

- Moon Phase
  https://www.youtube.com/watch?v=wz01pTvuMa0
- Seasons and Ecliptic Simulator
  http://astro.unl.edu/naap/motion1/animations/seasons_ecliptic.html

Motion of Stars



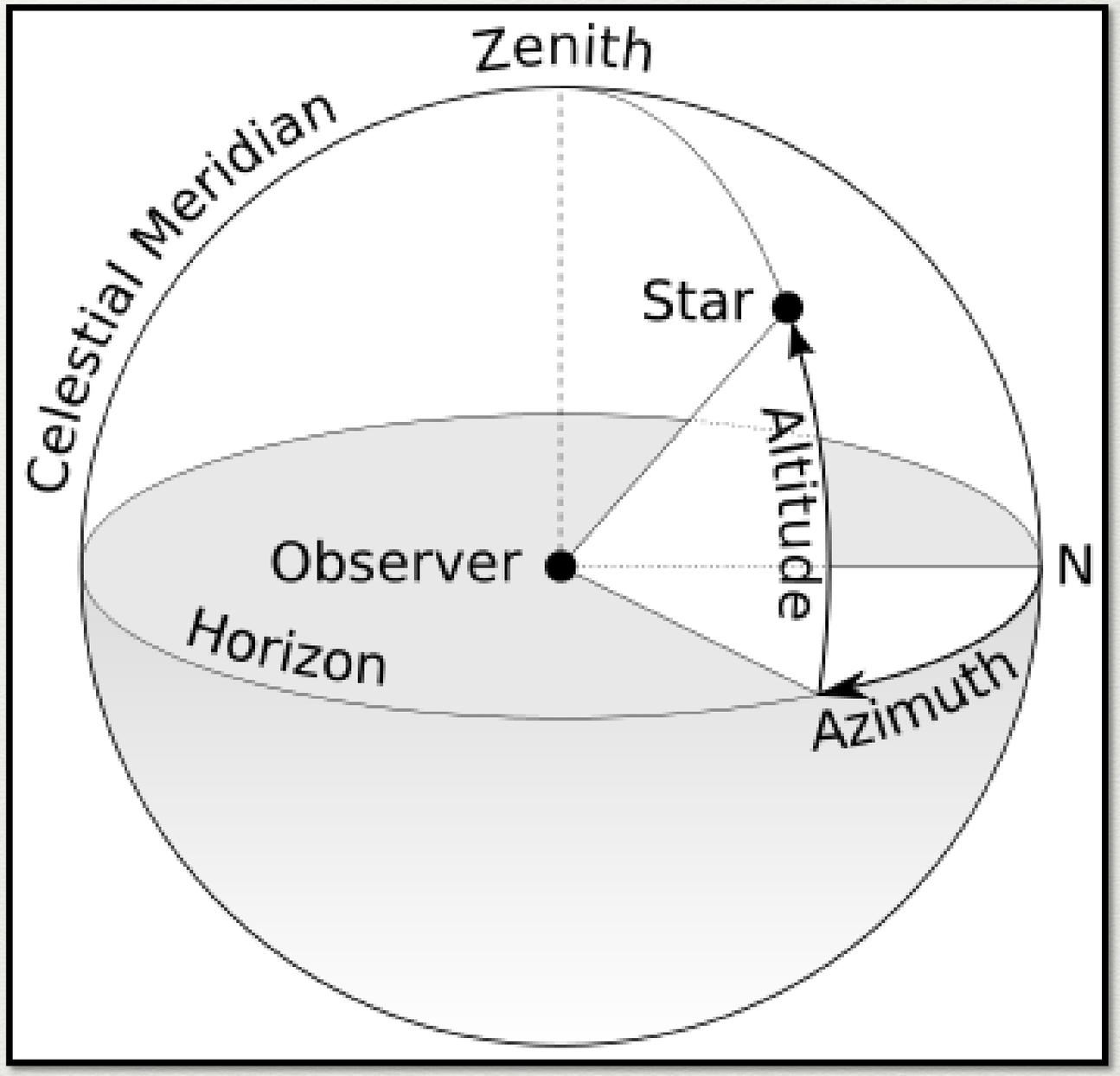




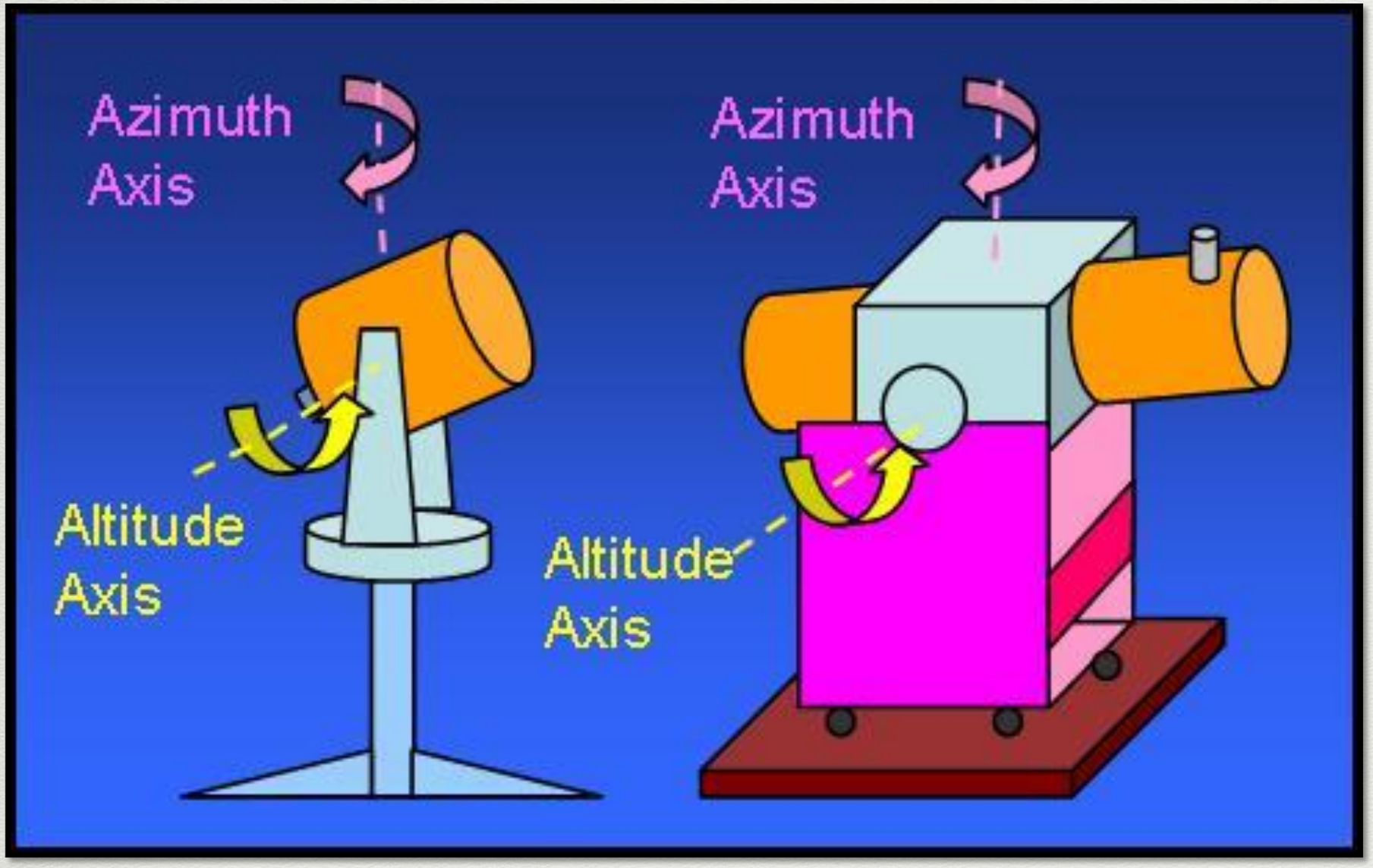
- Rotating Sky Explorer
  http://astro.unl.edu/naap/motion2/animations/ce_hc.html

Horizontal Coordinate System (地平坐標系統)

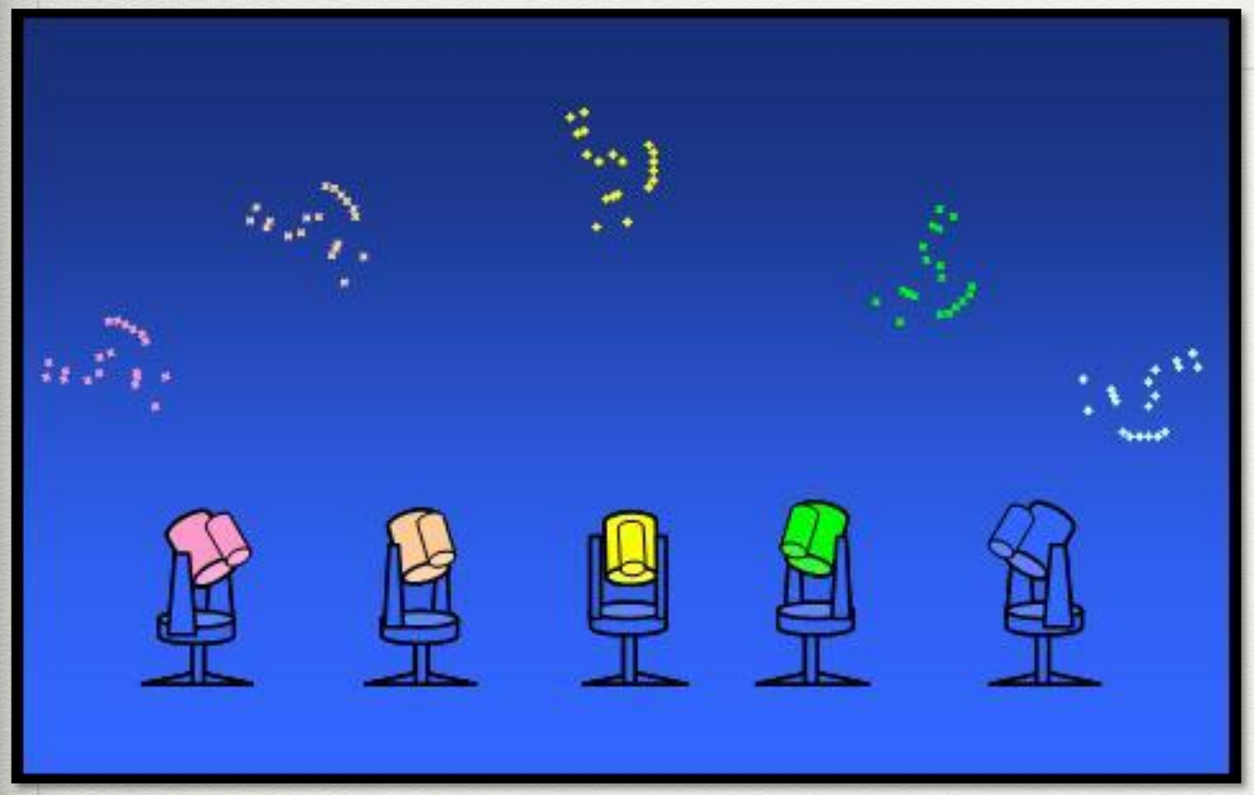
- Altitude(高度)
- Azimuth (方位)

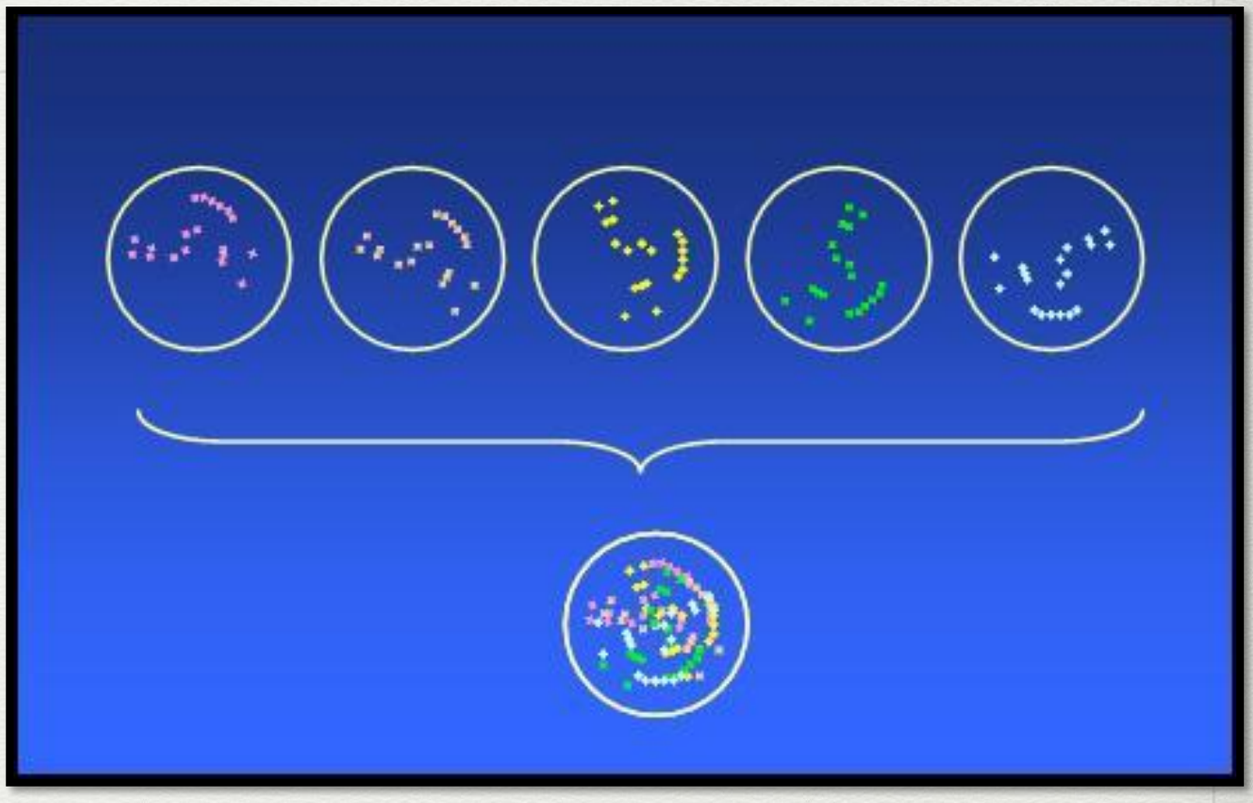


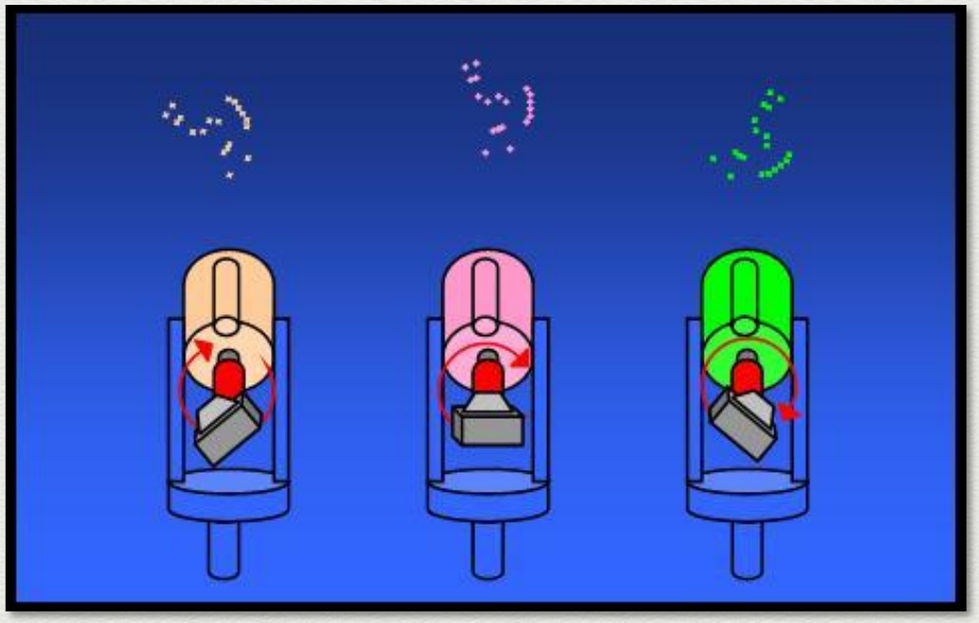
Altazimuth Mount(經緯儀)



Field Rotation

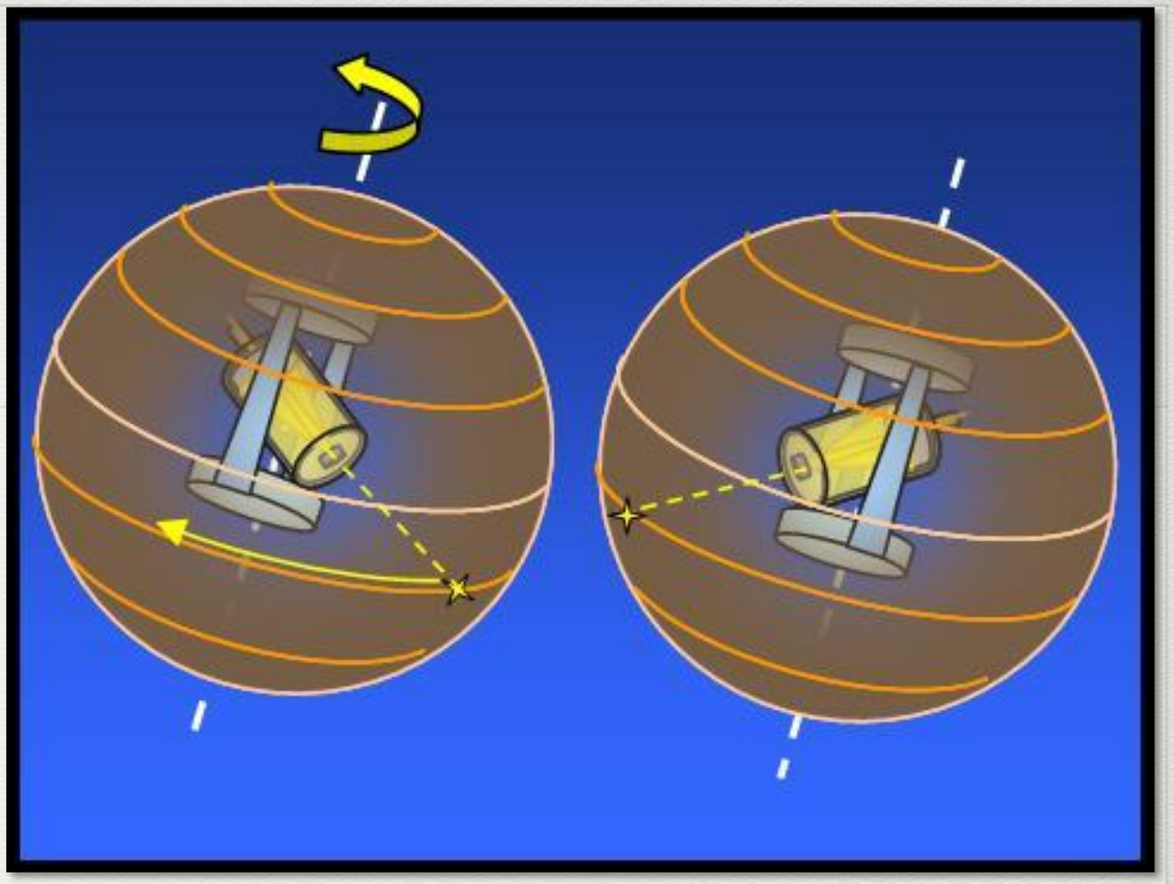


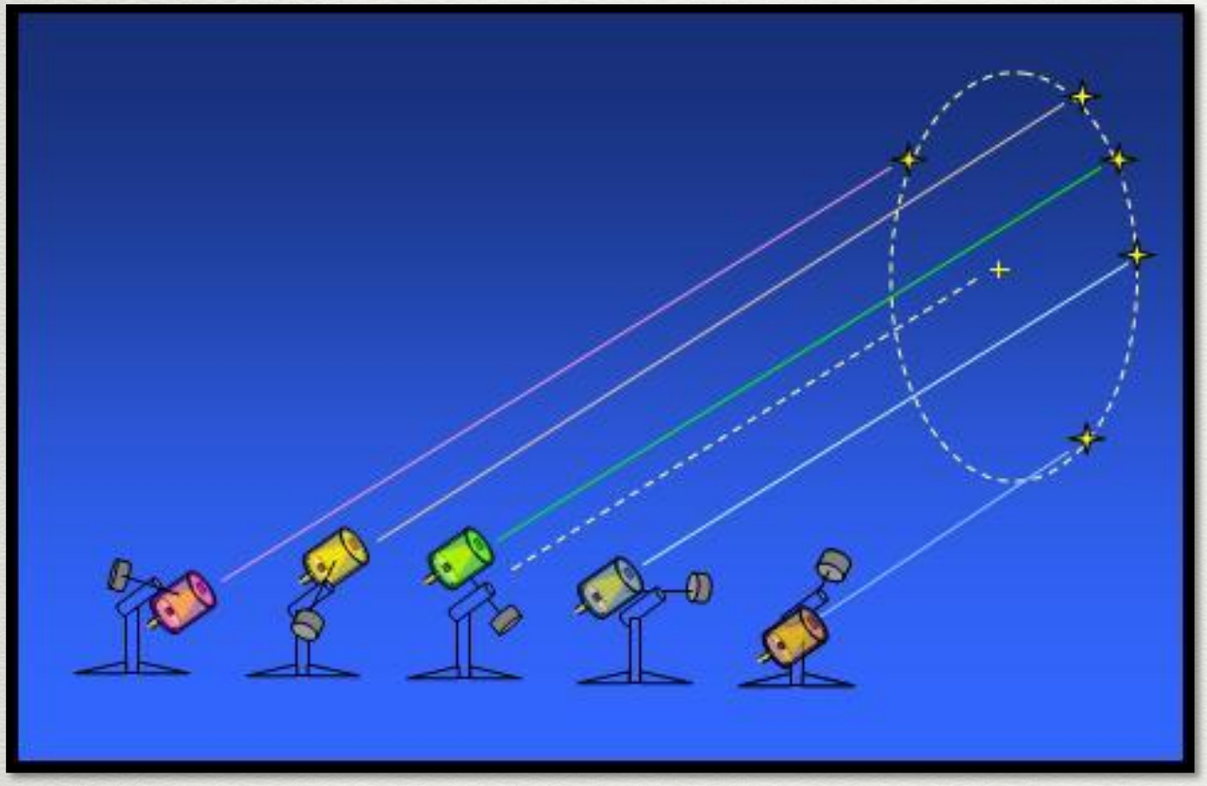


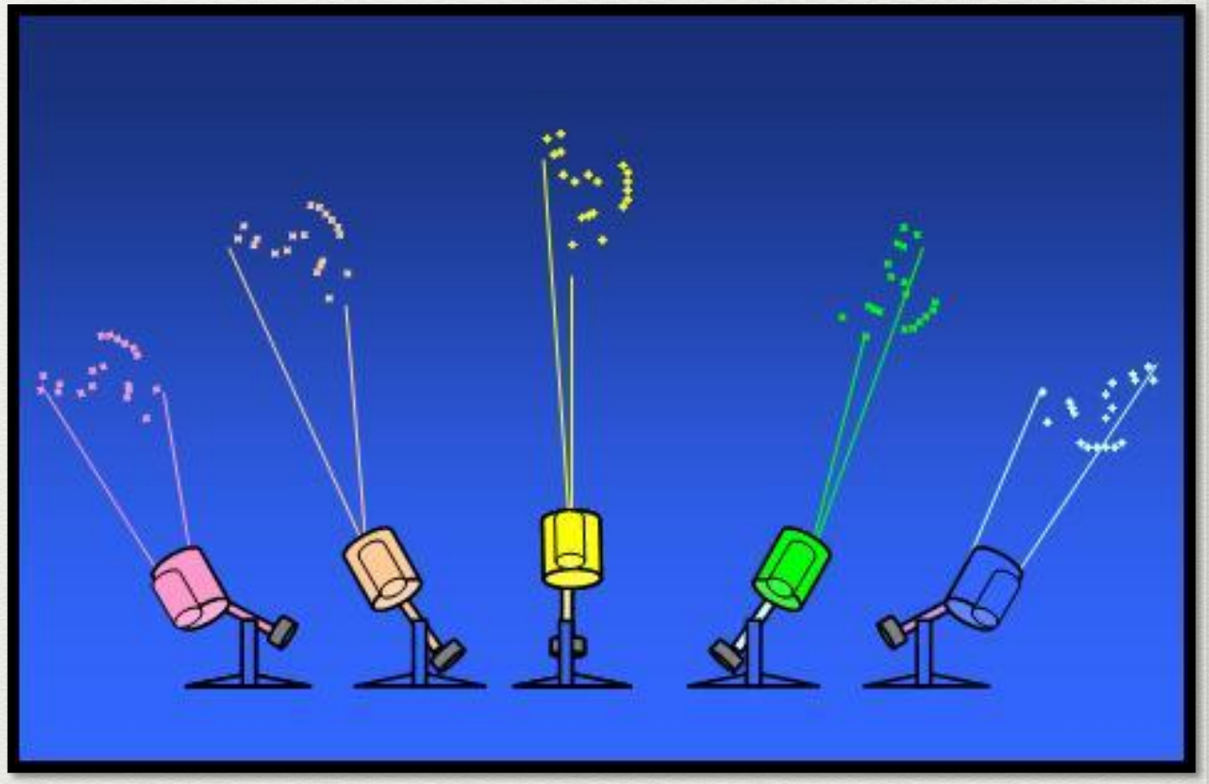


- https://themcdonalds.net/richard/wp/astrophotography-field-rotation/

Equatorial Tracking





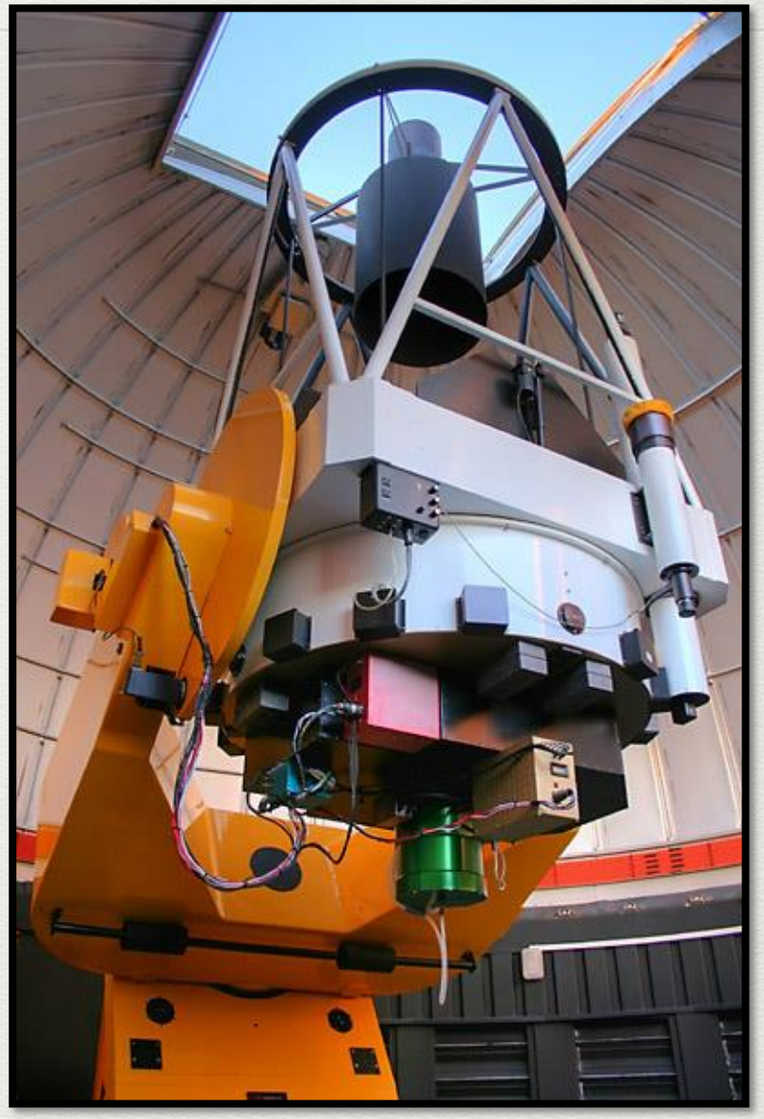


- https://themcdonalds.net/richard/wp/astrophotography-field-rotation/

Equatorial Mount (赤道儀)

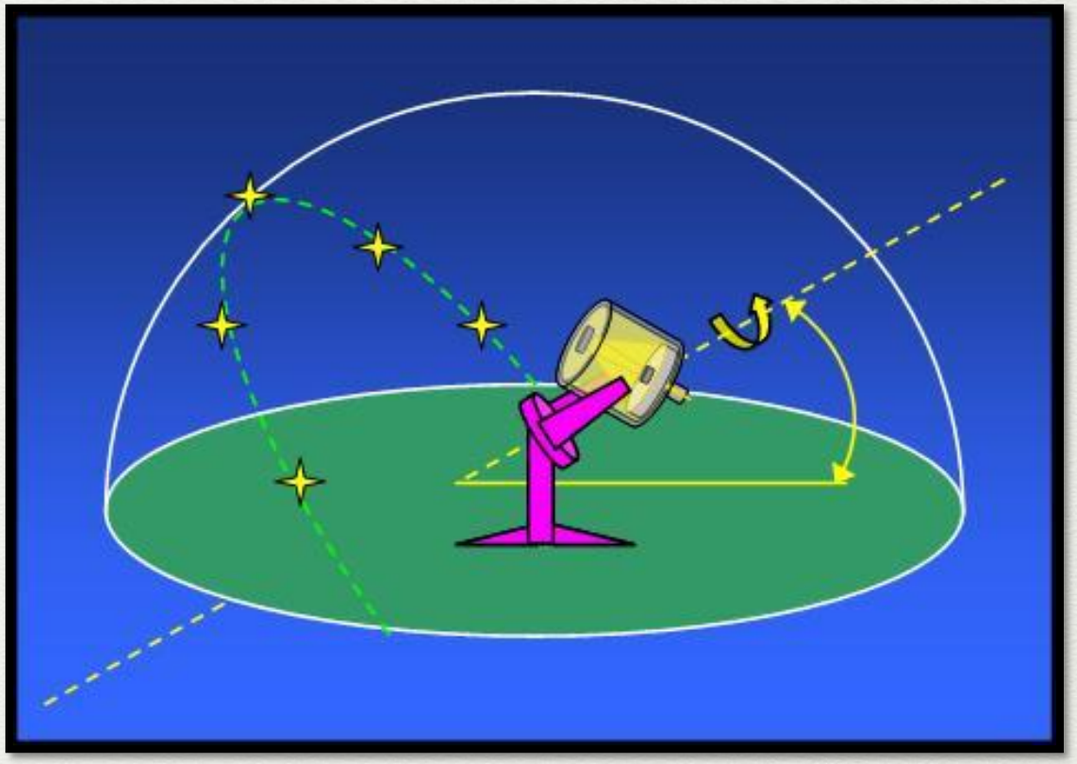
German
(德式)

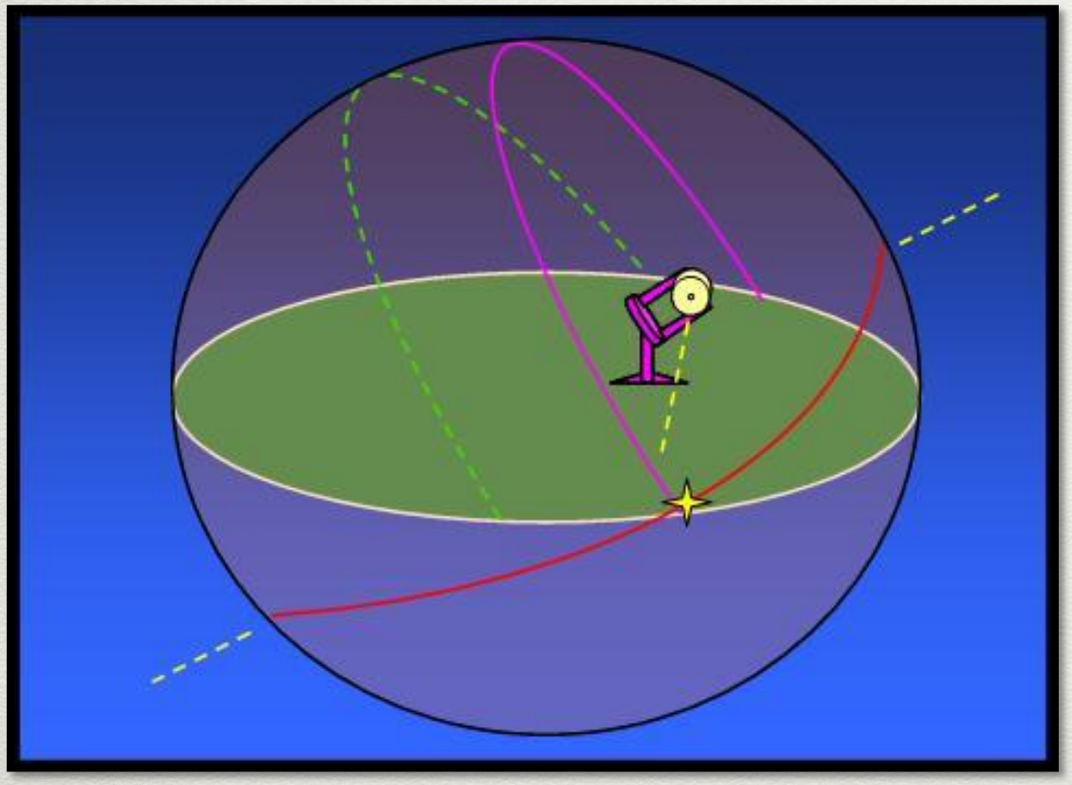
English Cross Axis
(英國十字軸式)

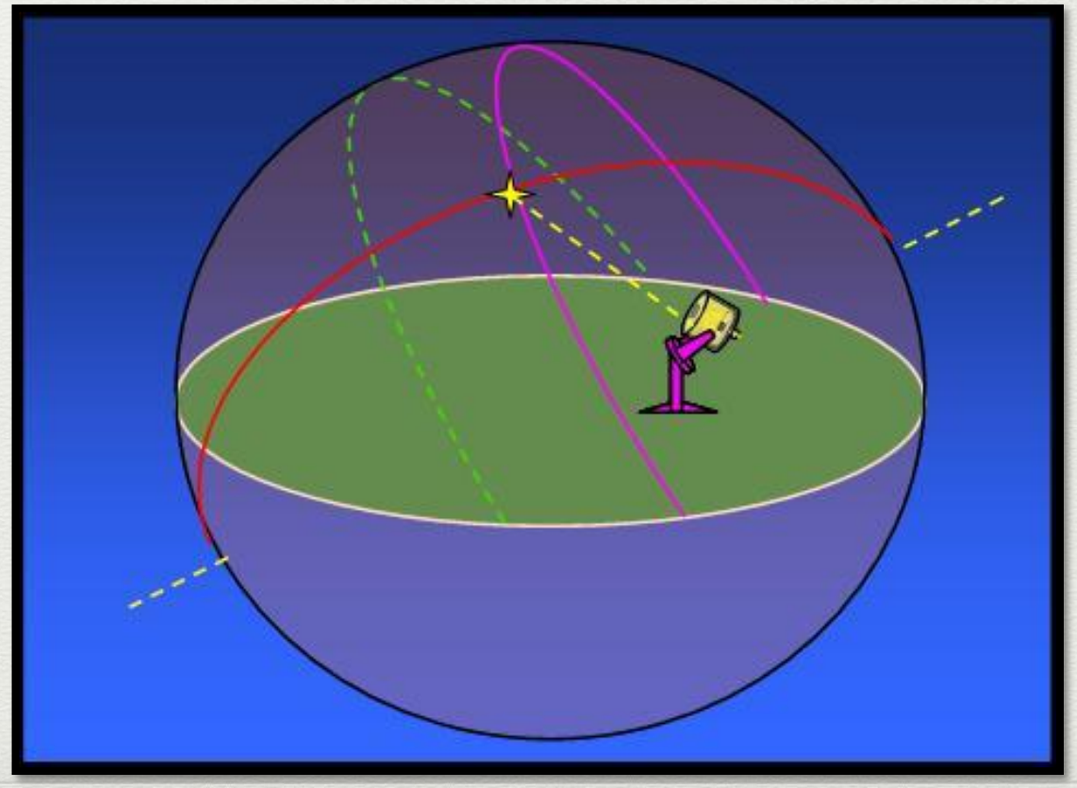


Open Fork
(開放叉式)

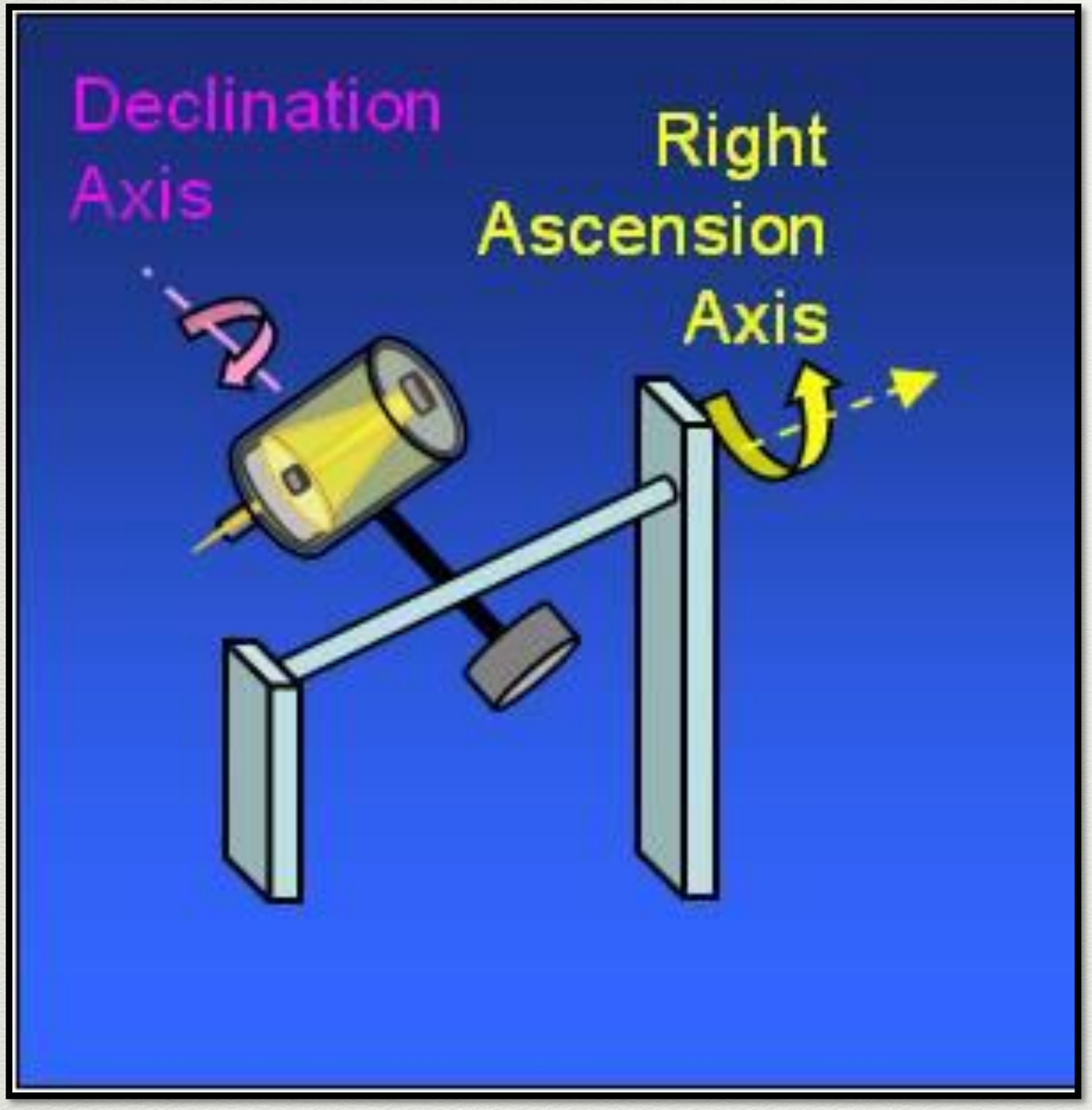
Equatorial Fork Mount叉式赤道儀



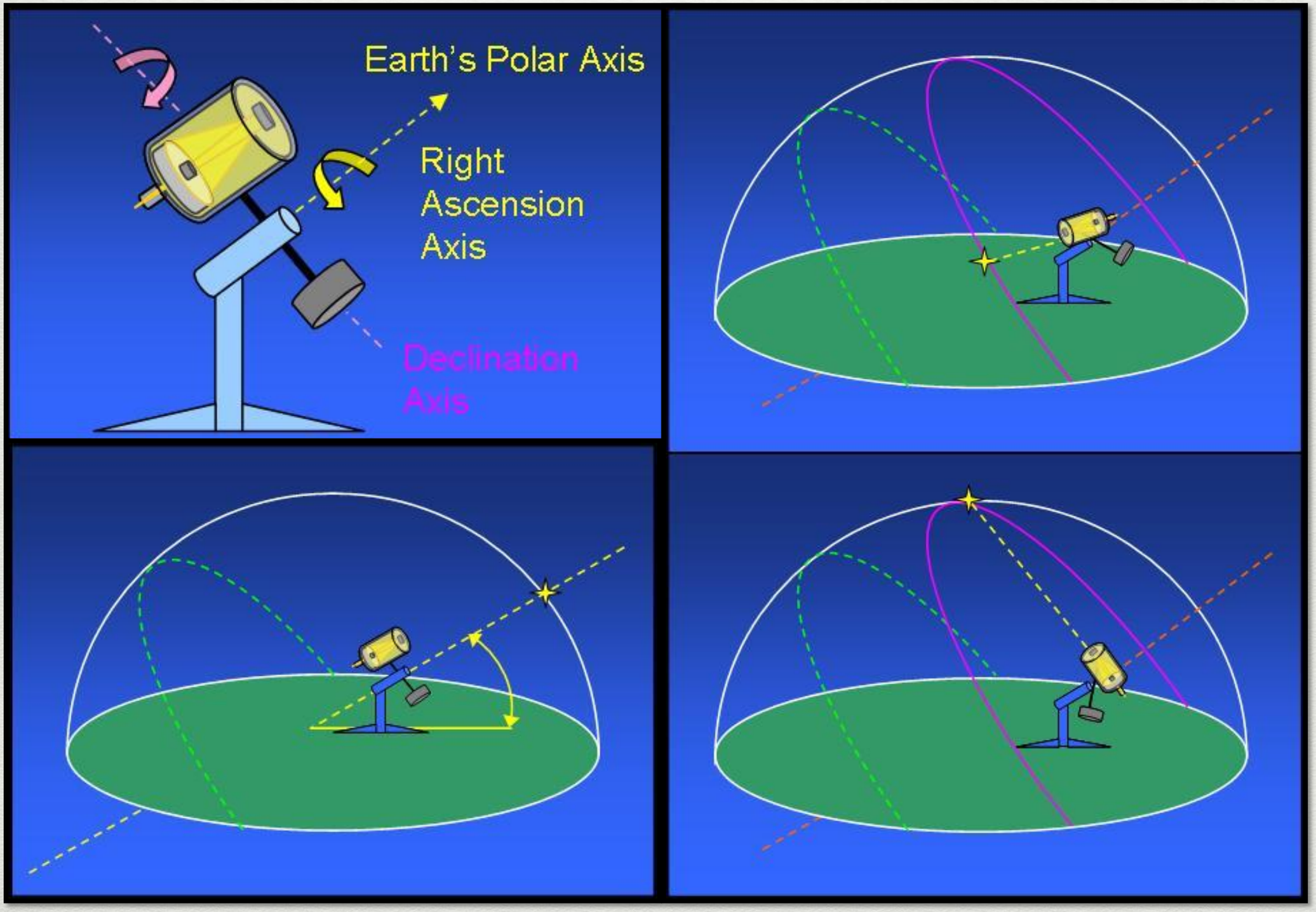




English Cross Axis Mount
英國十字軸式赤道儀

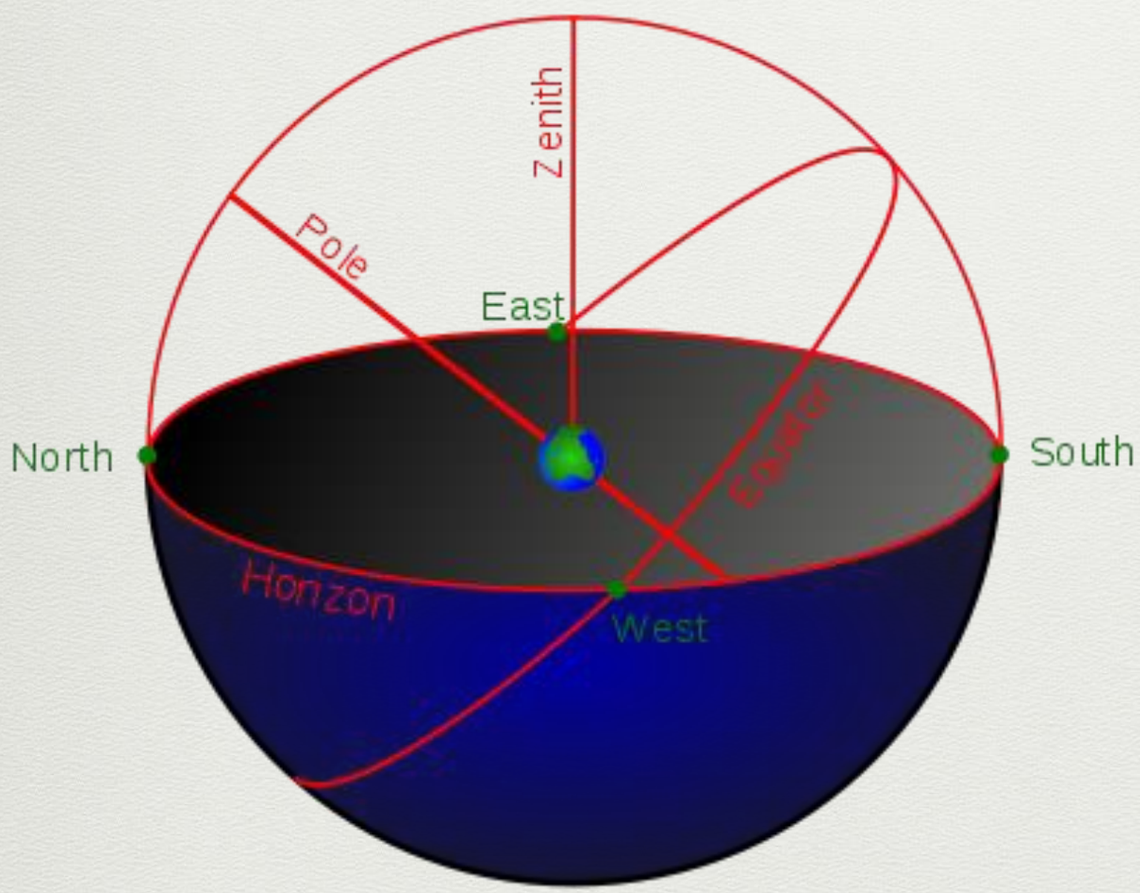


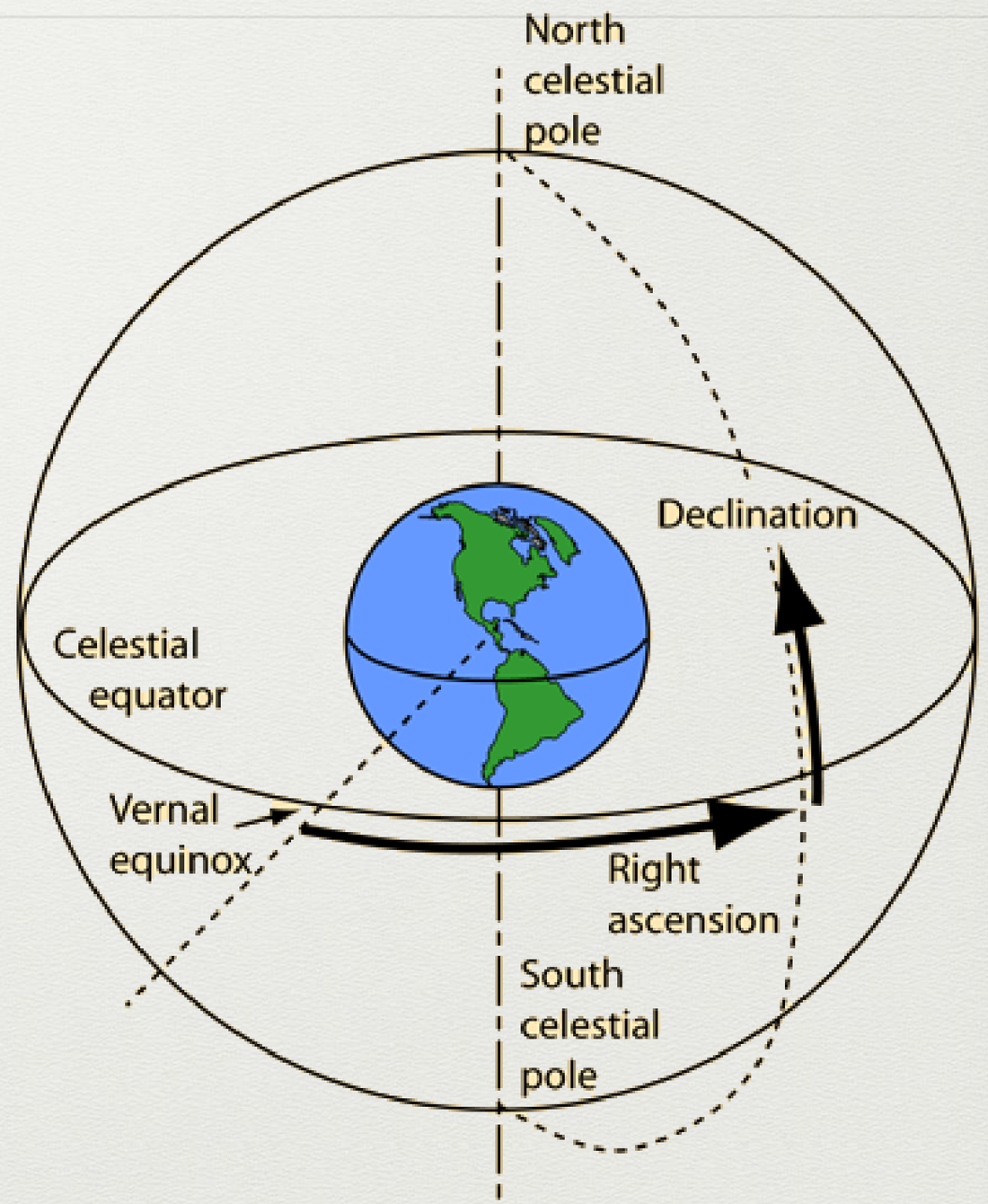
German Equatorial Mount
德式赤道儀



Equatorial coordinate system (赤道坐標系統)

- Right Ascension(赤經)
- Declination (赤緯)





http://astro.unl.edu/naap/motion2/animations/ce_hc.html

Reference

- **Telescope Mounts and Celestial Tracking Tutorial** http://www.astronomyasylum.com/telescopemountstutorial.html

- 組裝赤道儀及對極軸：
  https://youtu.be/oXgtGQq-3V0

- 安裝及平衡望遠鏡：
  https://youtu.be/UtZEgMOwFeU

- 對尋星鏡及主鏡：
  https://youtu.be/waPj5AkXirs

深空天體
Deep Sky Objects

深空天體簡介

梅西耶
(Charles Messier)

- 18世紀天文學家
- 彗星獵人
- 110個

深空天體的分類

星雲 Nebula

星團 Star Cluster

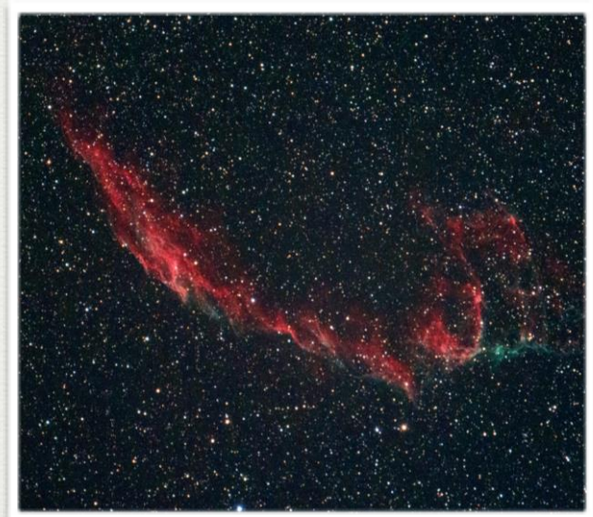
星系Galaxy

- 深空天體泛指非太陽、月球、行星、彗星、小行星及個別恆星的天體。
- 大多深空天體暗淡，甚至肉眼在望遠鏡輔助下也難以看見。

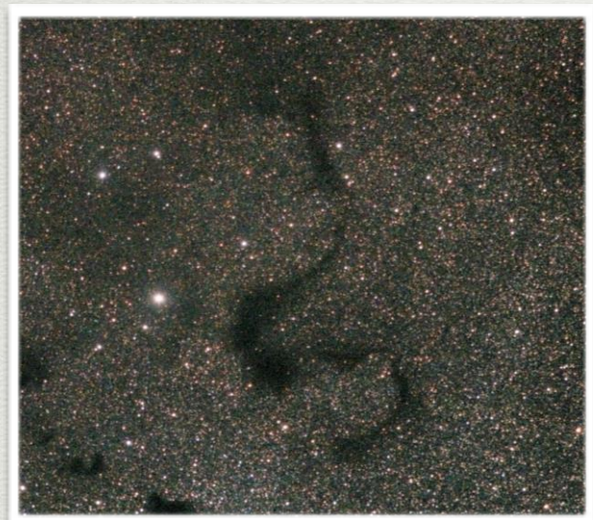
星雲 Nebula

發射星雲

反射星雲



超新星殘骸



暗星雲

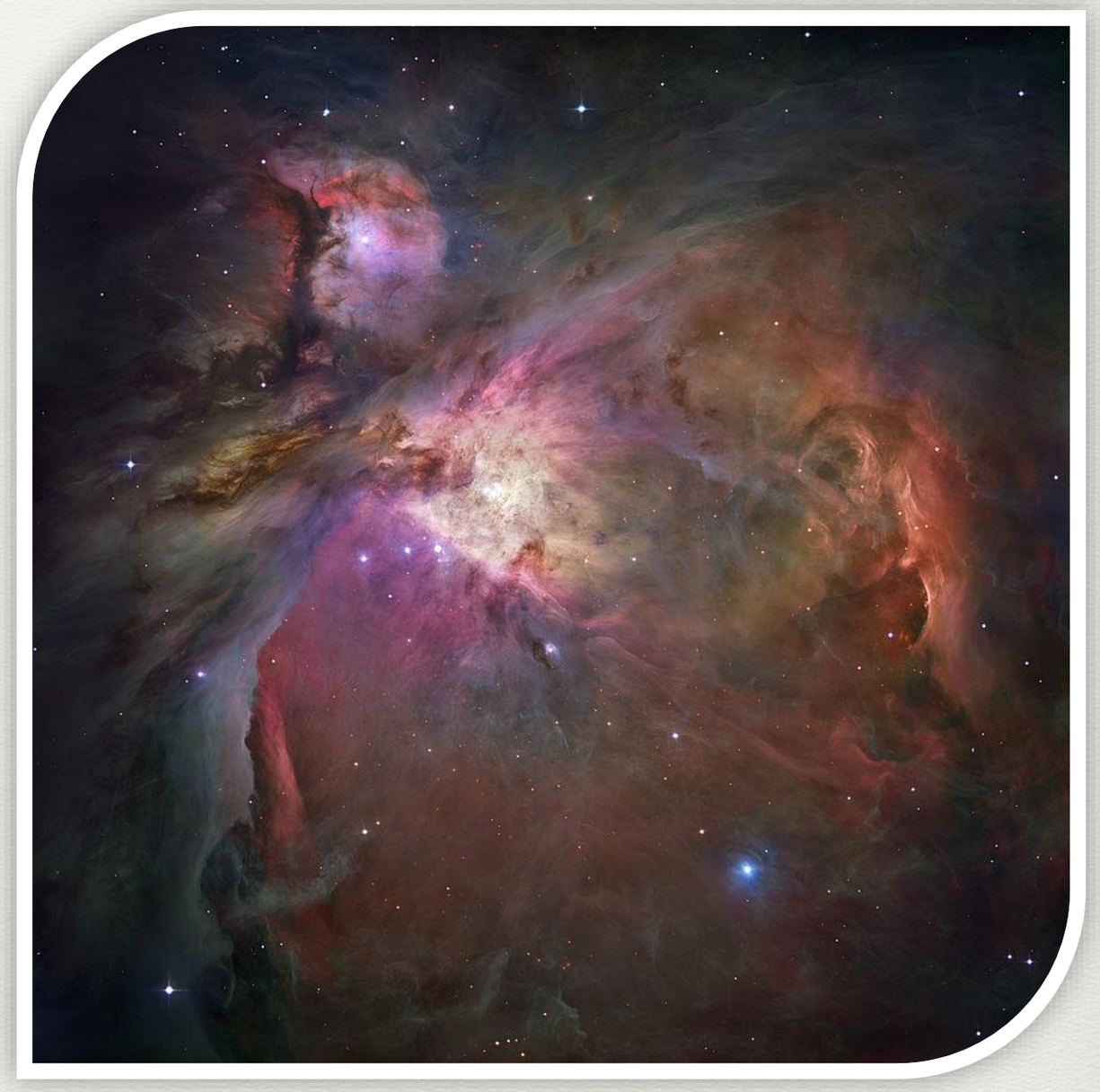
行星狀星雲

Planetary Nebula : Courtesy ESO
http://www.eso.org/public/images/eso9846a/

發射星雲 (Emission Nebula)

- 年輕熱星
- 輻射出各種不同色光的電離氣體雲

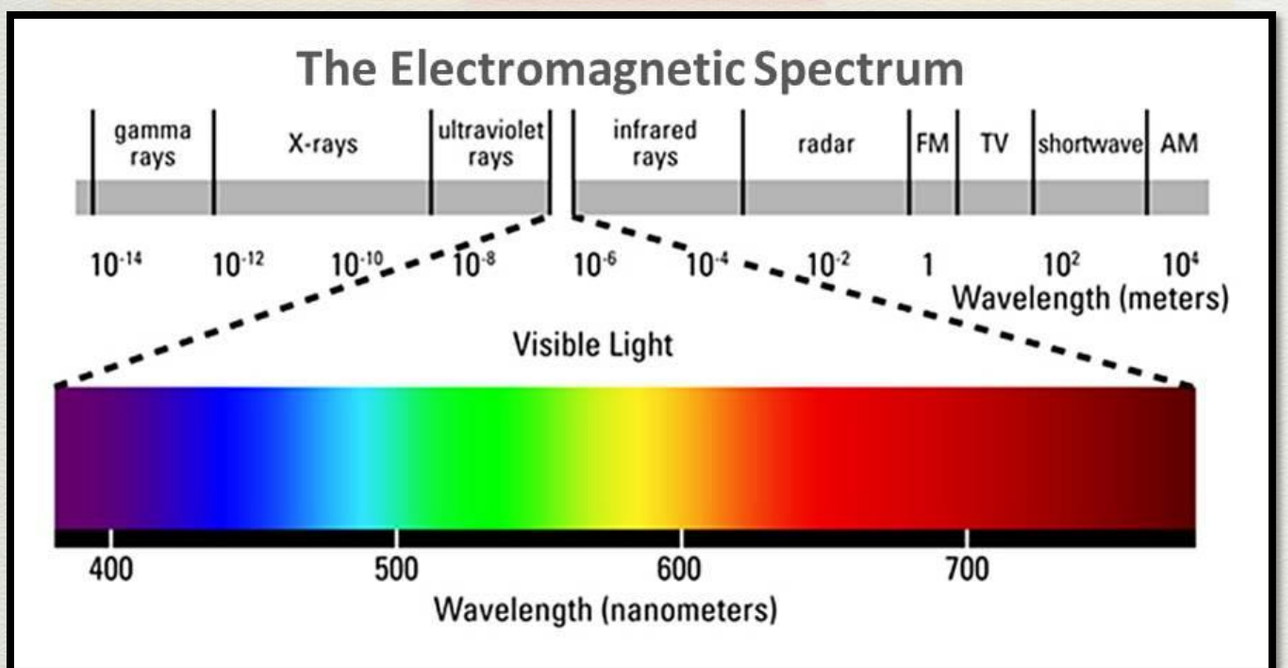
M42 獵戶座大星雲

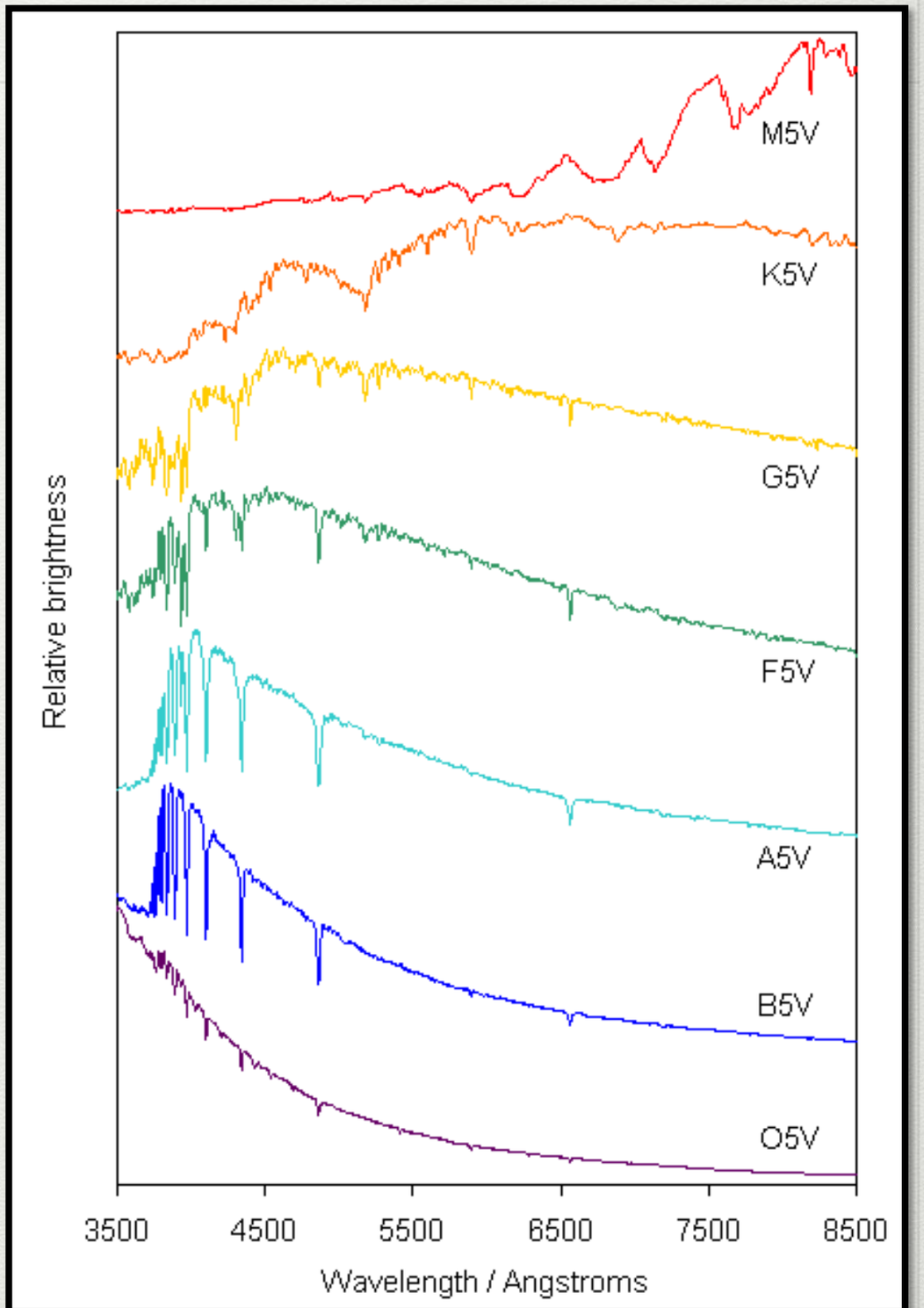


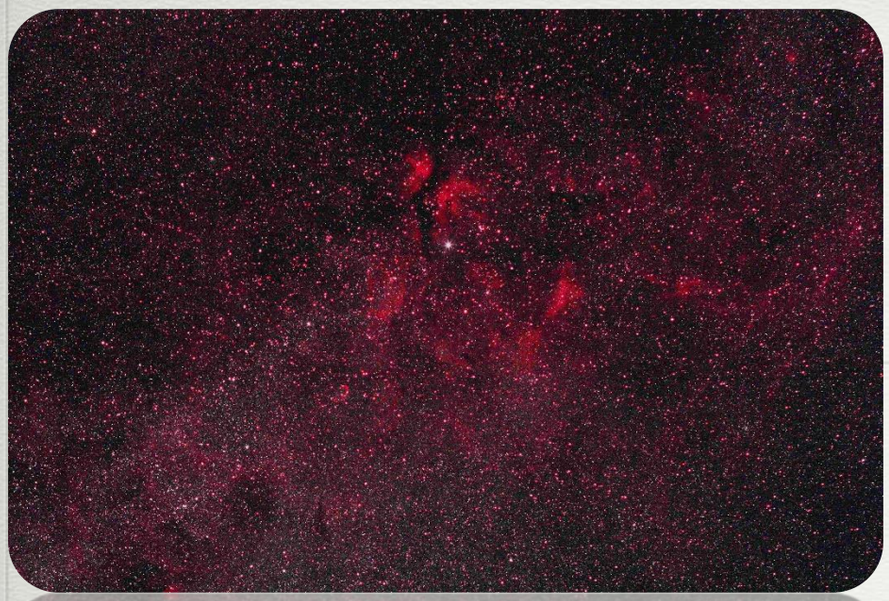
Courtesy NASA/ESA
http://hubblesite.org/newscenter/newsdesk/archive/releases/2006/01/

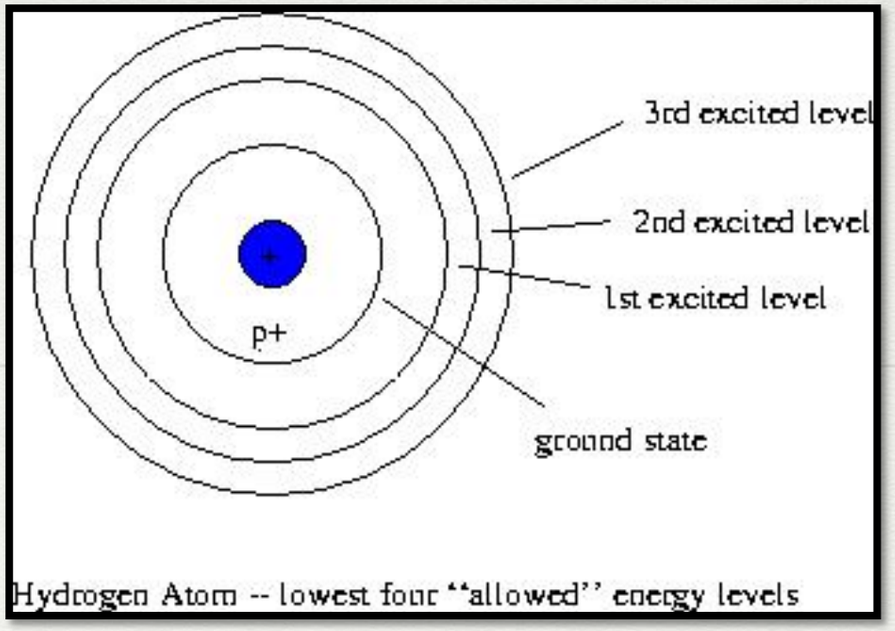
Oh Be A Fine Girl Kiss Me

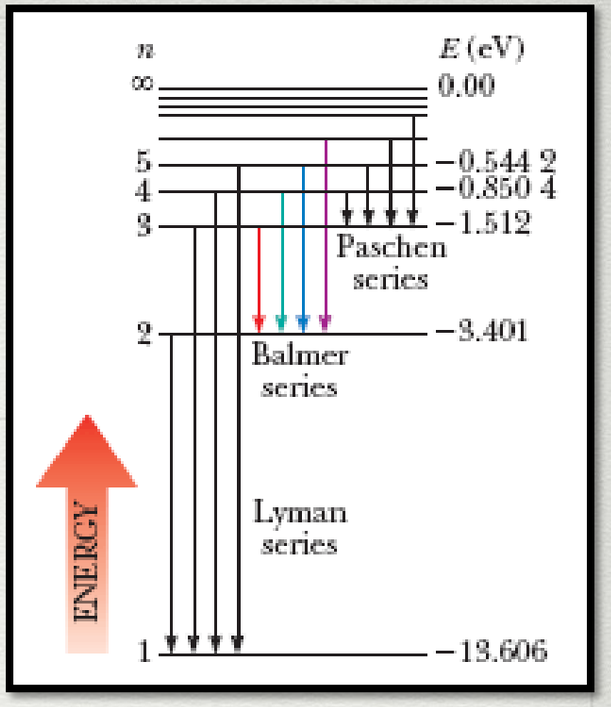
Class	Temperature (kelvins)	Conventional color	Apparent color
O	≥ 33,000 K	blue	blue
B	10,000–30,000 K	blue to blue white	blue white
A	7,500–10,000 K	white	white to blue white
F	6,000–7,500 K	yellowish white	white
G	5,200–6,000 K	yellow	yellowish white
K	3,700–5,200 K	orange	yellow orange
M	≤ 3,700 K	red	orange red

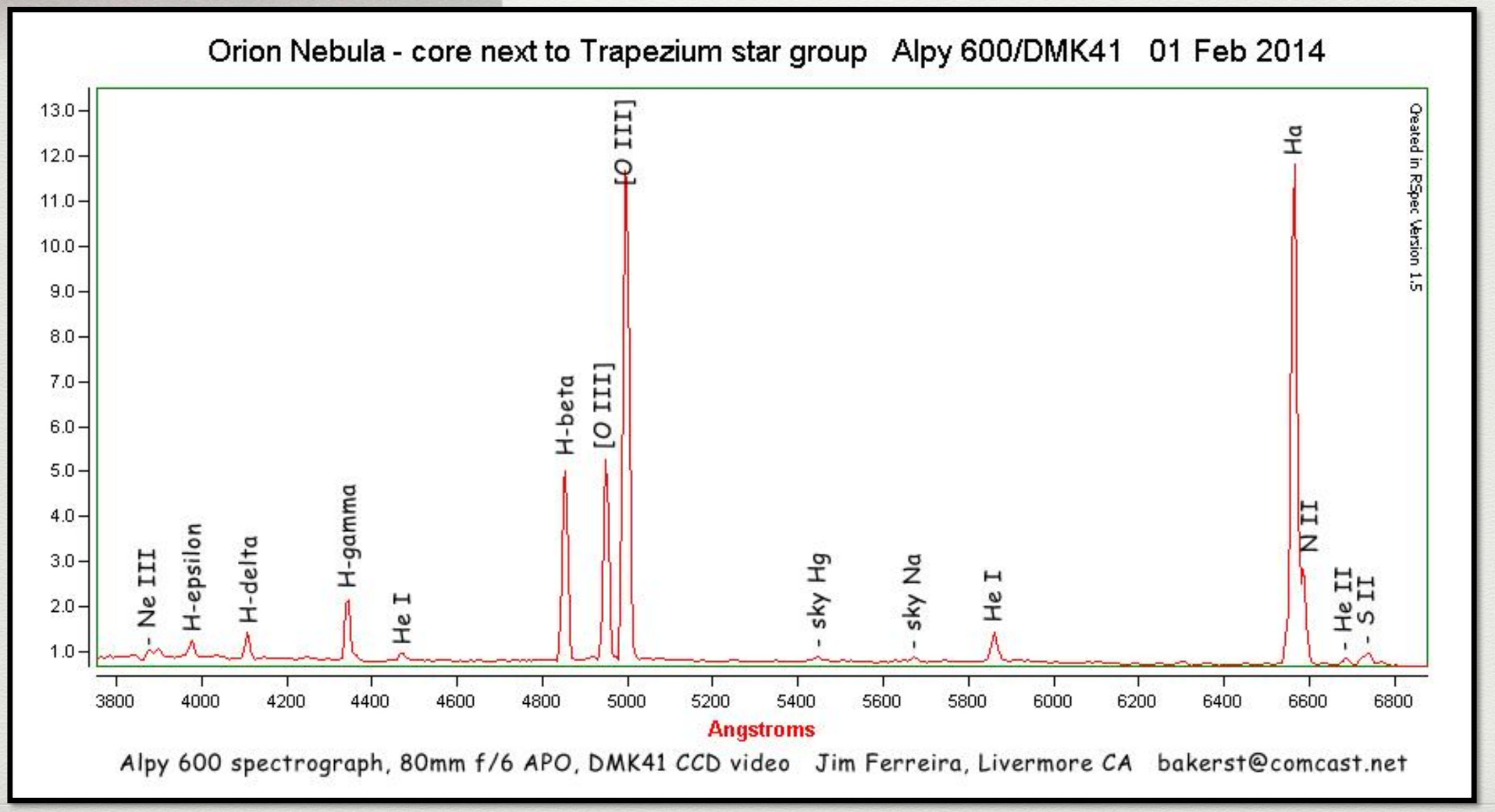







3rd excited level
2nd excited level
1st excited level
ground state
p+
Hydrogen Atom -- lowest four "allowed" energy levels


n
E (eV)
∞
0.00
5
−0.544 2
4
−0.850 4
3
−1.512
Paschen series
2
−3.401
Balmer series
Lyman series
1
−13.606
ENERGY


Orion Nebula - core next to Trapezium star group Alpy 600/DMK41 01 Feb 2014
Ne III
H-epsilon
H-delta
H-gamma
He I
H-beta
[O III]
[O III]
- sky Hg
- sky Na
He I
Hα
N II
He II
S II
Created in RSpec Version 1.5
Angstroms
Alpy 600 spectrograph, 80mm f/6 APO, DMK41 CCD video Jim Ferreira, Livermore CA bakerst@comcast.net

反射星雲(Reflection Nebula)

M78 星雲(光之星雲)

- 本身不發光
- 反射來自鄰近恆星的光

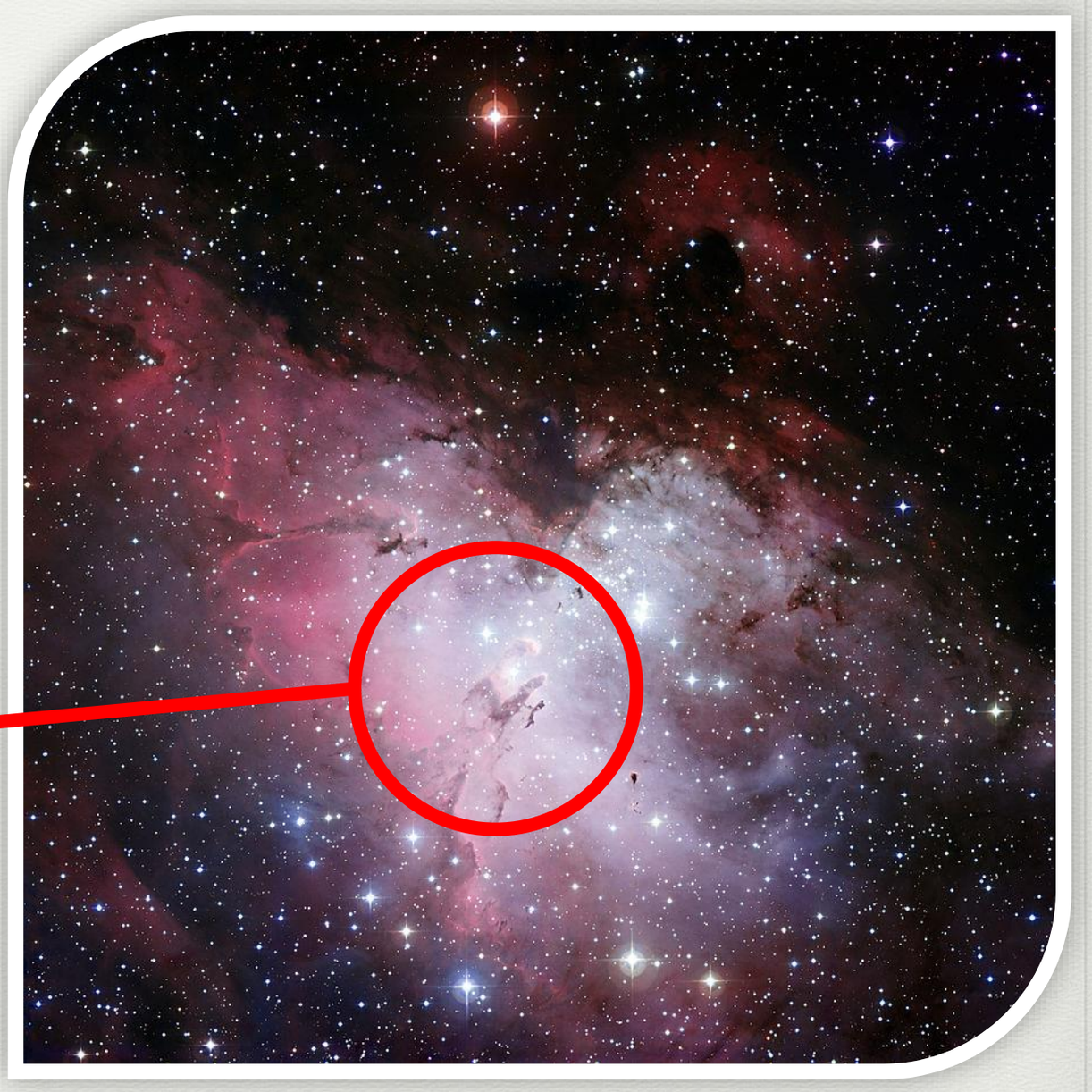
Courtesy ESO/Igor Chekalin
http://www.eso.org/public/images/eso1105a/

Class	Temperature (kelvins)	Conventional color	Apparent color
O	≥ 33,000 K	blue	blue
B	10,000–30,000 K	blue to blue white	blue white
A	7,500–10,000 K	white	white to blue white
F	6,000–7,500 K	yellowish white	white
G	5,200–6,000 K	yellow	yellowish white
K	3,700–5,200 K	orange	yellow orange
M	≤ 3,700 K	red	orange red

暗星雲 (Dark Nebula)

- 較亮恆星或星雲背景上的暗黑剪影
- 吸掉來自其後面遠方天體發的光

M16 鷹星雲



Courtesy NASA/ESA/Hubble Heritage Team
http://hubblesite.org/newscenter/archive/releases/2015/01/image/c/warn/

行星狀星雲(Planetary Nebula)

- 恆星在生命末期時拋射出的離子態氣體膨脹
- 形成發光外殼的一種發射星雲

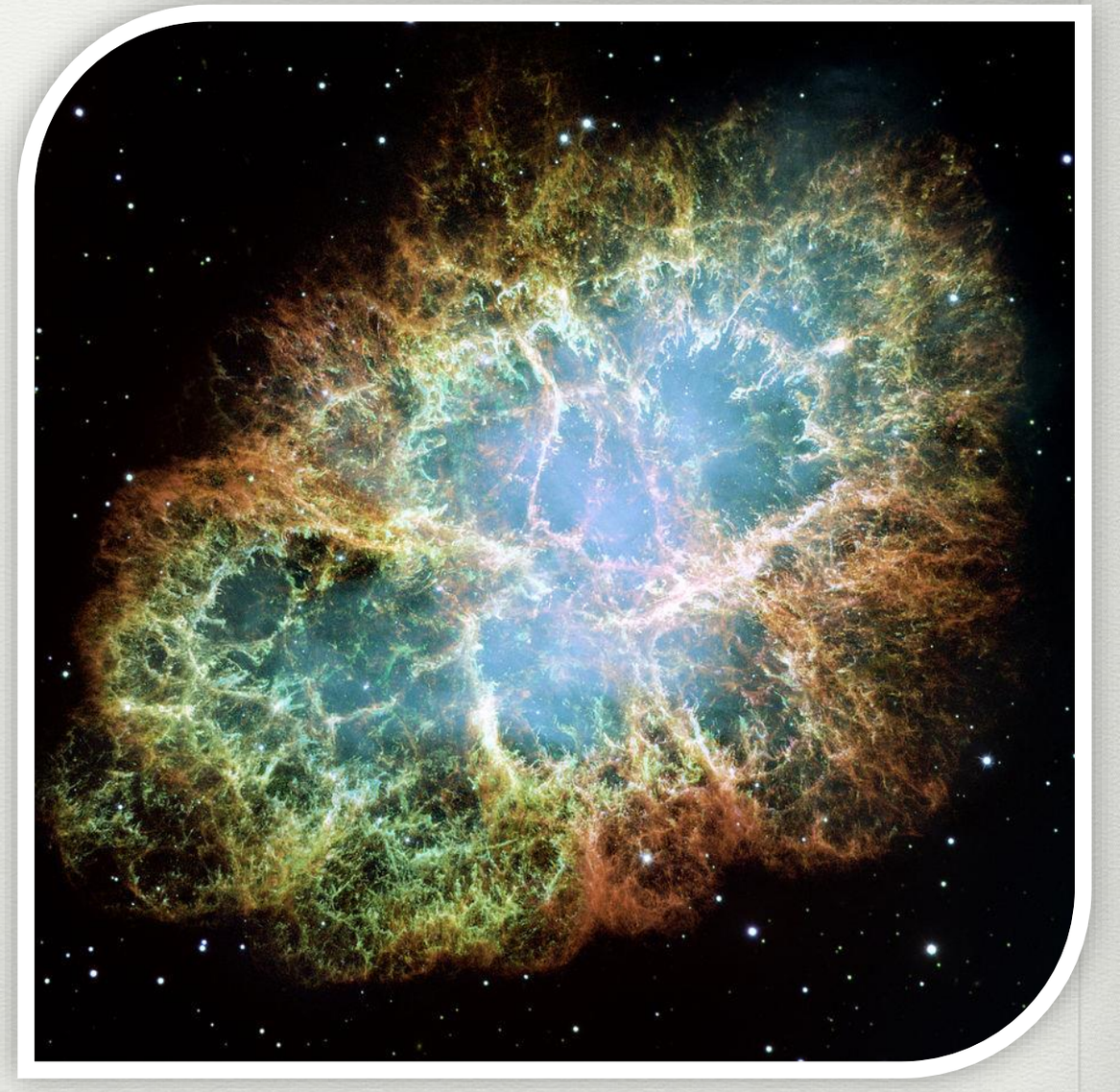
M57 戒指星雲

Courtesy The Hubble Heritage Team (AURA/STScI/NASA)
http://hubblesite.org/newscenter/archive/releases/1999/01/image/a/

超新星殘骸(Supernova)

- 是超新星爆發時拋出的物質在向外膨脹
- 在這過程中與星際介質相互作用

M1 蟹狀星雲

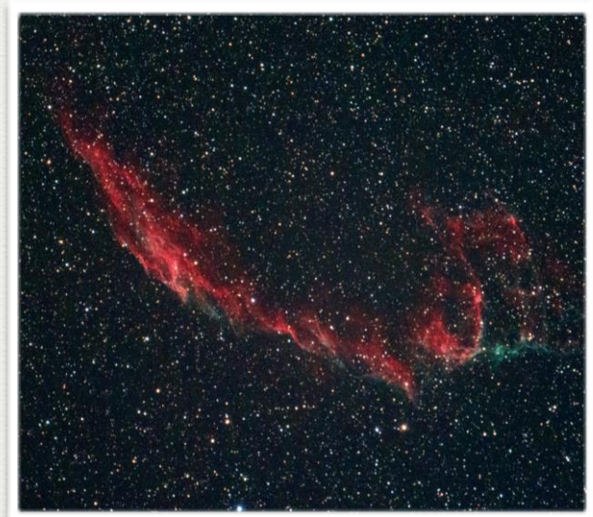


Courtesy NASA/ESA/J. Hester and A. Loll
(Arizona State University)

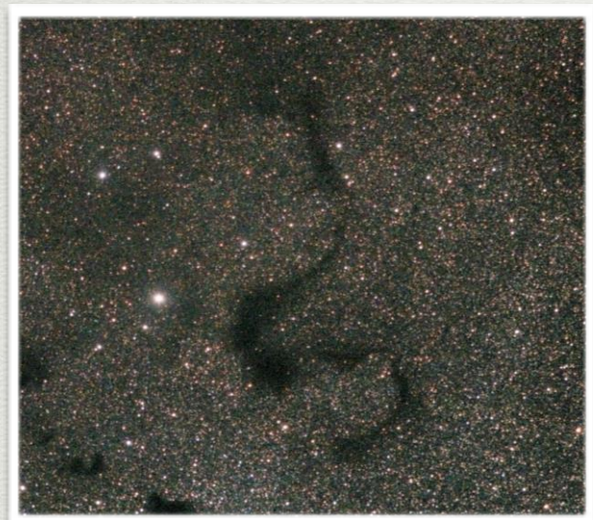
星雲 Nebula

發射星雲

反射星雲



超新星殘骸



暗星雲

行星狀星雲

Planetary Nebula : Courtesy ESO
http://www.eso.org/public/images/eso9846a/

星團 Star Cluster

疏散星團

球狀星團

球狀星團(Globular Cluster)

- 恆星高度向中心集中
- 外觀呈球型
- 被重力束縛
- 恆星較老

M13 武仙座球狀星團

Courtesy : Messier 13, Amateur astrophotographer (hgg) photo using the 9.25" Celestron Telescope (85min exposure)

疏散星團(Open Cluster)

- 密度比球狀星團低
- 只有數百萬年歷史
- 較弱引力聯繫

M45 昴宿星團(七姊妹星團)

Courtesy NASA/ESA/AURA/Caltech/ Palomar Observatory
The science team consists of:
D. Soderblom and E. Nelan (STScI), F. Benedict and B. Arthur (U. Texas), and B. Jones (Lick Obs.)
http://hubblesite.org/newscenter/archive/releases/2004/20/image/a/

星團 Star Cluster

疏散星團

球狀星團

星系 Galaxy

旋渦狀

橢圓狀

不規則狀

橢圓星系(Elliptical Galaxy)

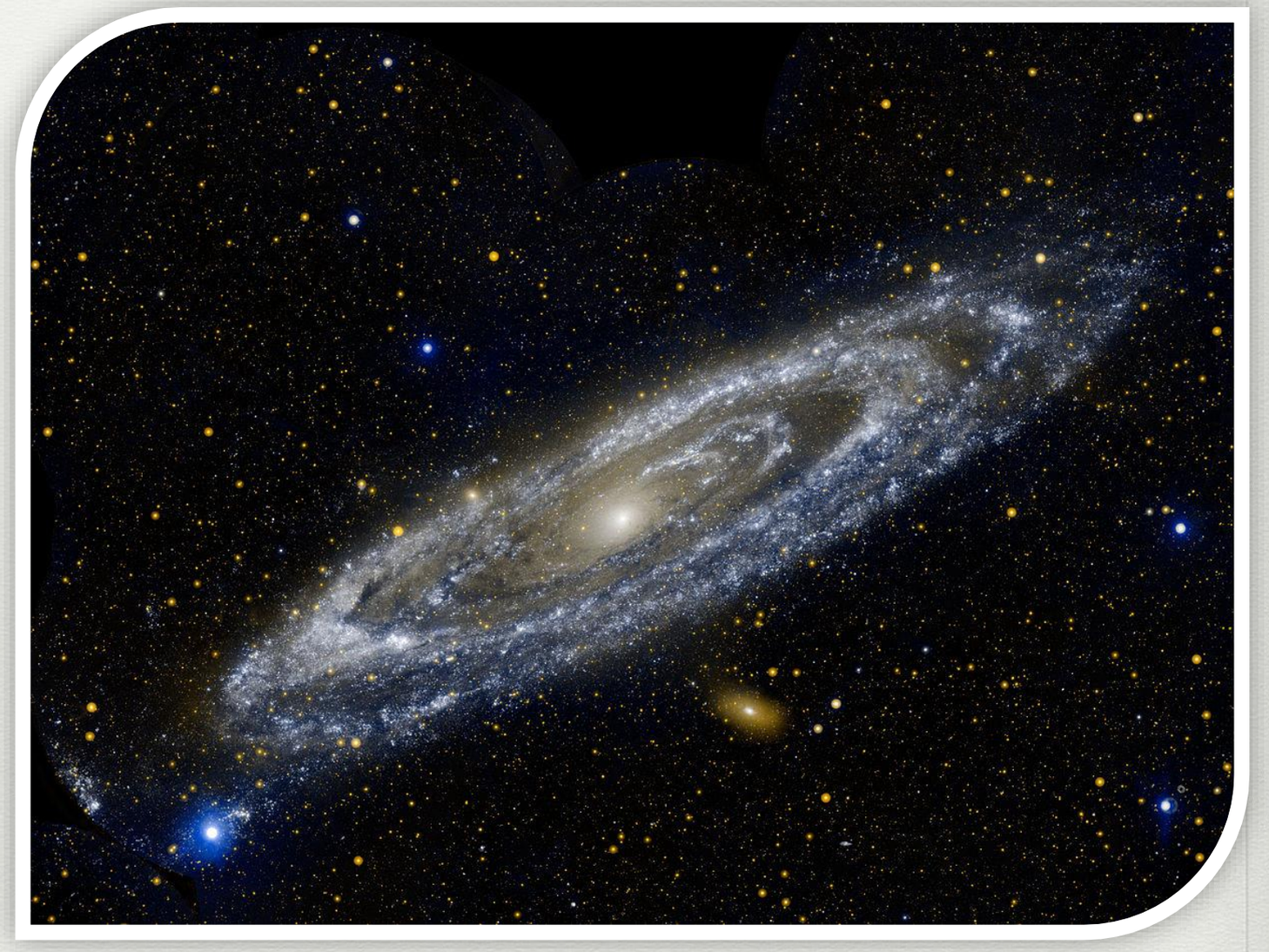
M32 仙女座橢圓星系

Courtesy : Unknown (2MASS-Team) - Two Micron All Sky Survey (2MASS)

螺旋星系(Spiral Galaxy)

- 螺旋臂上有許多明亮和年輕的恆星
- 螺旋臂也繞著中心旋轉
- 銀河系

M31 仙女座大星系



Courtesy : NASA/JPL-Caltech - NASA

不規則星系(Irregular Galaxy)

M82 雪茄星系

- 不規則外觀

Courtesy NASA/JPL-Caltech/STScI/CXC/UofA/ESA/AURA/JHU
http://gallery.spitzer.caltech.edu/Imagegallery/image.php?image_name=sig06-010

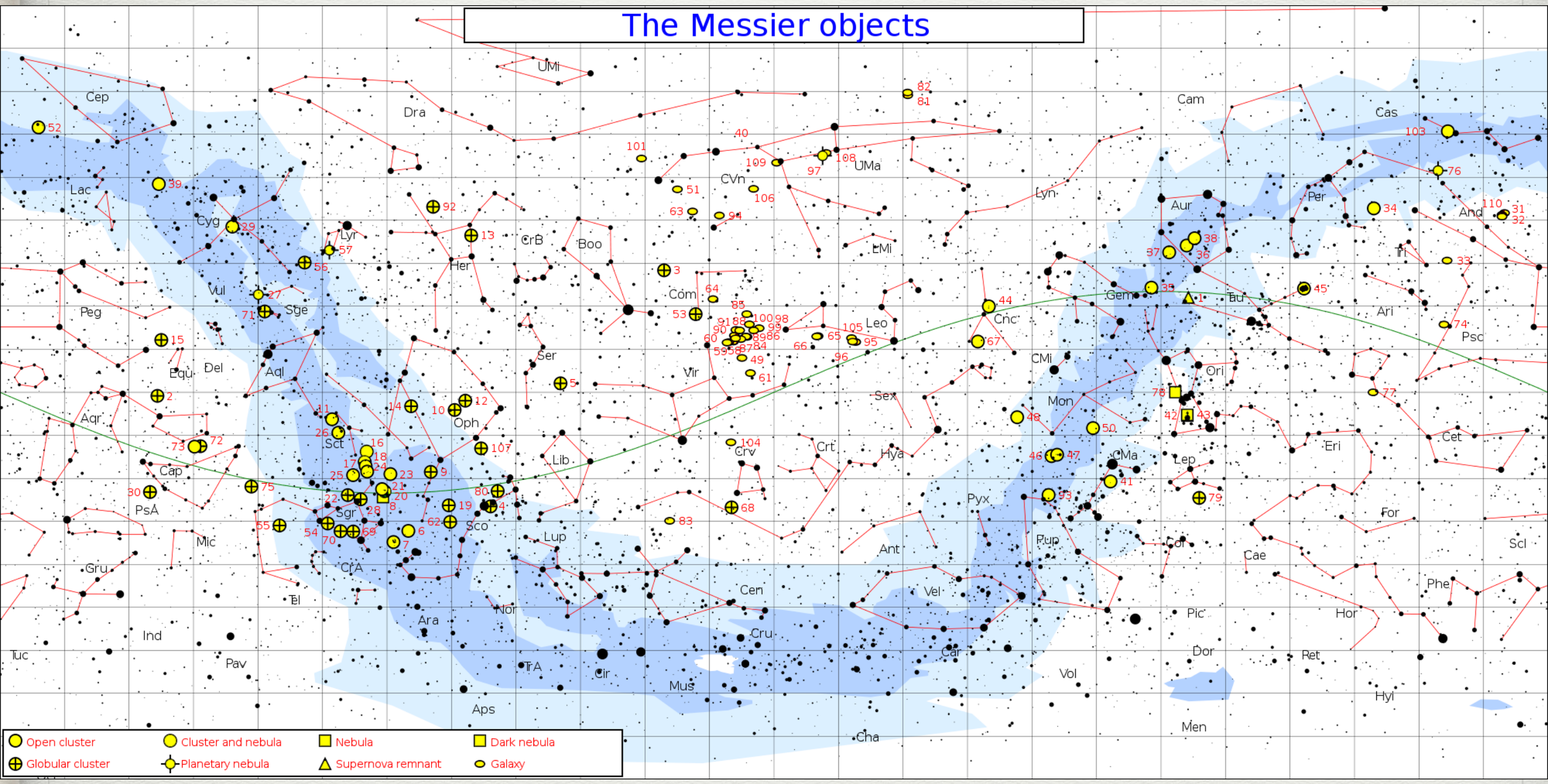
星系 Galaxy

旋渦狀

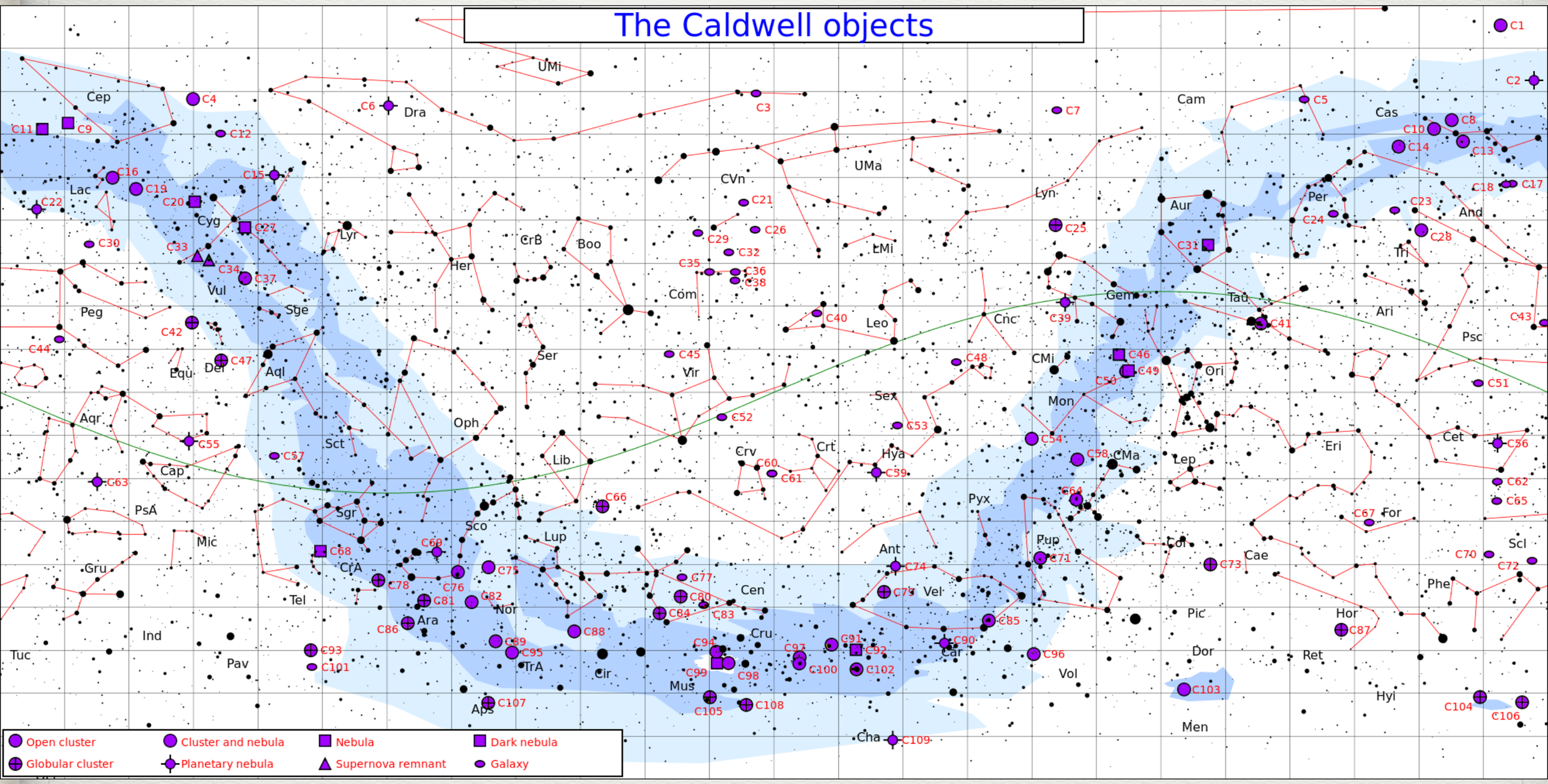
橢圓狀

不規則狀

梅西耶天體列表
(Messier Catalogue)



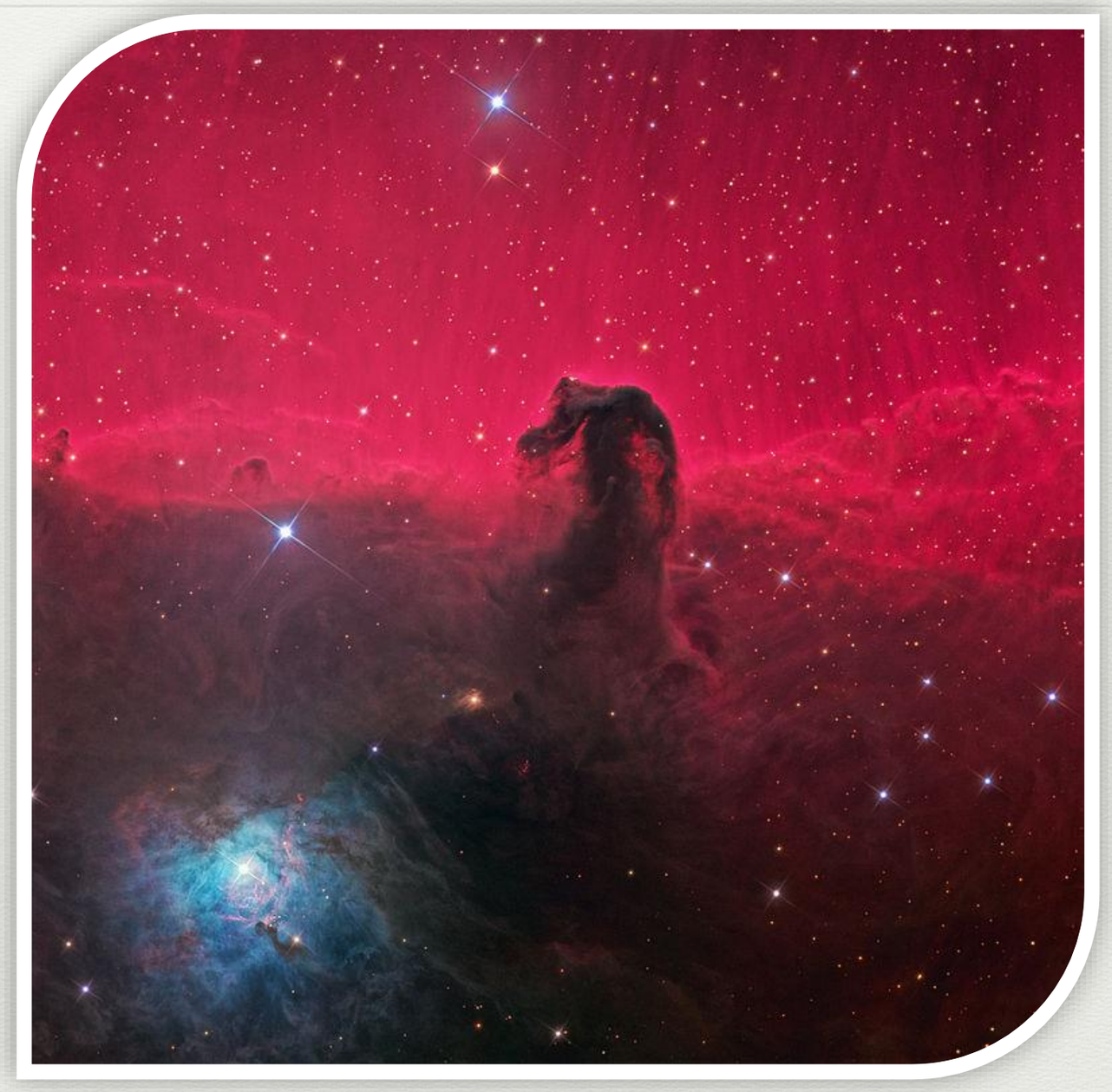
科德韋爾天體列表
(Caldwell Catalogue)



巴納德天體列表
(Barnard Catalogue)

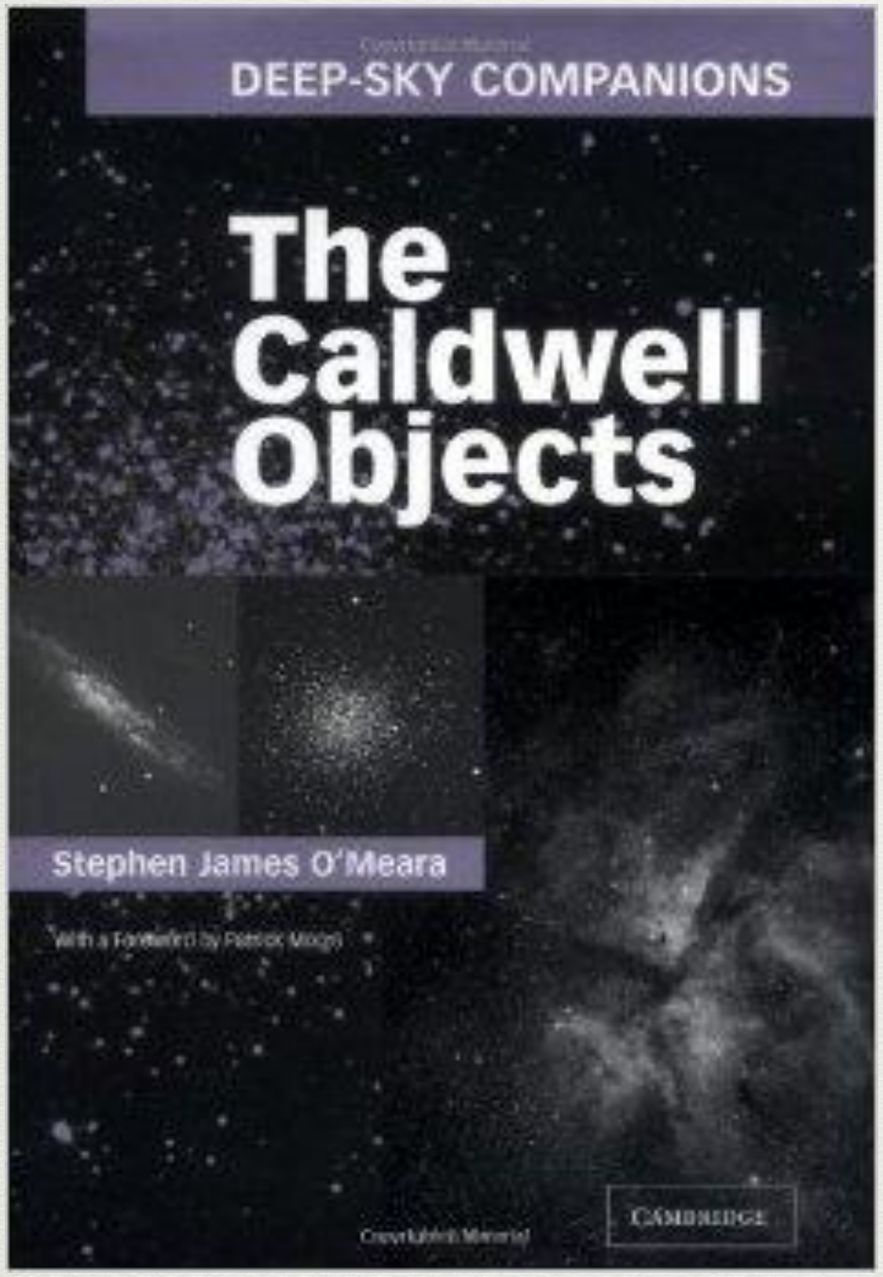
- 暗星雲
- 366個

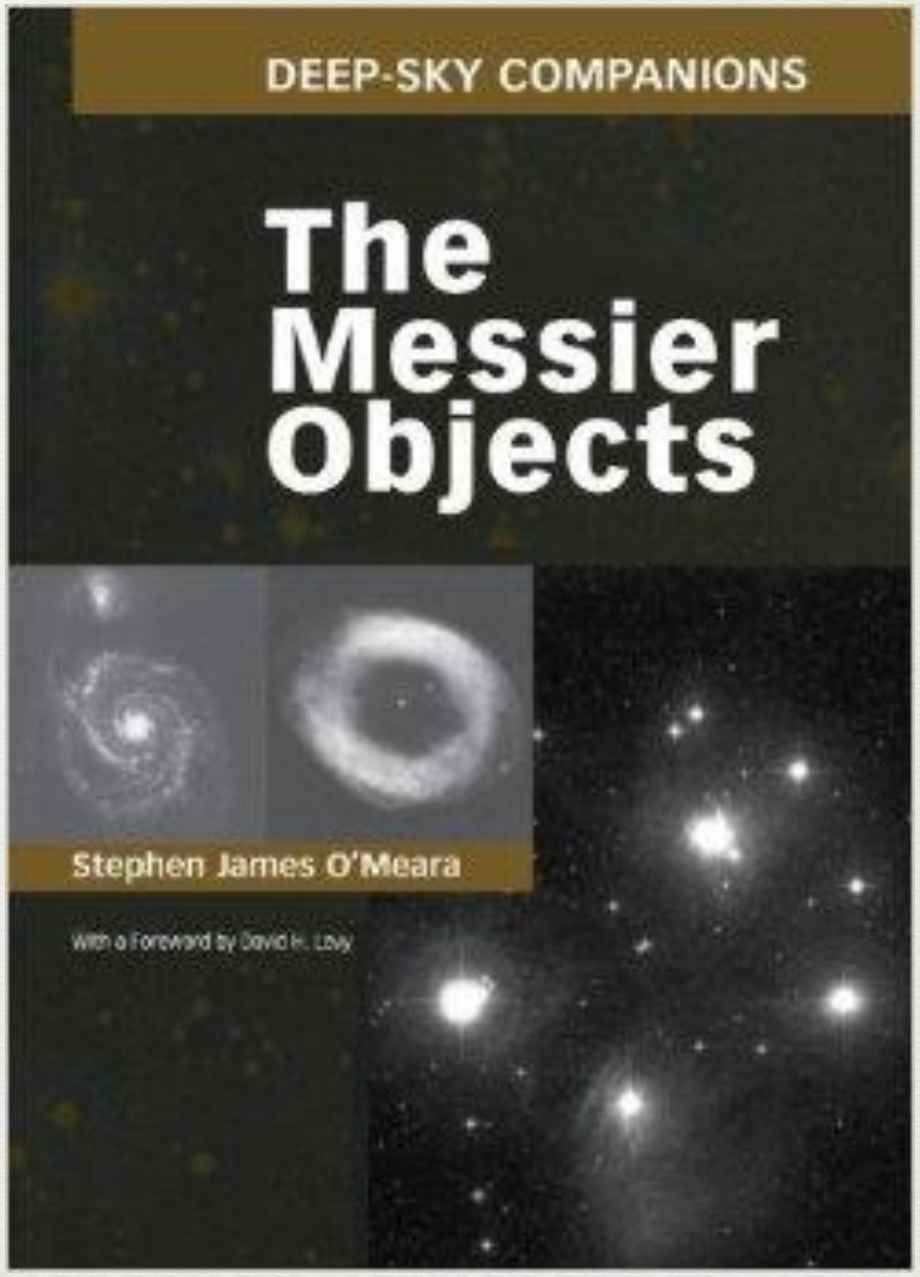
B33 馬頭星雲



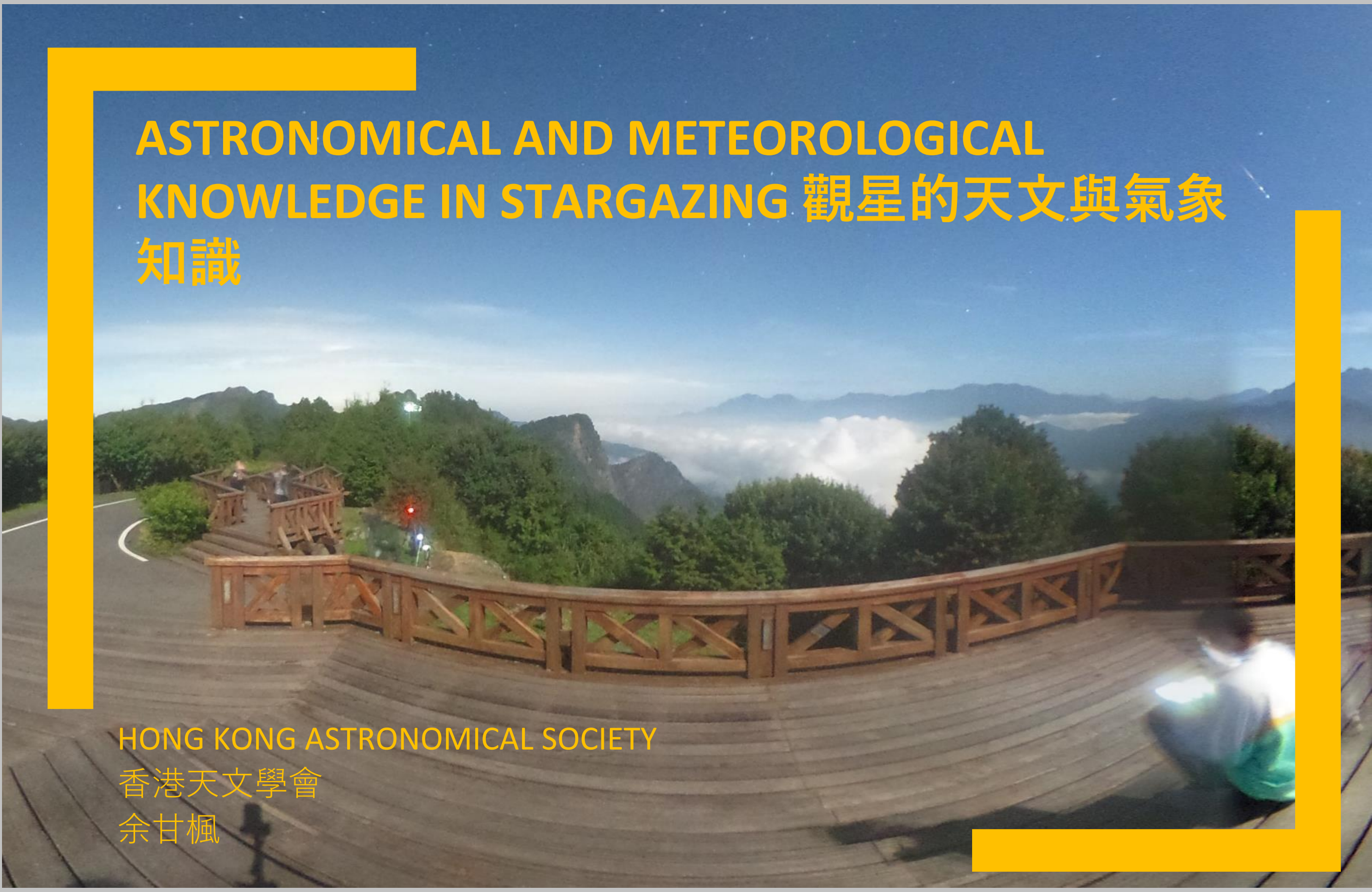
Attribution: Ken Crawford

好書推介


DEEP-SKY COMPANIONS
The Caldwell Objects
Stephen James O'Meara
CAMBRIDGE

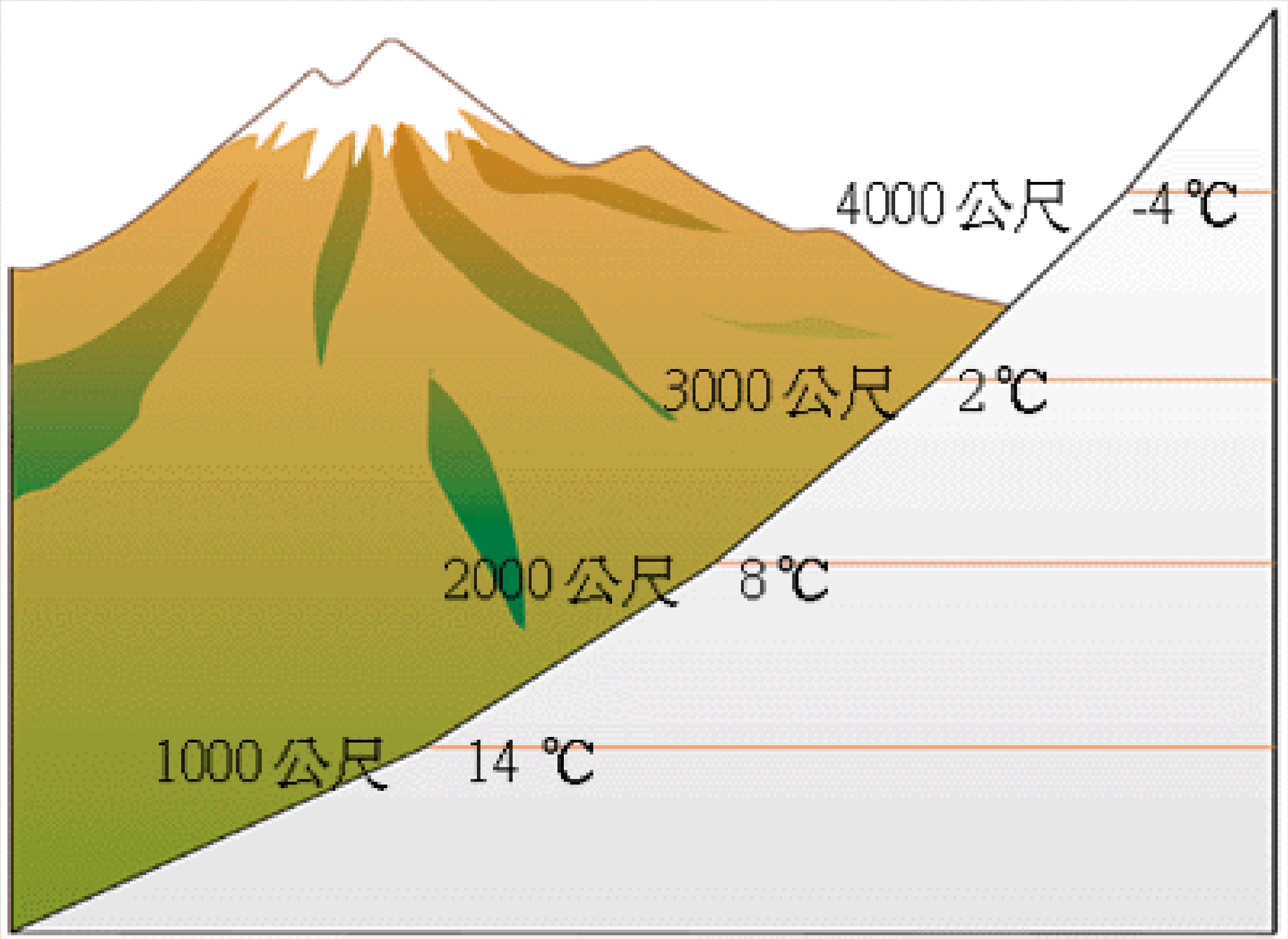

DEEP-SKY COMPANIONS
The Messier Objects
Stephen James O'Meara
With a Foreword by David H. Levy

ASTRONOMICAL AND METEOROLOGICAL KNOWLEDGE IN STARGAZING 觀星的天文與氣象知識

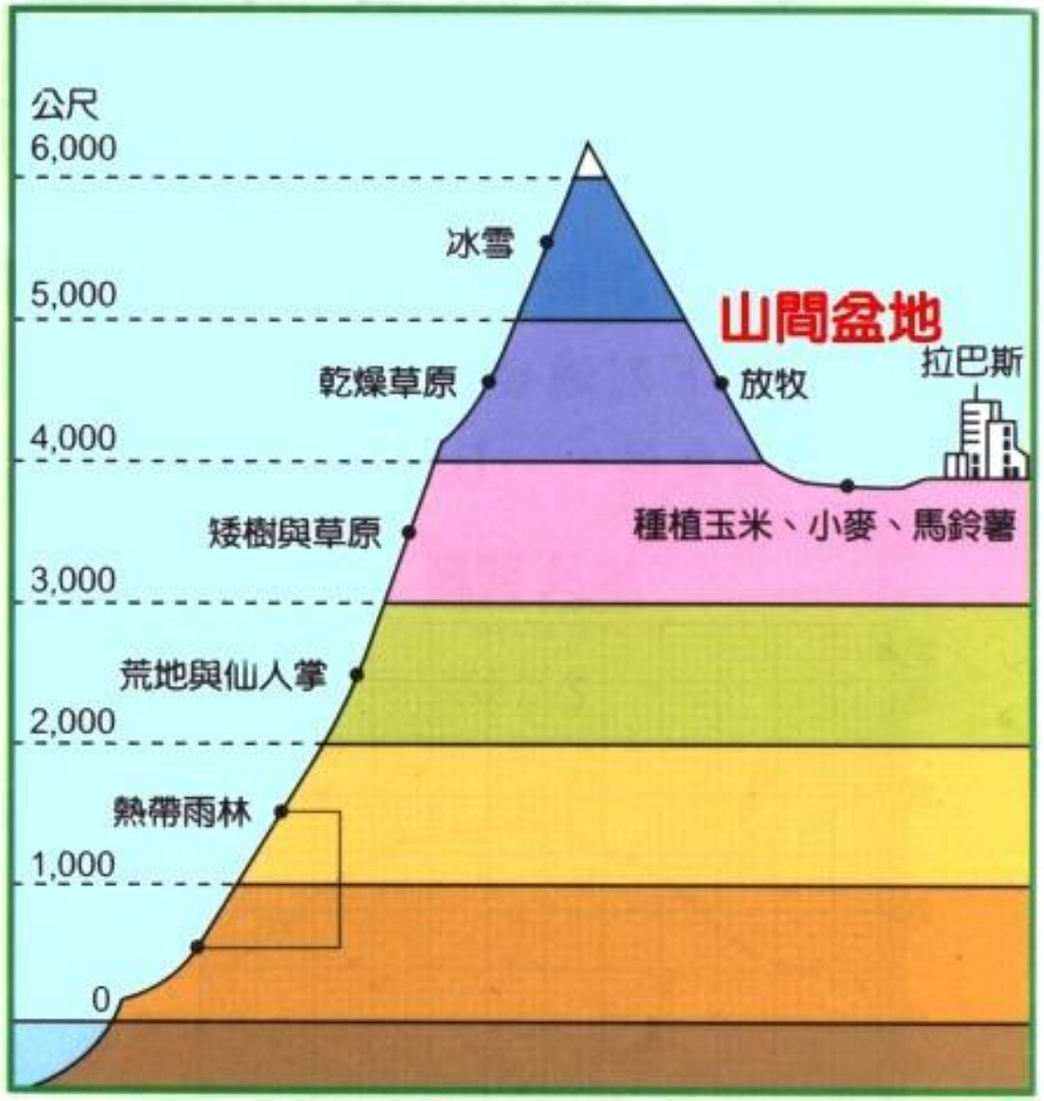


HONG KONG ASTRONOMICAL SOCIETY
香港天文學會
余甘楓

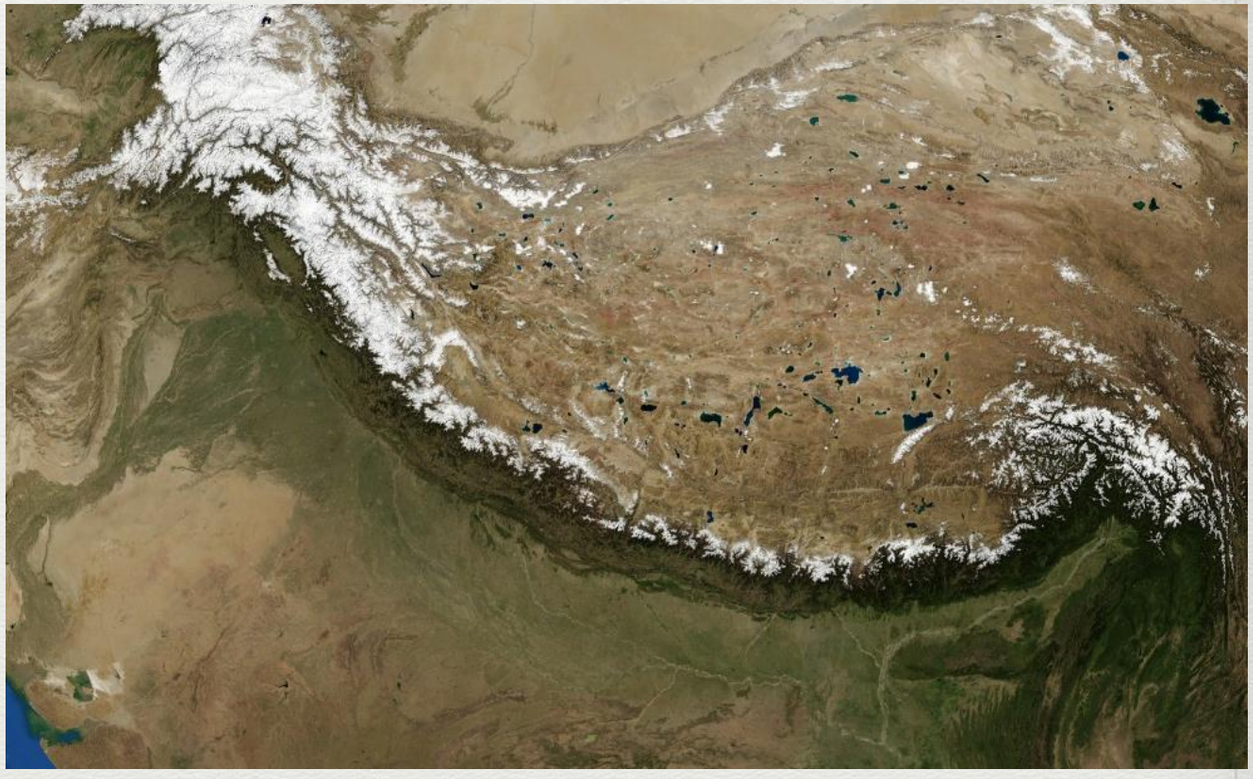
高度與溫度



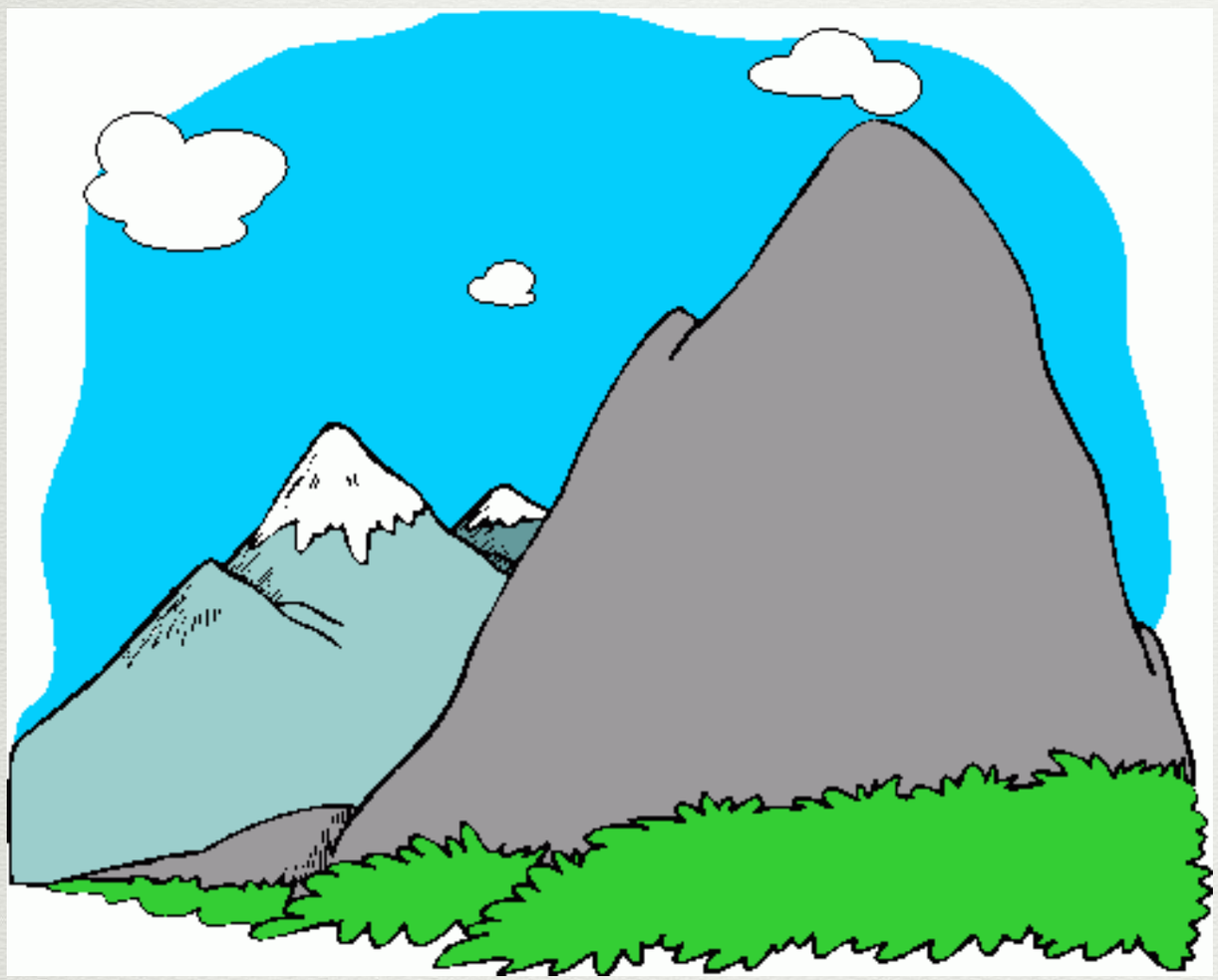
高山

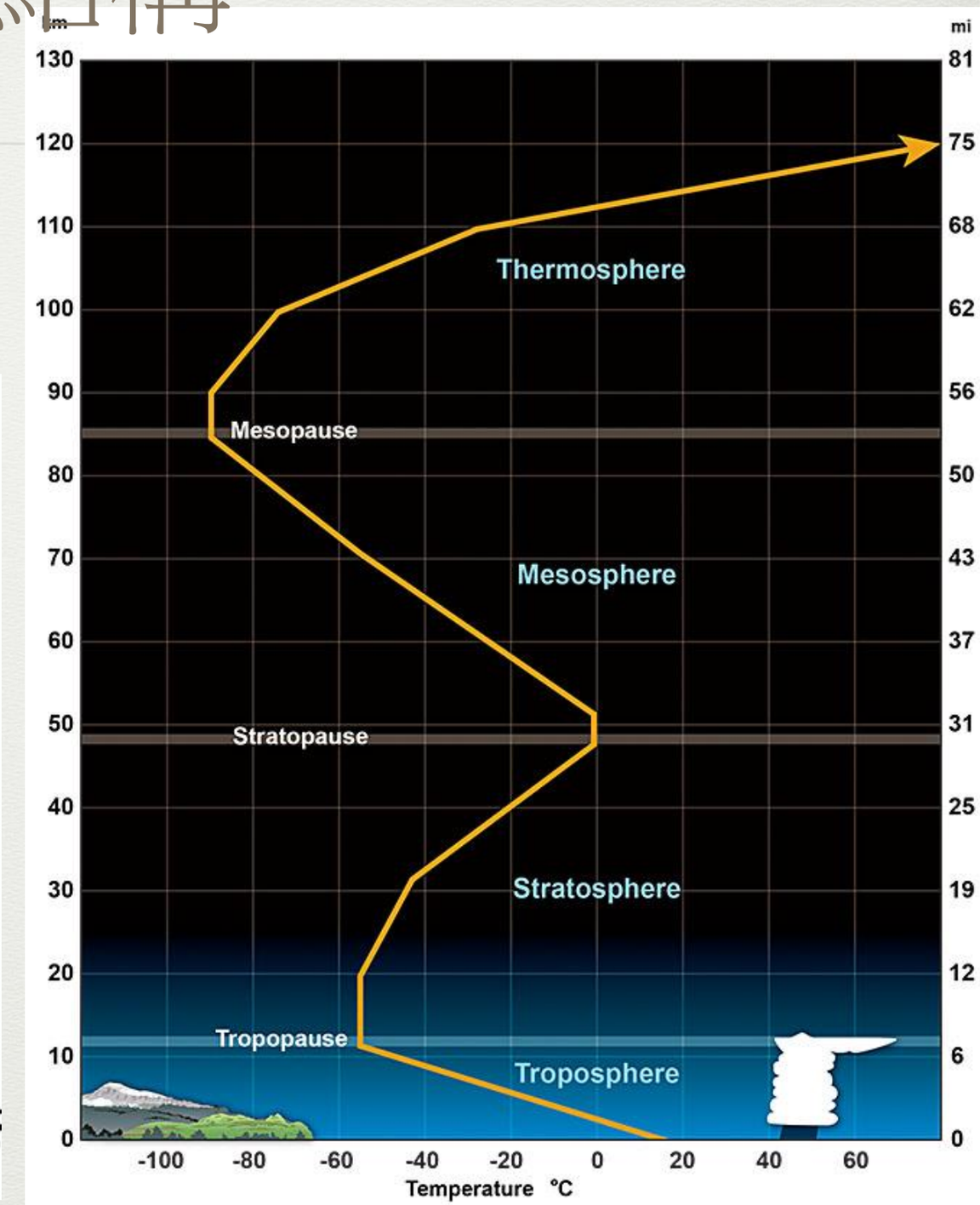


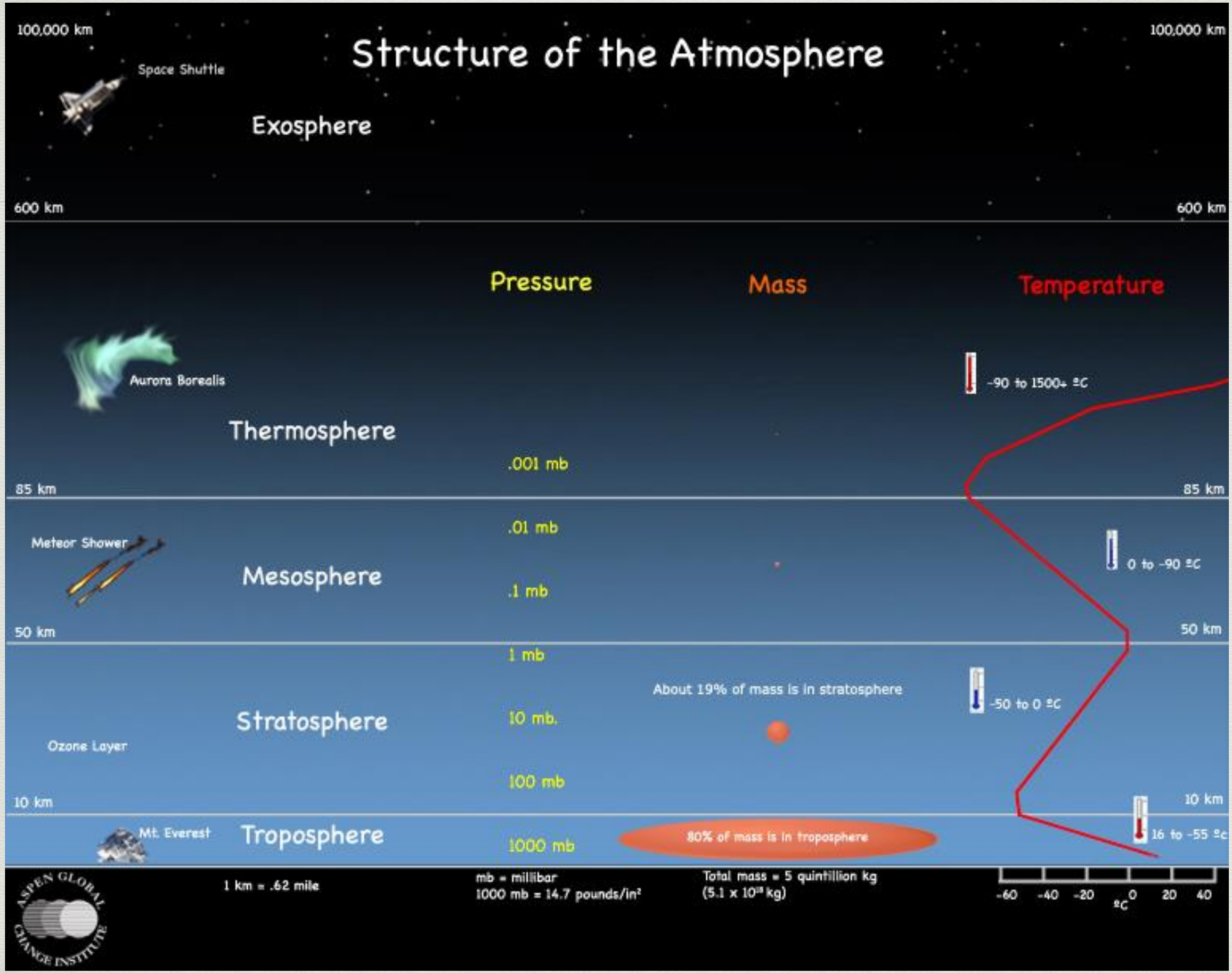
熱帶高山(安地斯山脈)植被垂直變化示意圖



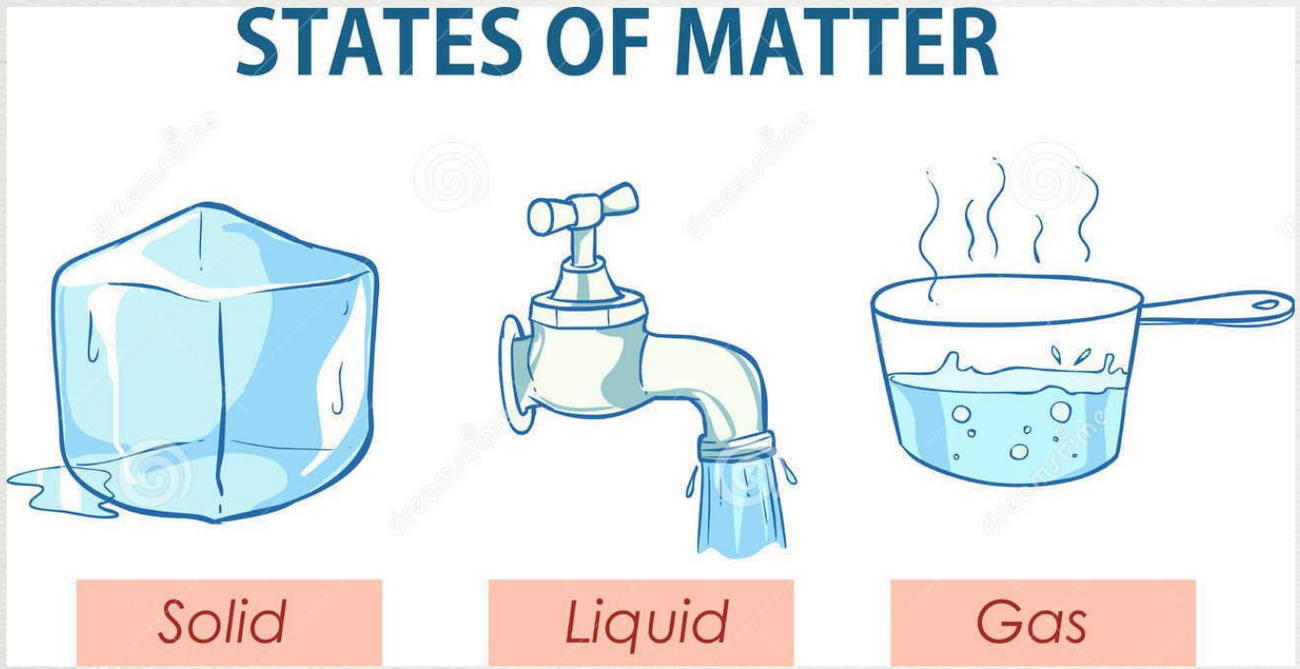
大氣的結構

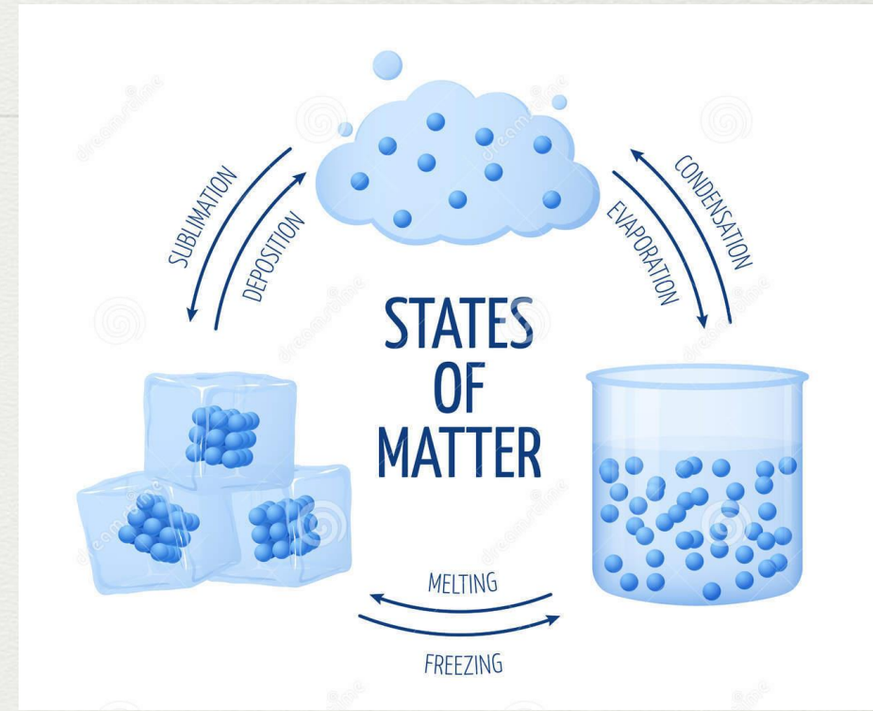


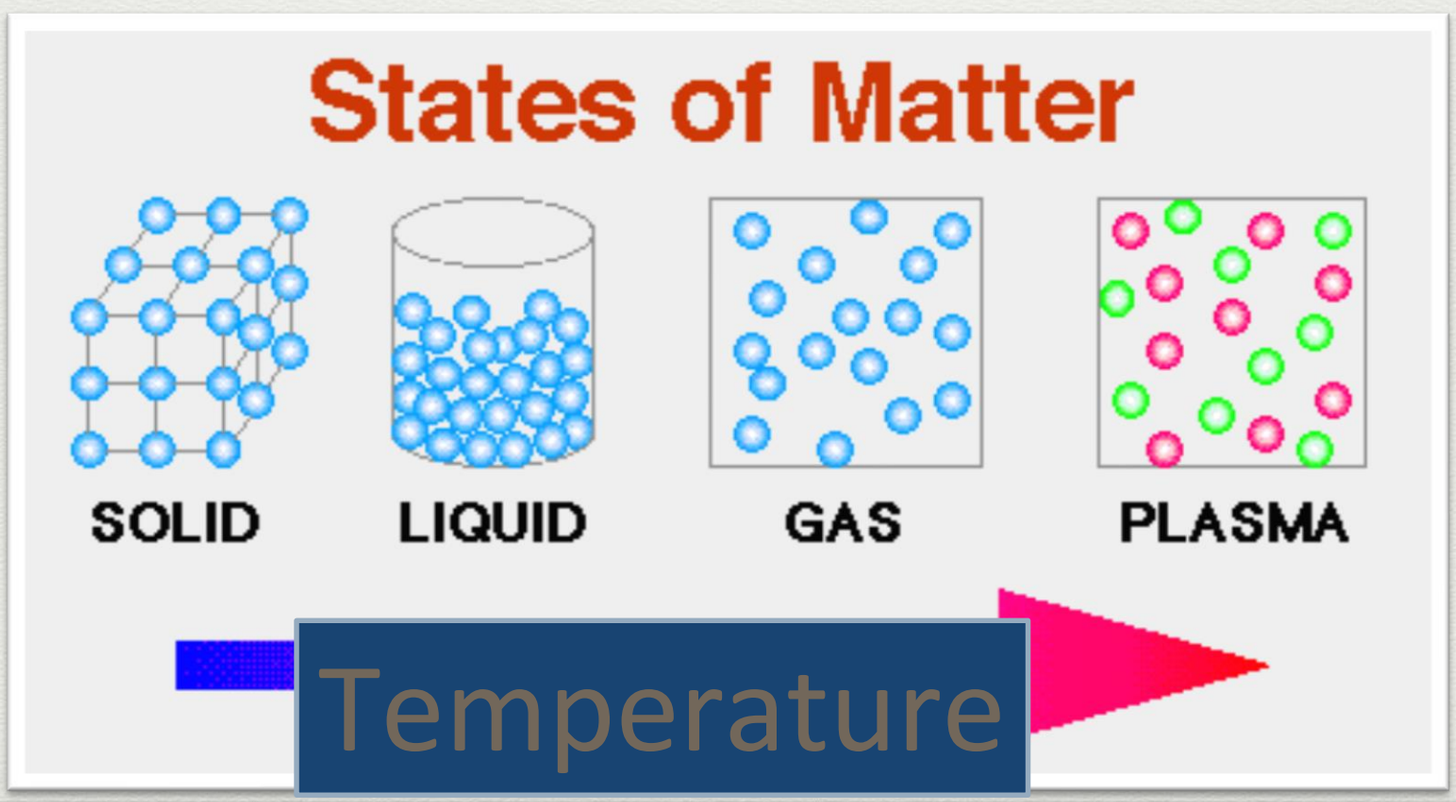

km
mi
130
120
110
100
90
80
70
60
50
40
30
20
10
0
81
75
68
62
56
50
43
37
31
25
19
12
6
0
Thermosphere
Mesopause
Mesosphere
Stratopause
Stratosphere
Tropopause
Troposphere
-100
-80
-60
-40
-20
0
20
40
60
Temperature °C


Structure of the Atmosphere
100,000 km
100,000 km
Space Shuttle
Exosphere
600 km
600 km
Pressure
Mass
Temperature
Aurora Borealis
-90 to 1500+ ºC
Thermosphere
.001 mb
85 km
85 km
Meteor Shower
.01 mb
Mesosphere
.1 mb
0 to -90 ºC
50 km
50 km
1 mb
About 19% of mass is in stratosphere
-50 to 0 ºC
Stratosphere
10 mb.
Ozone Layer
100 mb
10 km
10 km
Mt. Everest
Troposphere
1000 mb
80% of mass is in troposphere
16 to -55 ºC
ASPEN GLOBAL CHANGE INSTITUTE
1 km = .62 mile
mb = millibar
1000 mb = 14.7 pounds/in²
Total mass = 5 quintillion kg
(5.1 x 10¹⁸ kg)
-60 -40 -20 0 20 40
ºC

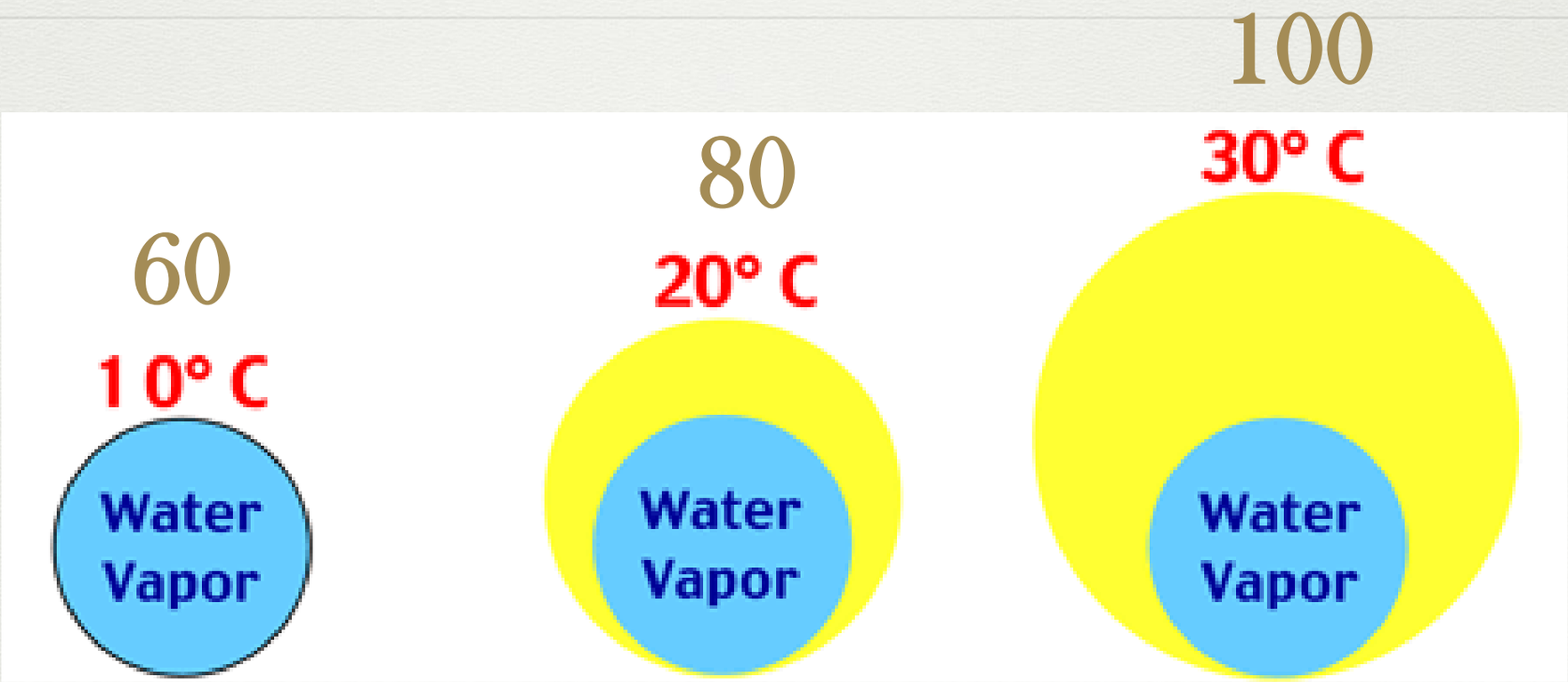
溫度與水


STATES OF MATTER
Solid
Liquid
Gas


SUBLIMATION
DEPOSITION
CONDENSATION
EVAPORATION
STATES OF MATTER
MELTING
FREEZING


States of Matter
SOLID
LIQUID
GAS
PLASMA
Temperature

相對濕度
Relative Humidity



60 60 60

Relative Humidity

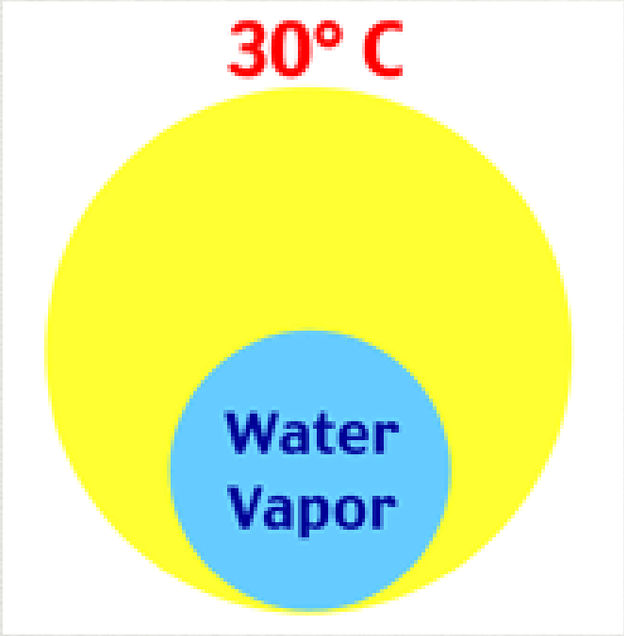
60/60 =100%

60/80 =75%

60/100 =60%

D

When would the air not able to carry this much water vapor?



60/100

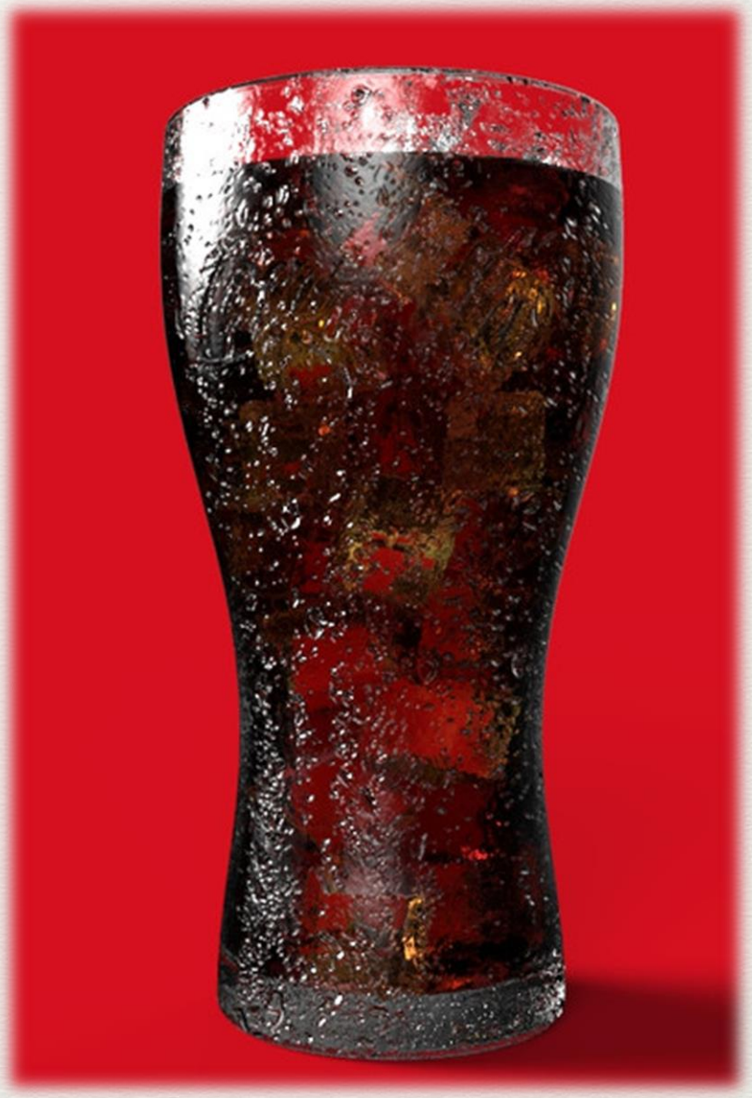
=60%

100%

10°C

This is called the Dew Point

Coca-Cola
CLASSIC



濕凍天氣下巴士玻璃起霞
九巴車長不滿 或涉錯誤設計

俗稱「金簿仔」的九巴僱員工會主席郭志誠表示，近日收到很多前線司機投訴車頭「大銀幕」起霧問題，遍佈九巴四大廠。他質疑「除霞器」本身在**舊車設計為吹熱風**，行之有效，但**新車的冷風「除霞器」效果不佳**，他指九巴工程師早年改變設計，質疑公司**取消熱風設計為了「慳皮」**、質疑公司為節省成本而犧牲行車安全。

香港中文大學物理系高級講師湯兆昇博士接受訪問時認為在巴士「除霞器」的情況中，巴士司機的說法正確，吹熱風會比吹冷風更為有效，因為熱風提高玻璃表面的溫度，車廂內的水蒸汽便不會那麼容易在玻璃表面上凝結成水點，有效防止「霞氣」形成。

注意！高透明度的情況

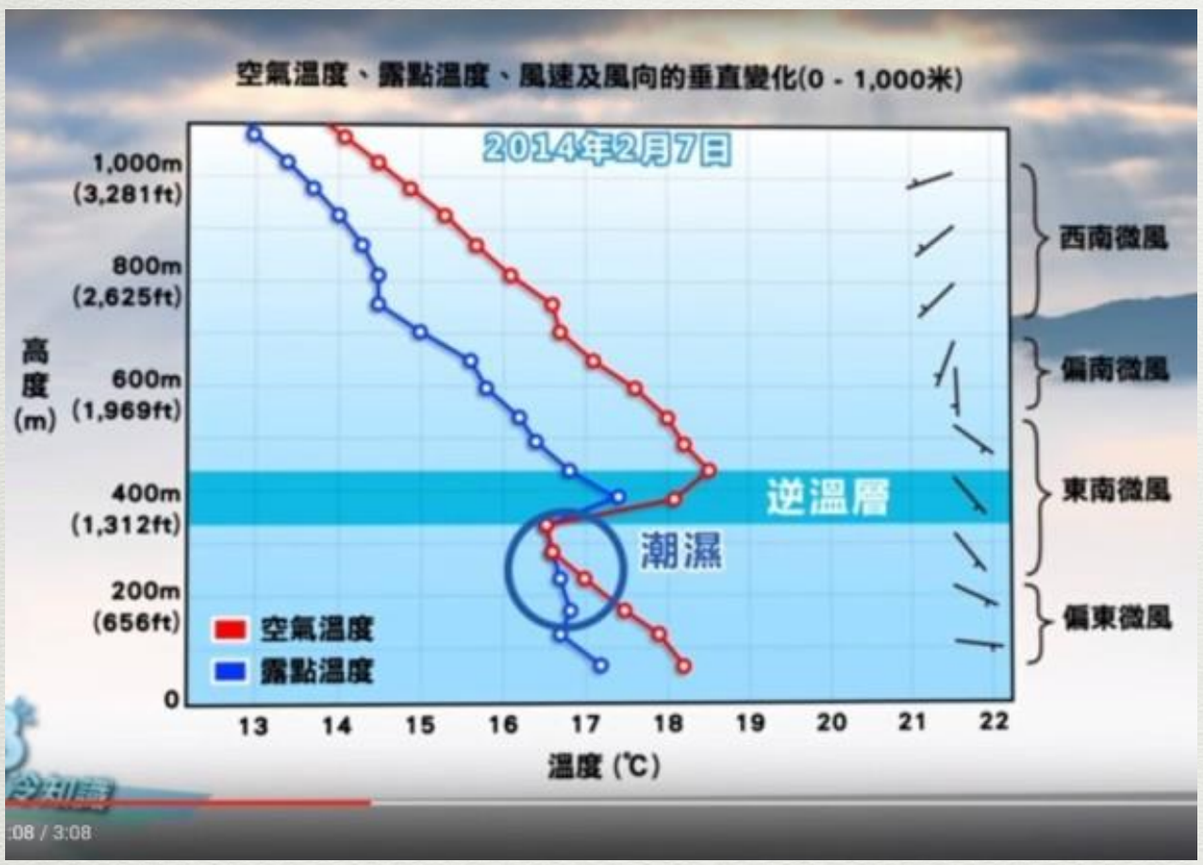
透明度高的晚上，清晨時份起霧！

http://ihouse.hkedcity.net/~hm1203/atmosphere/moisture.htm

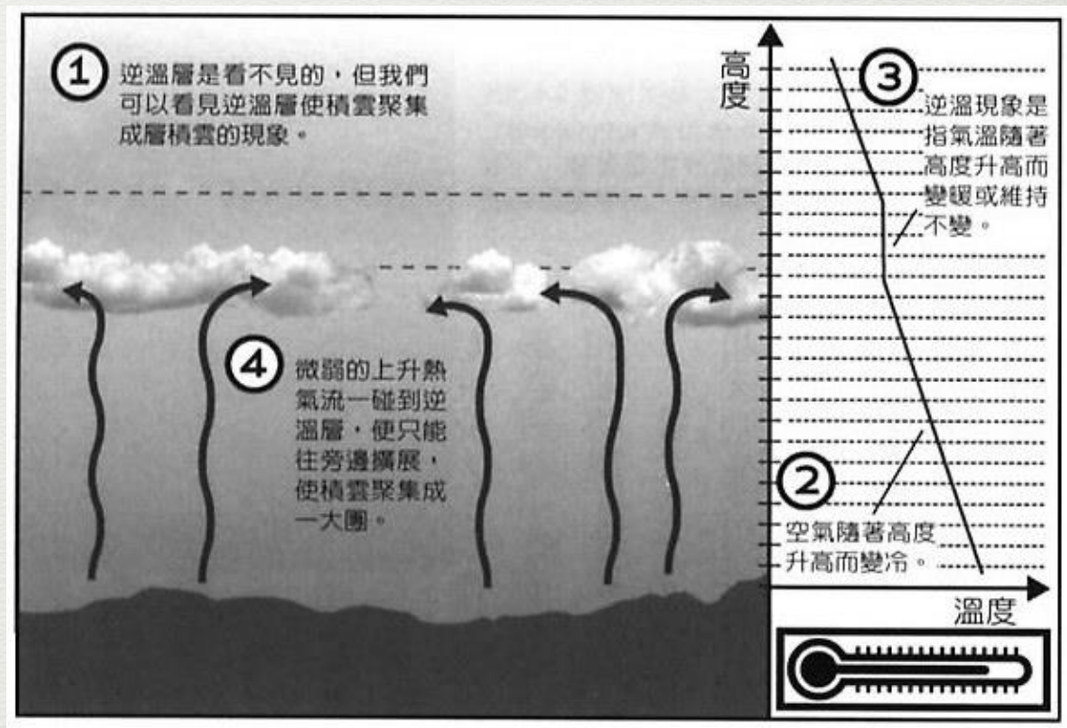
香港情況:

- 大帽山(957m)
- 鳳凰山(934m)
- 大東山(869m)

天文台高空氣象觀測數據



逆溫層

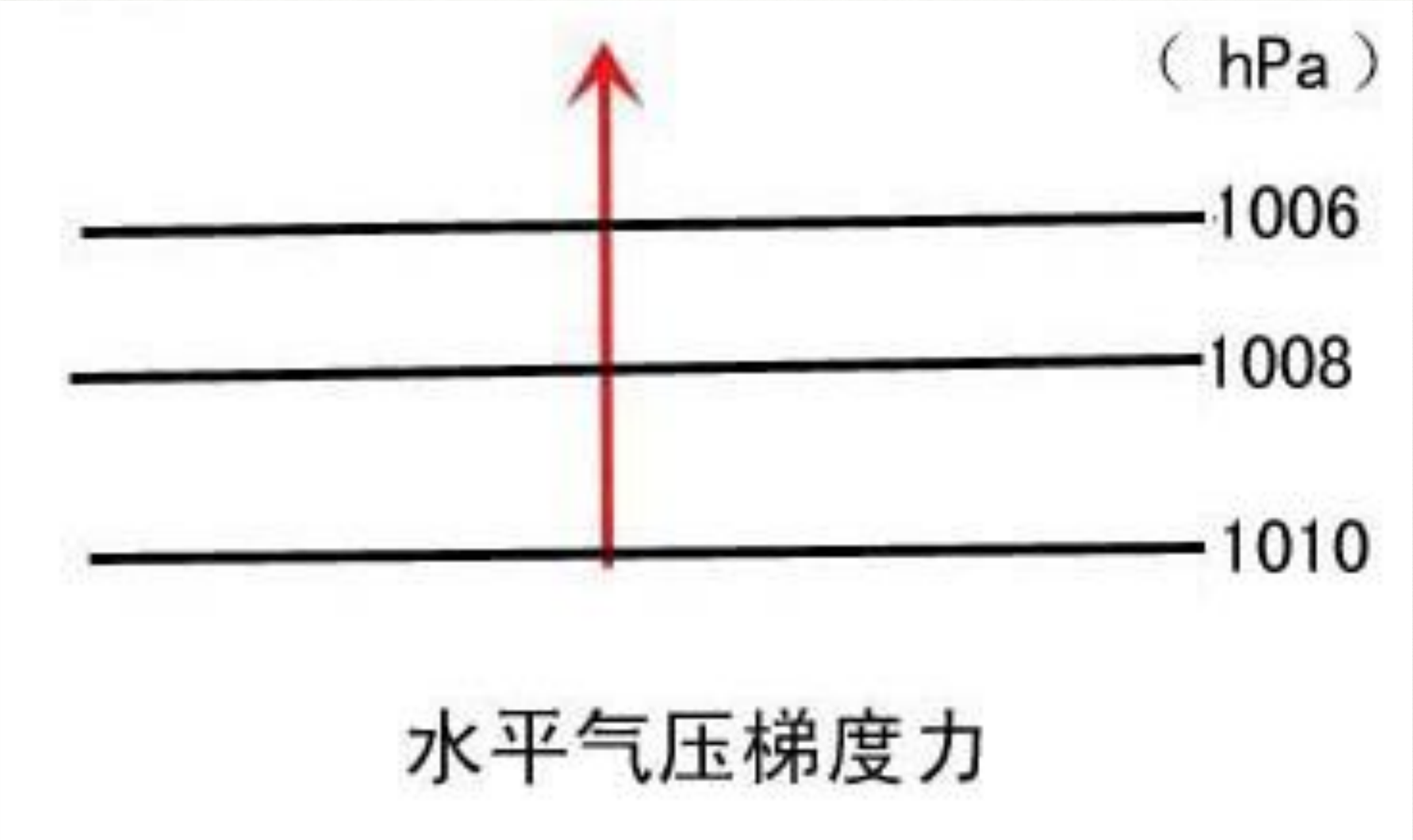


逆溫層是積雲擴展聚集成層積雲的原因之一。

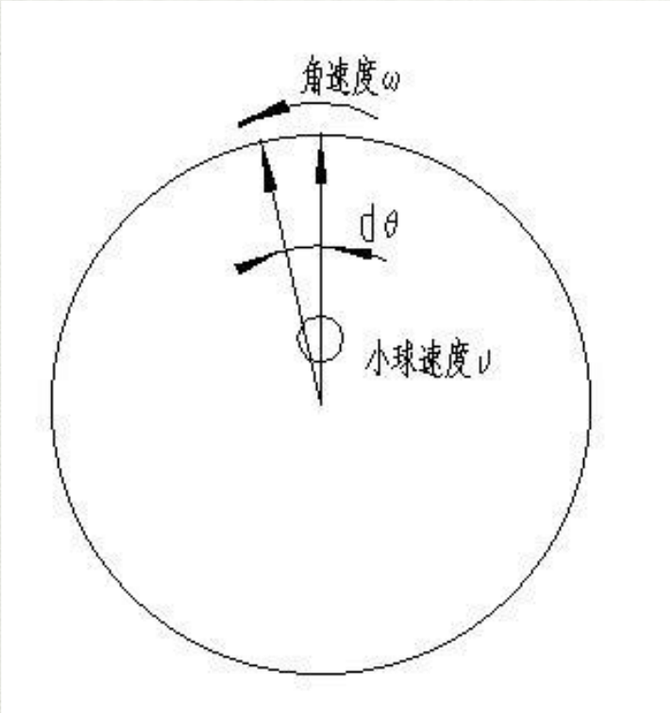
w.hko.gov.hk/out_photo/upper-air-weather_uc.htm

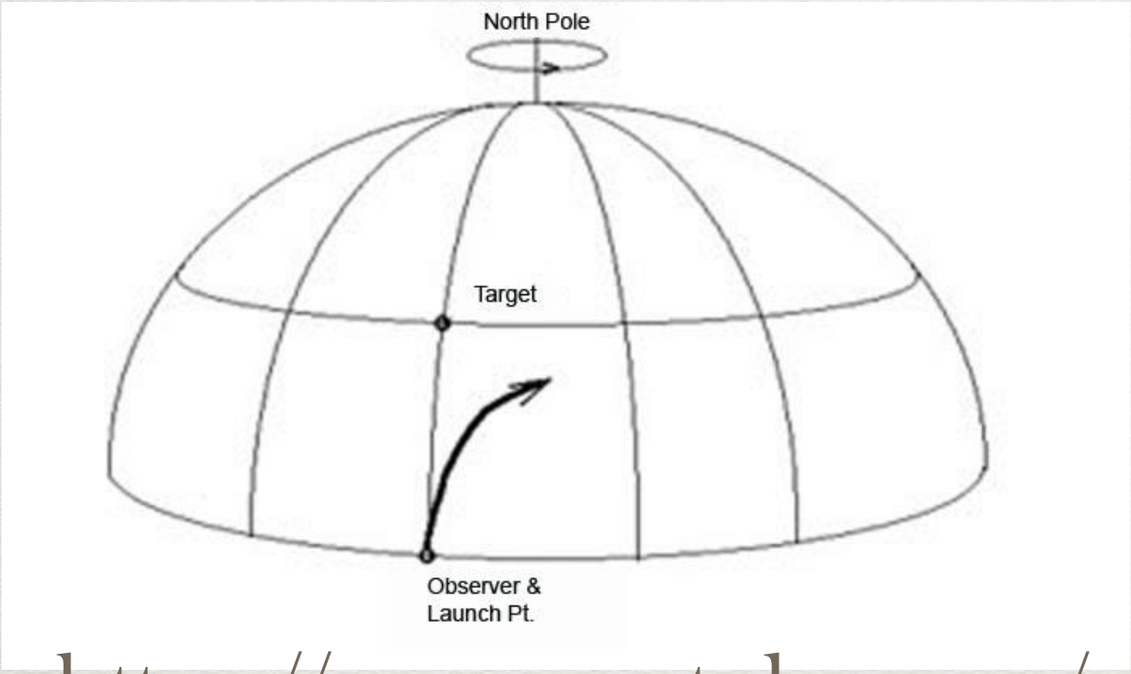
SHUN TAK

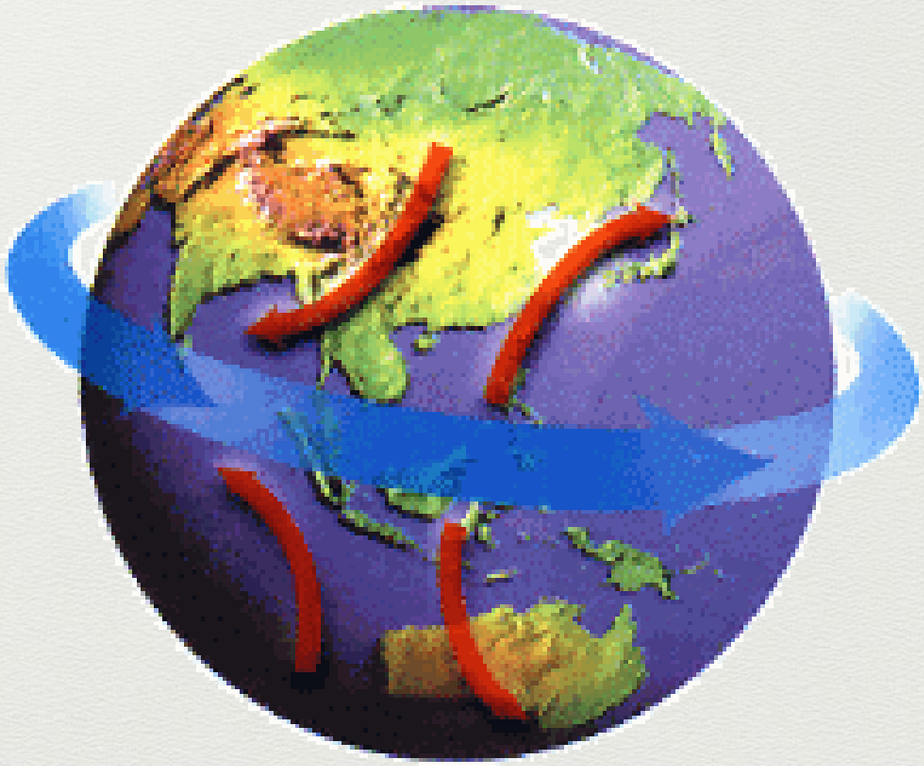
氣壓Pressure



科氏力 Coriolis Force

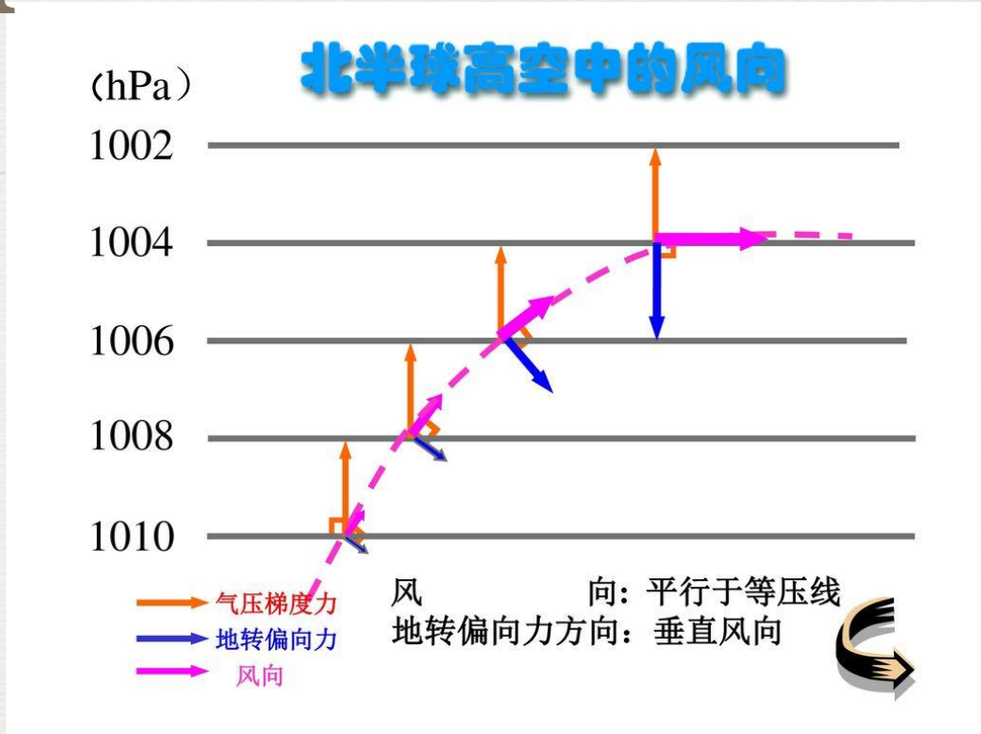




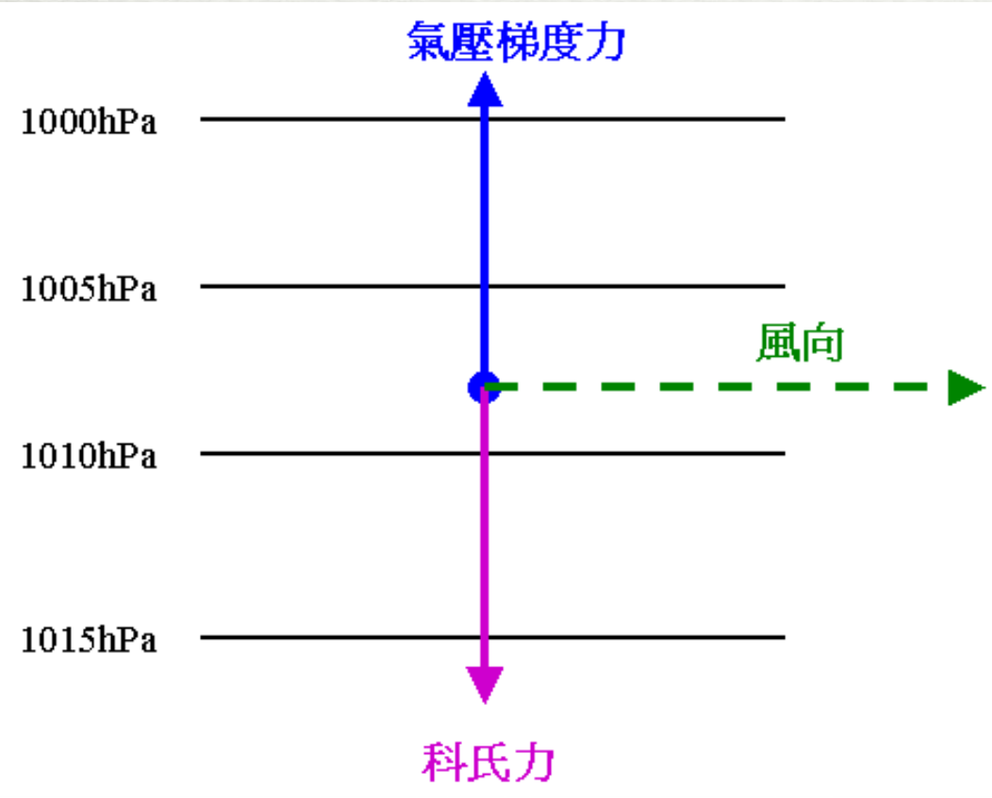


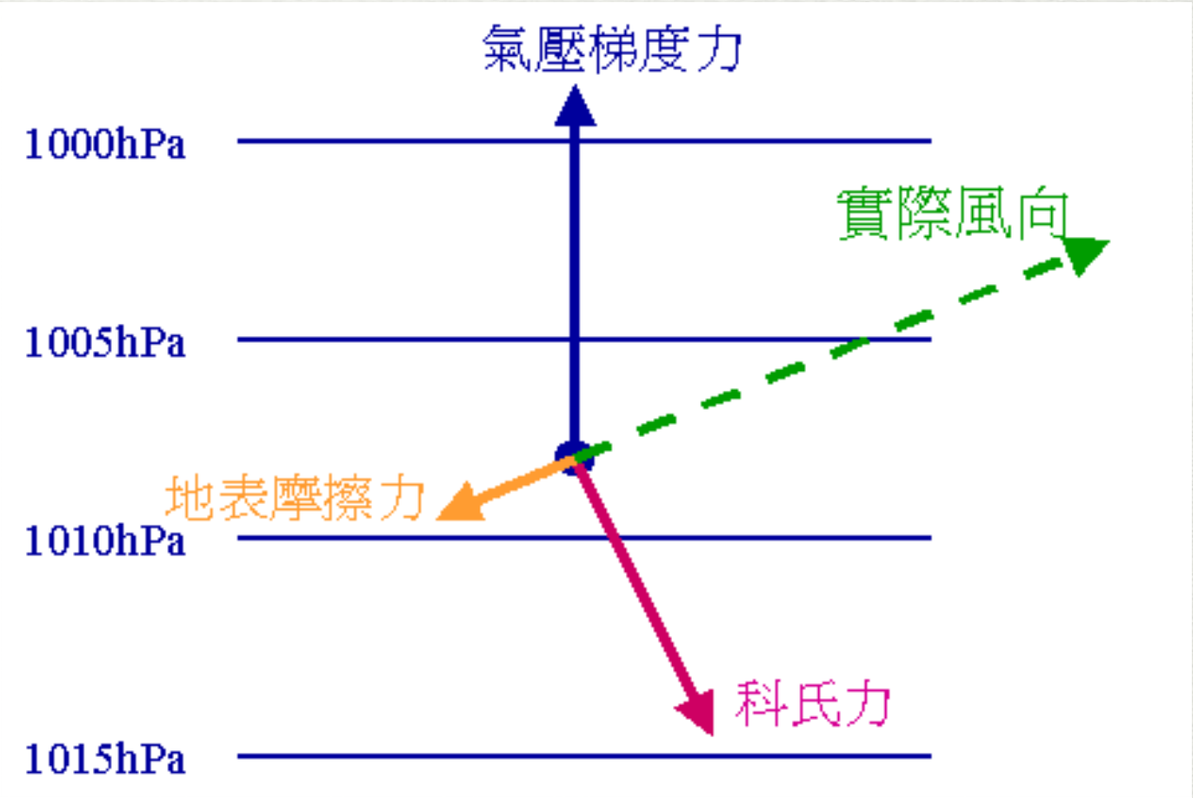
https://www.youtube.com/watch?v=cWdUGv7ExY0

地轉風 Geostrophic Wind

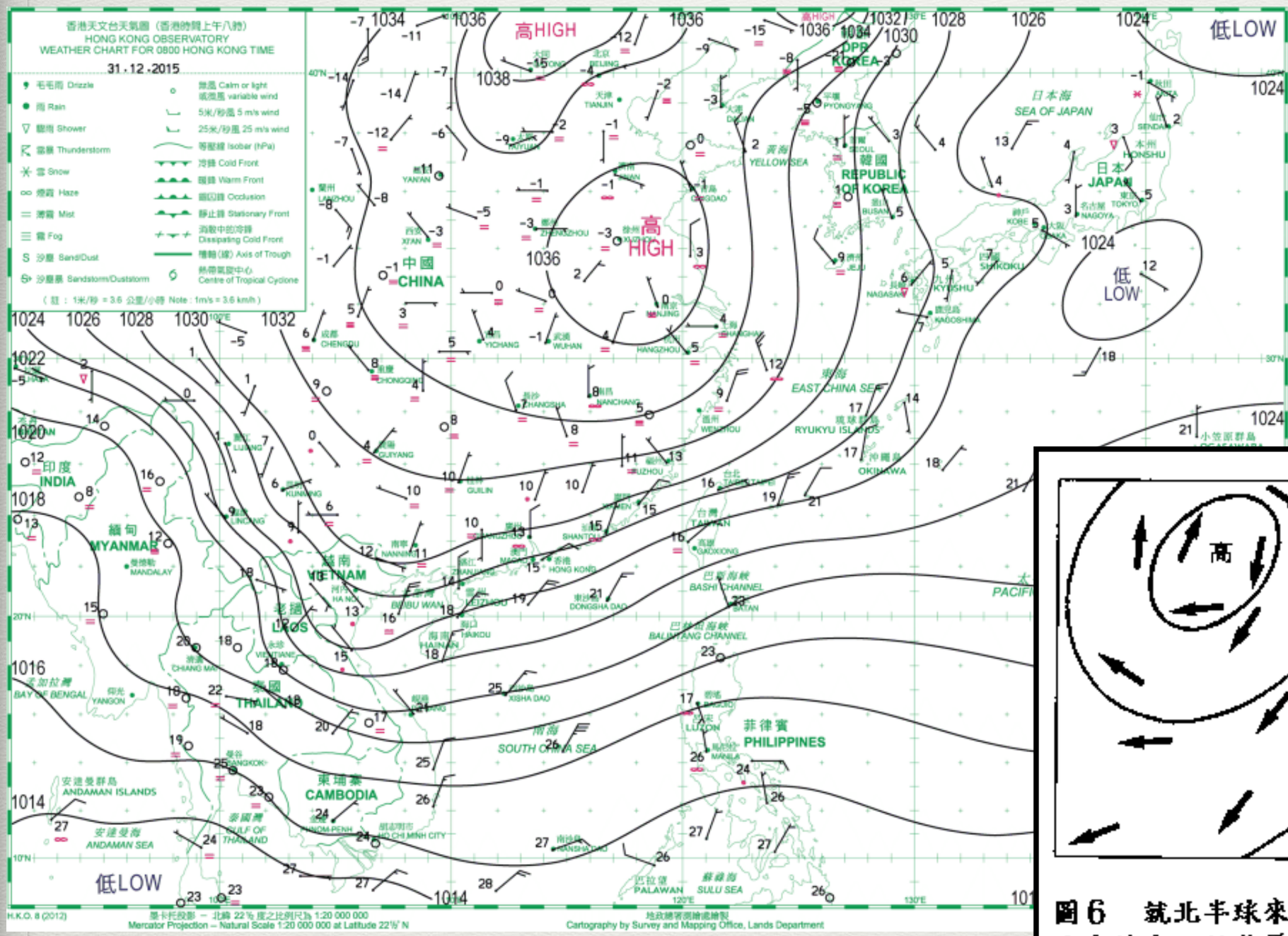


『背風而立 高壓在右』





天氣圖



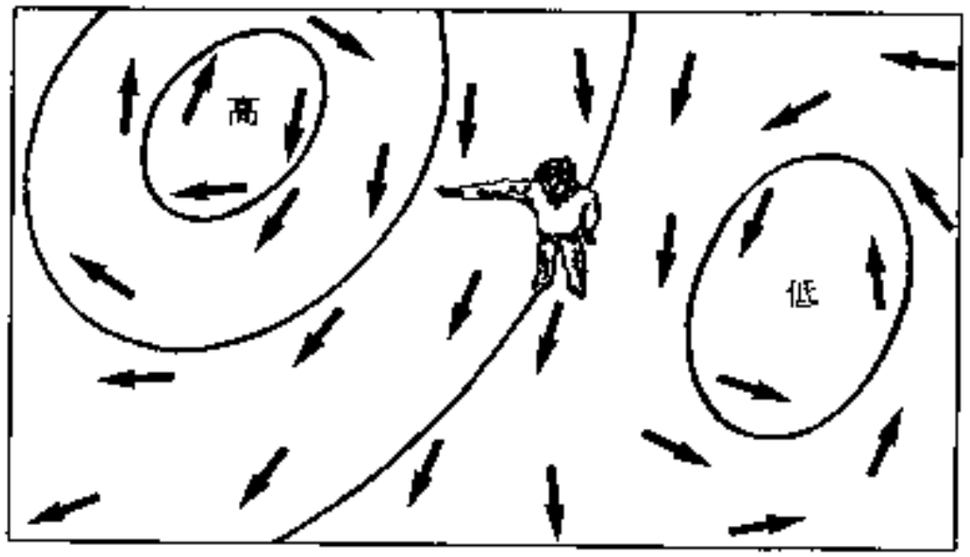
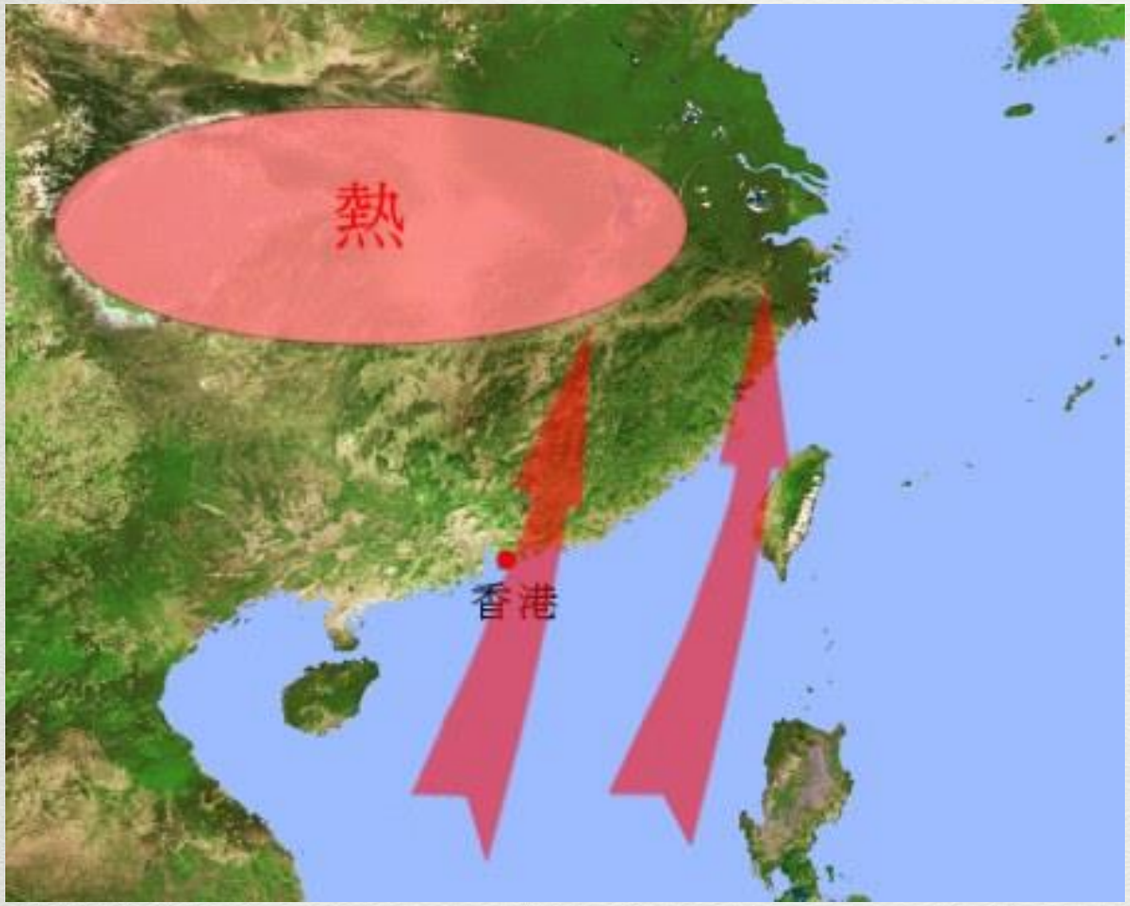
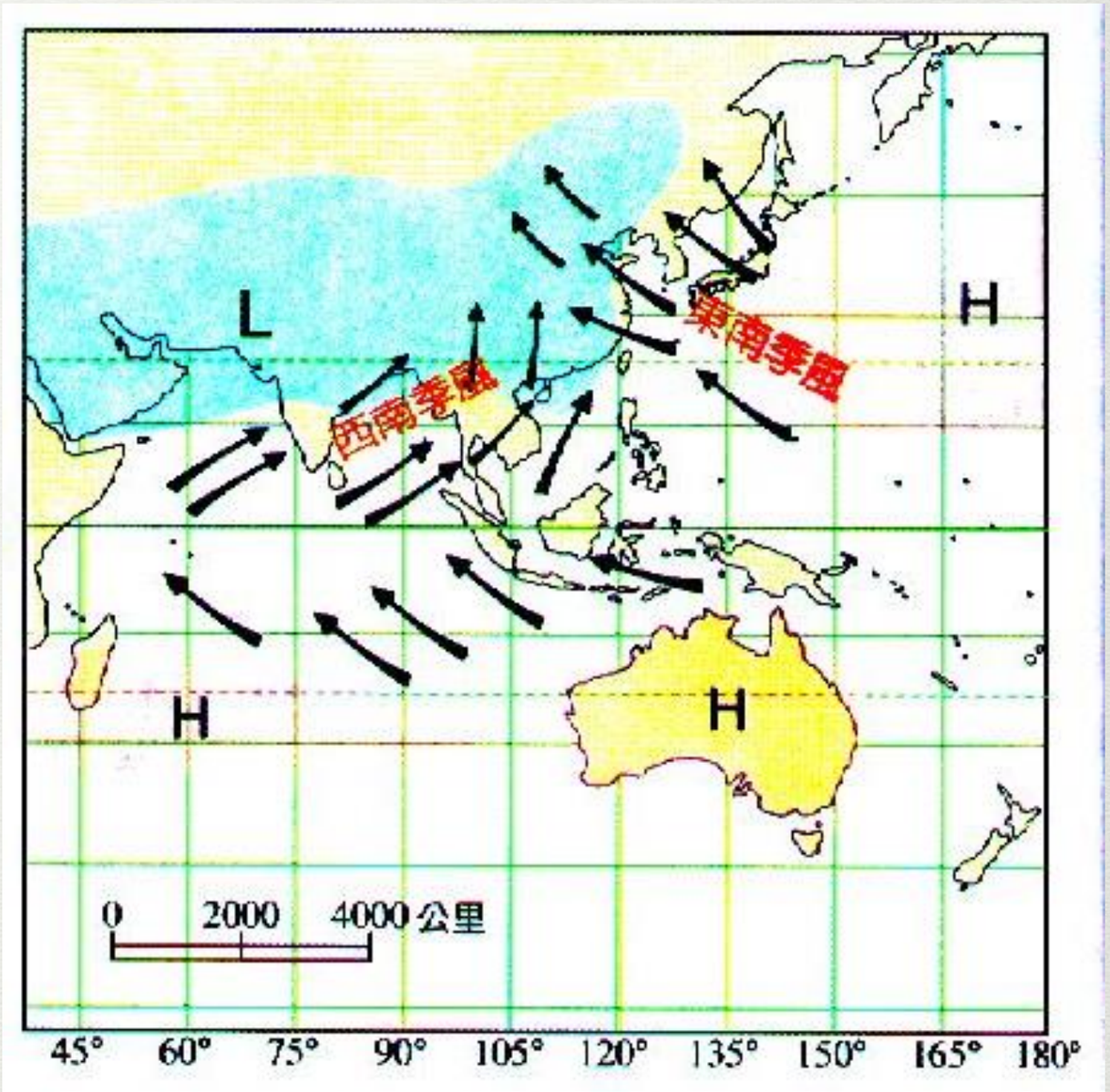


圖6　就北半球來說，在高氣壓範圍內的風順時針方向繞出，低氣壓範圍內，風反時針方向繞入，因此背風而立A高氣壓在右，低氣壓在左邊。

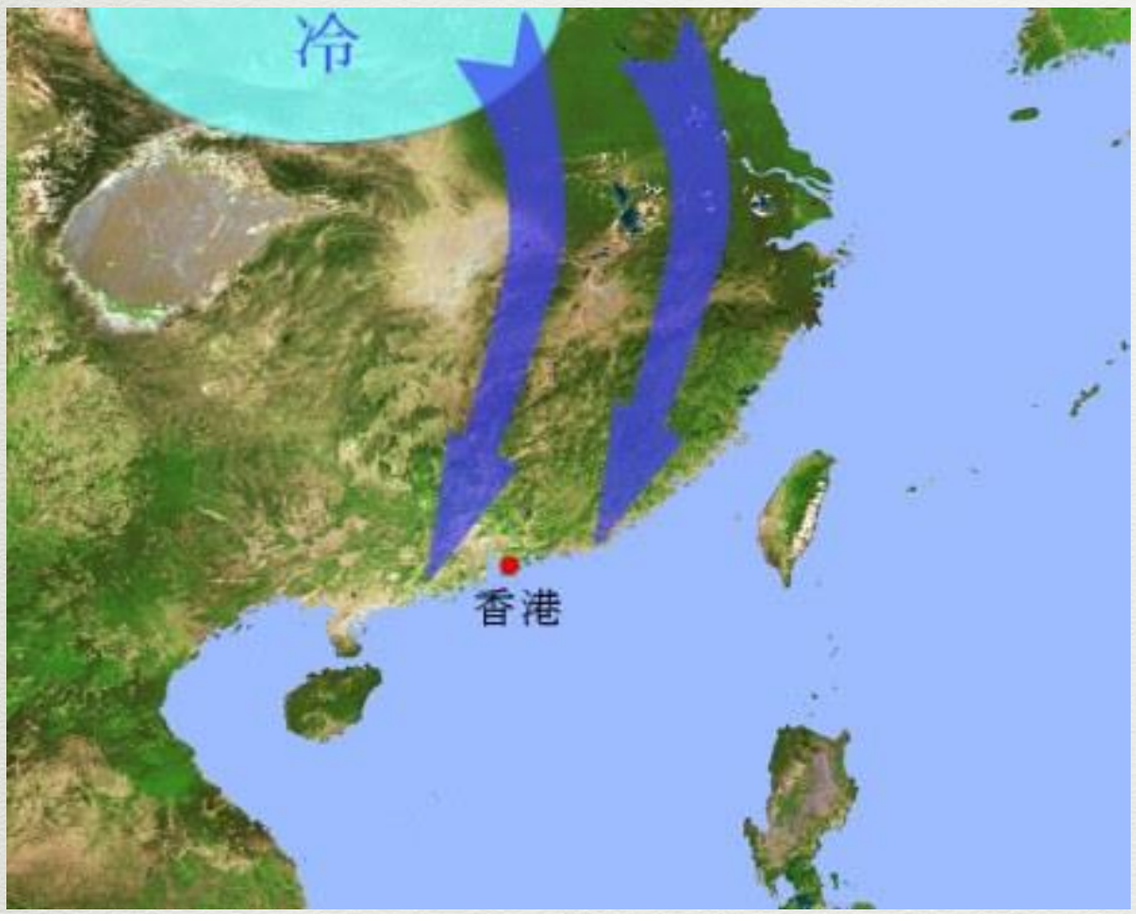
季風

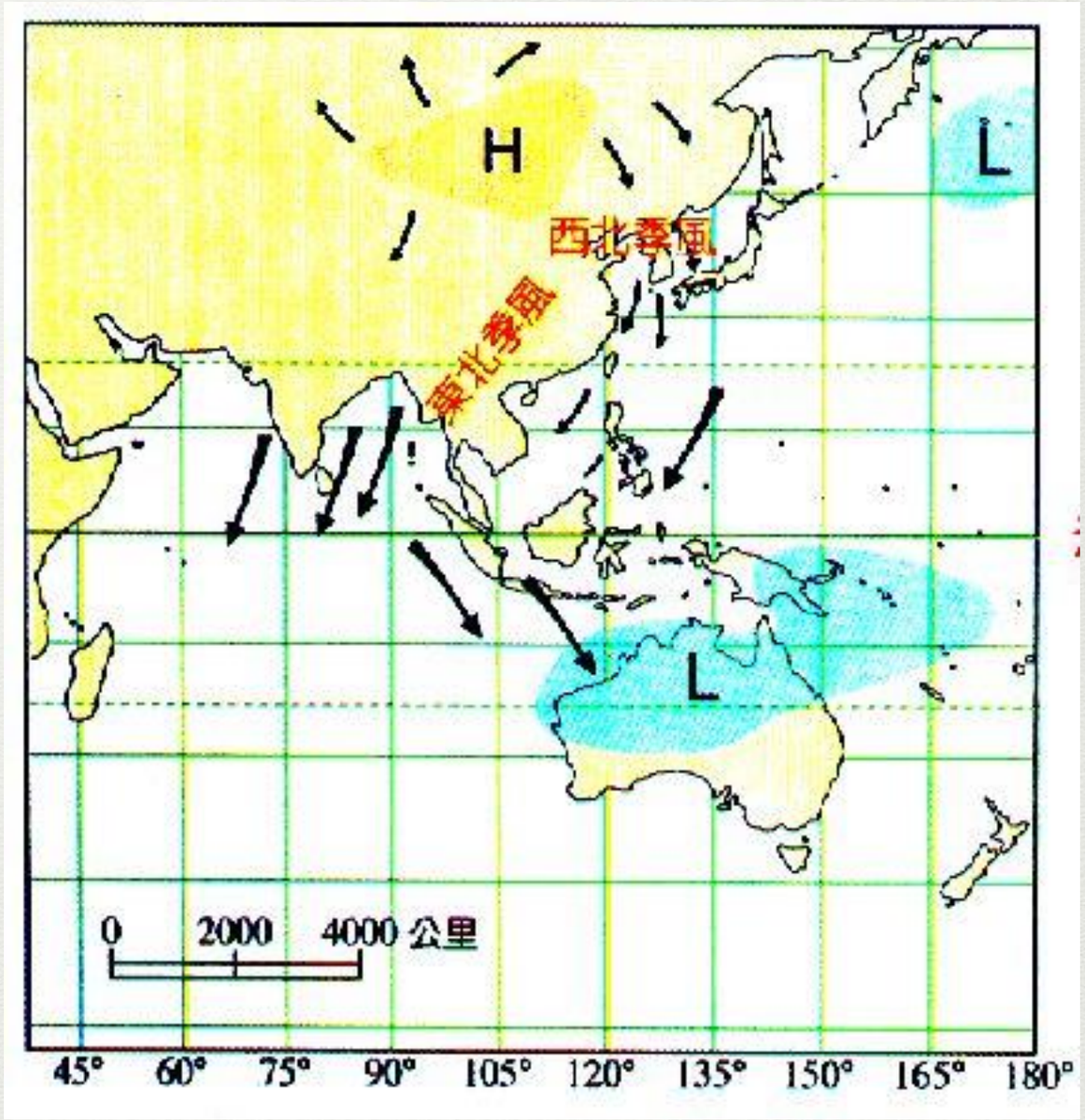

熱
香港


L
H
H
H
西南季風
東南季風
0
2000
4000 公里
45°
60°
75°
90°
105°
120°
135°
150°
165°
180°

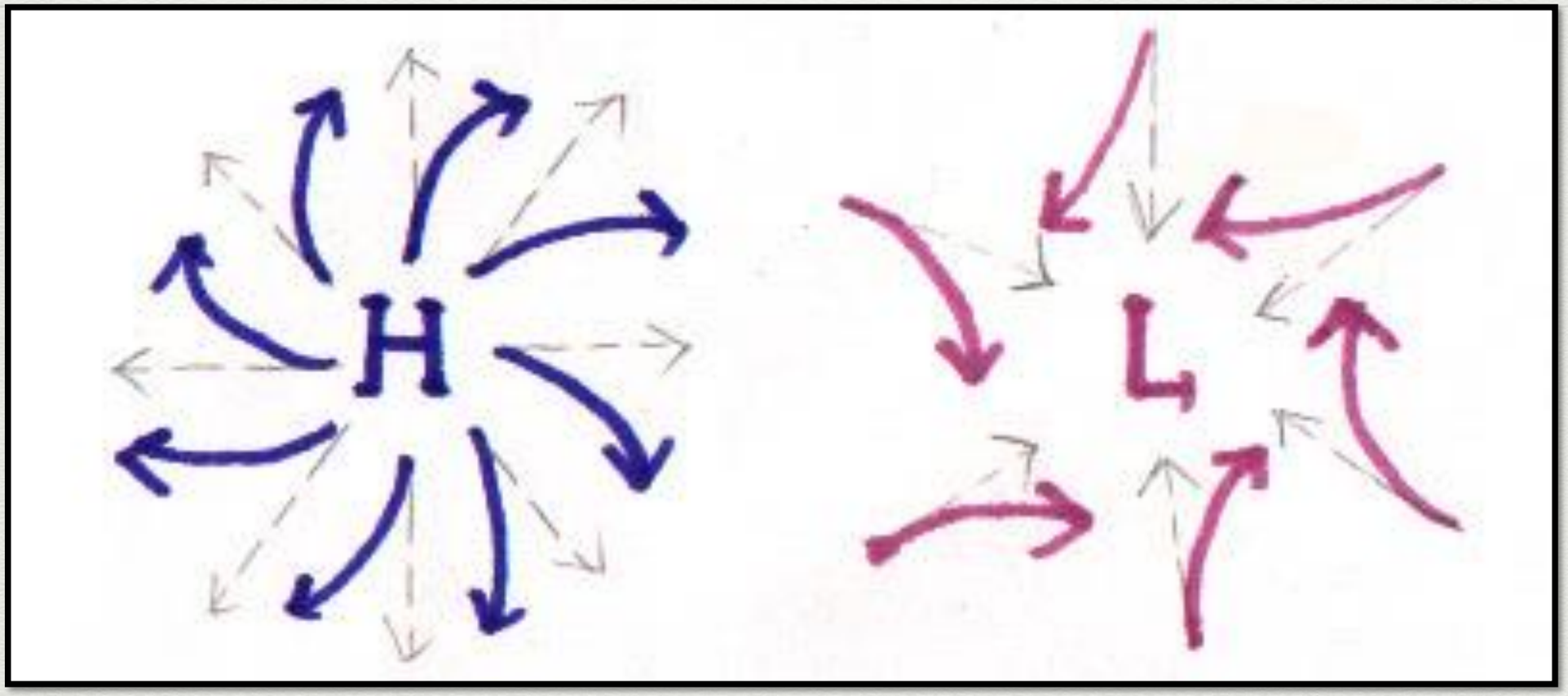
季風

■冬


冷
香港


H
L
西北季風
東北季風
L
0 2000 4000 公里
45° 60° 75° 90° 105° 120° 135° 150° 165° 180°

北半球氣旋



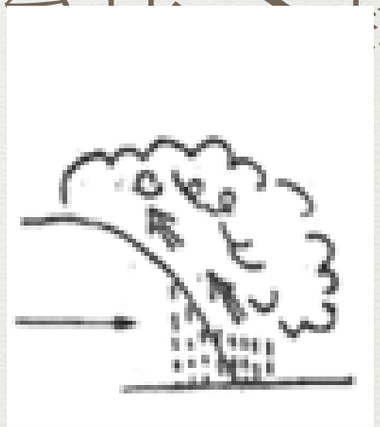
雲

- 以成因分類
- 以形態分類

以成因分類

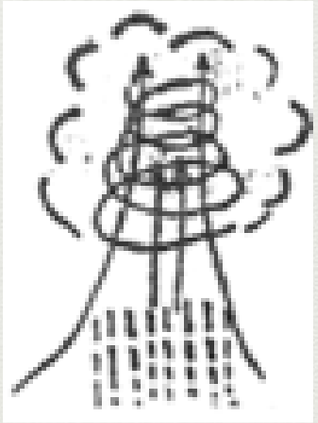
1. 對流 -> 對流雲

3. 動力抬升 -> 鋒面雲



2. 地形抬升-> 地形雲

4. 輻合 -> 氣旋雲



比熱容 Specific Heat Capacity (*c*)

- c_{land} = 800 $(J/kg/°C)$

山→天氣易變

- c_{ocean} = 4180 $(J/kg/°C)$

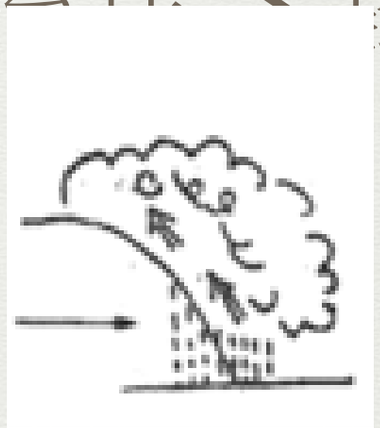
海→天氣穩定

航海見陸地

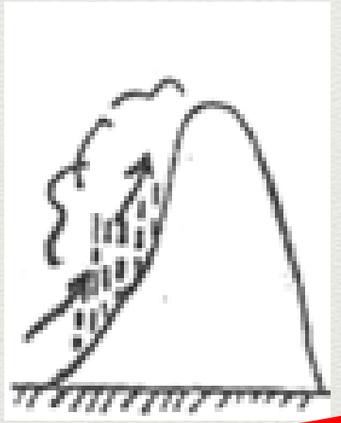
以成因分類

1. 對流 -> 對流雲

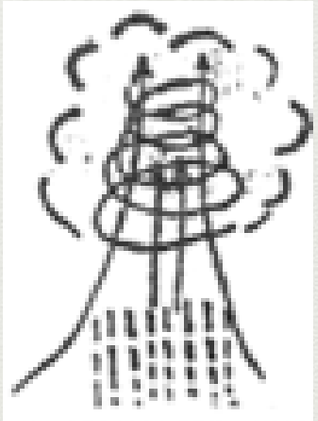
3. 動力抬升 -> 鋒面雲

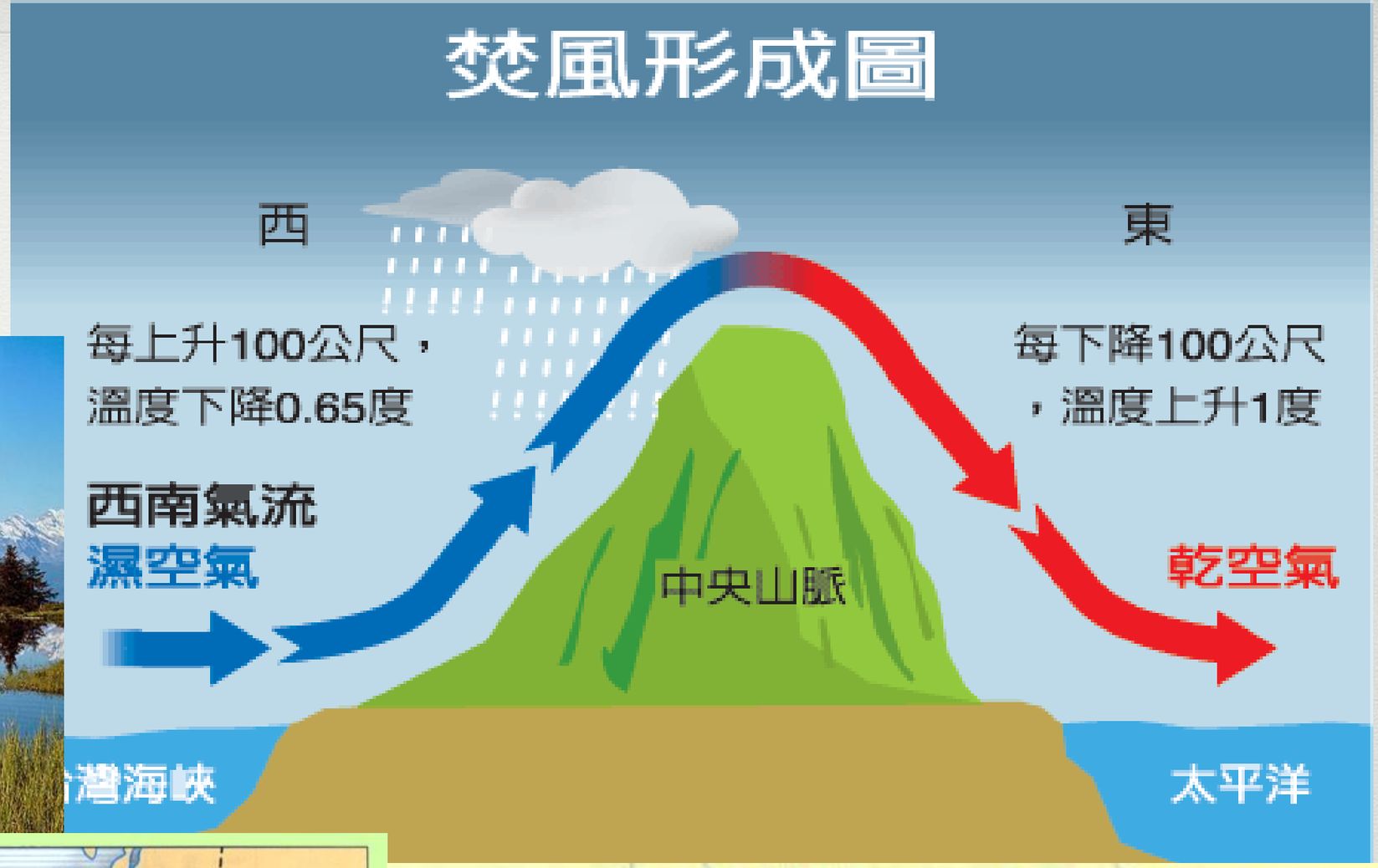


2. 地形抬升-> 地形雲



4. 輻合 -> 氣旋雲





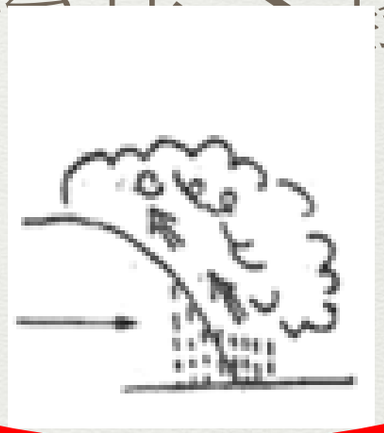
歐洲地形圖

南歐焚風示意圖

以成因分類

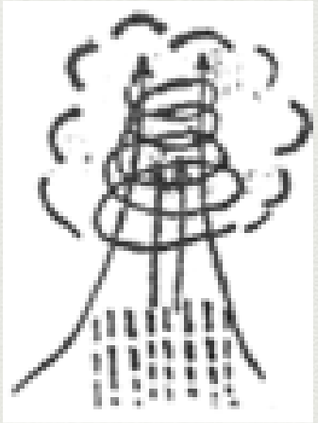
1. 對流 -> 對流雲

3. 動力抬升 -> 鋒面雲

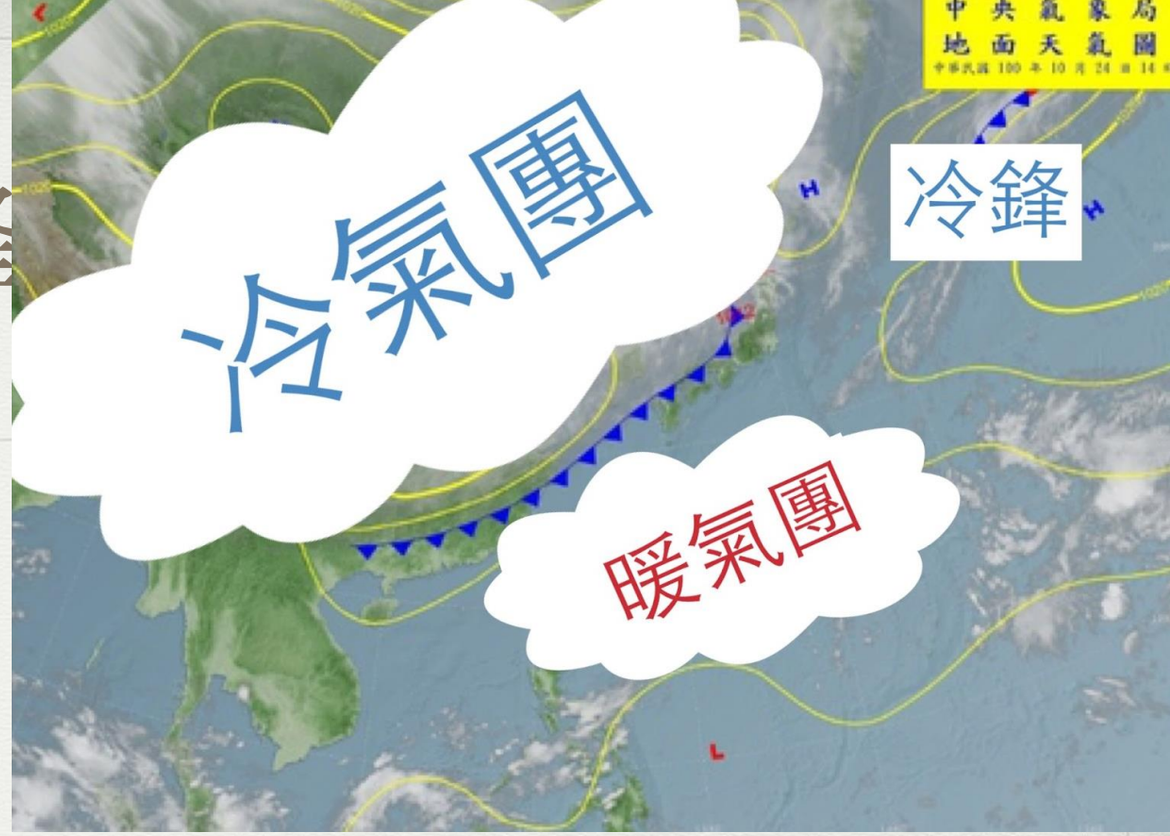


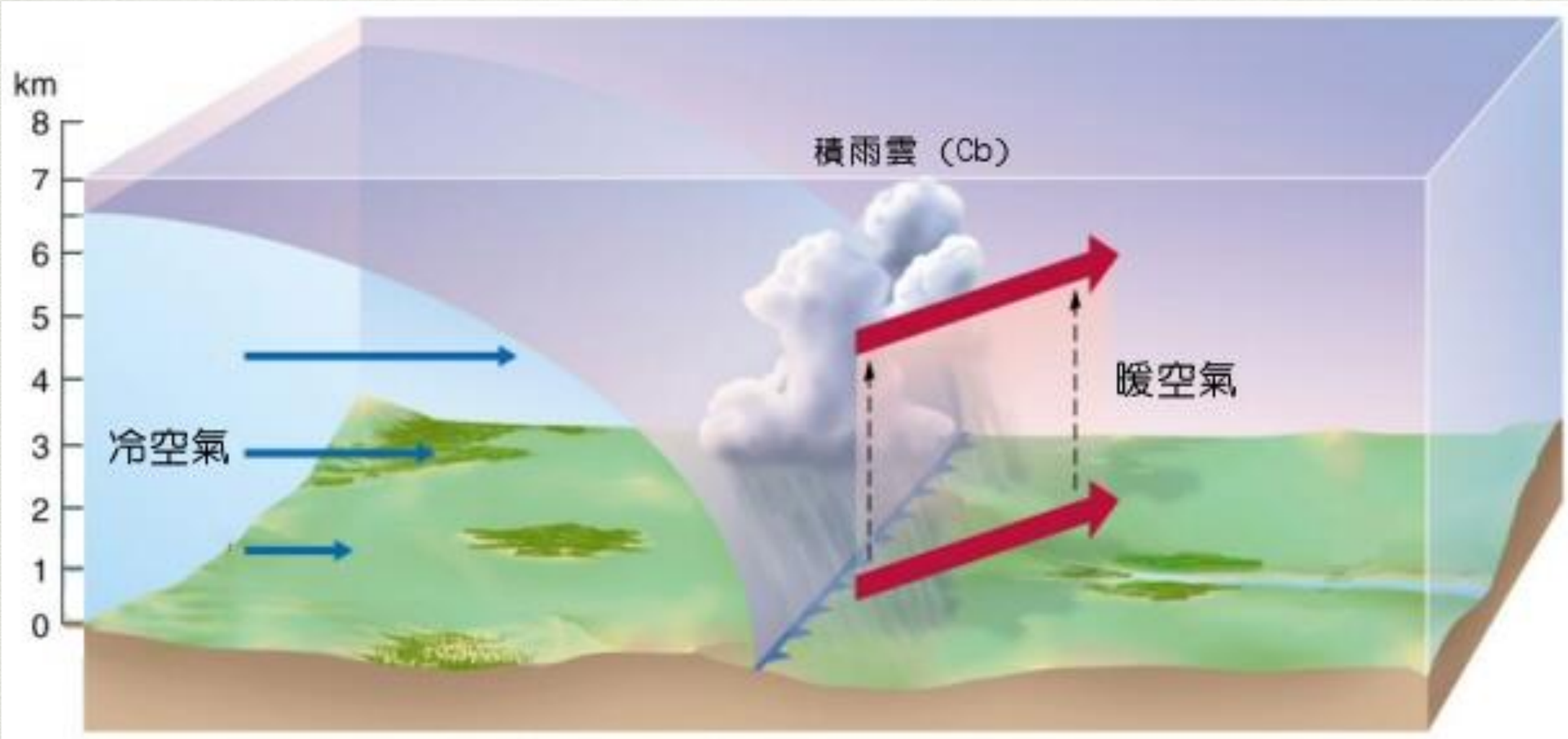
2. 地形抬升-> 地形雲

4. 輻合 -> 氣旋雲

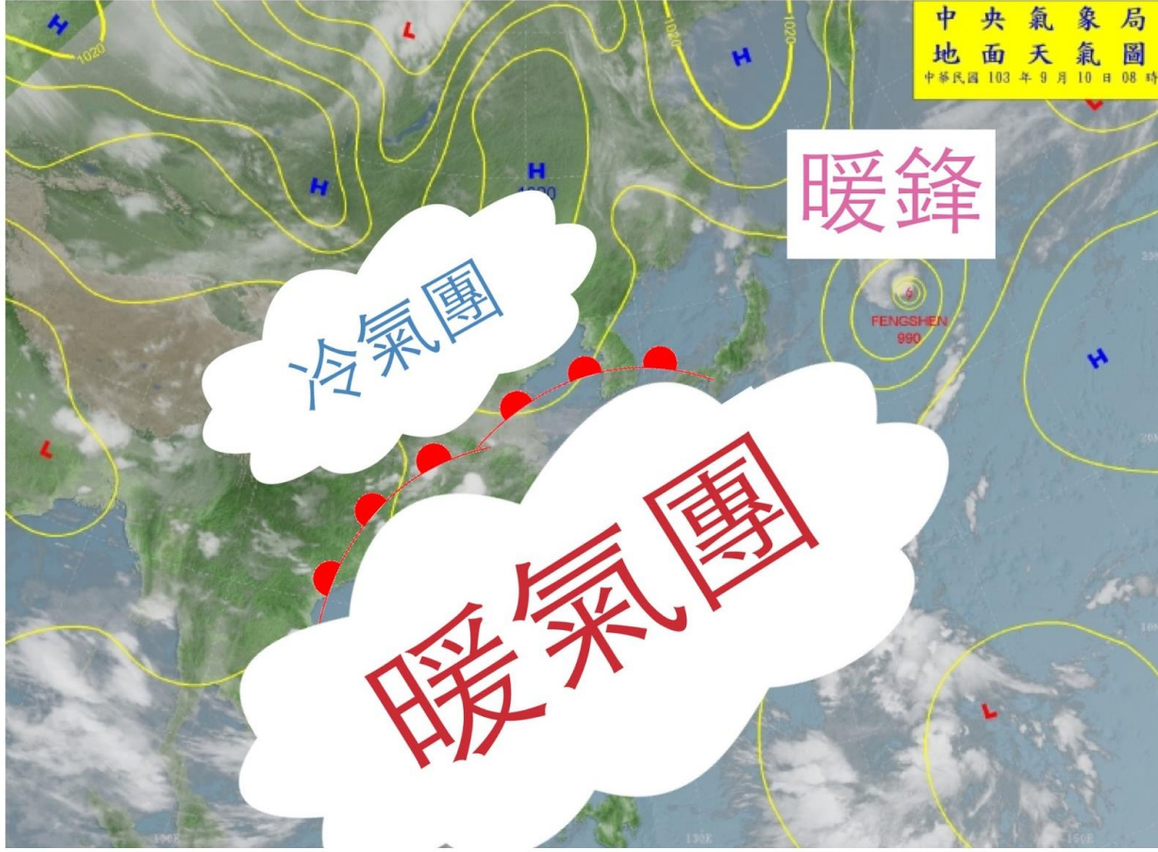


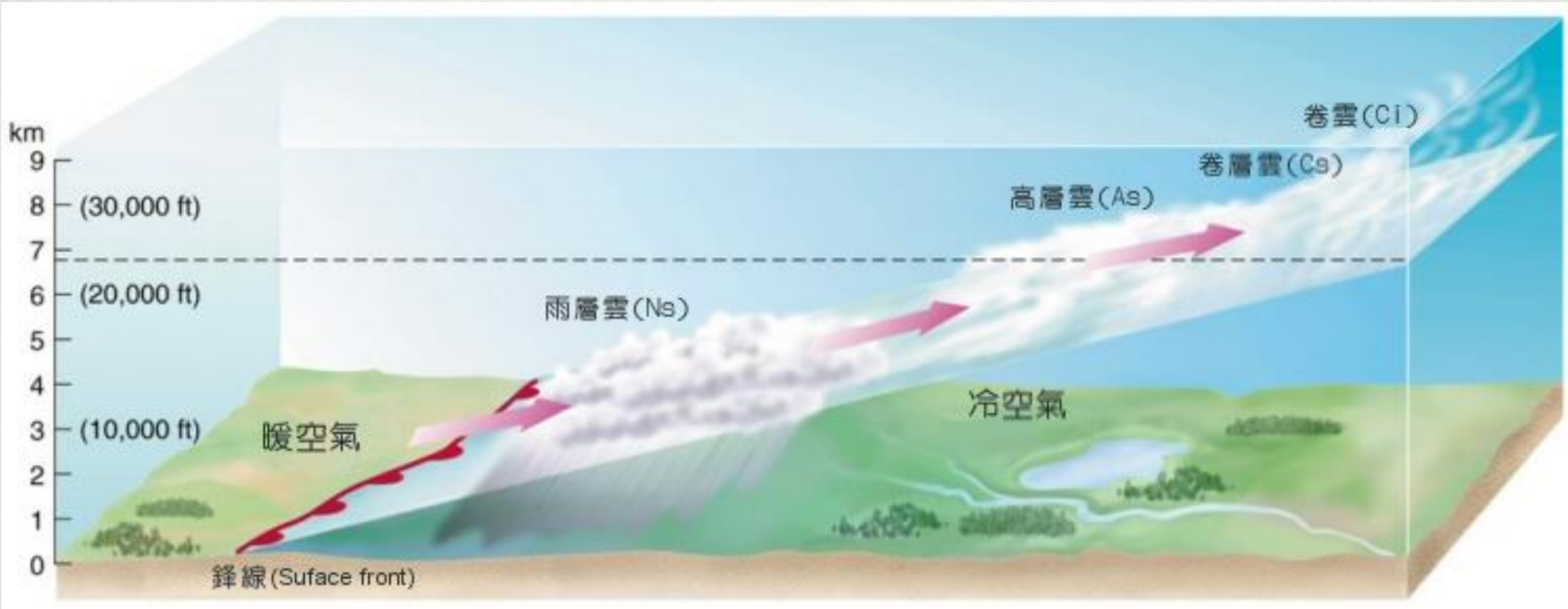
冷鋒





暖鋒


中央氣象局
地面天氣圖
中華民國 103 年 9 月 10 日 08 時
暖鋒
冷氣團
暖氣團
FENGSHEN
990


km
9
8
7
6
5
4
3
2
1
0
(30,000 ft)
(20,000 ft)
(10,000 ft)
卷雲(Ci)
卷層雲(Cs)
高層雲(As)
雨層雲(Ns)
暖空氣
冷空氣
鋒線(Suface front)

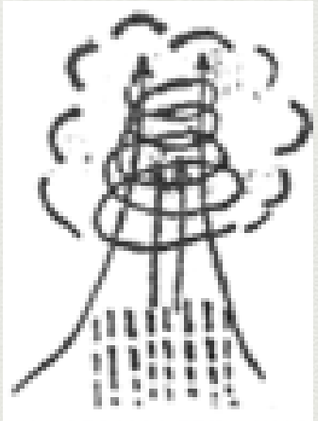
以成因分類

1. 對流 -> 對流雲

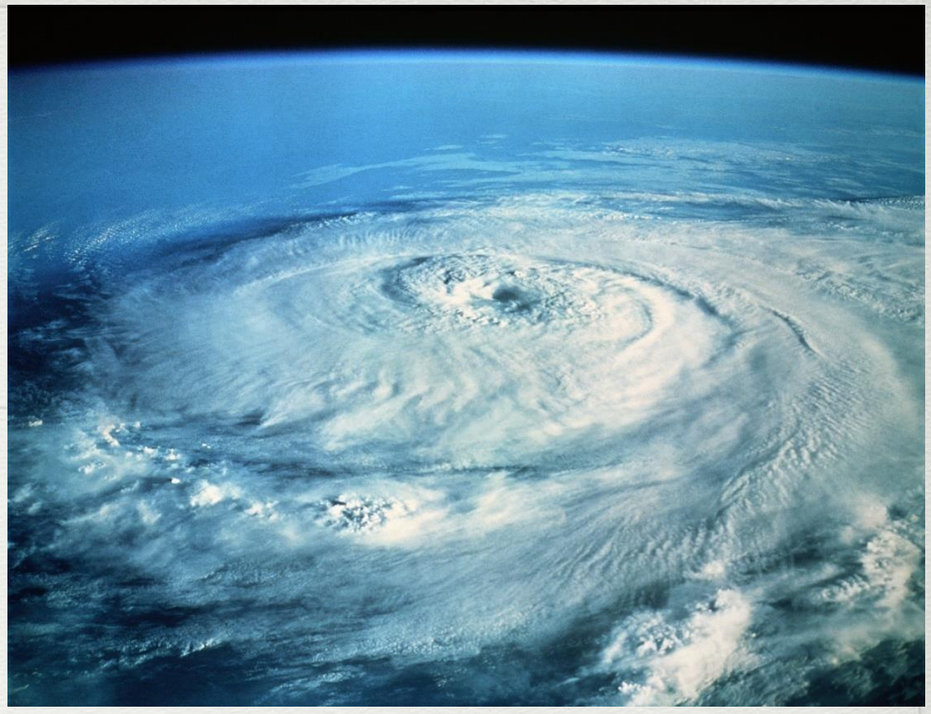
3. 動力抬升 -> 鋒面雲

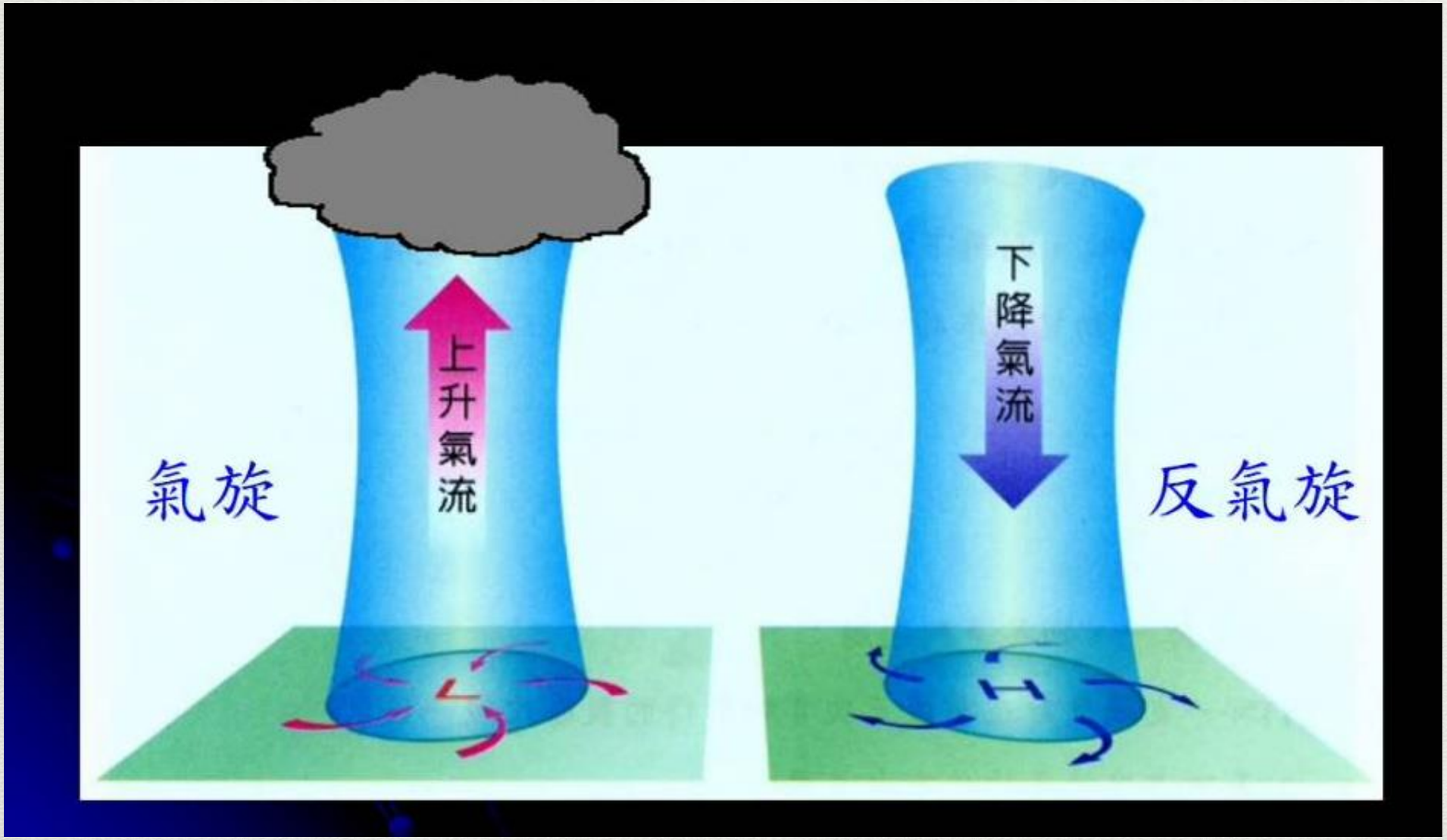
2. 地形抬升-> 地形雲

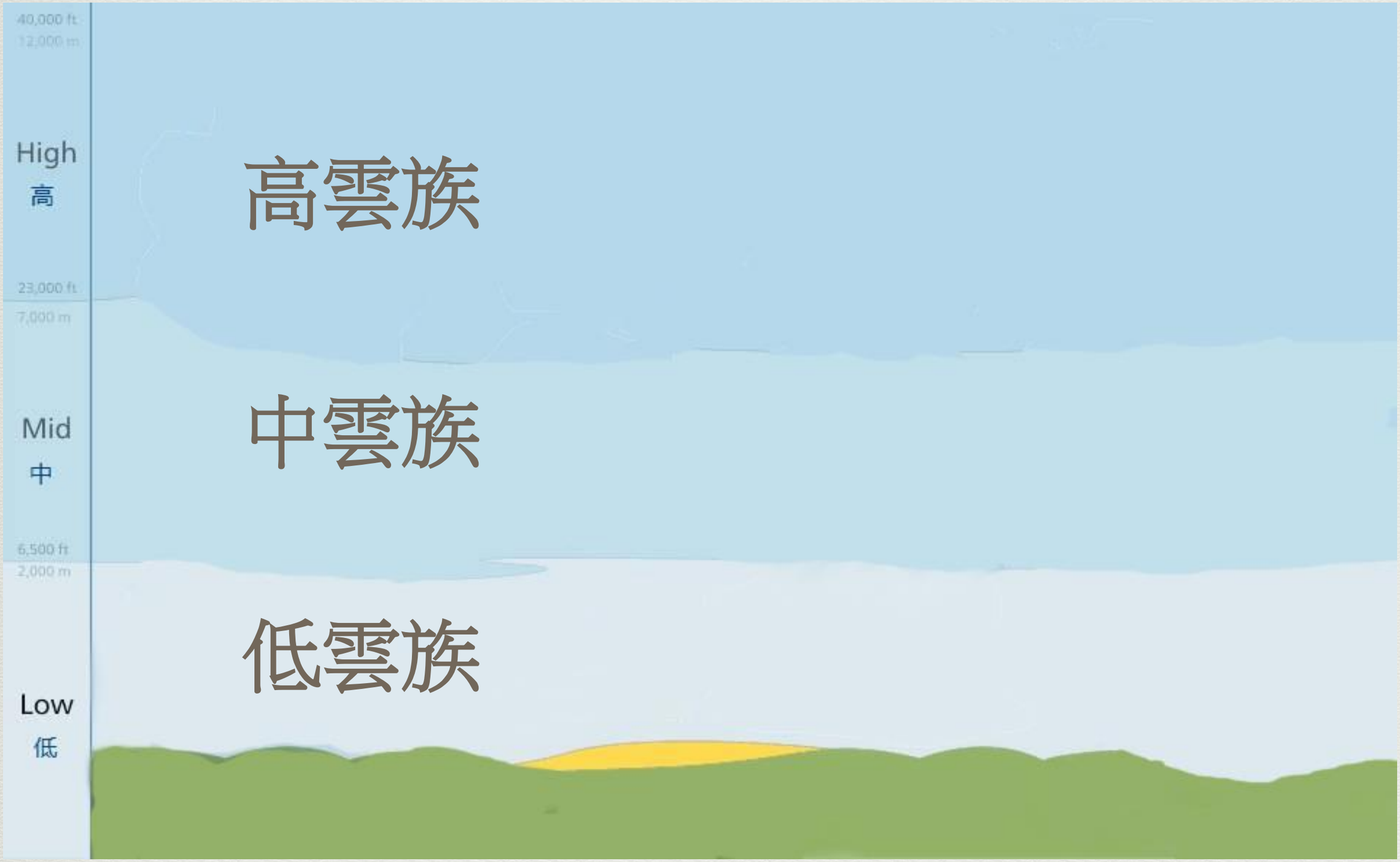
4. 輻合 -> 氣旋雲



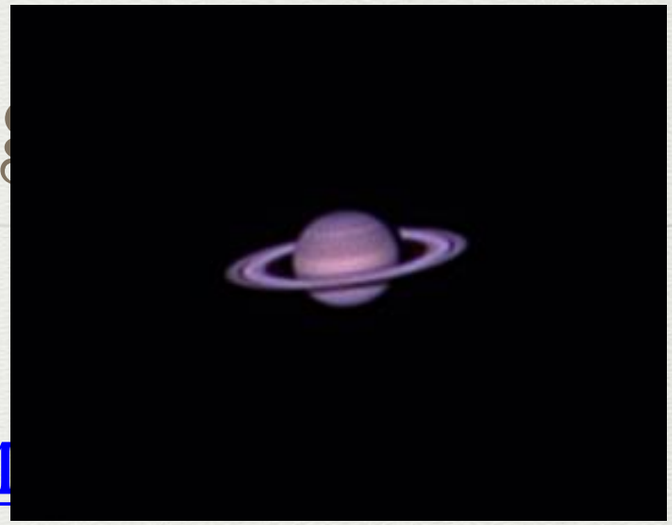
氣旋






40,000 ft
12,000 m
High
高
23,000 ft
7,000 m
Mid
中
6,500 ft
2,000 m
Low
低
高雲族
中雲族
低雲族

大氣視寧度
(Atmospheric Seein

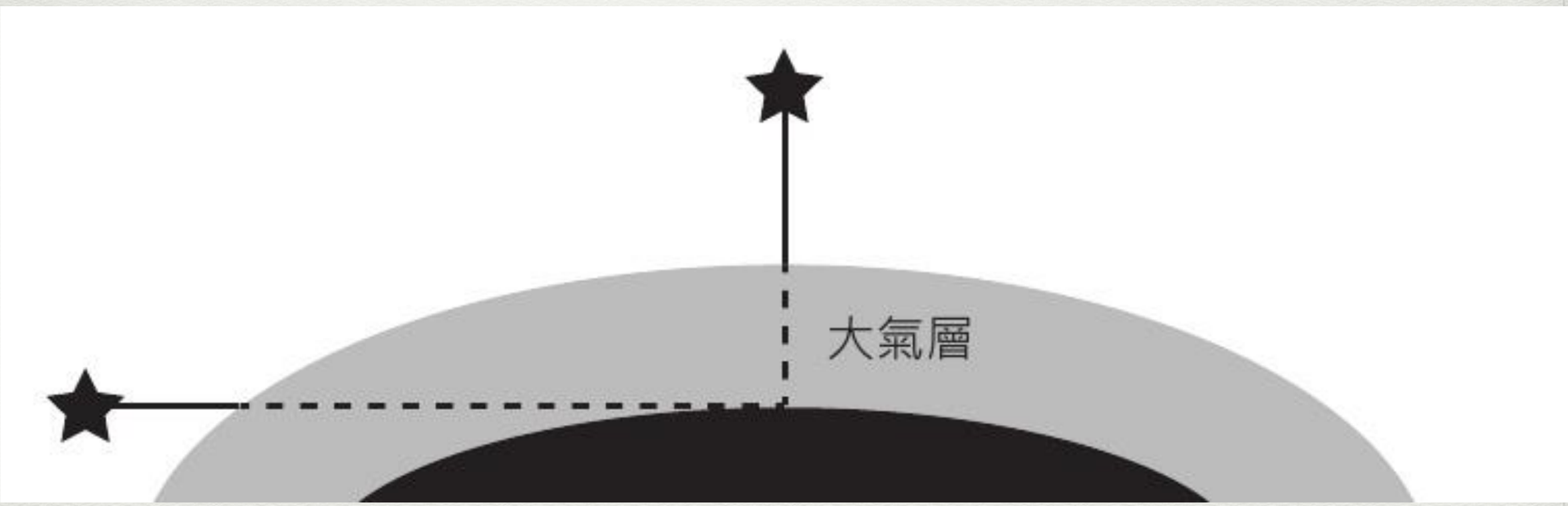


- Twinkle Twinkle Little Star
- https://www.youtube.com/watch?v=CYhIKRd-yBM
- https://www.youtube.com/watch?v=7nKaYCSxqpU
- 皮克韻視寧度(Pickering Seeing Scale) 1-10級

  http://calgary.rasc.ca/seeing.htm

口徑的影響

仰角的影響



大氣透明度 (Transparency)

- AAAA (The American Association of Amateur Astronomers) Scale 1-7 級

  1 極差:大部份天區有雲

  2 差:部份天區有雲或嚴重煙霞，可見小北斗中的1至2顆星

  3 有些天區清:有中度煙霞，見小北斗中的3至4顆星

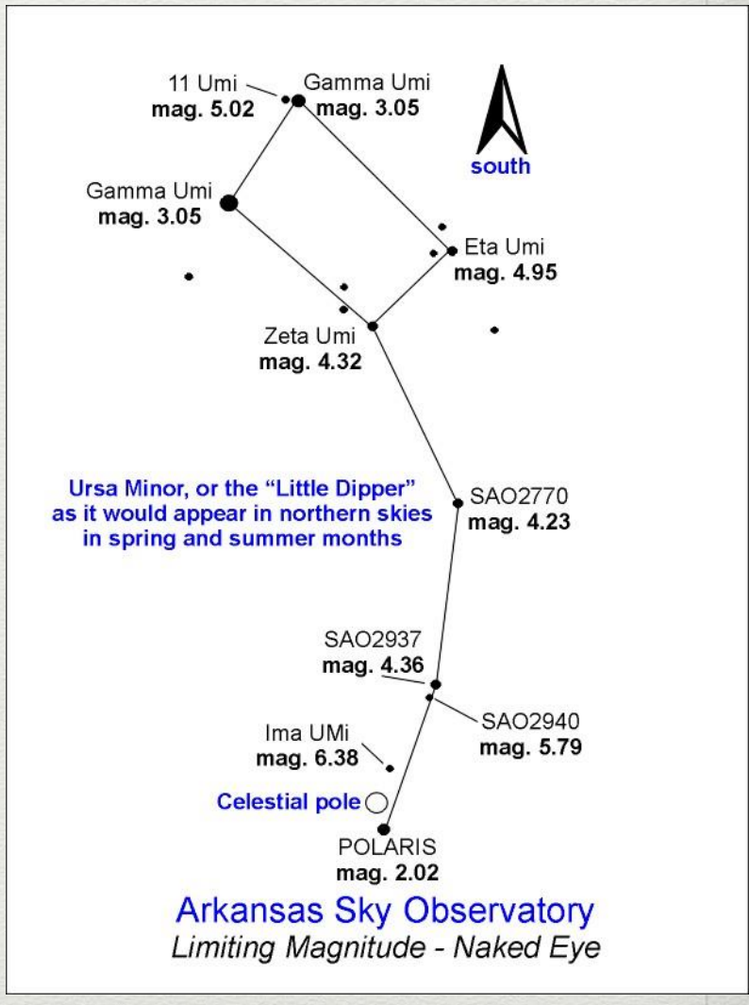
  4 部份天清:有輕微煙霞，見小北斗中的4至5顆星

  5 天清:無雲，肉眼可見銀河和小北斗中6顆星

  6 天空非常清:肉眼可見銀河、M31和7顆小北斗

  7 天空極清澈:肉眼可見 M33 和 M81。

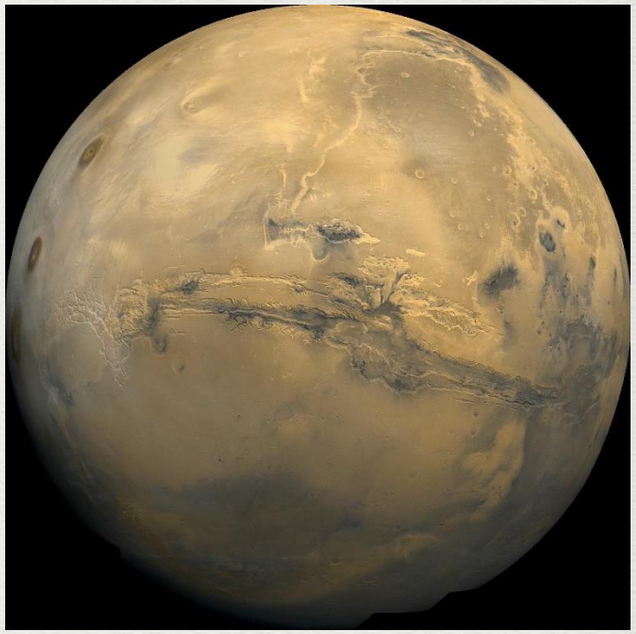
颱風後/雨後 (無塵)



月圓睇星?

海邊觀星

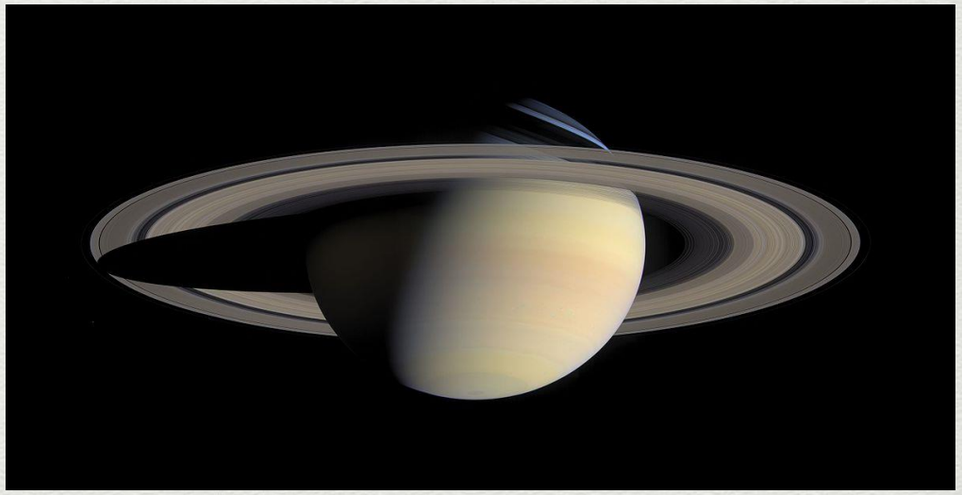
主要目的：穩定大氣



觀測目標：月球/行星

留意風向：

- 早上 (海風)
- 晚間 (陸風)



曠野觀星

最佳時分：

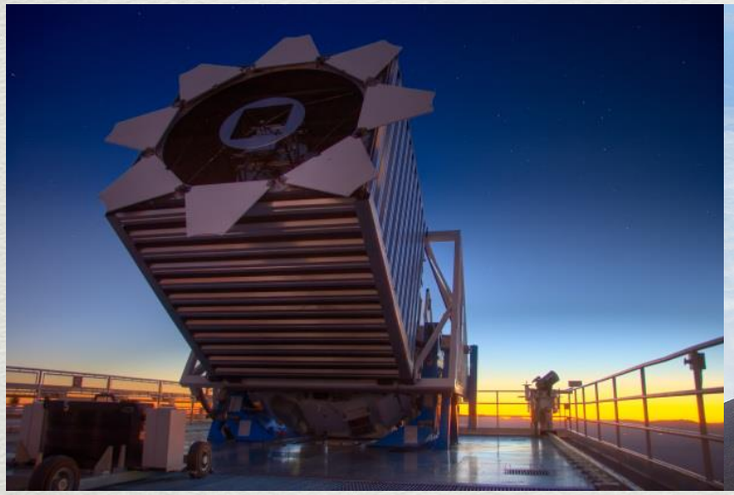
- 黃昏入黑後幾小時內散熱 → 視寧度差
- 天亮前(3-5am) 地面已散熱 → 視寧度好

注意！高透明度的情況

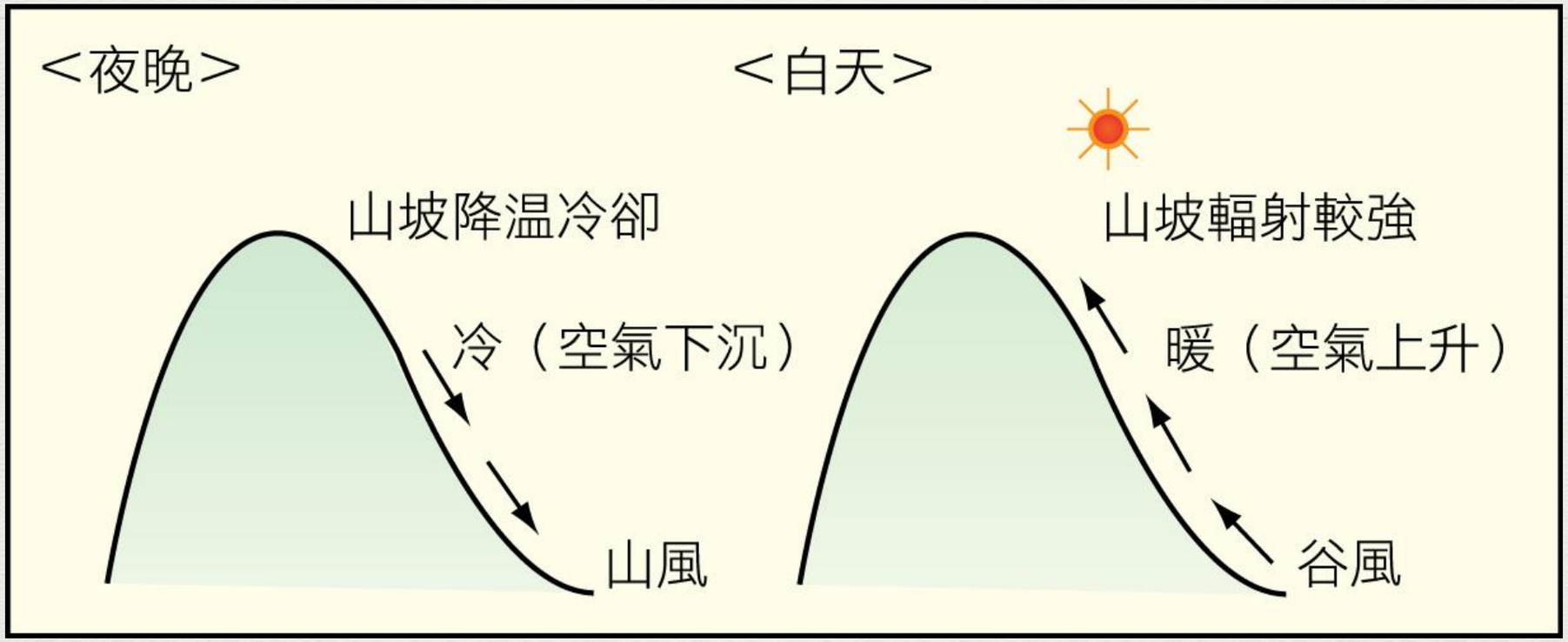
透明度高的晚上，清晨時份起霧！

http://ihouse.hkedcity.net/~hm1203/atmosphere/moisture.htm

天文台/望遠鏡	地點	高度
ALMA 阿塔卡瑪大型毫米及次毫米波陣列 VLT 甚大望遠鏡	智利	5640m 2635m
SDSS 史隆數位巡天	新墨西哥	2632m
SUBARU 昴星團望遠鏡 KECK I & II 凱克望遠鏡	夏威夷	4139m 4145m



山風 谷風



- 谷風輸送水氣上昇到山頂，往往可凝結成雲。
- 山風沿山坡下降積聚山谷內，使谷內水氣凝結產生霧。

http://www.cwb.gov.tw/V7/knowledge/encyclopedia/me_all.htm

上山準備

- 外層:防水及防風
  - 中層:保暖
  - 底層:排汗

安全第一！！

香港天文台
天氣監測圖像

- 天氣圖

  http://www.hko.gov.hk/wxinfo/currwx/wxchtc.htm

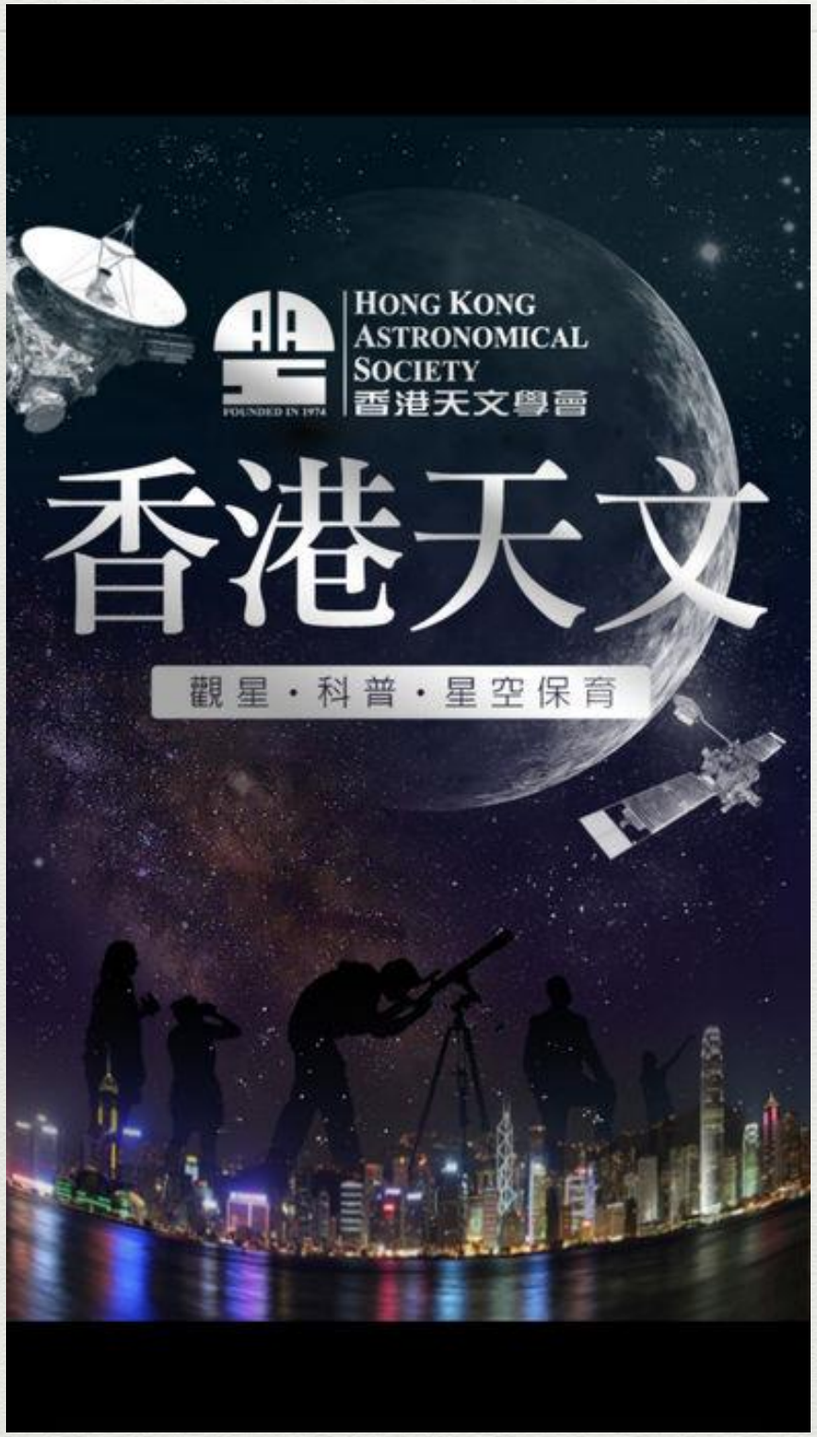
- 天氣雷達圖像

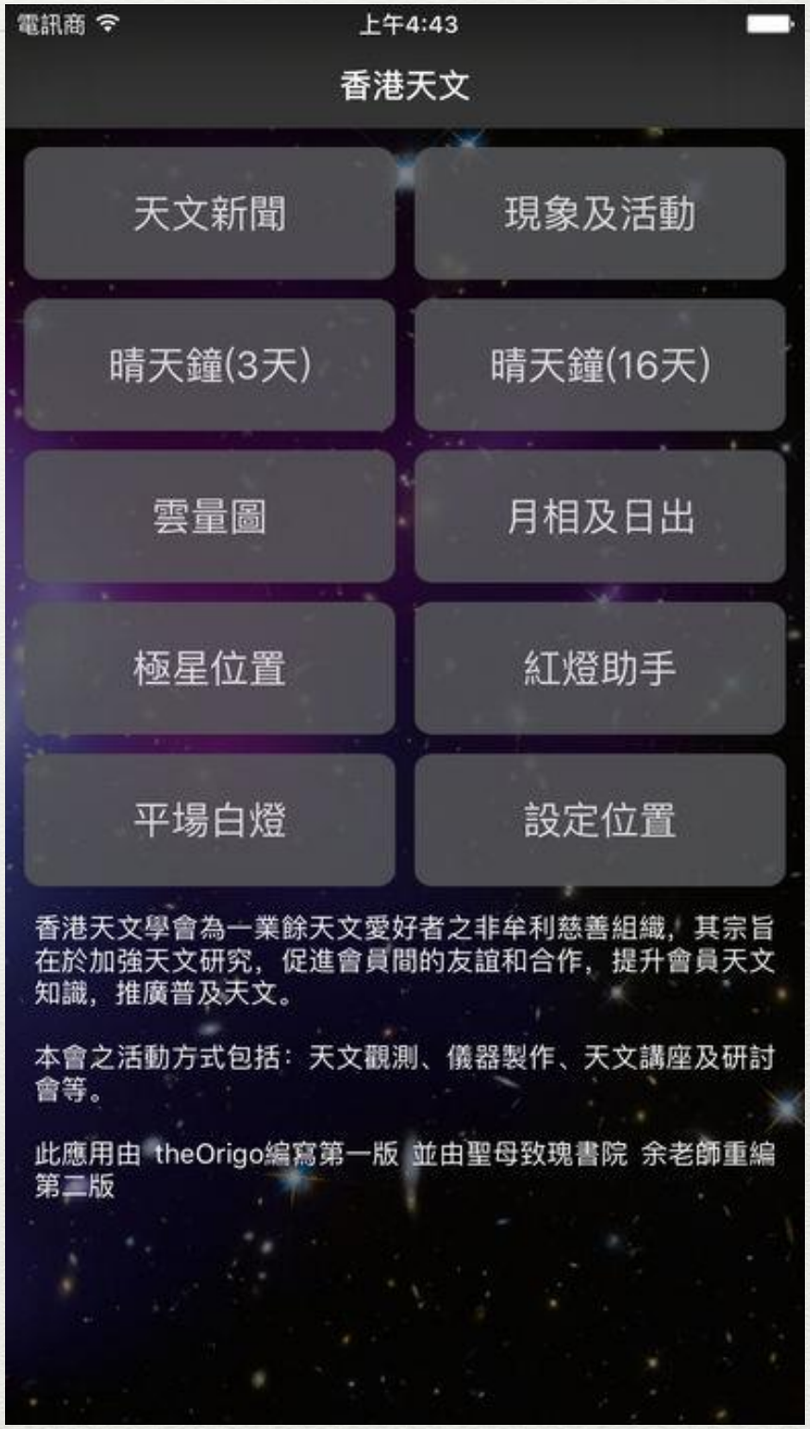
  http://www.hko.gov.hk/wxinfo/radars/radarc_range1.htm

- 氣象衛星圖像

  http://www.hko.gov.hk/wxinfo/intersat/satellite/satc_uc.htm

香港天文





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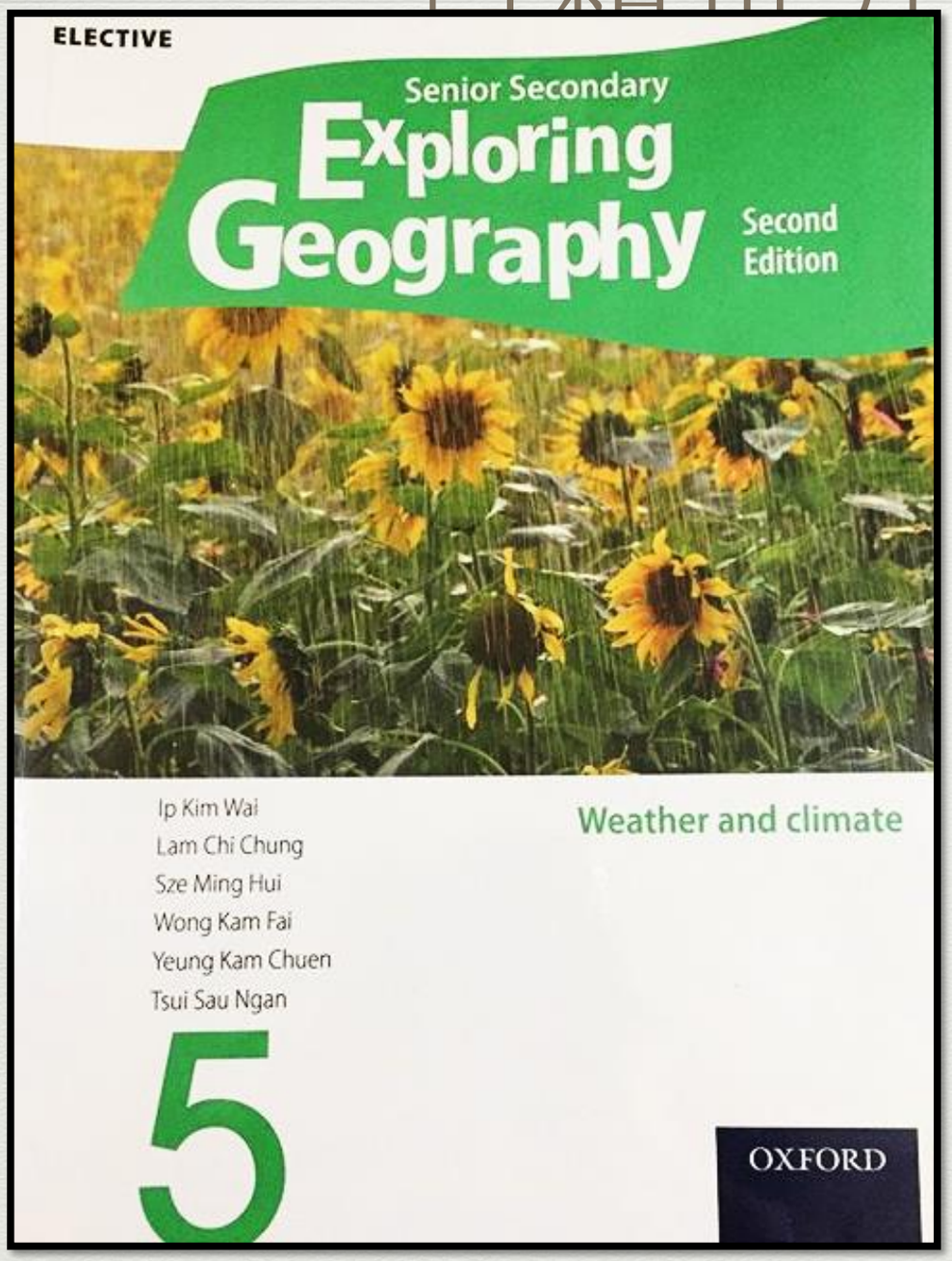
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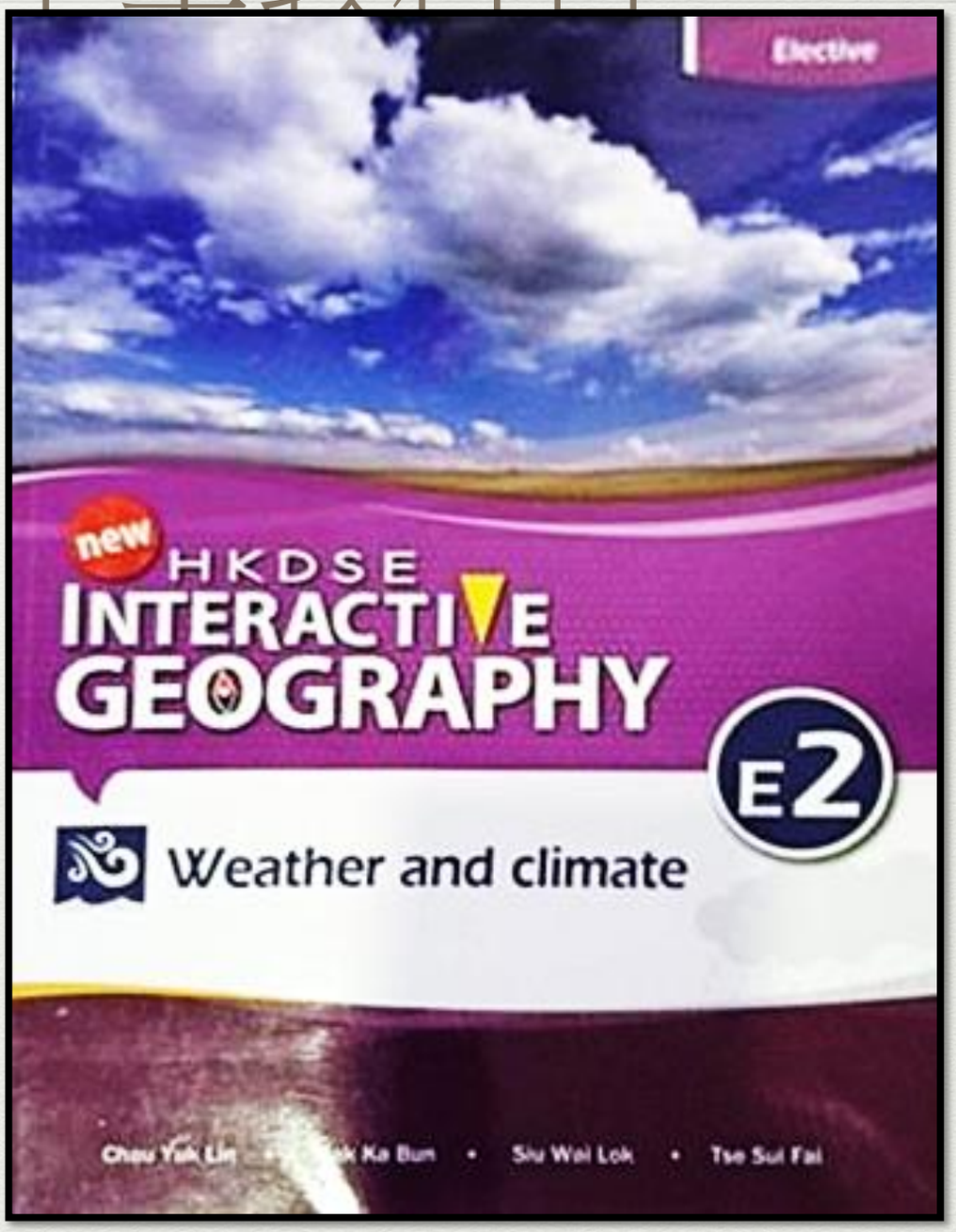
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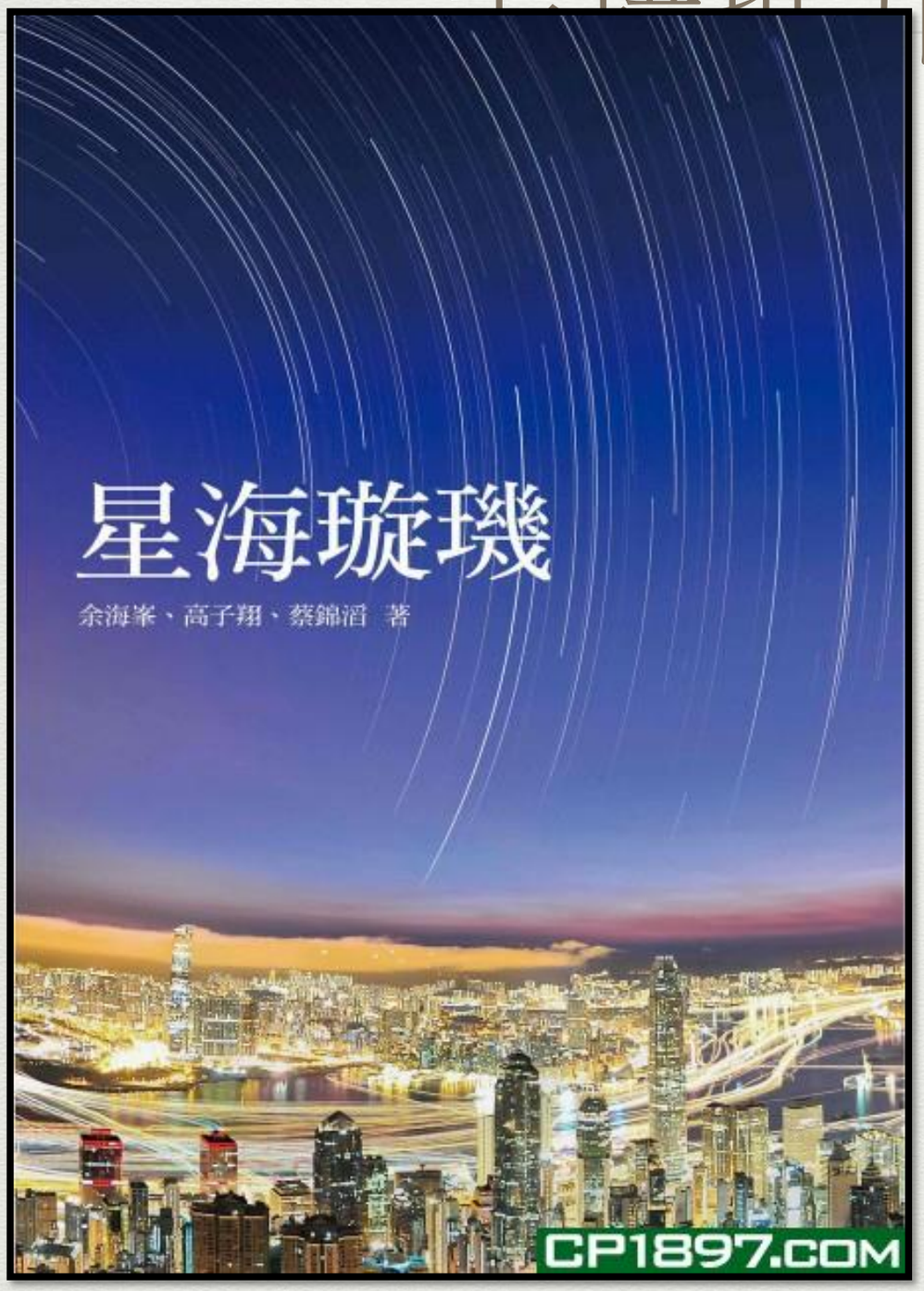
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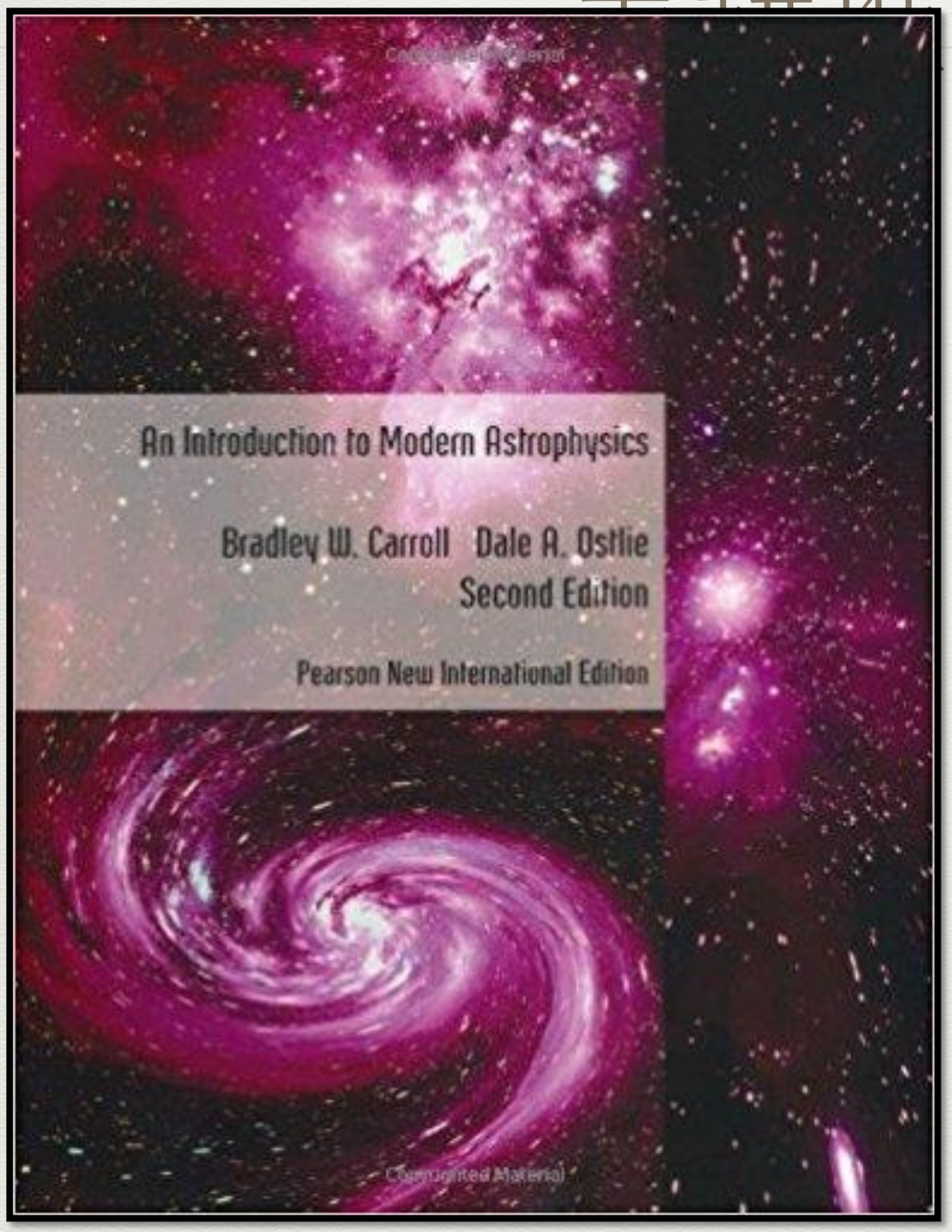
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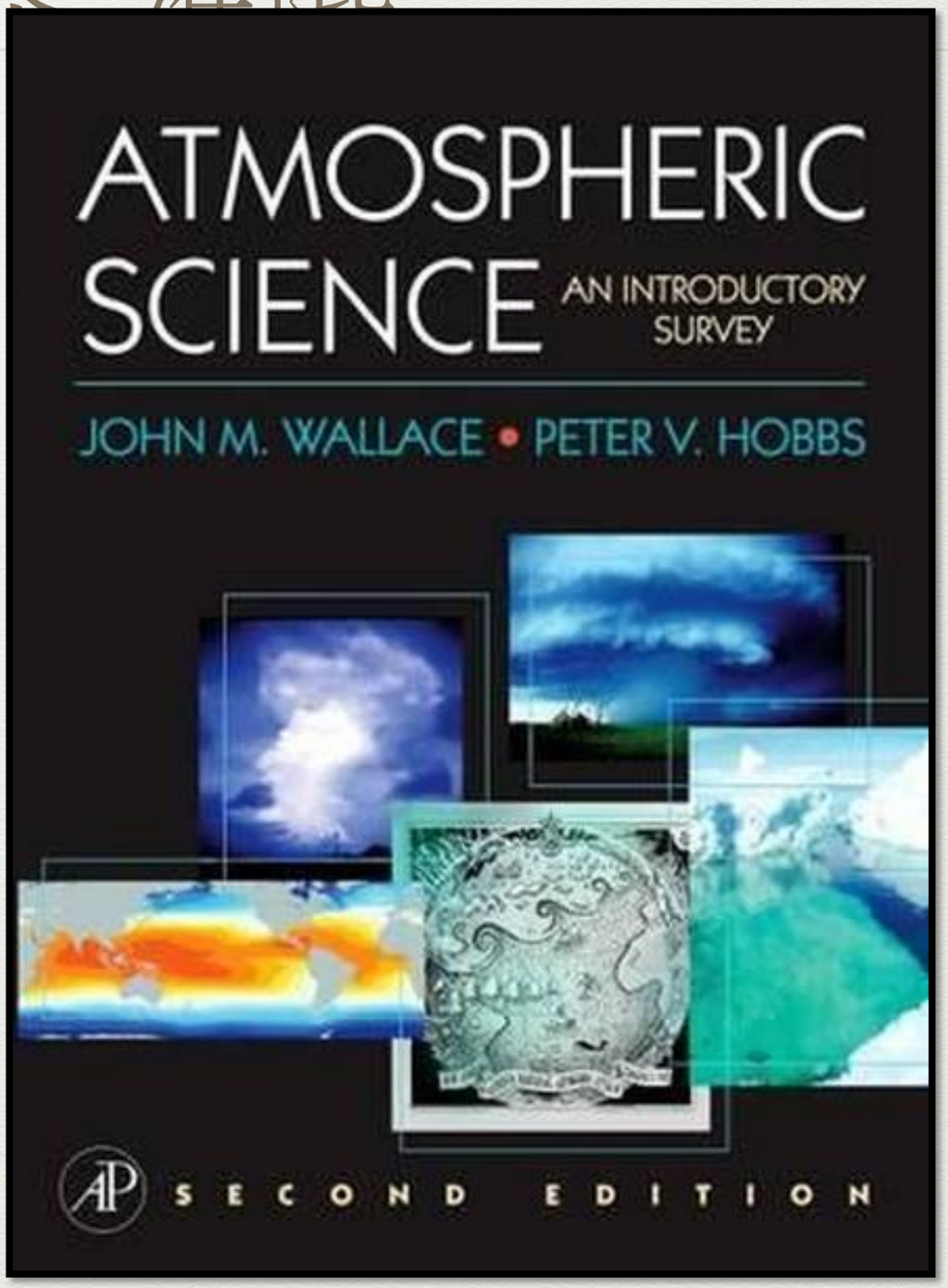
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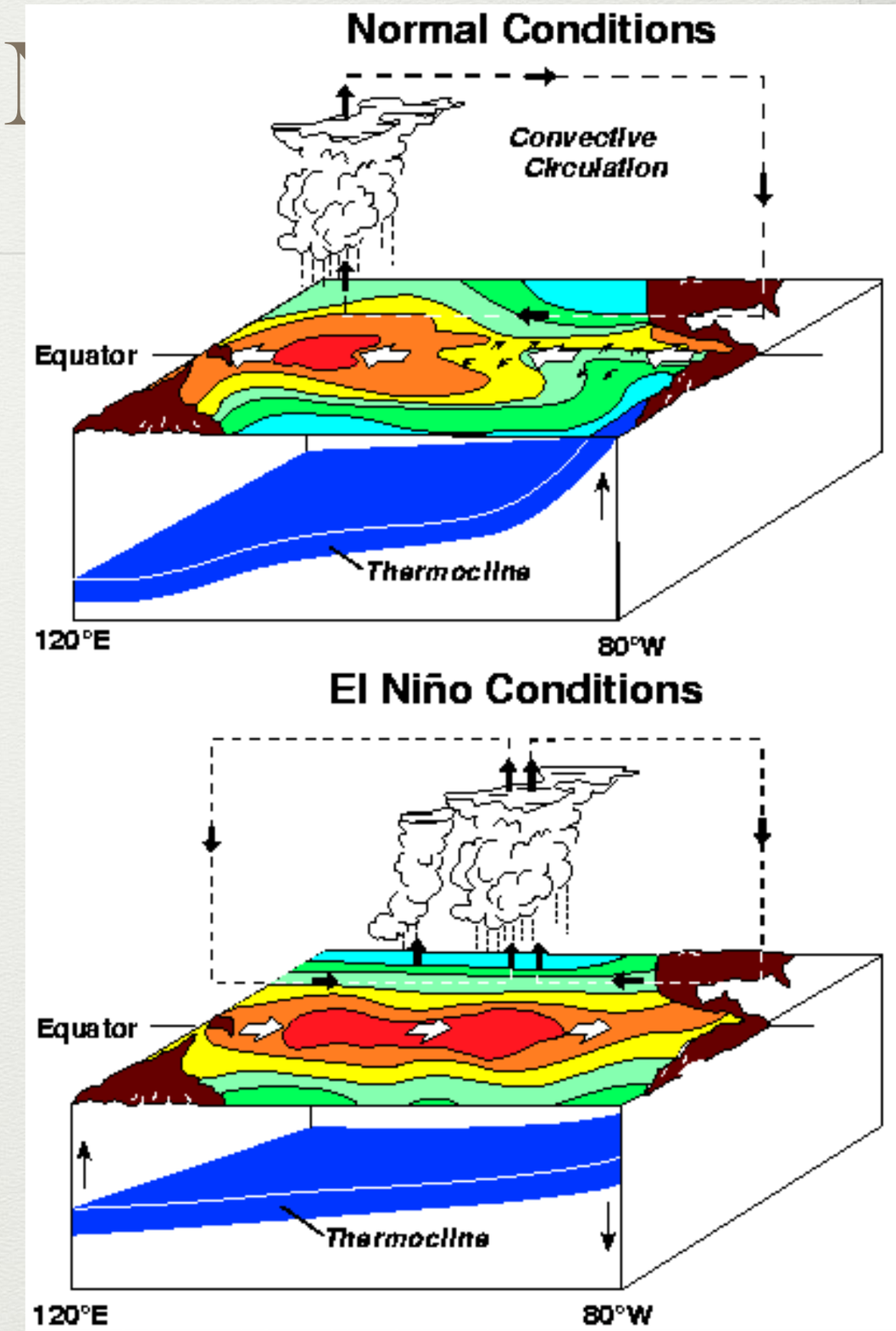
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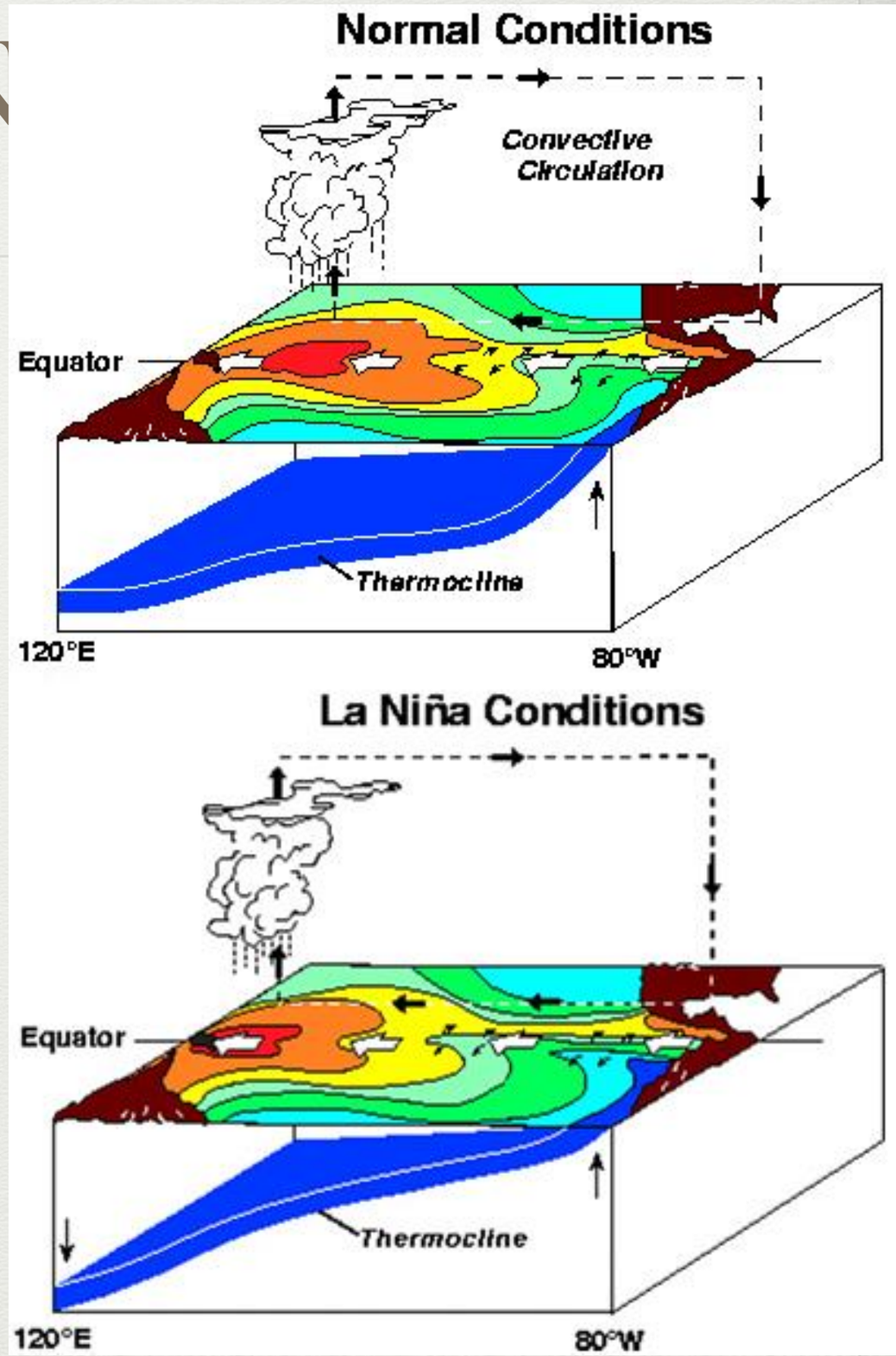
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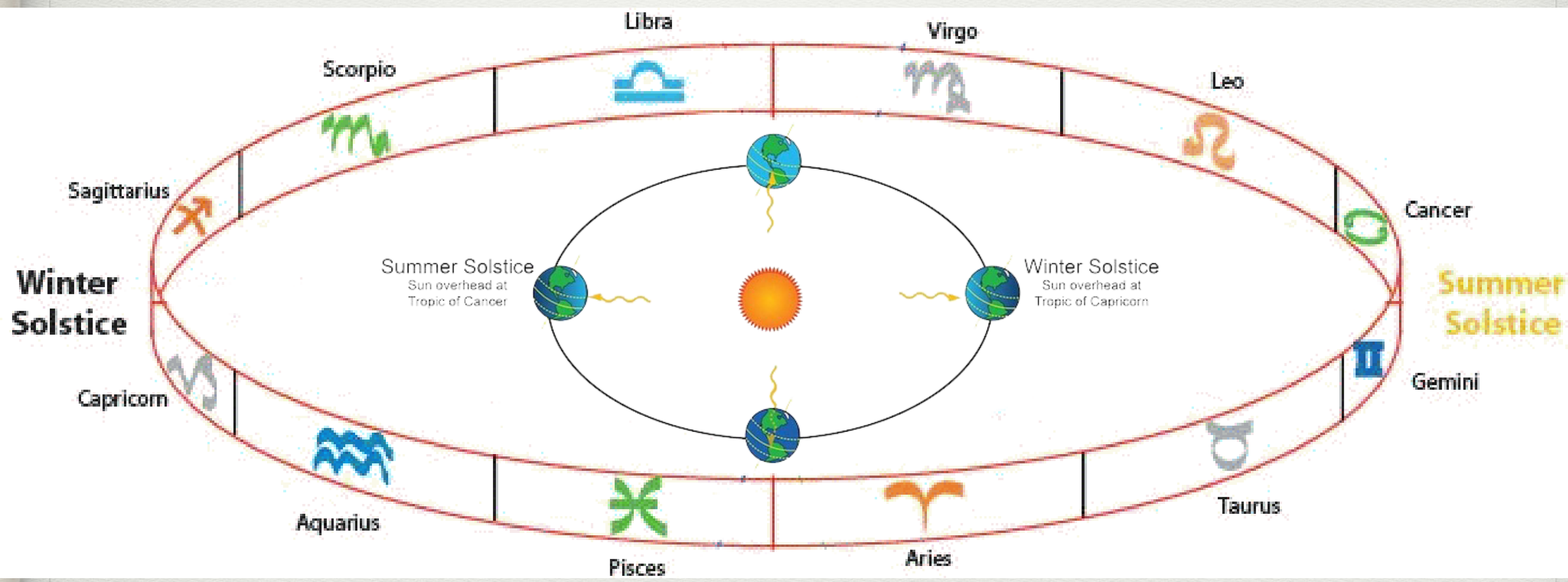
至點 Solstice

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