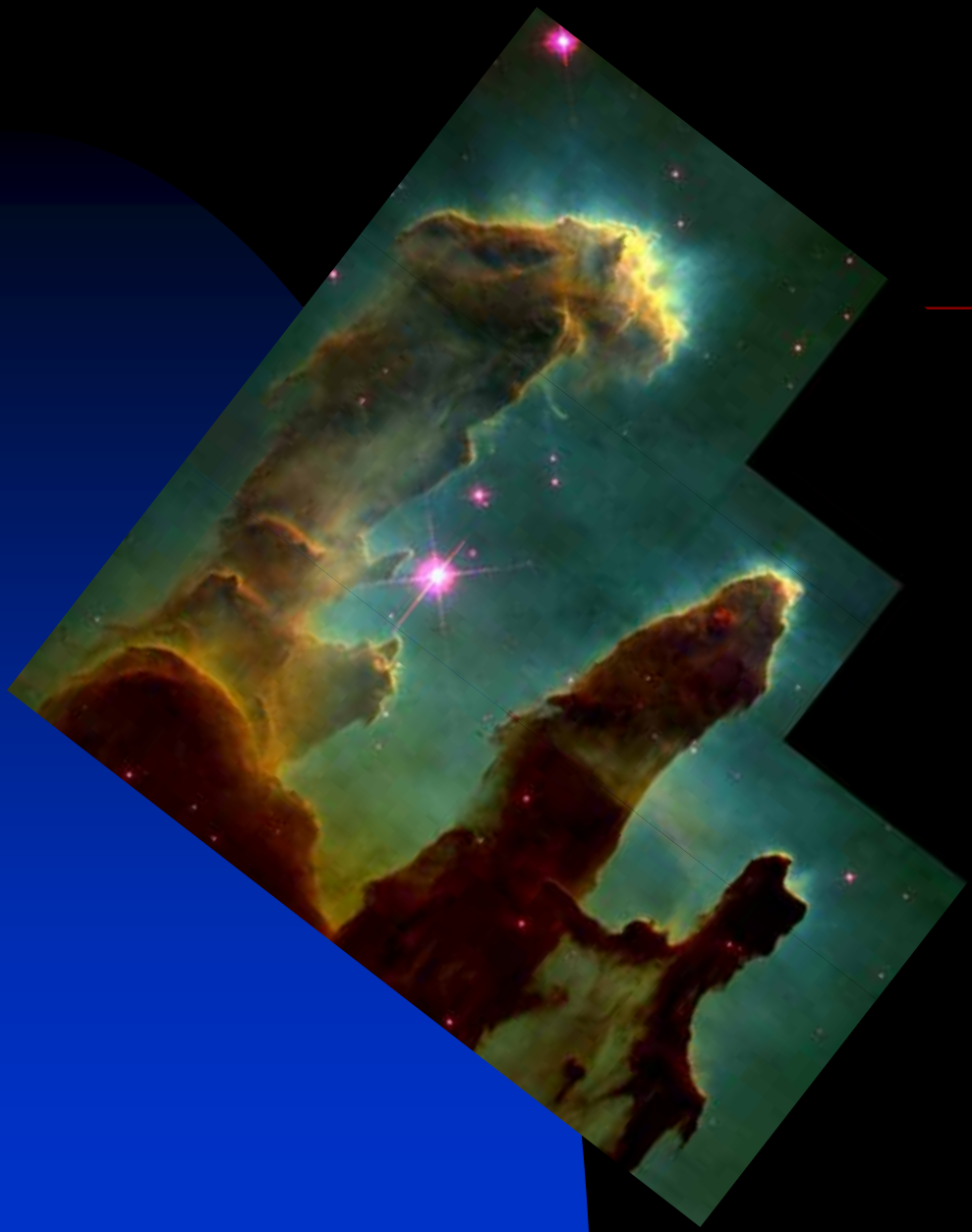
天體輻射



輻射體——靠自己熱度發光

越熱➔ 越明亮、顏色越白熾

溫度低 ——————————→ 溫度高

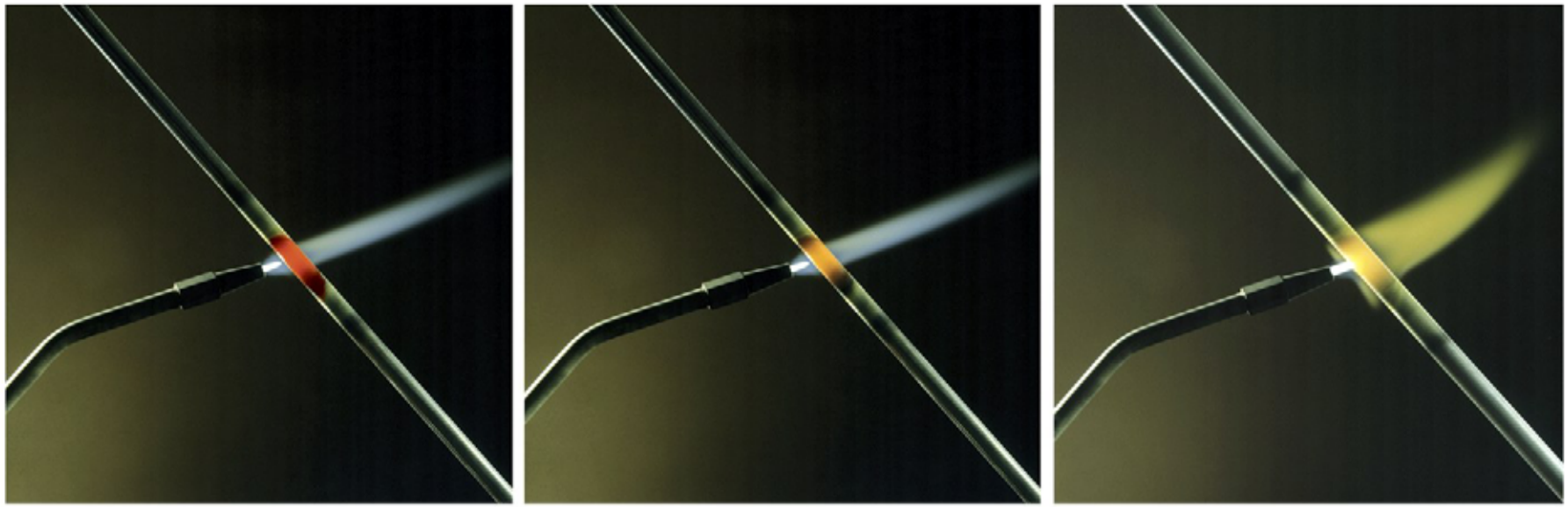


Figure 4-1
Discovering the Universe, Seventh Edition

紅橙 ———— 黃綠 ———— 藍白

Planck Function

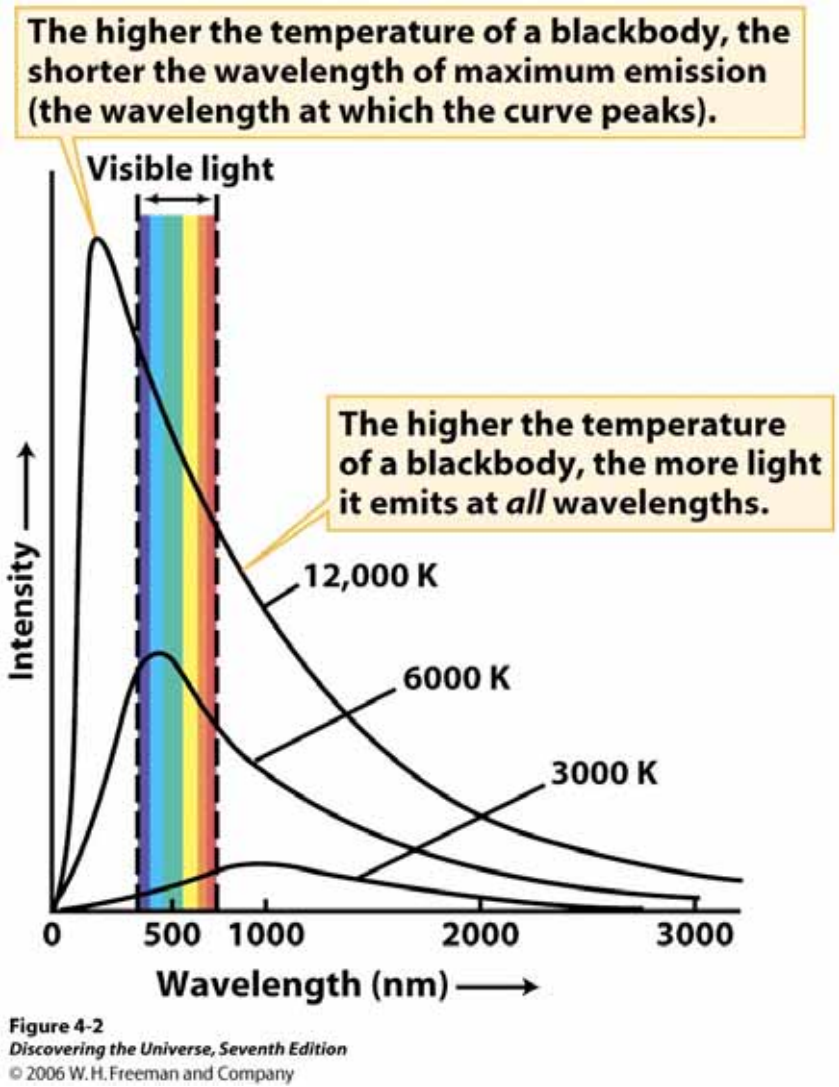


Figure 4-2
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$$B_\nu(T)\,d\nu = \frac{2h\nu^3}{c^2}\frac{1}{e^{\frac{h\nu}{kT}}-1}\,d\nu$$

The Planck's constant $h = 6.626 \times 10^{-34}$ [J s]
$= 4.135 \times 10^{-15}$ [eV s]

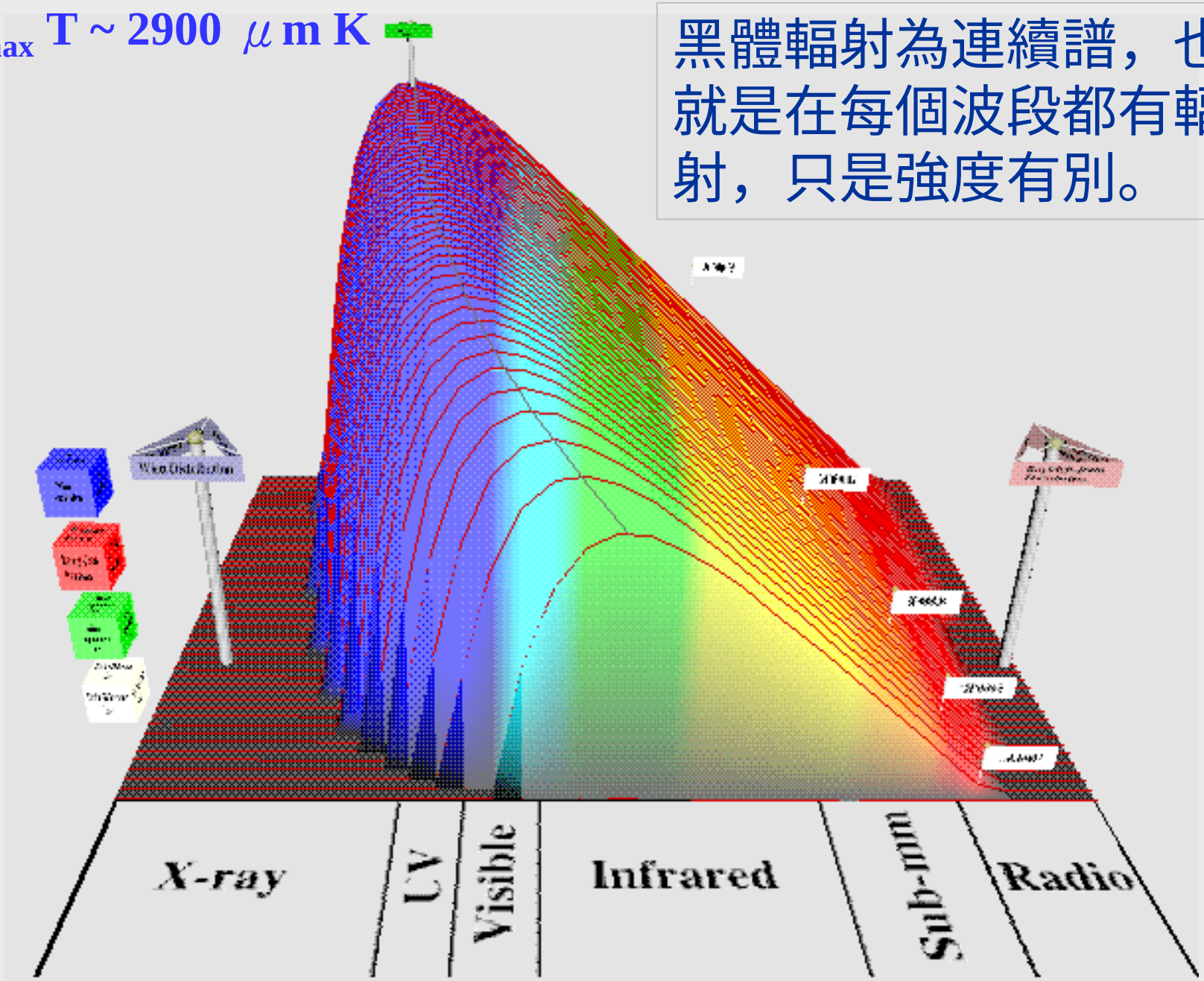
The Boltzmanns' constant $k = 1.38 \times 10^{-23}$ [J/K]

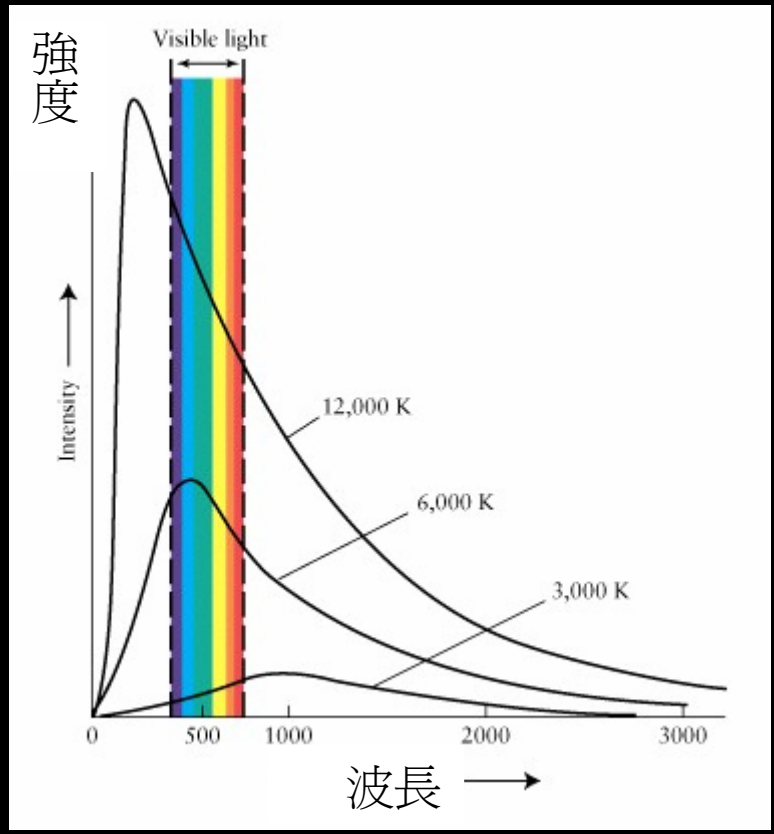
Wien's displacement law --- wavelength of the peak of the emission of a black body and its temperature

$$\lambda_{\max} T \approx 2900\ [\mu\mathrm{m\ K}]$$

$\lambda_{max} T \sim 2900 \ \mu m K$

黑體輻射為連續譜，也就是在每個波段都有輻射，只是強度有別。





恆星（自行發光）

表面溫度高 → 藍白

表面溫度低 → 紅黃

→ 從恆星的顏色可以估計其輻射溫度

我們的太陽是顆黃綠色的恆星
表面輻射溫度大約爲5800K

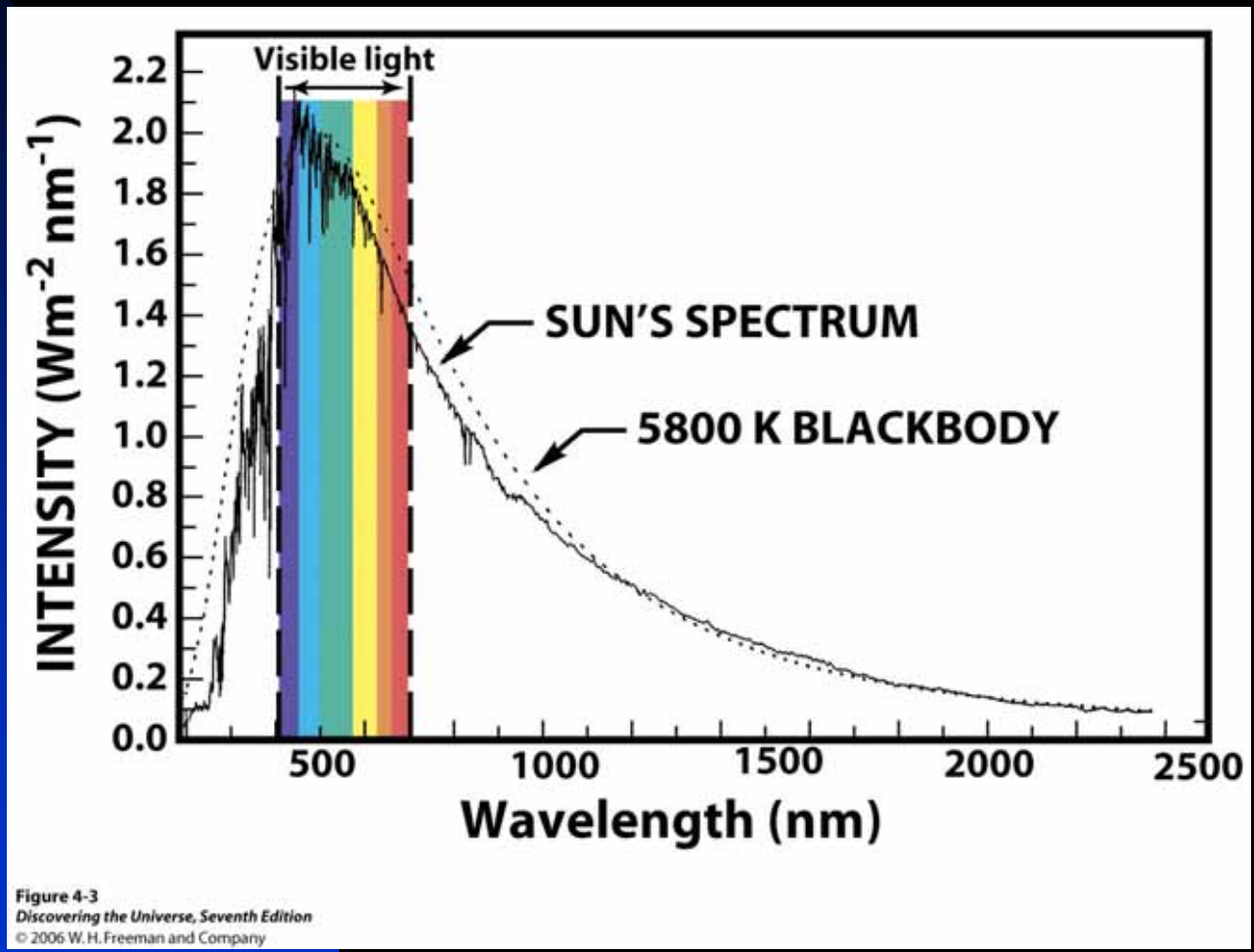


Figure 4-3
Discovering the Universe, Seventh Edition

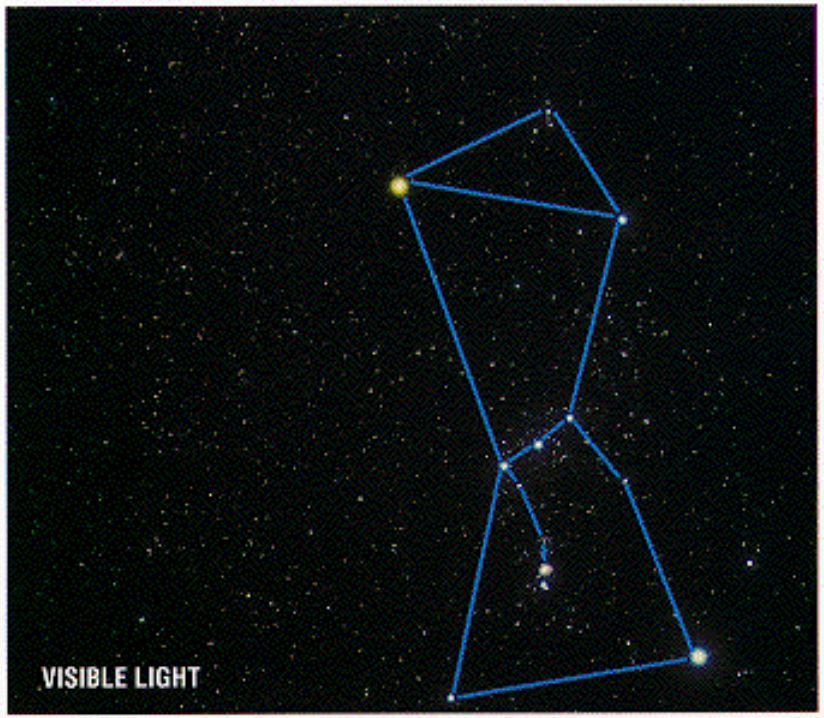
$$T \approx 5800\mathrm{K}, \lambda_{\max} \approx 0.5\mu\mathrm{m} = 5000\text{Å}$$

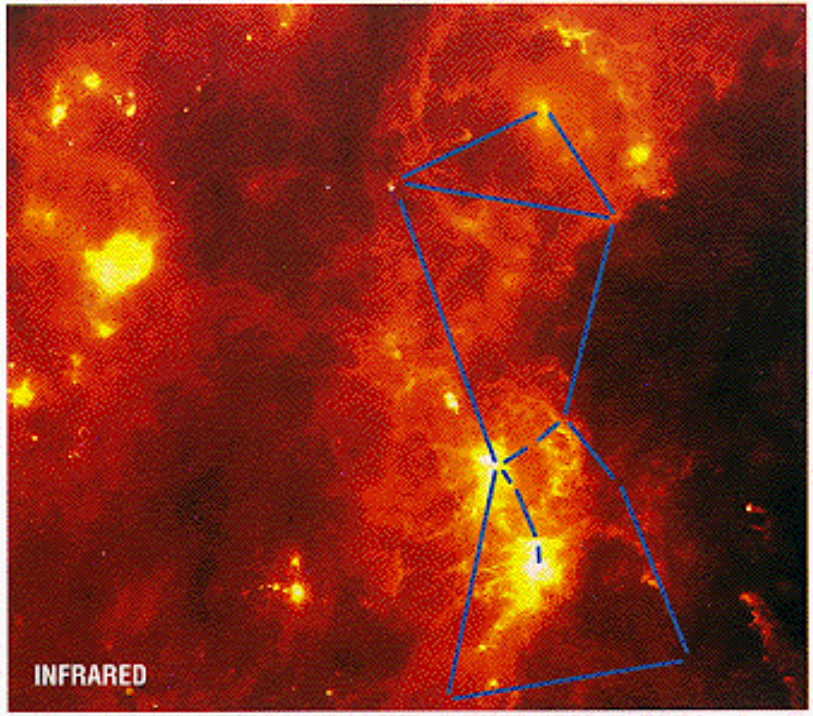
$$T \approx 300\text{K}, \lambda_{\text{max}} \approx 10\mu\text{m}$$

National Aeronautics and Space Administration

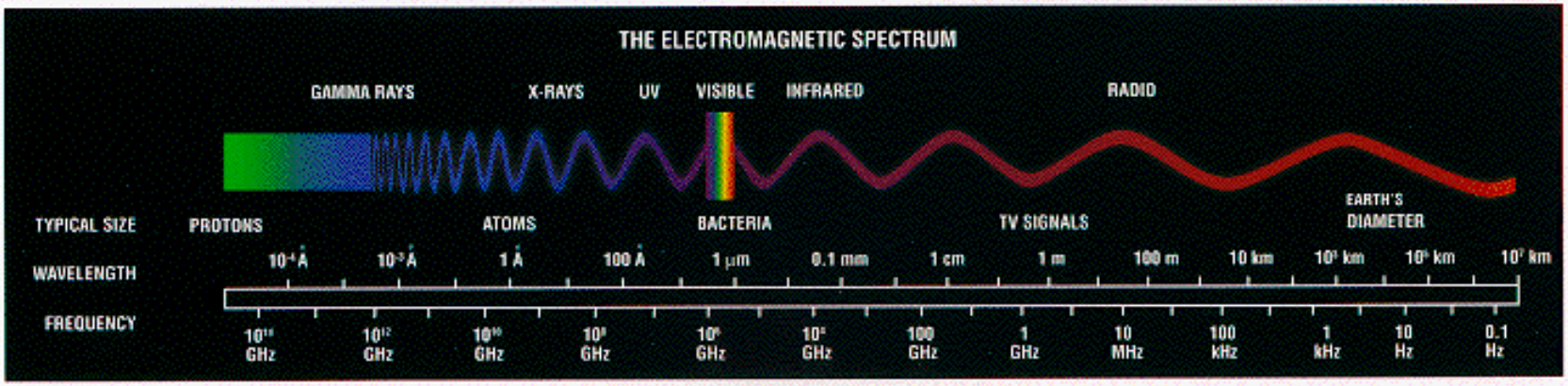
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Infrared Astronomy: More than Our Eyes Can See





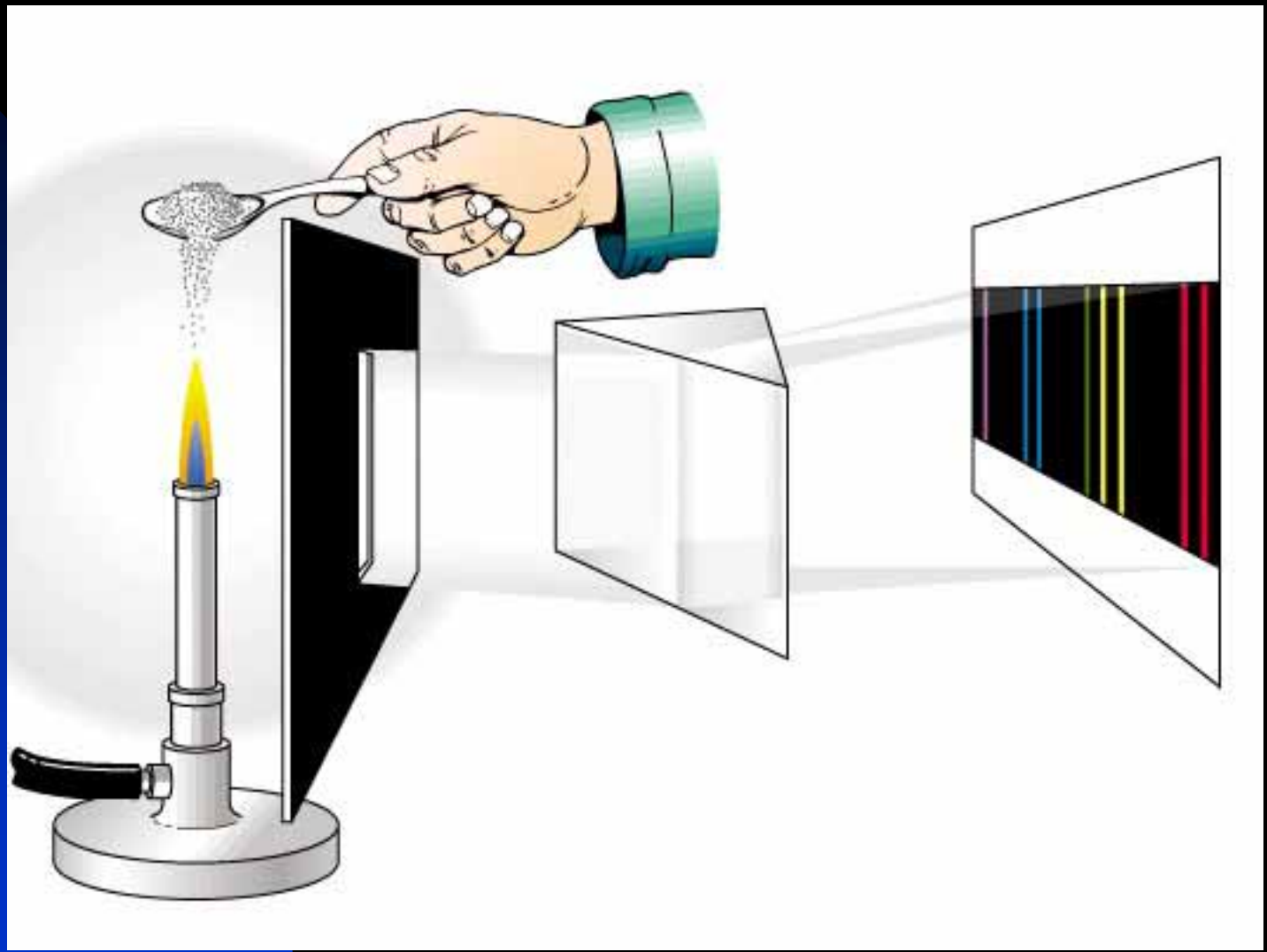
These views of the constellation Orion dramatically illustrate the difference between the familiar, visible-light view and the richness of the universe that is invisible to our eyes, though accessible in other parts of the electromagnetic spectrum.



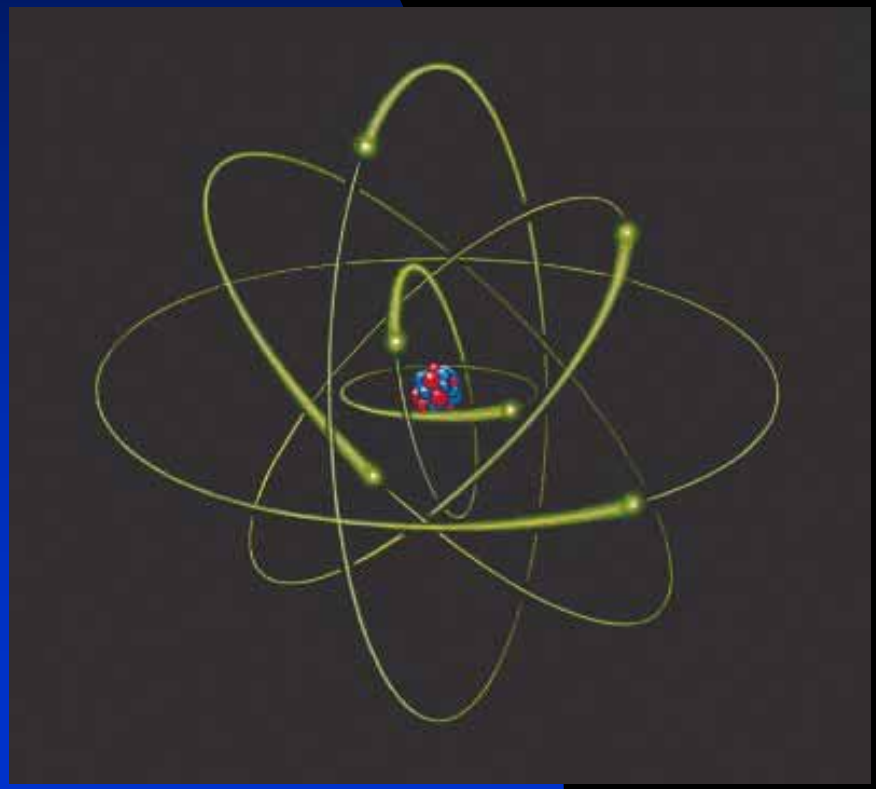
可見光　　近紅外　　中紅外

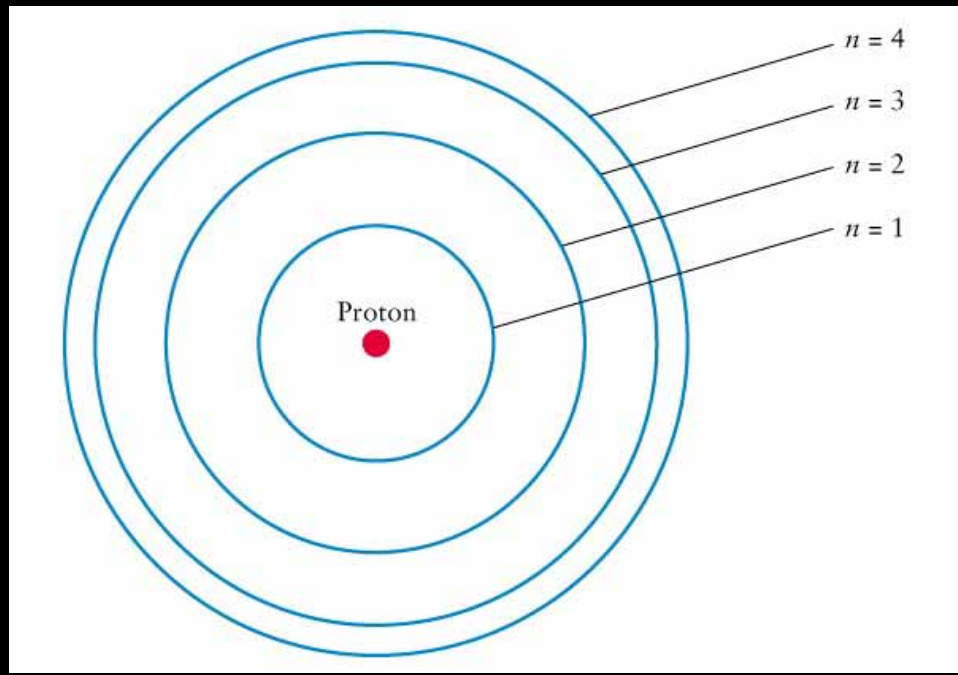
恆星　　熱灰塵　　溫灰塵

獵戶座馬頭星雲（恆星誕生之處）
在不同波段呈現的影像



電子繞著原子核，在一定的軌道區域運行，每個軌道能量不同

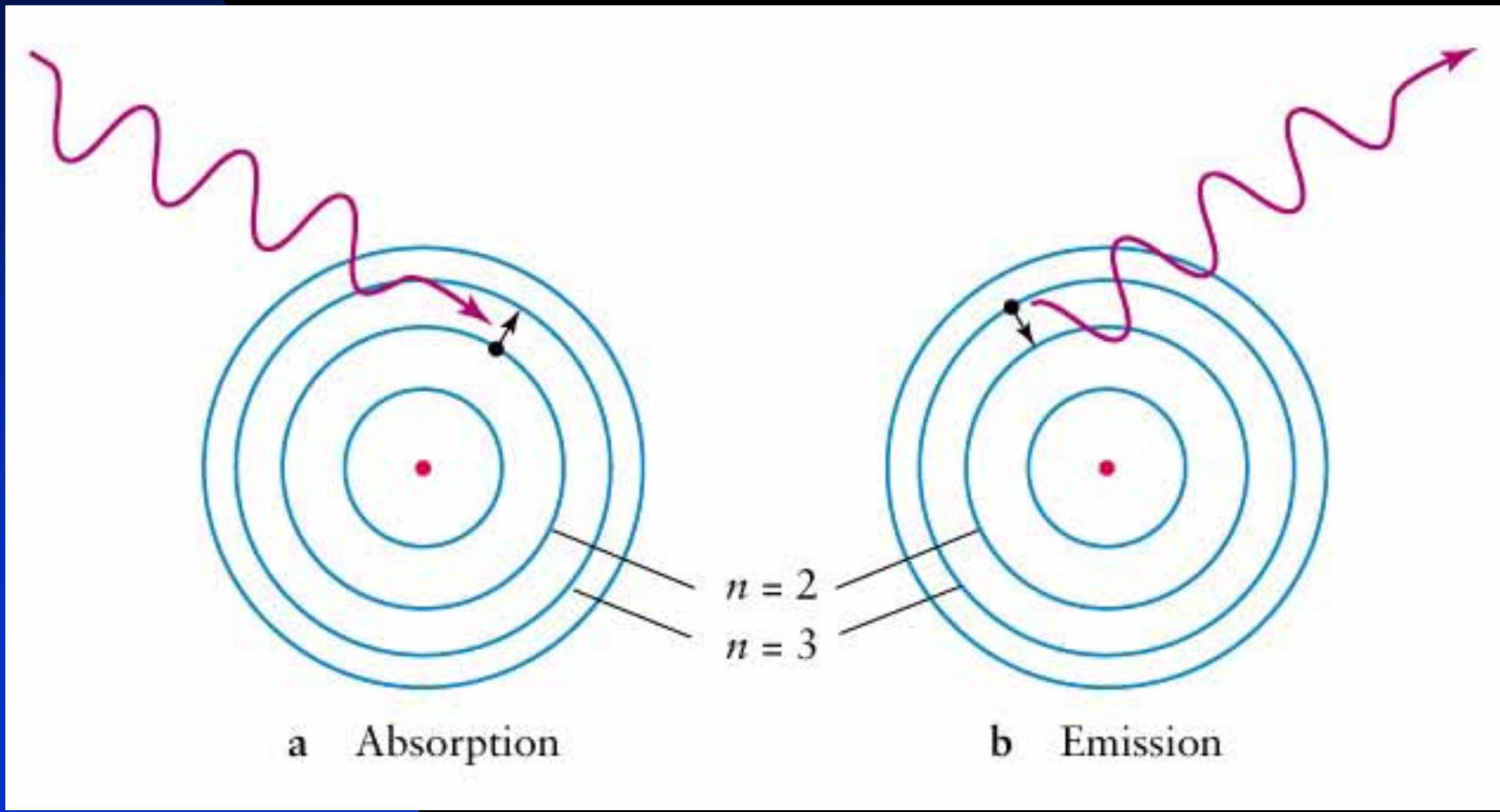




變換軌道 → 能量改變

低 → 高能量軌道 → 吸收能量

高 → 低能量軌道 → 放出能量



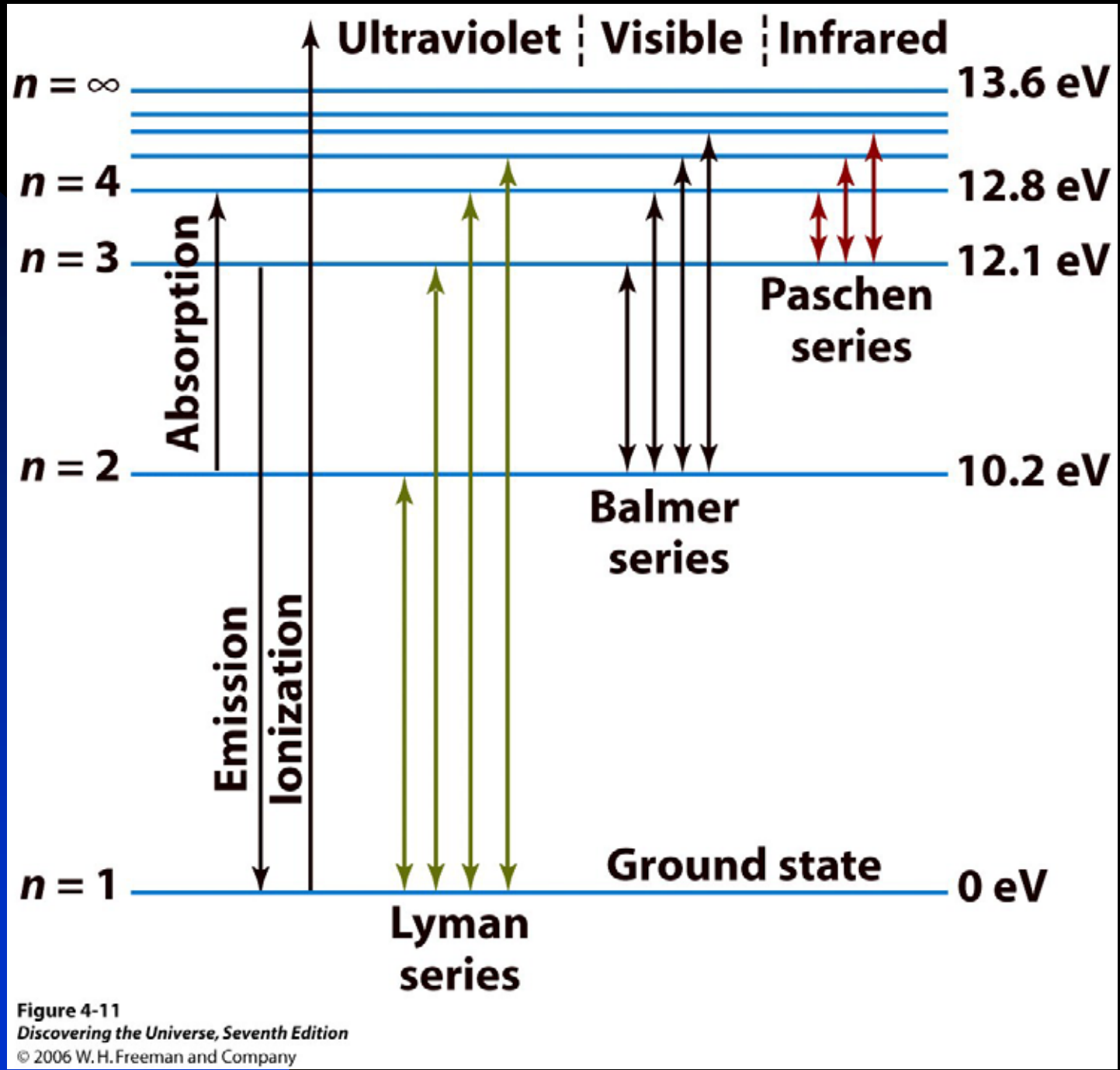
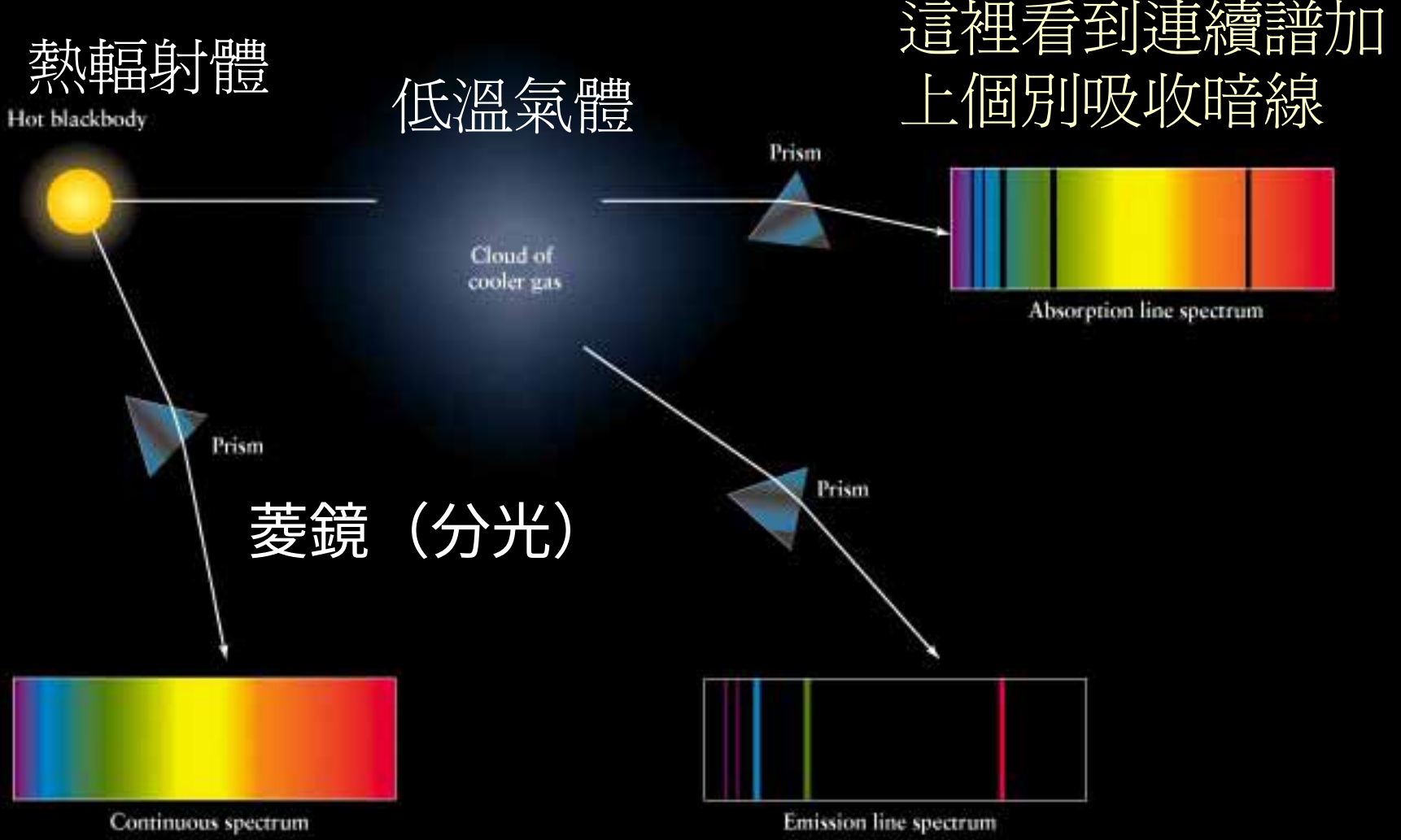
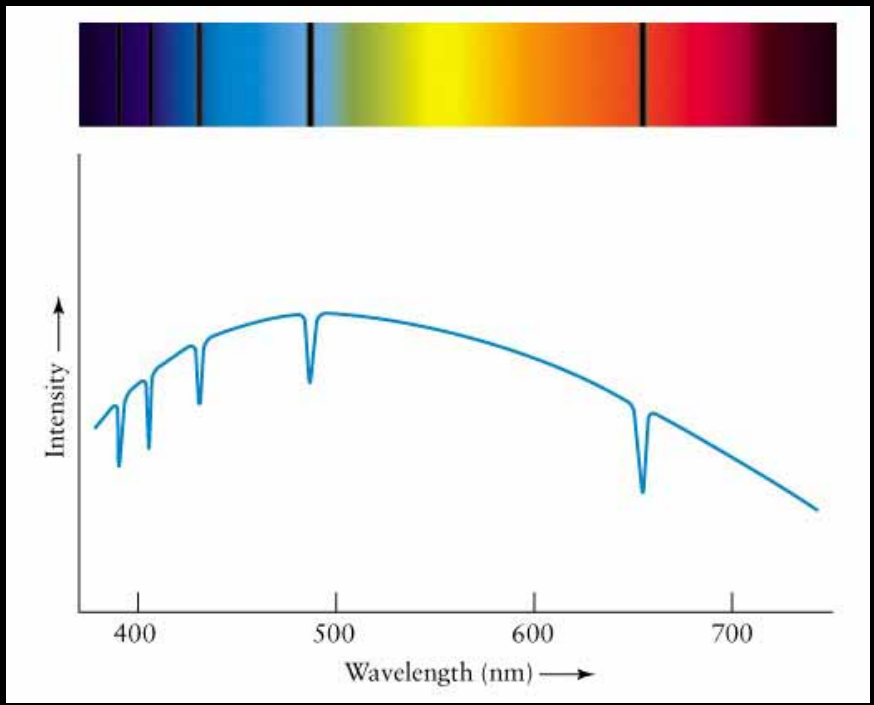


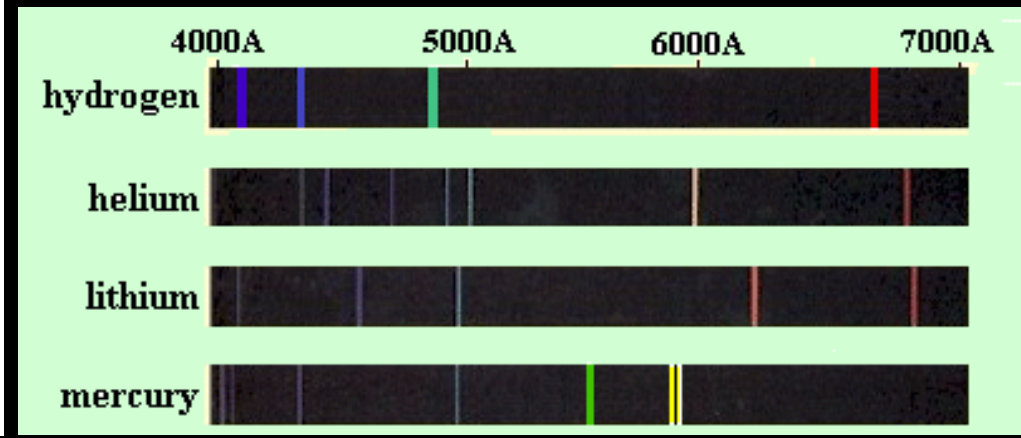
Figure 4-11
Discovering the Universe, Seventh Edition


熱輻射體
Hot blackbody
低溫氣體
這裡看到連續譜加
上個別吸收暗線
Prism
Cloud of
cooler gas
Absorption line spectrum
Prism
菱鏡（分光）
Prism
Continuous spectrum
Emission line spectrum
這裡看到如彩
虹般連續譜
這裡看到個別
發射亮線

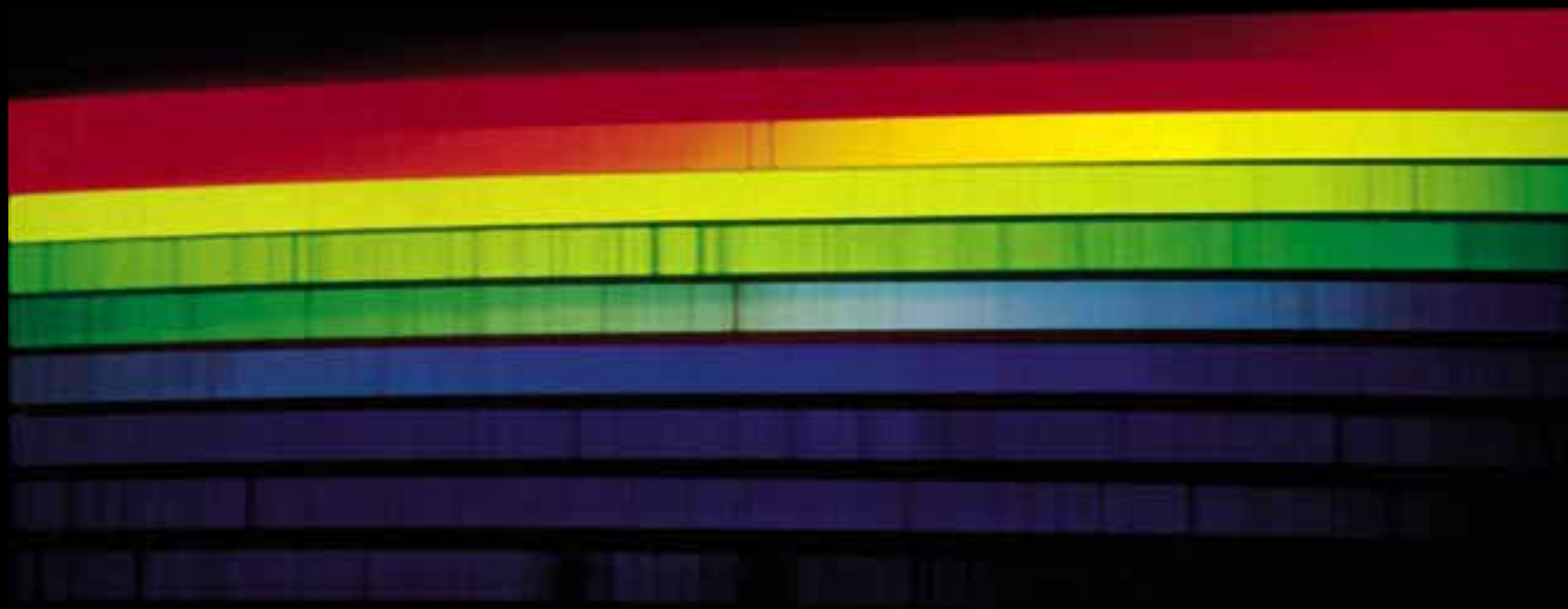
原來各個能量（波長）都有的輻射，要是某個能量的光被吸收，便產生吸收（暗）線。



不同元素有不同躍遷
→ 不同譜線。



氫、氦、鋰、汞等元素的光譜
web.fccj.org/~ethall/thallium/spectra.gif



太陽內部很熱，發出高能量的光，經過較冷的外層氣體，部分能量被吸收

太陽光譜中可以看到很多吸收線

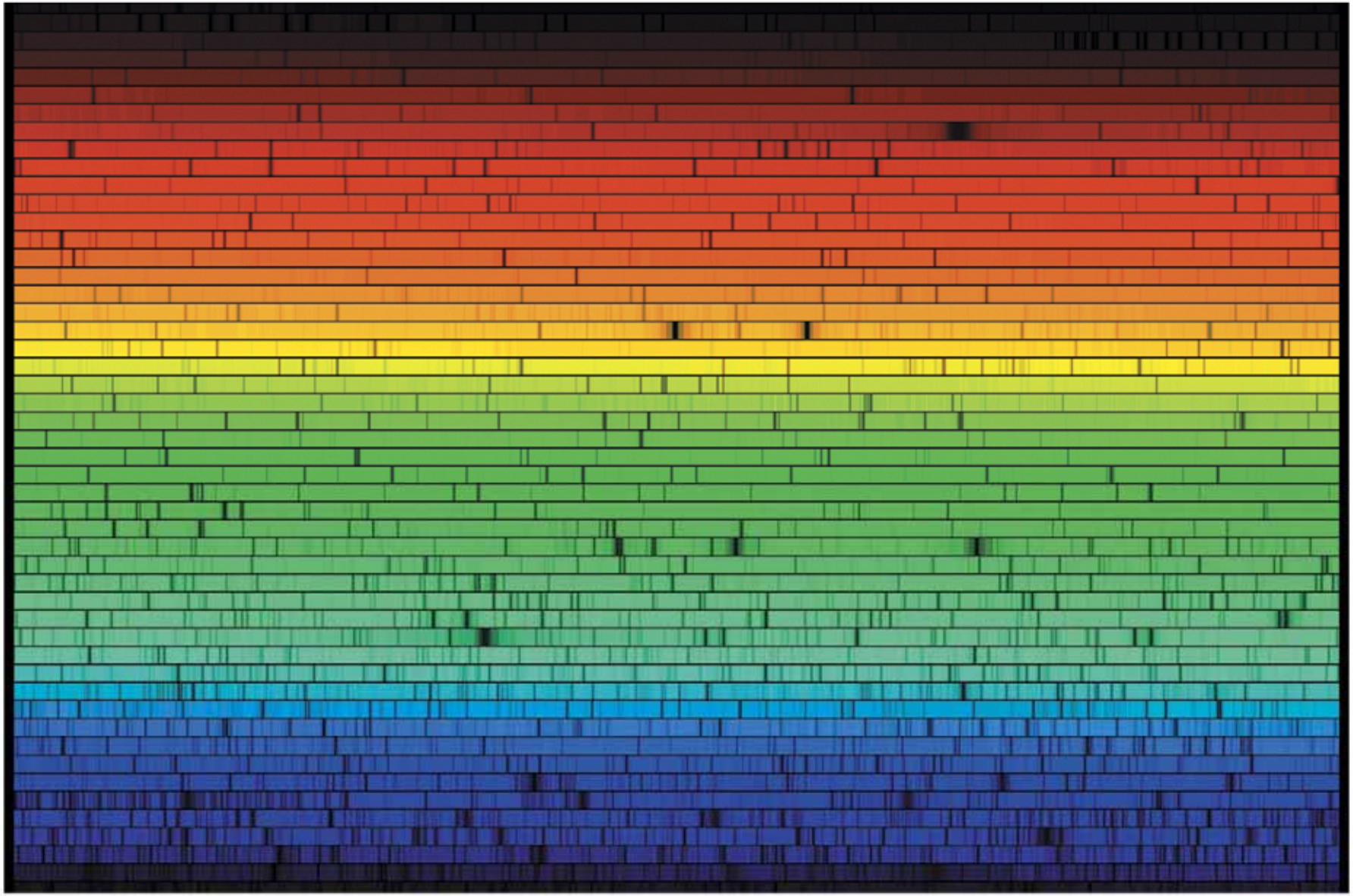
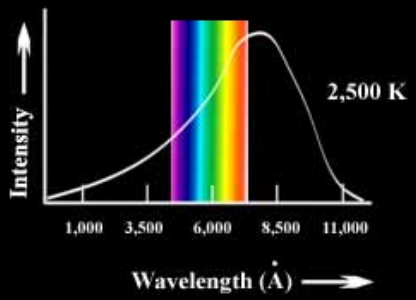
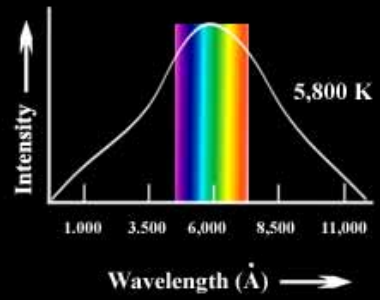
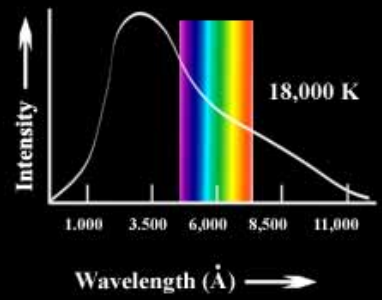
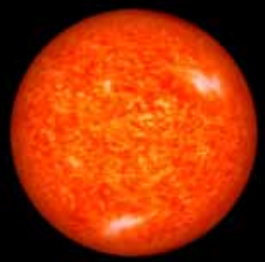


Figure 4-4
Discovering the Universe, Seventh Edition

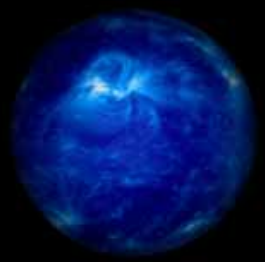








Colors are exagerrated

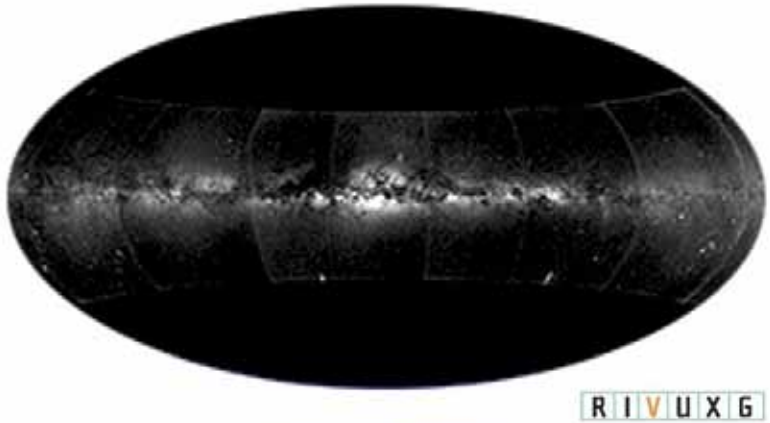


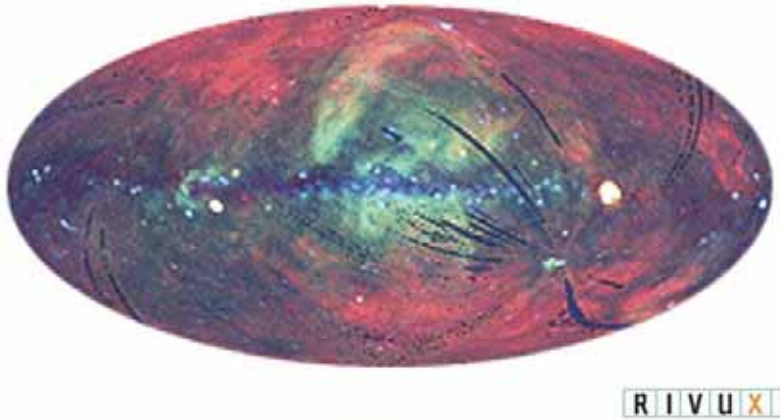
熾熱年輕恆星
組成的星團

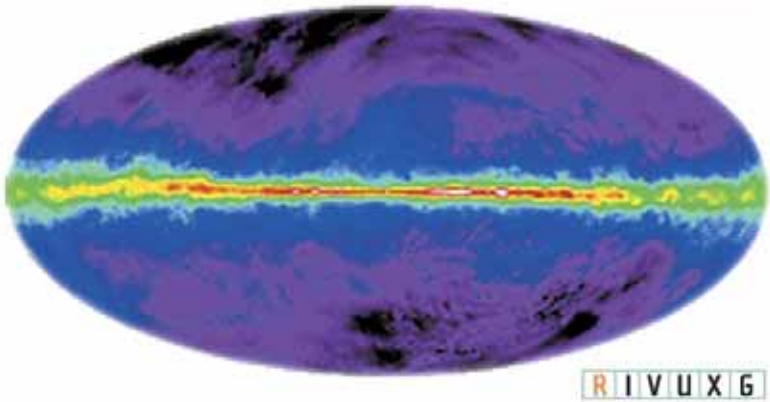
月全食的月球

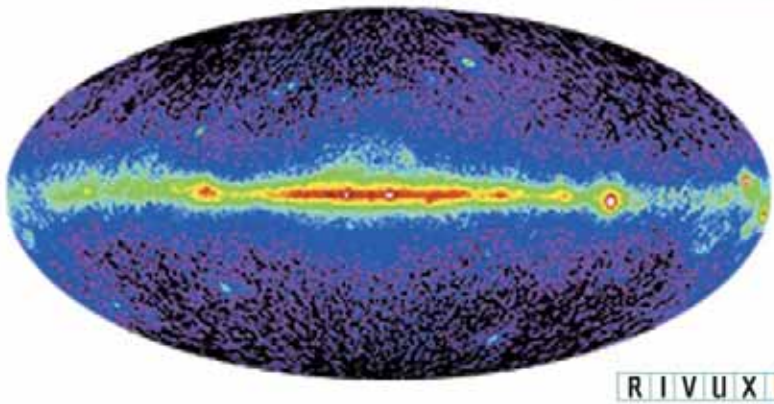
各種恆星正在雲氣中誕生

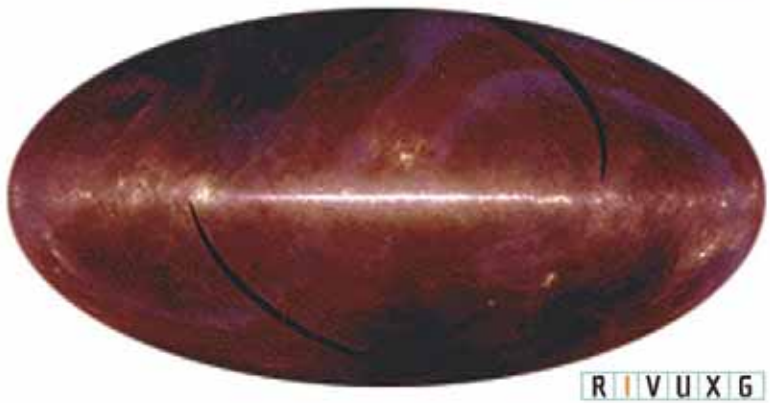

恆星之間太空中的雲氣
太陽系當中的彗星
© 1997 Jerry Lodriguss











The universe seen at different wavelengths

Figure 3-35a
Discovering the Universe, Seventh Edition

Orion
獵戶座


ECLIPTIC
Aldebaran
Betelgeuse
Bellatrix
Rigel
MAJOR
LEPUS
ERID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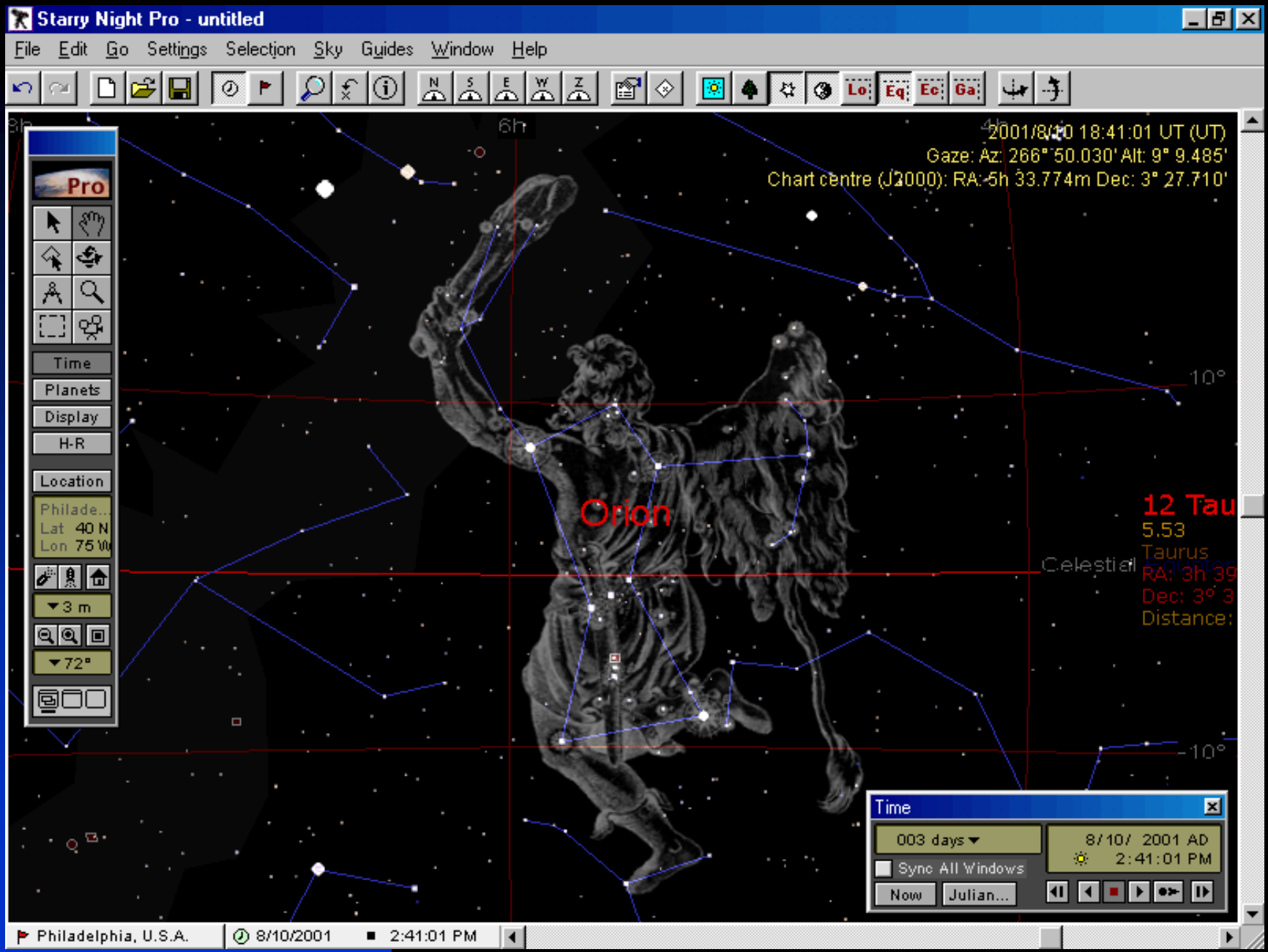
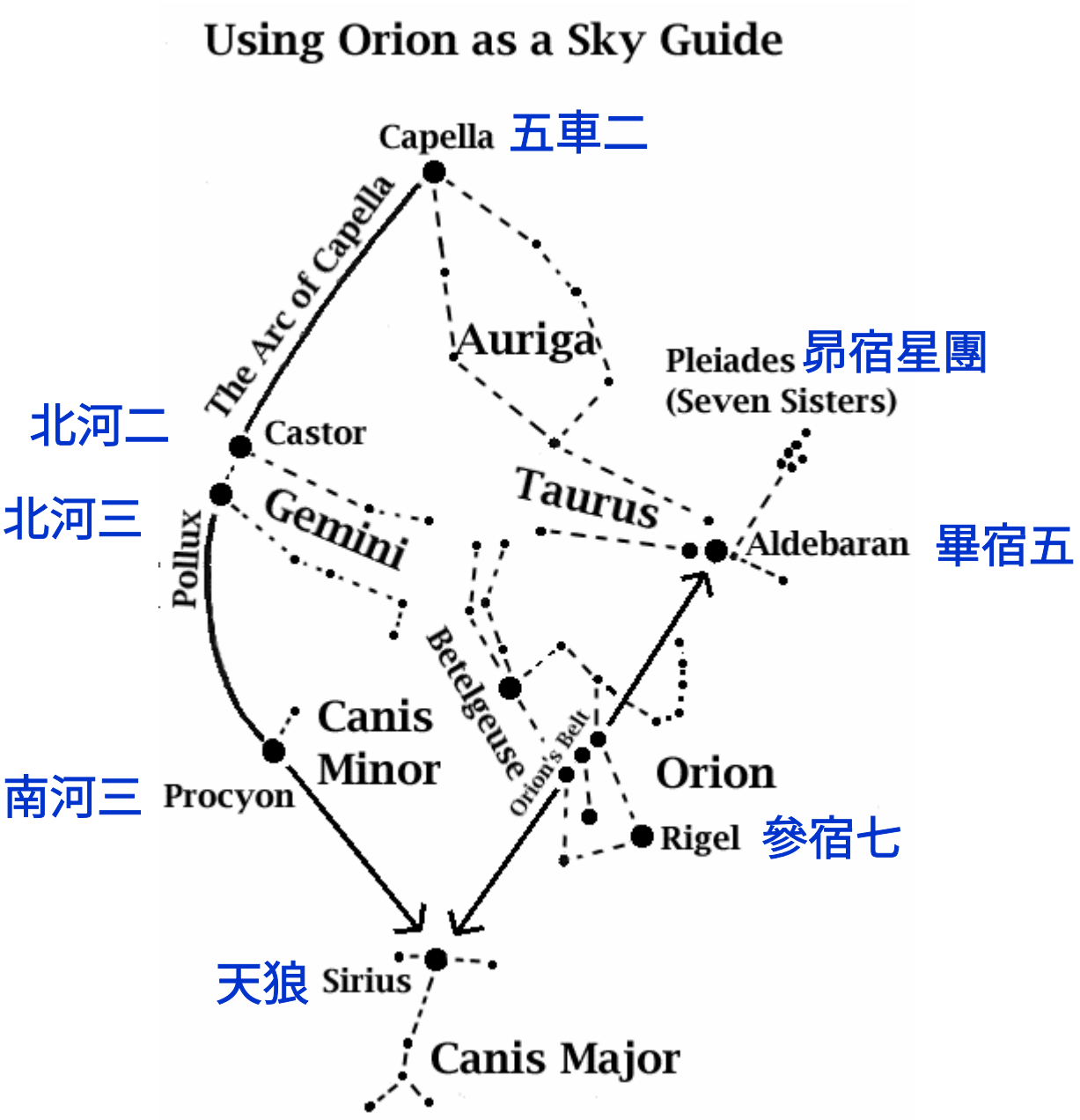
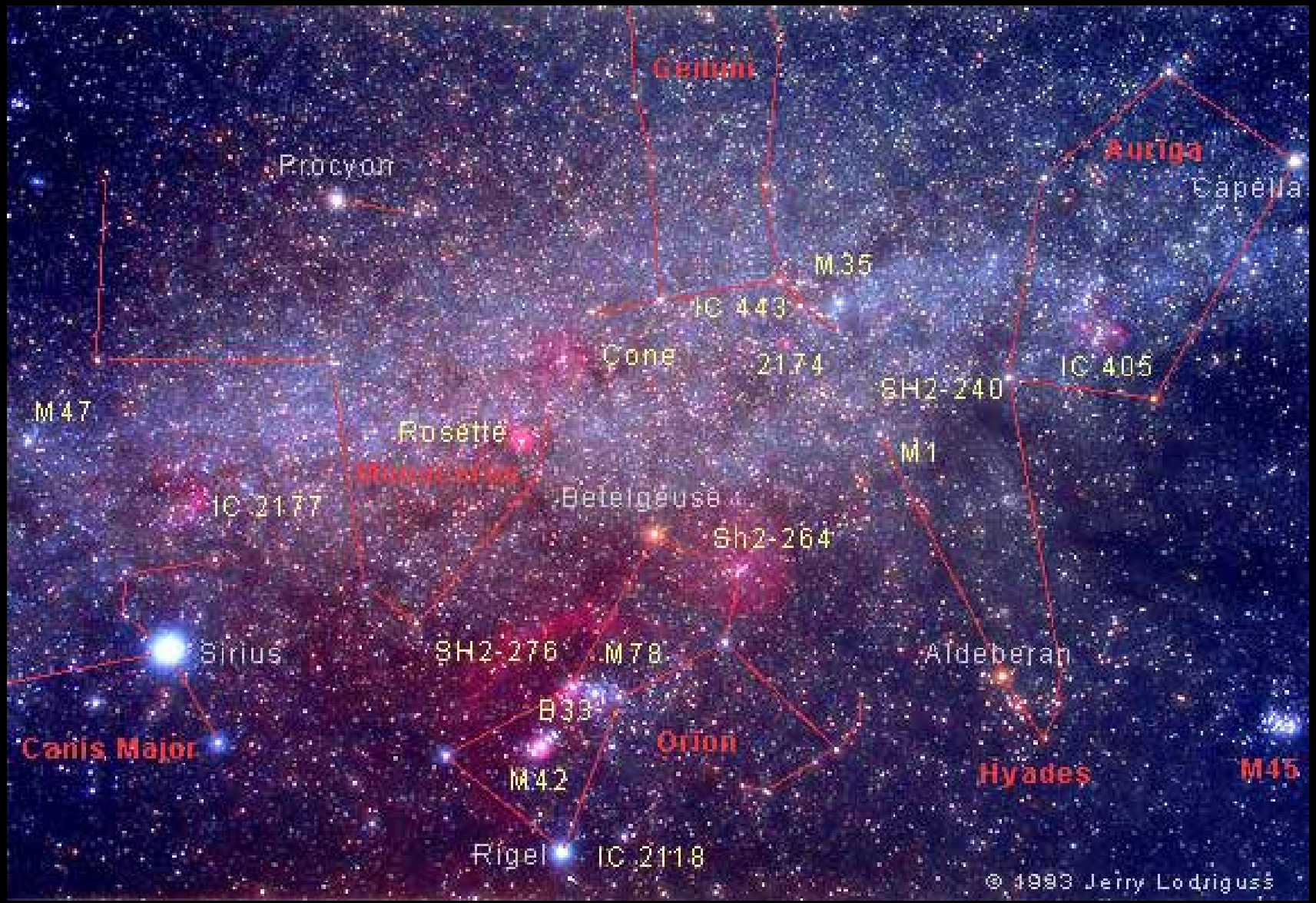
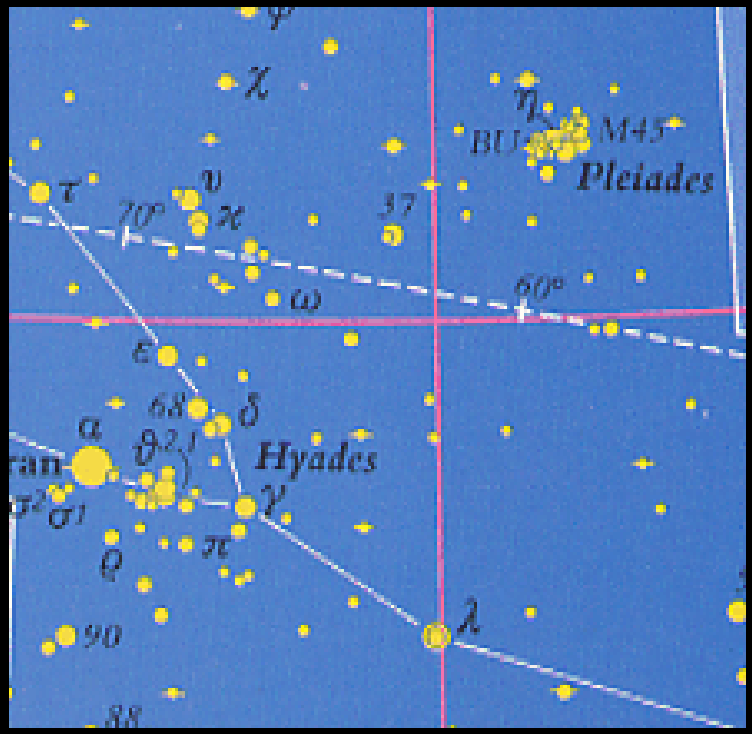
© 1993 Jerry Lodriguss


Starry Night Pro - untitled
File Edit Go Settings Selection Sky Guides Window Help
Pro
Time
Planets
Display
H-R
Location
Philade...
Lat 40 N
Lon 75 W
3 m
72°
6h
2001/8/10 18:41:01 UT (UT)
Gaze: Az: 266° 50.030' Alt: 9° 9.485'
Chart centre (J2000): RA: 5h 33.774m Dec: 3° 27.710'
Orion
10°
Celestial
12 Tau
5.53
Taurus
RA: 3h 39
Dec: 3° 3
Distance:
-10°
Time
003 days
8/10/ 2001 AD
2:41:01 PM
Sync All Windows
Now
Julian...
Philadelphia, U.S.A.
8/10/2001
2:41:01 PM

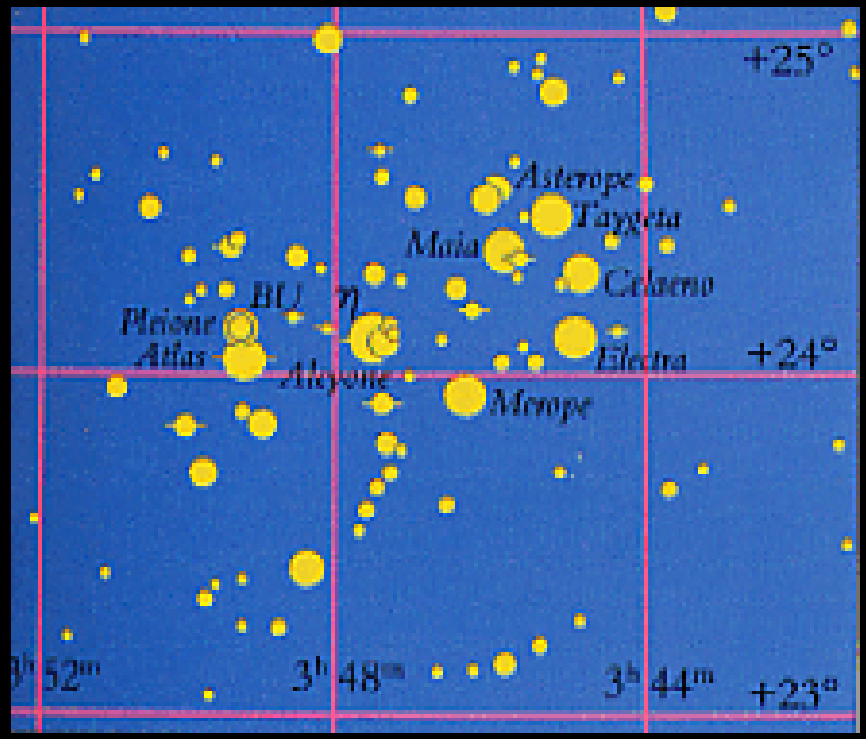

Using Orion as a Sky Guide
Capella 五車二
The Arc of Capella
Auriga
Pleiades 昴宿星團
(Seven Sisters)
北河二
Castor
北河三
Gemini
Taurus
Pollux
Aldebaran 畢宿五
Betelgeuse
Orion's Belt
Canis
Minor
Orion
南河三
Procyon
Rigel 參宿七
天狼 Sirius
Canis Major



http://www.astropix.com



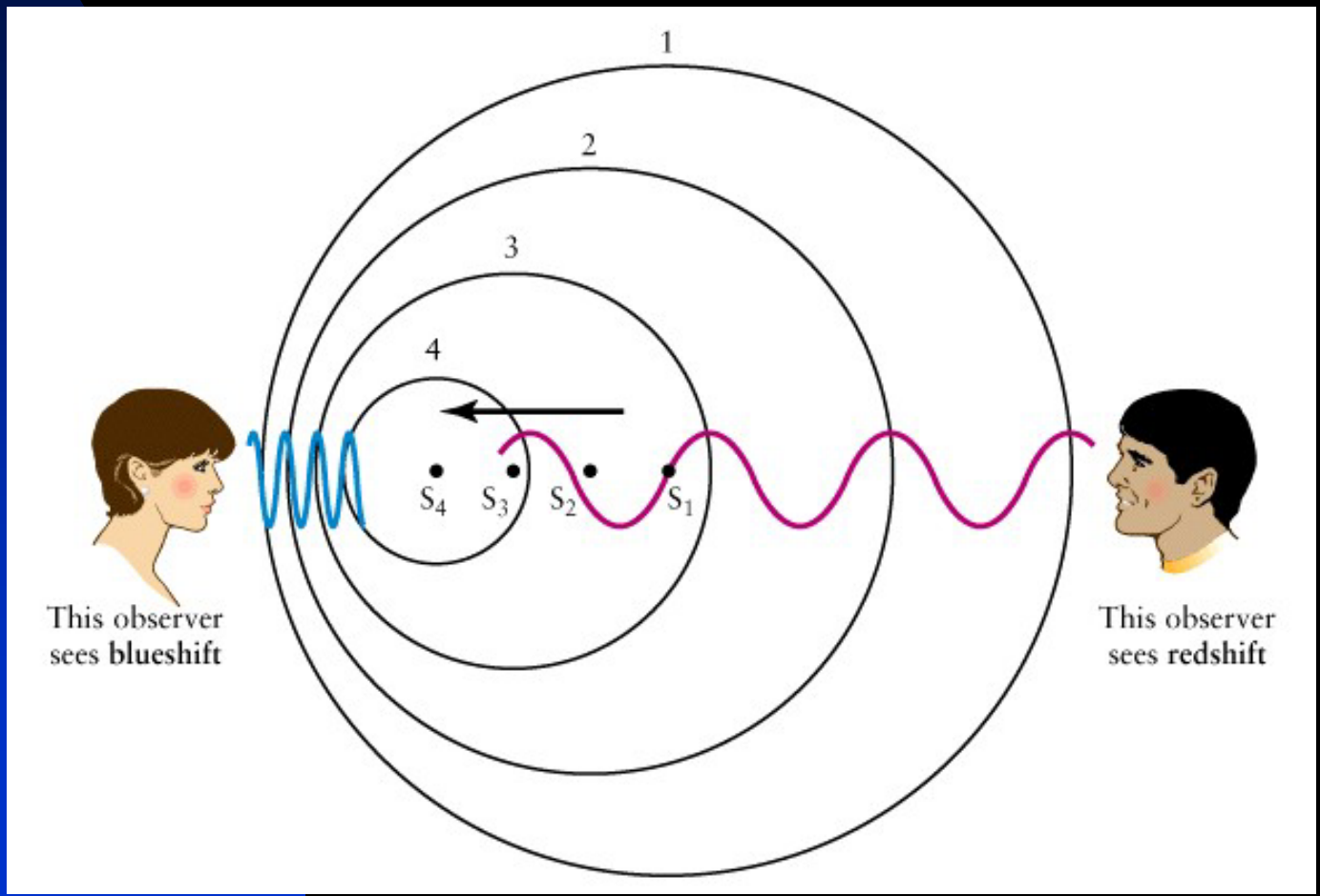
畢宿星團 (Hyades) 位於金牛頭部，距離我們只有150光年。Aldebaran（阿拉伯文「追隨者」）乃金牛眼睛，距離60光年）。

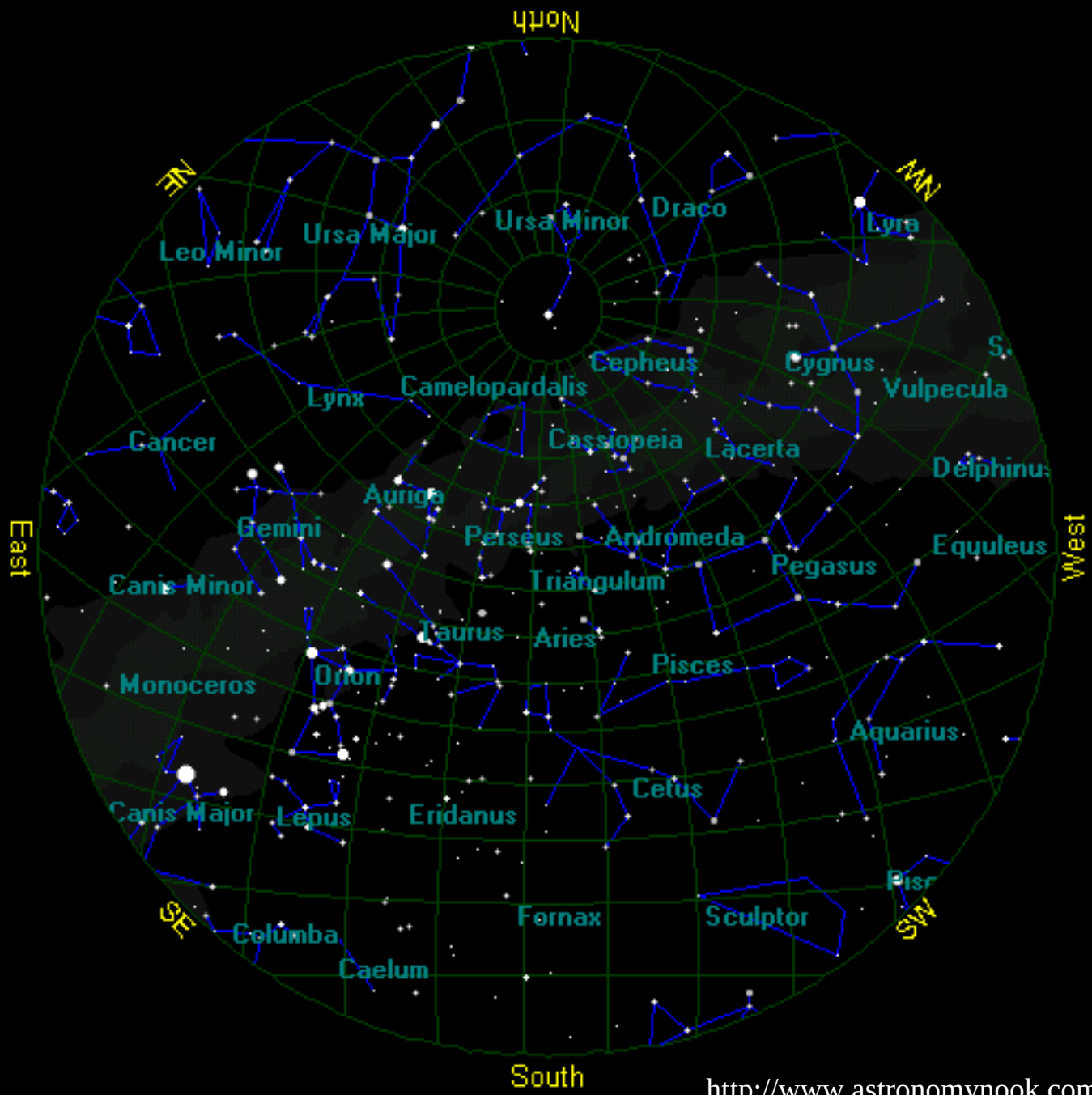


昴宿星團（Pleiades）位於金牛肩膀，裸眼可見6～7顆，故也稱「七姊妹」。透過雙筒望遠鏡可見9顆，全部星團約500顆星

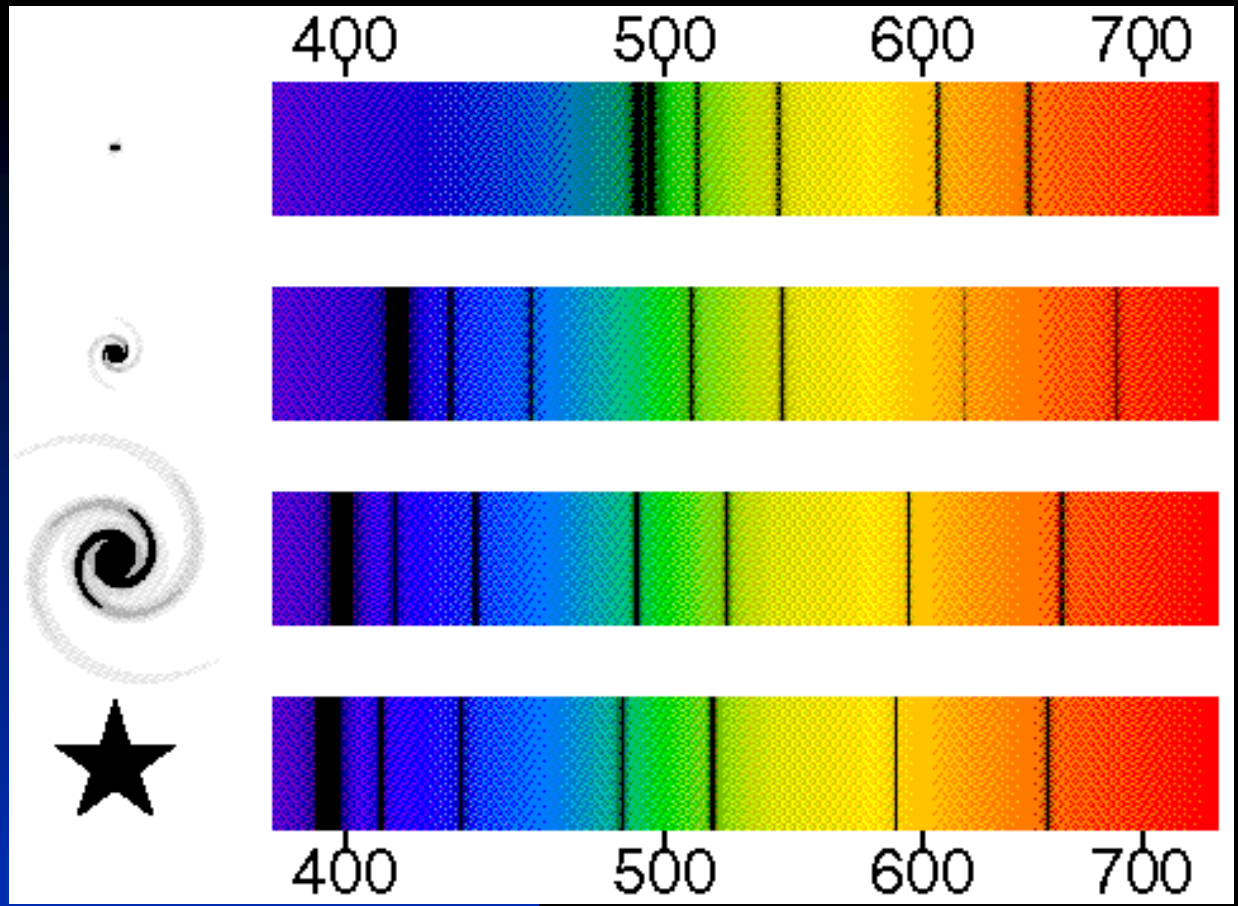
都卜勒效應 (Doppler effiect)

測量波動頻率（振動快慢）的改變，可以知道我們和波源之間的速度





http://www.astronomynook.com/images/fall_chart.gif



http://www.astro.ucla.edu/~wright/doppler.htm

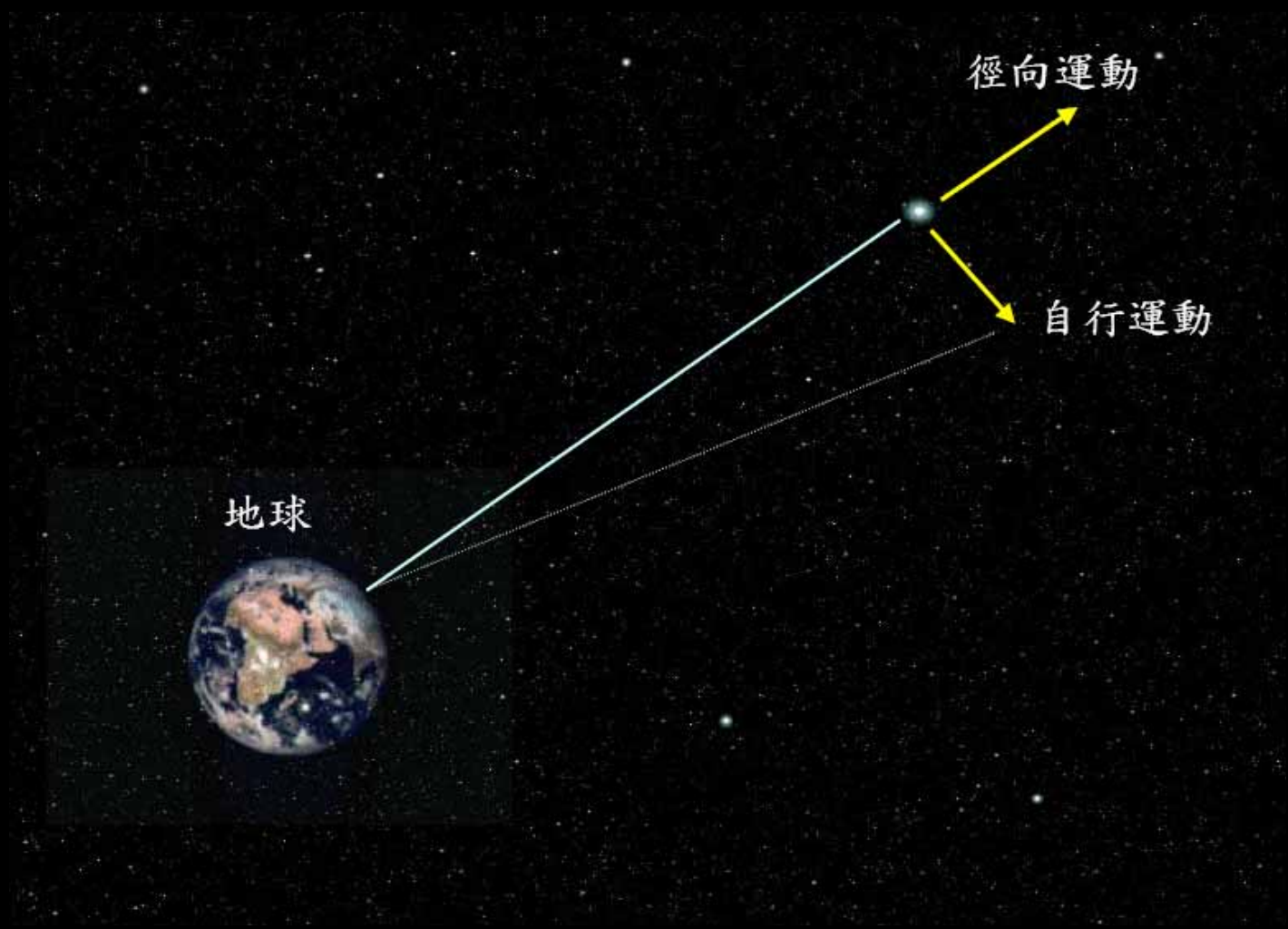
$$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

v: speed of the source along the line of sight

c: speed of light $= 3 \times 10^5$ km/s

- 都卜勒效應 —— 駛近與遠離的火車鳴笛
- 利用此原理可以
  - ★ 觀察心臟跳動情形
  - ★ 判斷高速公路上的車速
  - ★ 測知天體**沿視線方向**的運動
    - → 太陽表面震盪的情形
    - → 恆星在銀河系中運動情形
    - → 雙星互繞、繞行恆星的行星
    - → 星系運動的情形（宇宙膨脹）
    - → …

天體在太空的運動可以分成兩個分量，一個投影在天球上的**自行運動** (proper motion)，另一個爲垂直的**徑向運動** (radial velocity)。



巴納德星爲離我們第三近的恆星（最近的是太陽，其次是毗鄰星），距離地球6光年，它的 proper motions 爲每年10.3角秒，以其距離換算，也就是每秒90公里的速度。經由 Doppler effect 測量光譜線，得到 Barnard's star 的 radial velocity 爲每秒111公里，因此其在太空中實際運動的速度爲每秒142公里。

Q: 直徑10公里的小行星，若以每秒140公里的速率撞向地面，動能有多大？要是這些動能全部都轉換成熱能，撞擊點的溫度有多高？這樣的能量對周遭環境會造成怎樣的影響？