

# 天文 X STEM

中天訓 WORKSHOP 4





# OUTLINE

Demo/Experiment

Workshop

Stargazing

Talk/booth

Sharing

# DEMO/ EXPERIMENT

## COMET MOON CRATER

在實驗室裏製作  
彗星、模擬月球  
隕石坑的形成

## ASTRONOMICAL PHENOMENA

模擬各種天文現象：  
月亮盈虧、  
日 / 月全蝕

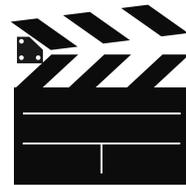
## STARRY NIGHT METEOR SHOWER

星空模擬、流星  
雨 ZHR

## ASTROPHYSICS

協助同學去理解  
較抽象的物理理論：  
超新星爆炸、重力……

# COMET



WARNING

注意事項

實驗中會使用到乾冰，因此必須有老師在場。

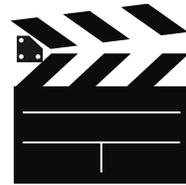
# DRY ICE



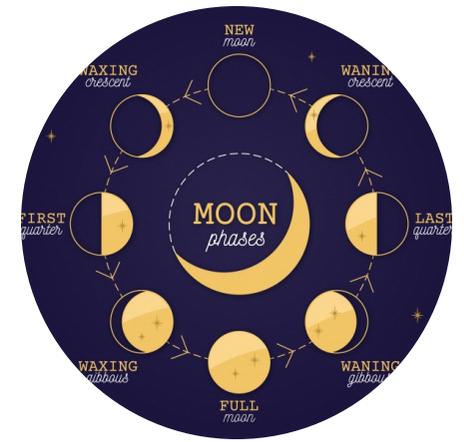
**WARNING**

注意事項  
小心凍親

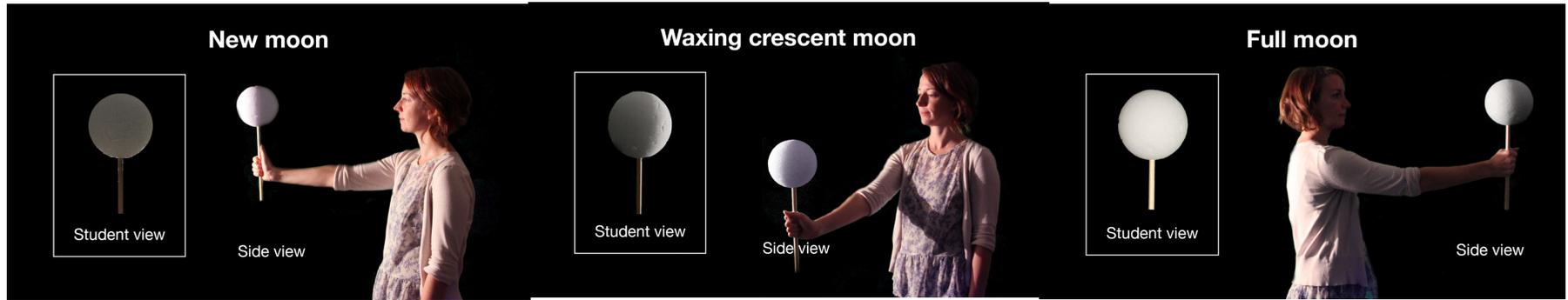
# MOON CRATER



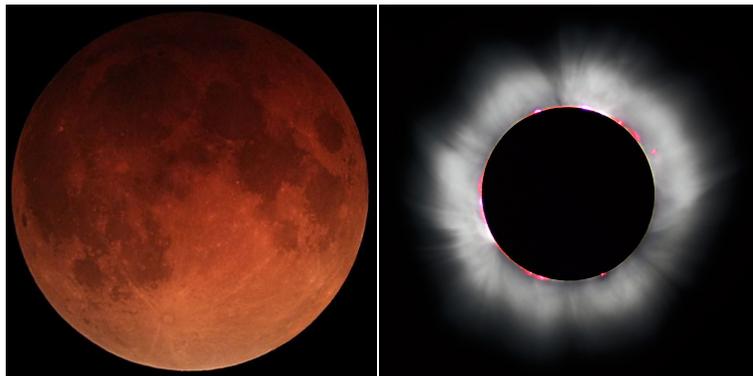
# ASTRONOMICAL PHENOMENA



## 月亮盈虧



## 月 / 日全食



credit: science in school

# ASTRONOMICAL PHENOMENA

## 月全食



credit: universe today

# STARRY NIGHT



## 數碼立體星象館



REMIND

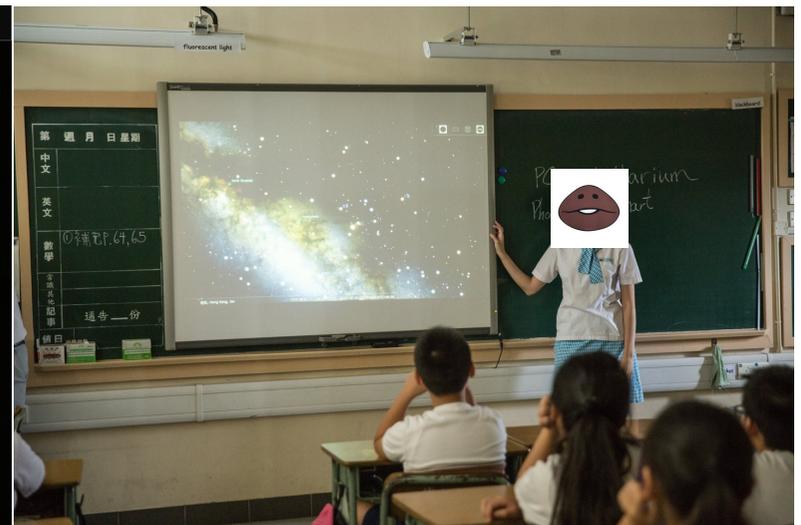
### 溫馨提示

星象館可向可觀自然教育中心天文館借用。記得留意星象館大小是否能於校內場地安置。

# STARRY NIGHT



stellarium



## 軟件介紹

INTRODUCTION

電腦版是免費的。可模擬當晚及不同日子的星空，包括特別的天文現象，例如凌日，日食等等（彗星除外）。此外，可以放大觀察不同行星，深空天體。

# METEOR SHOWER



**ZHR (ZENITHAL HOURLY RATE)** : 在高峰時期，假設流星輻射點在天頂位置，全天100%無遮擋視野，肉眼可見6.5等星的情況下，觀察者可看到的流星之每小時出現頻率。  
**每小時天頂流星數**

$$ZHR = \frac{\overline{HR} \cdot F \cdot r^{6.5-lm}}{\sin(hR)}$$

# METEOR SHOWER



## 英仙座流星雨

Given:

- 1) ZHR 100
- 2) 20% of the observer 's field of view was covered by clouds
- 3)  $r=2$
- 4)  $l_m = 4$
- 5)  $hR = 27$  deg

$$ZHR = \frac{\overline{HR} \cdot F \cdot r^{6.5-l_m}}{\sin(hR)}$$

$$F = \frac{1}{1 - k}$$

$k$  = fraction of the sky which you cannot see

$l_m$  = the observer's limiting magnitude

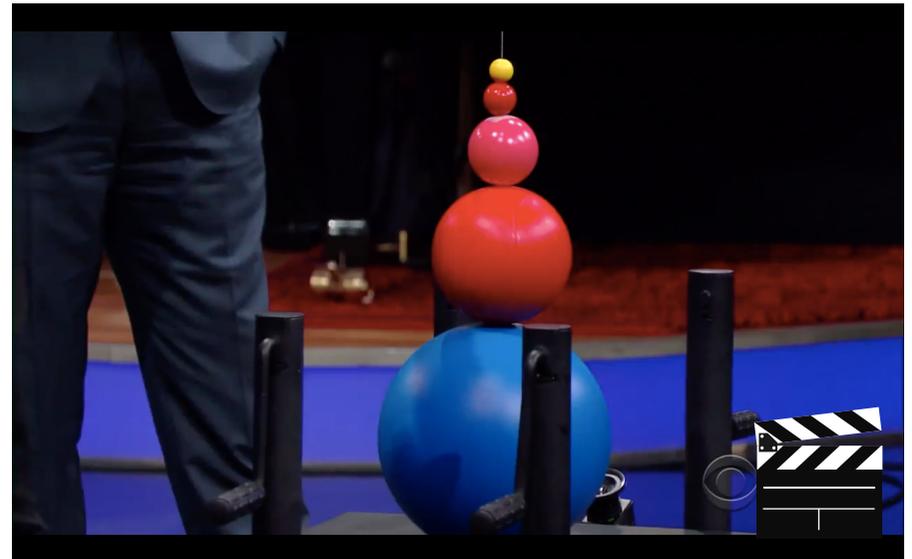
# ASTROPHYSICS



## 重力



## 超新星



REMIND

### 溫馨提示

有些同學比較不擅長理解較抽象的物理概念，利用實驗 / 示範去協助同學理解相關理論是較好的方法。

# WORKSHOP

## SUN FUNNEL

自製太陽濾光片  
及投影儀

## MODEL

用紙製作跟天文  
相關的模型，例  
如太空望遠鏡、  
行星等等。甚至  
用3D打印技術製  
作模型

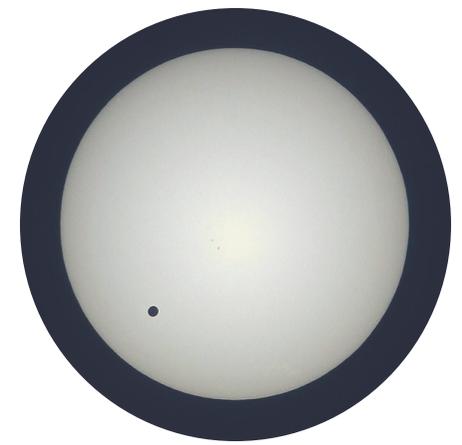
## REFRACTING TELESCOPE

製作伽利略望遠  
鏡，從中明白折  
射式望遠鏡的原  
理

## SPECTROSCOPE

光譜儀是宇宙探  
索中不可缺少的  
儀器。學習制作  
簡易的光譜儀。

# SUN FUNNEL



## 太陽濾光片 / 巴德膜

淘寶網 Taobao.com

宝贝 巴德膜 搜索

所有宝贝 天猫 二手 今日发现

上传图片就能搜同款啦! x

掌柜热卖

品牌: Angeleyes/星缘 CELESTRON Sky-Watcher 博冠 CELESTRON/星特朗 BELONA 多选  
 Datsyn Gskyer AQUILA HERCULES/昊锐

上市时间: 2016年夏季 2016年冬季 2015年春季 2014年夏季 2014年春季 2014年秋季 多选 更多~

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相关分类: 3C数码配件市场 ZIPPO/瑞士军刀/眼镜

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 15x15cm 安全太阳拍摄观测膜正品  
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¥20.00 12人付款  
 星缘40mm太阳巴德膜5.0密度天文望远镜配件观看观测摄影使用  
 天缘星户外专营店 江苏 徐州

¥50.00 1人付款  
 40-50mm口径硅胶太阳膜 双筒望远镜用巴德膜 双星太阳观测膜  
 星缘户外专营店 江苏 徐州

¥50.00 5人付款  
 德国baader太阳膜5.0密度巴德膜  
 15x15cm 安全太阳拍摄观测膜正品  
 天缘星户外专营店 江苏 徐州

上海雨雨结构工程有限公司  
 13621785117  
 ¥248.00 销量: 0

全黑高清夜视录像拍照



太陽濾光片

上海天文馆 SHANGHAI天文馆 SHANGHAI天文馆 MUSEUM

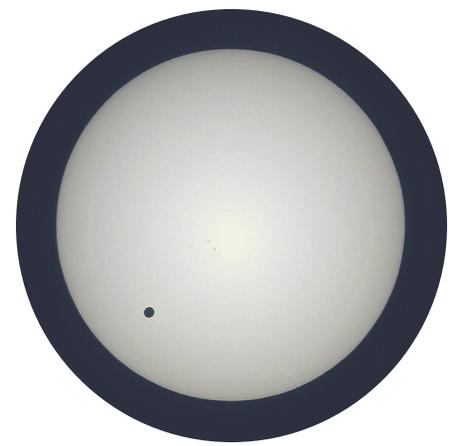
使用須知:  
 使用前先檢查有否破損; 不可與雙筒望遠鏡、望遠鏡、相機或其他光學儀器連接使用; 兒童使用時須有成人指導; 不要連續觀看超過3分鐘, 應不時讓眼睛充分休息; 接受眼部手術後或患有眼疾者不宜使用; 減光率1/100,000, 適合直接觀看太陽。



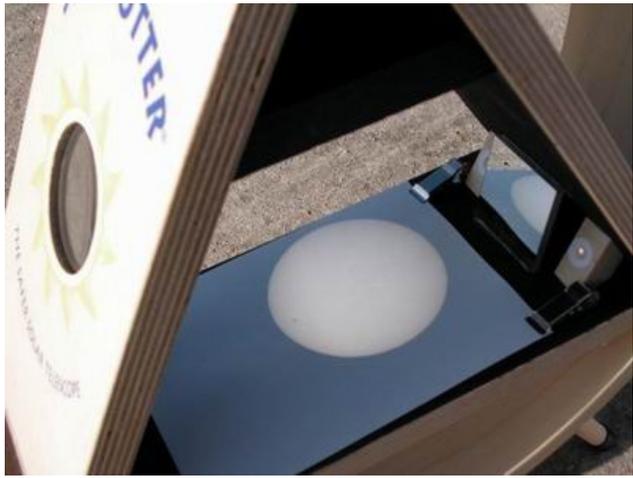
### 溫馨提示

訂購巴德膜時要注意密度，5.0才是適合用作肉眼觀測。  
 使用前檢□有沒有漏光情況。

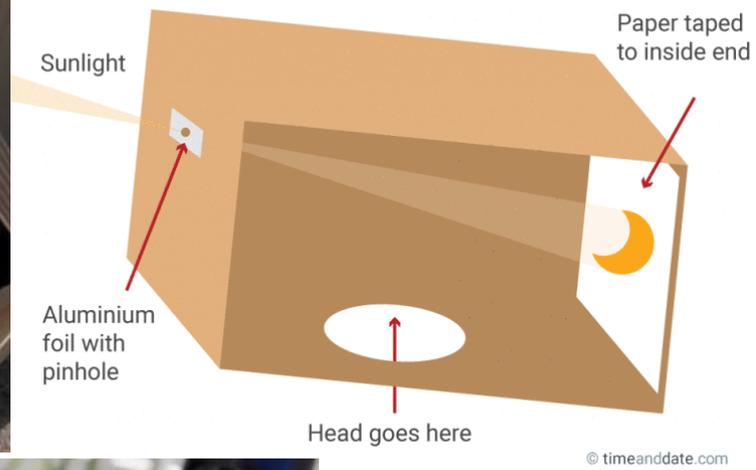
# SUN FUNNEL



投影儀



針孔投影儀



credit: timeanddate.com



# PAPER MODEL



## 紙模型製作

香港太空館

參觀資料	關於我們	何鴻燊天象廳
展覽	活動	天文資訊
其他設施	租務資料	表格下載

### 下載製作紙

天文資訊 ▲  
教育資源 ▲  
下載製作紙

神舟號

下載：  
第一頁 第二頁 第三頁 第四頁

地球儀

下載：  
第一頁 第二頁 第三頁 第四頁

火星儀

下載：

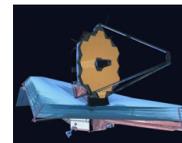
香港太空館：天文資訊：教育資源：下載製作紙



### Hubble Space Telescope

This Model is Rated: **Challenging**  
12.07 MB PDF, 30+ pages - Requires Adobe Reader - Prints on 8 1/2 x 11 paper

This expert paper model consists of around 300 pieces and will take approximately 30 hours to complete. It has extremely accurate 3-D representations of details ranging from the cryocoolers to handrails. It reflects the state of the telescope after Servicing Mission 3B, which took place in March 2002.



### James Webb Space Telescope

This Model is Rated: **Easy**  
3.3 MB PDF, 35 pages - Requires Adobe Reader - Prints on 8 1/2 x 11 paper

Launching in 2018, Webb will be the premier infrared telescope of the next decade. An international collaboration with the European Space Agency (ESA) and the Canadian Space Agency (CSA), Webb will study from the first luminous glows after the Big Bang, to the formation of solar systems.



### Kepler

This Model is Rated: **Moderate**  
713 KB PDF, 12 pages - Requires Adobe Reader - Prints on 8 1/2 x 11 paper

Launched in 2009, the Kepler mission was designed to detect Earth-sized planets orbiting other stars. Kepler has discovered over 2400 confirmed exoplanets including some in the habitable zone of their stars.

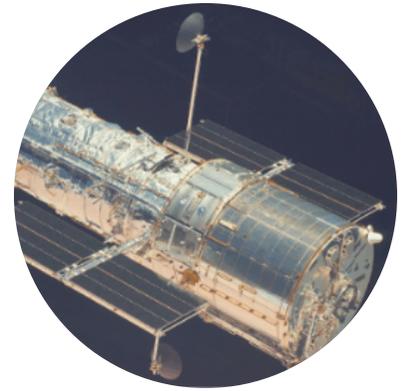
NASA paper models

## 溫馨提示

REMIND

利用像卡紙這種較厚的紙來製作紙模型效果更佳。每個模型製作時間和難度均不同，最好活動前先自行製作一次。

# 3D PRINTING MODEL

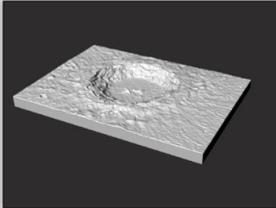


**NASA 3D Resources**

Home  
3D Models  
3D Printing  
Images and Textures  
Visualizations  
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3D in the News

**Related Links**  
science.nasa.gov  
3D Printable Pinhole Projectors  
NASA Mars Trek  
NASA Vesta Trek  
Lunar Mapping and Modeling Portal  
National Institutes of Health 3D Print  
Article: "Printing Space: Using 3D Printing"  
3D Printing in space  
3D Models Put Students in Touch with Planets

## Copernicus Crater



**Description**

**Author/Origin:** Northeast Planetary Data Center, NASA RPIF System, Seth S Horowitz & Peter H. Schultz

**Relevant Mission:** [Lunar Orbit and Landing Approach](#)

**Date Added:** August 3, 2015

**Keywords:** [Moon](#), [Lunar](#), [Crater](#)

**GitHub Repository:** [Moon - Copernicus Crater](#)

**3D Printing**

We understand that 3D printing often involves trial and error. If you have to make adjustments or changes when printing these models, please share your experience with us: [arc-special-proj@lists.nasa.gov](mailto:arc-special-proj@lists.nasa.gov)

One of the more prominent craters on the Moon is named Copernicus. Copernicus is a large young crater visible with binoculars slightly northwest of the center of the Moon's Earth-facing hemisphere. Copernicus is distinguished by its size and by the many bright rays pointing out from it. Although Copernicus is relatively young for a lunar crater, it was formed nearly a billion years ago by a colossal impact. The center of Copernicus is about 93 kilometers across. This model is rendered with a 3x vertical exaggeration.

[Download Copernicuscrater3Xv.zip file - 7 MB](#)

NASA 3D Resources



## 網頁介紹

網頁中有許多模型可作打印，包括隕石坑、太空探測器等等

# REFRACTING TELESCOPE

## 製作折射式望遠鏡



### INTRODUCTION

#### 工作坊介紹

折射式望遠鏡結構較簡易，適合協助中學生去理解望遠鏡原理。製作後可以讓同學利用望遠鏡眺望遠的景物，明白折射式望遠鏡的優缺點（如色差）。

# REFRACTING TELESCOPE

## 製作折射式望遠鏡



IMPETUS TEACHING 原动力教仪  
泰州原动力教学仪器有限公司—淘宝直营店

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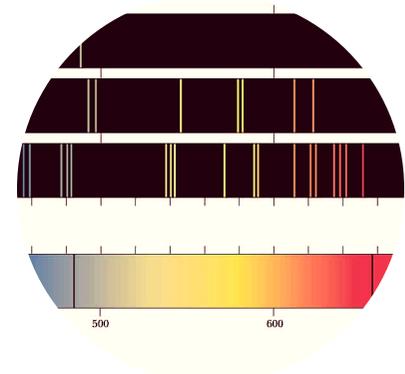
看了又看  
¥25.00 ¥15.00

INTRODUCTION

## 工作坊介紹

購買凹凸透鏡自行組裝。

# SPECTROSCOPE



## 製作光譜儀

製作方法:

- 請先下載展開圖,

簡易摺紙光譜儀

- 以96dpi解析度, 不要做任何的縮小或放大, 列印在厚紙板上。
- 厚紙板的厚度以能不透光, 並且放入印表機或影像機列印為原則。
- 組裝過程, 請參閱【簡易摺紙光譜儀】的照片說明。
- 組裝過程也可以參考下面的影片:

### A DIY CD-SPECTROSCOPE 簡易自製 CD 光譜儀

我們平時用肉眼看見的光, 亦即是可見光, 大多是由不同顏色的光波所組成。例如, 太陽光其實是一條從紅色到紫色的連續光譜。太陽 - 這個距離我們1.496億公里的光體, 你又有親眼見過它所發出的光譜嗎? 用我們教的簡易CD光譜儀, 將它指向不同的光源, 便可以親眼看到不同的光譜。

Light that can be seen with the naked eye is called visible light. It is usually composed of light of different colours. For example, light radiated from the Sun constitutes a continuous spectrum from red to violet. But have you ever seen the spectrum of the glowing Sun, which is 149.6 million kilometres away? When you point this DIY CD-spectroscope at different light sources, you are going to see different kinds of spectra.

光源：太陽  
Light source: Sun

光源：省電燈泡  
Light source: Energy-saving light bulb.

是不是很有趣呢? 那就快點動手跟我們做一個出來啦!  
And a lot more is waiting for you to discover! Let's make one for yourself!

#### 如何自製一個簡易CD光譜儀? How to make a CD-spectroscope?

材料：長方形紙盒 x1  
光碟 x1  
剪刀 x2

Materials: Rectangular paper box x1  
Compact Disc x 1  
Cutter blade x2

工具：間尺  
剪刀  
刀  
膠紙

Tools: A ruler  
A pair of scissors  
A cutter  
A roll of adhesive tape

- 根據左方圖 1 製作一個長方形紙盒。  
Make a rectangular paper box as shown in Diagram I on the left.  
(製作CD光譜儀的長方形紙盒圖樣可於以下網址下載：  
http://www.kids.gov.hk/CD/Museum/SpaceEducation/Workshop/educator\_wk.htm  
For details pattern of making a rectangular paper box for CD-spectroscope, please refer to  
http://www.kids.gov.hk/CD/Museum/SpaceEducation/Workshop/educator\_wk.htm)
- 在盒子的旁邊切開一小正方形, 用以觀察內部, 並在其中一面的底部, 以45°切開一條小縫, 然後放入光碟, 如圖 II。  
Cut out a small square on the side for us to view inside. At the bottom, make a slit at 45°. Then slide in a CD, as in Diagram II.
- 在盒子的頂部, 切開一個小正方形, 放兩塊刀片在正方形上做一條小縫隙, 如圖 III, 小縫隙不能闊於一毫米並須與底部放入光碟的縫隙平行, 用膠紙固定刀片的位置, 以及包住刀片尖銳的地方。  
Cut out a small square on top of the box. Place two blades in the square hole to make a sharp slit, as in Diagram III. The slit should be less than 1mm wide. Make sure it is parallel to the one made for sliding in the CD. Fix the position of the blades with adhesive tape and mask those sharp edges.
- 這樣, 你的簡易CD光譜儀已經完成了 (如圖 IV)! 試試把它向着不同的光源, 比較一下結果吧!  
And now you have got your own CD-Spectroscope (Diagram IV). Let's point to it at various light sources to see different results!

INTRODUCTION

## 工作坊介紹

Google「大凡化宇宙：簡易摺紙光譜儀」/

香港太空館：天文資訊：教育資源：下載製作紙：簡易CD光譜儀可找到模型平面圖及教學

# STARGAZING

## NAKED-EYE OBSERVATION

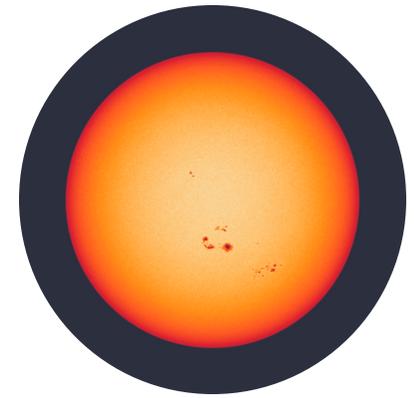
普通單憑肉眼觀  
察

## THROUGH TELESCOPE

透過雙筒 / 各式  
天文望遠鏡去觀  
察

# NAKED-EYE OBSERVATION

太陽



credit : The Straits Times



credit : space.com

REMIND

## 太陽觀測提醒

設置望遠鏡時小心同學仔走近，提醒同學不要直望太陽。

# NAKED-EYE OBSERVATION

星座



credit : staples

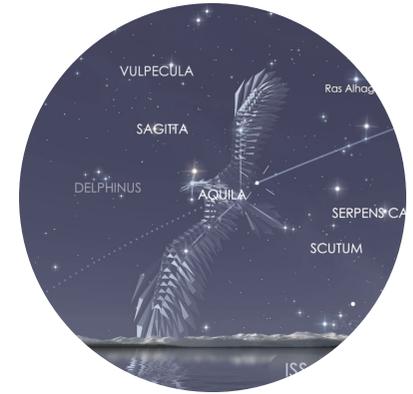
## INTRODUCTION

### 觀星介紹 (1)

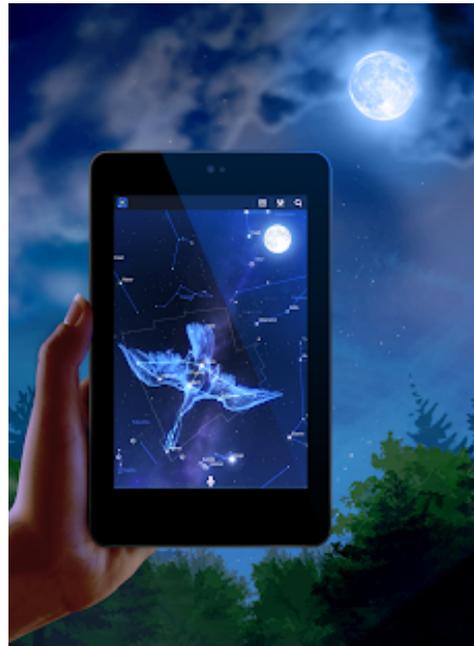
活動前準備當晚星空會出現甚麼較顯眼的星座。除了指出星座的形狀之外可準備一些相關的神話故事，令同學留下較深刻印象。講星的同時用指星筆會更好。

# NAKED-EYE OBSERVATION

觀星軟件



Sky Chart



Star walk

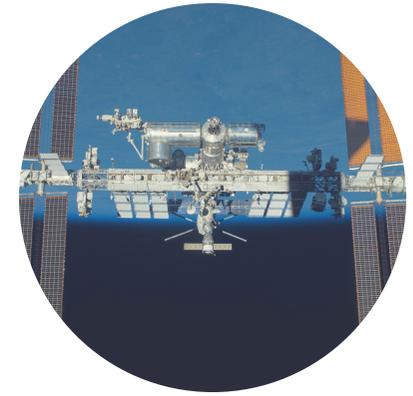
INTRODUCTION

## 觀星介紹 (2)

推介同學下載觀星軟件，方便同學辨認星座。

# NAKED-EYE OBSERVATION

## 人造衛星



**Calsky** The Astronomical Calendar  
 Observation Planning | Historical Research | Events | CalSKY  
 Sun - Moon - Planets - Asteroids - Comets - Deep-Sky - Satellites - and more...

Setup | Calendar | Sun | Moon | Planets | Comets | Asteroids | Meteors | Deep-Sky | Satellites

→ Select from menu above! → to long Table of Contents → Nightvision-Mode

You have not yet specified your observing site. You can do so →here, or using the menu entry "Intro", or by clicking the small Earth icon on the right ☹ side.

City Of Victoria, Hong Kong ☹

Easting: 114.15  
 Northing: 22.291  
 Time zone: UT

Hobby

Weather

Local Sponsors: Your name?

**Next Launches**

Superbird 8/DSN 1/  
 Hylas 4 Ariane 5  
 Launch

Wednesday  
 21 March Soyuz MS-8 Soyuz-  
 2018 FG Launch  
 (International  
 Space Station  
 54S)

**Today at CalSKY**

meteor streams	51
comets	965
astronomy shops	685
star	160
parties/events	160
satellites	26239
solar/lunar eclipses	23332
deep-sky objects	110000
asteroids	755698
occultations	4441937
phenomena	15213579
satellite elements	32023484
noncircular	

### Current Topics

- See the **International Space Station ISS** as it silently crosses the sky during visible passes - an easy target to the naked eye.
- Have you ever wanted to see the ISS cross the front of the Sun or Moon yourself? Here you get accurate predictions for these rare events (looking at the Sun requires proper safety equipment). Get a larger chance by traveling to transits taking place within 25 km. Even want to try to catch the ISS occulting a planet or a bright star?

Another bright objects orbiting the Earth are **Tiangong-1** and **Tiangong-2**.

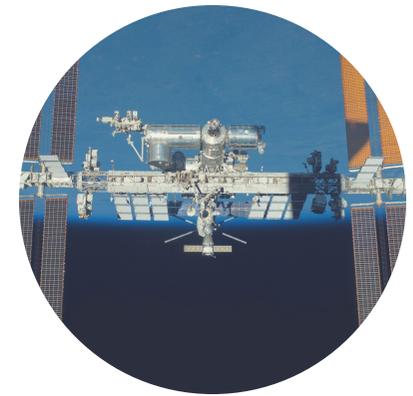
See some flashes from **Humanity Star** in the twilights. But hurry, the disco ball will decay before the end of March. Flashes are as bright as 0 mag.

- Try out our **E-mail Alert Manager**. You first need to register and give your e-mail address; it's free – then you can subscribe to aurora alerts, good ISS passes and Iridium flares, satellites and ISS transiting the Sun or planets, your detailed daily celestial calendar, or simply get warned of the full Moon by e-mail.

# Calsky

# NAKED-EYE OBSERVATION

## 國際太空站 (ISS)



Thursday 11 April 2019

Time (24-hour clock)	Object (Link)	Event
11h46m26s	 <a href="#">ISS</a> <a href="#">Ground track</a> <a href="#">Star chart</a>	<p>Appears 11h41m06s 1.3mag az:325.4° NW horizon</p> <p>at Meridian 11h45m39s -3.1mag az: 0.0° N h:40.7°</p> <p>Culmination 11h46m26s -3.9mag az: 49.0° NE h:53.2°</p> <p>distance: 503.3km height above Earth: 409.4km elevation of Sun: -15° angular velocity: 0.90°/s</p> <p>Disappears 11h47m24s -3.6mag az:103.9° ESE h:36.7°</p> <p>Time uncertainty of about 22 seconds</p> 

Friday 12 April 2019

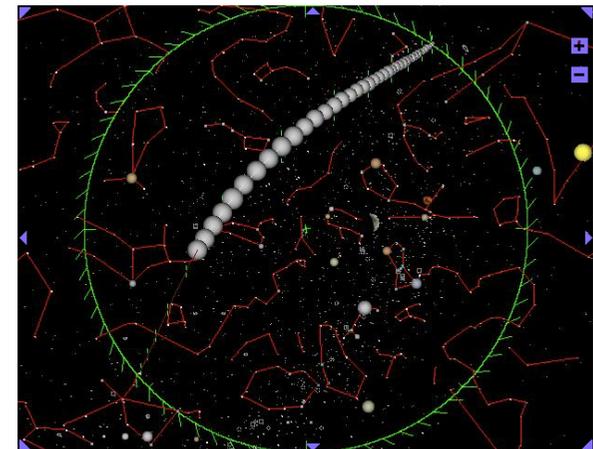
Time (24-hour clock)	Object (Link)	Event
10h55m34s	 <a href="#">ISS</a> <a href="#">Ground track</a> <a href="#">Star chart</a>	<p>Appears 10h50m31s 0.8mag az:335.2° NNW horizon</p> <p>at Meridian 10h53m38s -1.3mag az: 0.0° N h:14.4°</p> <p>Culmination 10h55m34s -2.7mag az: 45.8° NE h:23.1°</p> <p>distance: 912.8km height above Earth: 410.0km elevation of Sun: -15° angular velocity: 0.49°/s</p> <p>Disappears 10h59m17s -1.4mag az:109.6° ESE h:5.1°</p> <p>Time uncertainty of about 26 seconds</p> 
12h31m57s	 <a href="#">ISS</a> <a href="#">Ground track</a> <a href="#">Star chart</a>	<p>Appears 12h27m16s 2.4mag az:296.5° WNW horizon</p> <p>Culmination 12h31m56s -1.1mag az:235.4° SW h:15.1°</p> <p>distance: 1197.9km height above Earth: 408.6km elevation of Sun: -15° angular velocity: 0.38°/s</p> <p>Disappears 12h32m05s -1.2mag az:232.3° SW h:15.1°</p> <p>Time uncertainty of about 26 seconds</p>

Saturday 13 April 2019

Time (24-hour clock)	Object (Link)	Event
11h41m14s	 <a href="#">ISS</a> <a href="#">Ground track</a> <a href="#">Star chart</a>	<p>Appears 11h36m02s 2.2mag az:309.2° NW horizon</p> <p>Culmination 11h41m14s -2.4mag az:233.2° SW h:34.1°</p> <p>distance: 686.3km height above Earth: 408.9km elevation of Sun: -15° angular velocity: 0.66°/s</p> <p>at Meridian 11h42m57s -2.3mag az:180.0° S h:20.1°</p> <p>Disappears 11h44m05s -1.7mag az:167.3° SSE h:11.1°</p> <p>Time uncertainty of about 31 seconds</p>

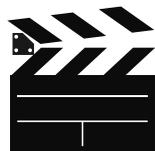
22:17:27.24 Declination

ISS R.A.=11:15:18 Dec=+38:55:08 (J2000) -4.0 mag  
11.04.2019 11:46:30.0



# NAKED-EYE OBSERVATION

☐ 衛星 (Iridium satellites)



Thursday 11 April 2019

Time (24-hour clock)	Object (Link)	Event
21h47m59s	COSMO-SkyMed 2	<p>Flare from SAR-Panel Magnitude=-2.5mag Azimuth= 74.4° ENE altitude= 69.9° in constellation Vulpecula Flare angle=0.39°</p> <p>Flare center line, closest point →MapIt: Longitude=114.105°E Latitude=+22.281° (WGS84) Distance=4.8 km Azimuth=257.0° WSW Peak Magnitude=-2.6mag Satellite above: longitude=116.1°E latitude=+22.8° height above Earth=624.4 km distance to satellite=661.1 km Altitude of Sun=-5.1°</p> <p>This is an experimental flare prediction. Brightness estimate may be unreliable. Please report a successful observation (Object/site coordinates/date/measured time/accuracy/magnitude).</p> 

Friday 12 April 2019

Time (24-hour clock)	Object (Link)	Event
21h47m59s	COSMO-SkyMed 3	<p>Flare from SAR-Panel Magnitude=-2.5mag Azimuth= 73.5° ENE altitude= 69.8° in constellation Vulpecula Flare angle=0.60°</p> <p>Flare center line, closest point →MapIt: Longitude=114.080°E Latitude=+22.276° (WGS84) Distance=7.3 km Azimuth=257.0° WSW Peak Magnitude=-2.6mag Satellite above: longitude=116.1°E latitude=+22.8° height above Earth=624.4 km distance to satellite=661.3 km Altitude of Sun=-4.9°</p> <p>This is an experimental flare prediction. Brightness estimate may be unreliable. Please report a successful observation (Object/site coordinates/date/measured time/accuracy/magnitude).</p> 

Saturday 13 April 2019

Time (24-hour clock)	Object (Link)	Event
21h36m43s	COSMO-SkyMed 1	<p>Flare from unknown Mirror Magnitude= 0.8mag Azimuth= 37.7° NE altitude= 39.1° in constellation Lacerta Flare angle=3.21°</p> <p>Flare center line, closest point →MapIt: Longitude=114.794°E Latitude=+22.444° (WGS84) Distance=68.4 km Azimuth= 75.5° ENE Peak Magnitude=-1.5mag Satellite above: longitude=118.3°E latitude=+26.7° height above Earth=624.8 km distance to satellite=932.3 km Altitude of Sun=-7.3°</p> <p>This is an experimental flare prediction. Brightness estimate may be unreliable. Please report a successful observation (Object/site coordinates/date/measured time/accuracy/magnitude).</p> 

# THROUGH TELESCOPE

## 雙筒望遠鏡



credit: leisurelyscientist.com

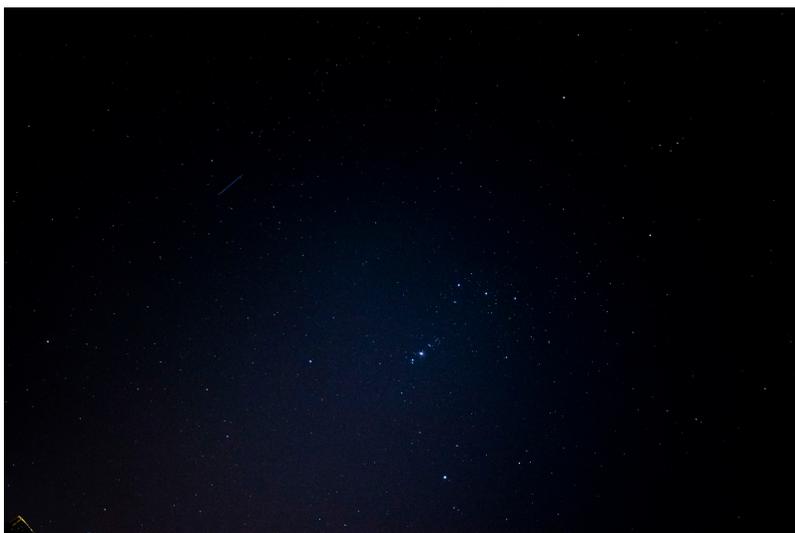
### INTRODUCTION

#### 觀星介紹 (3)

雙筒望遠鏡很適合觀星初學者去使用。可先跟同學教學使用雙筒望遠鏡的技巧。購買時要留意是否有濾鏡。可用指星筆輔助同學找到觀察目標。

# THROUGH TELESCOPE

天文望遠鏡



深空天體



行星



月球

## INTRODUCTION

### 觀星介紹 (4)

行星比較容易透過望遠鏡觀察，可留意最近有沒有行星出現。不建議在滿月時觀察月球，因為不容易看到月球上的坑紋。觀察月球時最好先安置濾鏡，以免眼睛受到傷害。

# TALK/BOOTH



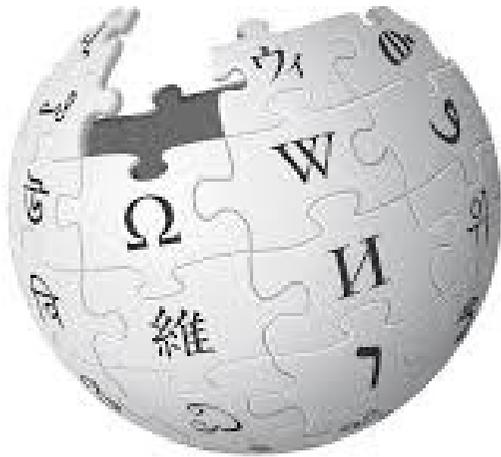
REMIND

## 溫馨提示

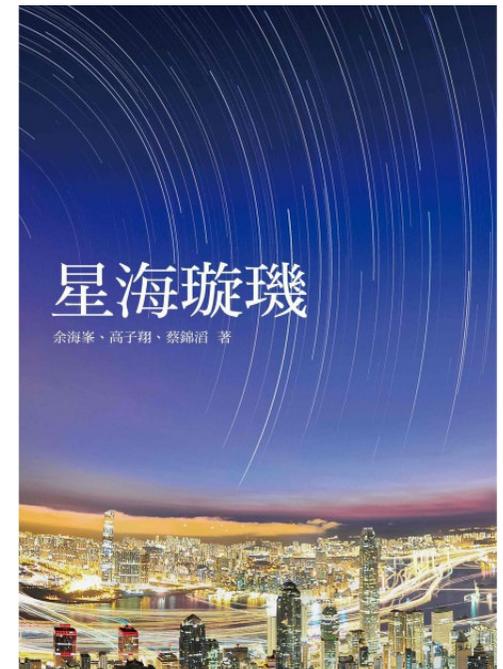
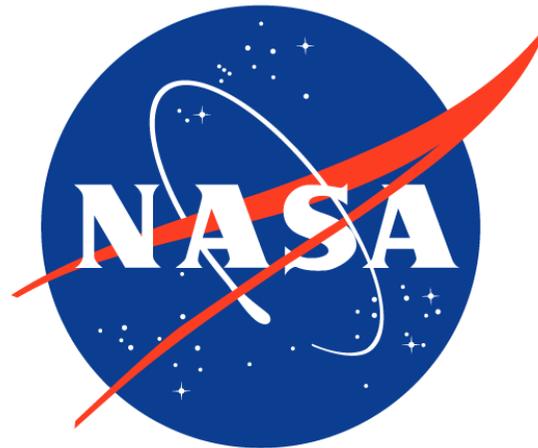
論座的內容自行決定，可多留意同學有興趣的課題。  
內容不要過多，同學未必能消化。

# TALK/BOOTH

資料來源……



**WIKIPEDIA**  
The Free Encyclopedia



**REMIND**

溫馨提示

不要直接抄襲。

# SHARING



PREPARED BY RAVEN LAU

DATE: MARCH 21, 2019