Astronomy 2023

Stardust

Chris Law, Chemist, HAS

SDG 17th July 2023

ASTRONOMY

Sky at night

PATRICK MOORE X2

Herschel Astronomical Soc, Eton,pr

Venus transit 2004. First since 19cen.

RTW Ticket 1997, Tas, Mauna Kea

Palomar, Kitt Peak, Aus, La Palma

Eclipses: 1954p, 1999c, 2001z, 2006e

2003 Byseewah observatory, Namibia

(booked Mt Teide, Tenerife May 2023)

Topics for this evening:

- [Safety: a)Newton/sun b) red light/night vision]
- 1] 400+ years of the ‘telescope’ in visible light
- 2] ‘Creation’ & Nucleosynthesis
- 3] Local & other resources
- 4] In the sky diary

- Although ‘glass’ may have been discovered in earlier times, by the 17th Century it was being made & used for optical purposes.
- Dutch lensmaker Hans Lippershey (Jacob Metius/Sacharias Jansen ?) had combined lenses to produce the ‘telescopic’ effect 1608
- Galileo Galilei learned of this, and in 1609 devised such a device, and aimed it terrestrially & heavenly, producing upright images with a magnification up to 30x
- Thomas Harriot drew Moon at Syon 26th July 1609
- Kepler modified to increase mag, but inverted

Refracting telescopes generally use convex lenses. They have several disadvantages

1] Chromatic aberration(now use doublets/triplets)

2] Weight-largest in practical use is Yerkes doublet (40in/102cm diameter, 500pounds, 62 feet focal length) in Wisconsin. Built 1895

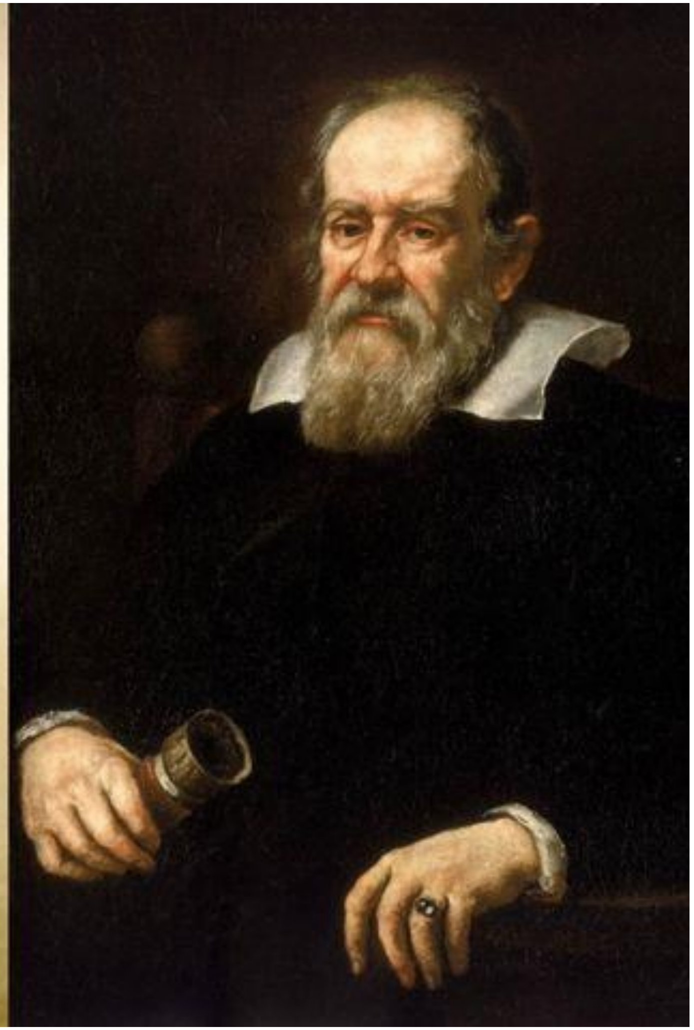
3]‘Light gathering’ diameter vv mass of lens

4] ‘Sag’ of glass, and support tubes

Smaller examples used now in amateur models.

(demo)

Galileo’s refractor



Reflecting telescopes

Isaac Newton produced a telescope using a concave spherical reflecting surface around 1668.

In 1721 John Hadley improved on the ‘figuring’

of the mirror, by using parabolic shape.

Reflecting mirrors were made from an alloy of Copper & Tin called speculum, which could be easily cast, ‘figured’ and polished.

Largest of this type, the Ross ‘Leviathon’ was 183cm(6ft) diameter, around 1845.

Mount Wilson’s 254cm/100in reflector was a new era of front silvered ‘glass’ mirrors (5715ft elev) [demo tape]

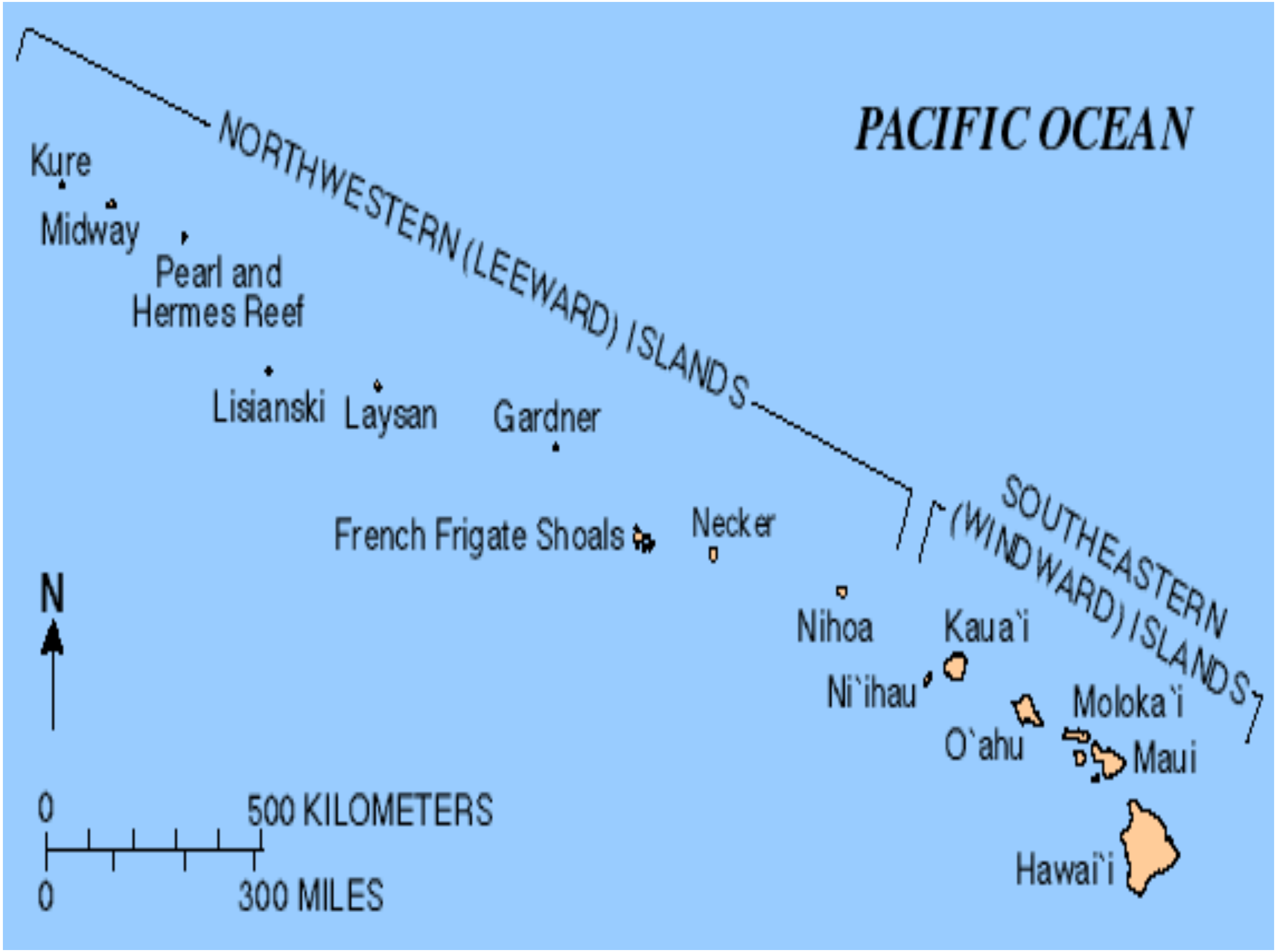
First light in 1917 remained largest till 1949 when Palomar 200in opened. [demo tape]

Multi-mirrors like the Keck pair now commonplace with ‘active’ compensation for atmospheric instability.

- ‘Ideal’ Telescope qualities:
- 1] Stable mount isolated from main foundation
- 2] Weather/ wind protection
- 3] Highest elevation accessible & safe for staff
- 4] ‘Purest’ optics+ resilvering facility (Hobart,no !)
- 5] Thermal stability (air conditioning?)
- 6] Precision drive for rotating mount
- 7] Dedicated dark sky area eg Palomar (hmmn!)
- 8] ‘Kind’ weather (Greenwich, Herstmonceux etc)
- La Palma, Atacama, Mauna Kea, Kitt Peak etc
- 9] Spectroscopy add-on facility

Astronomical Observatories in the Hawaiian Islands

- aloha


PACIFIC OCEAN
NORTHWESTERN (LEEWARD) ISLANDS
SOUTHEASTERN (WINDWARD) ISLANDS
Kure
Midway
Pearl and Hermes Reef
Lisianski
Laysan
Gardner
French Frigate Shoals
Necker
Nihoa
Kaua`i
Ni`ihau
O`ahu
Moloka`i
Maui
Hawai`i
N
0
500 KILOMETERS
0
300 MILES

Mauna Kea Observatories

Mauna Kea
- Overview
- Telescope List
- Summit map
- Visiting Mauna Kea
- Aerial tour
- MK weather center
- Webcams
- MKO Management
- Telescope coordinates
- Costs and Employment

Maintained by W-W

The 4,200 meter high summit of Mauna Kea in Hawaii houses the world's largest observatory for optical, infrared, and submillimeter astronomy.

Move your mouse over a dome to identify a telescope
Click on the dome to go to its website

Maunakea Telescopes

Mauna Kea
Overview
Telescope List
Summit map
Visiting Mauna Kea
Aerial tour
MK weather center
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MKO Management
Telescope coordinates

Maintained by LG

Optical/Infrared

UH 0.9m	UH Hilo Educational Telescope	0.9m	University of Hawaii at Hilo	2010
UH 2.2m	UH 2.2-m telescope	2.2m	UH Institute for Astronomy	1970
IRTF	NASA Infrared Telescope Facility	3.0m	NASA	1979
CFHT	Canada-France-Hawaii Telescope	3.6m	Canada/France/UH	1979
UKIRT	UKIRT	3.8m	UH Institute for Astronomy	1979
Keck I	W. M. Keck Observatory	10m	Caltech/University of California	1993
Keck II	W. M. Keck Observatory	10m	Caltech/University of California	1996
Subaru	Subaru Telescope	8.3m	Japan	1999
Gemini	Gemini Northern Telescope	8.1m	USA/UK/ Canada/Argentina/ Australia/Brazil/Chile	1999

Submillimeter

CSO	Caltech Submillimeter Observatory	10.4m	Caltech/NSF	1987
JCMT	James Clerk Maxwell Telescope	15m	UK/Canada/Netherlands	1987
SMA	Submillimeter Array	8x6m	Smithsonian Astrophysical Observatory/Taiwan	2002

Radio

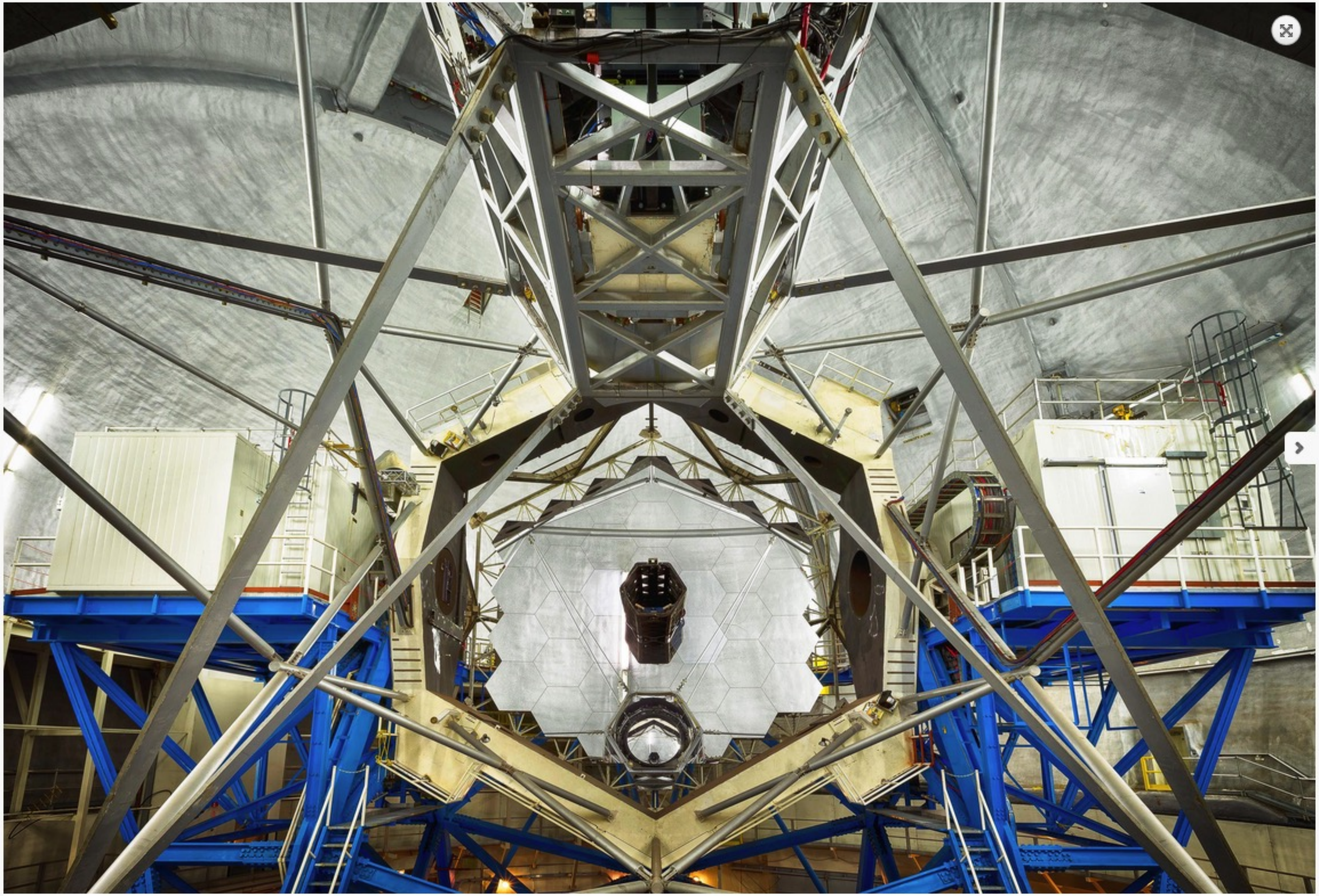
VLBA	Very Long Baseline Array	25m	NRAO/AUI/NSF	1992

Mirror sizes

This chart shows all the mirrors of the optical and infrared telescopes on Mauna Kea to the same scale (click to enlarge)

The Hubble Space Telescope's mirror is similar in size to that of the UH 2.2 meter telescope -- the second smallest telescope on the mountain.

Keck Mirror Wide



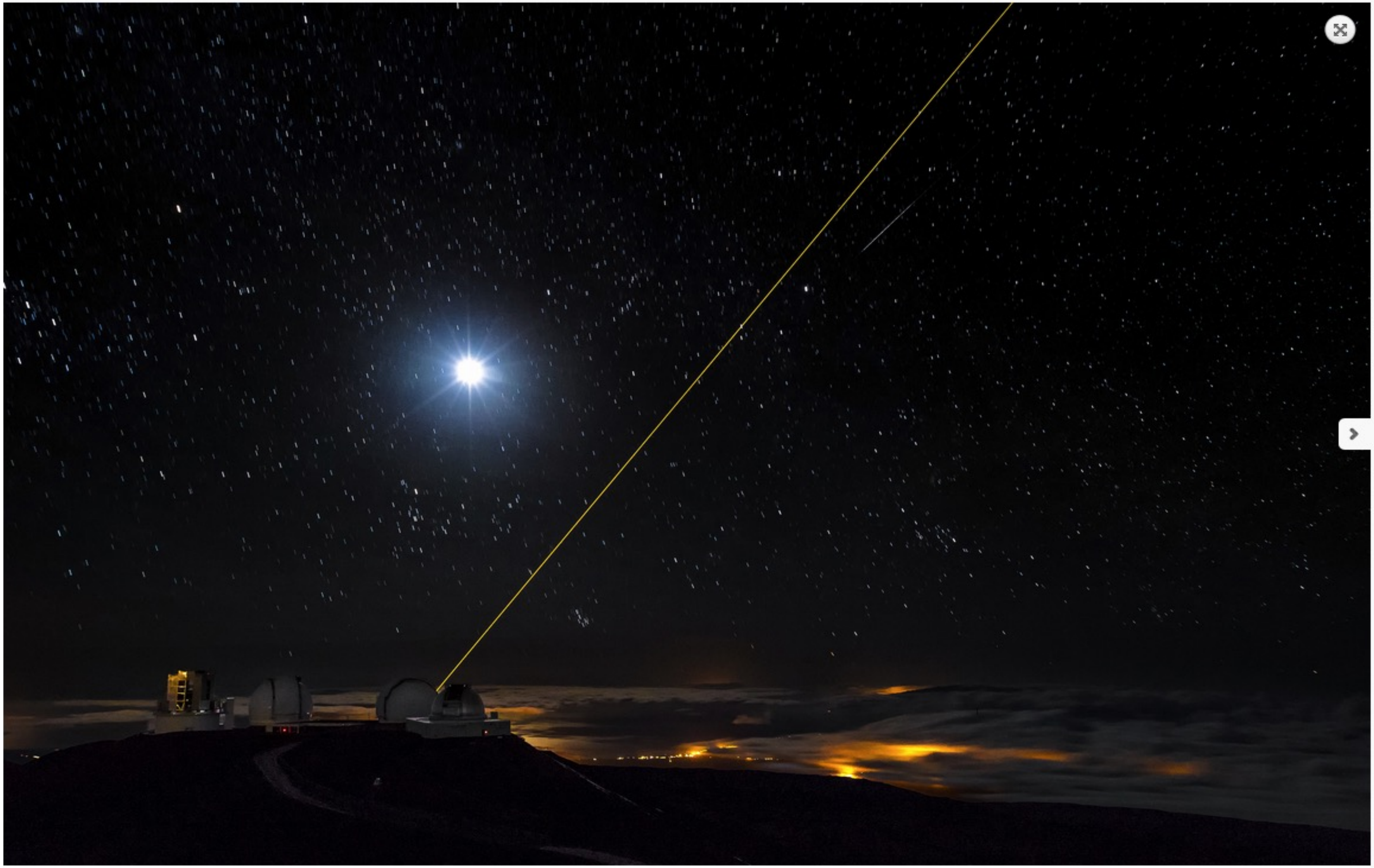
21/25 A wide angle view of the ten meter Keck mirror. - Ethan Tweedie

Like

Three Lasers and Light Pollution

23/25 The Keck I Laser propagating, alongside the Keck II and Subaru lasers. WMKO Engineer Andrew Cooper took over 90 x 1minute exposures from near UKIRT on the summit ridge on May 26. The result has been combined into the attached image and a video. The image combines 23 exposures, each 1 minute long. During the exposure, the Keck II laser is aimed over the camera at the Milky Way's Galactic Center. The image also shows a car driving down the summit road which appears as a stream of light. - Andrew Cooper

Keck Summit Moonlit



24/25 Keck II beaming its laser towards the cosmos on a moonlit night. The lights from Waimea, other town on the Big Island, and even a few towns on other islands glow 14,000 feet below. - Ethan Tweedie

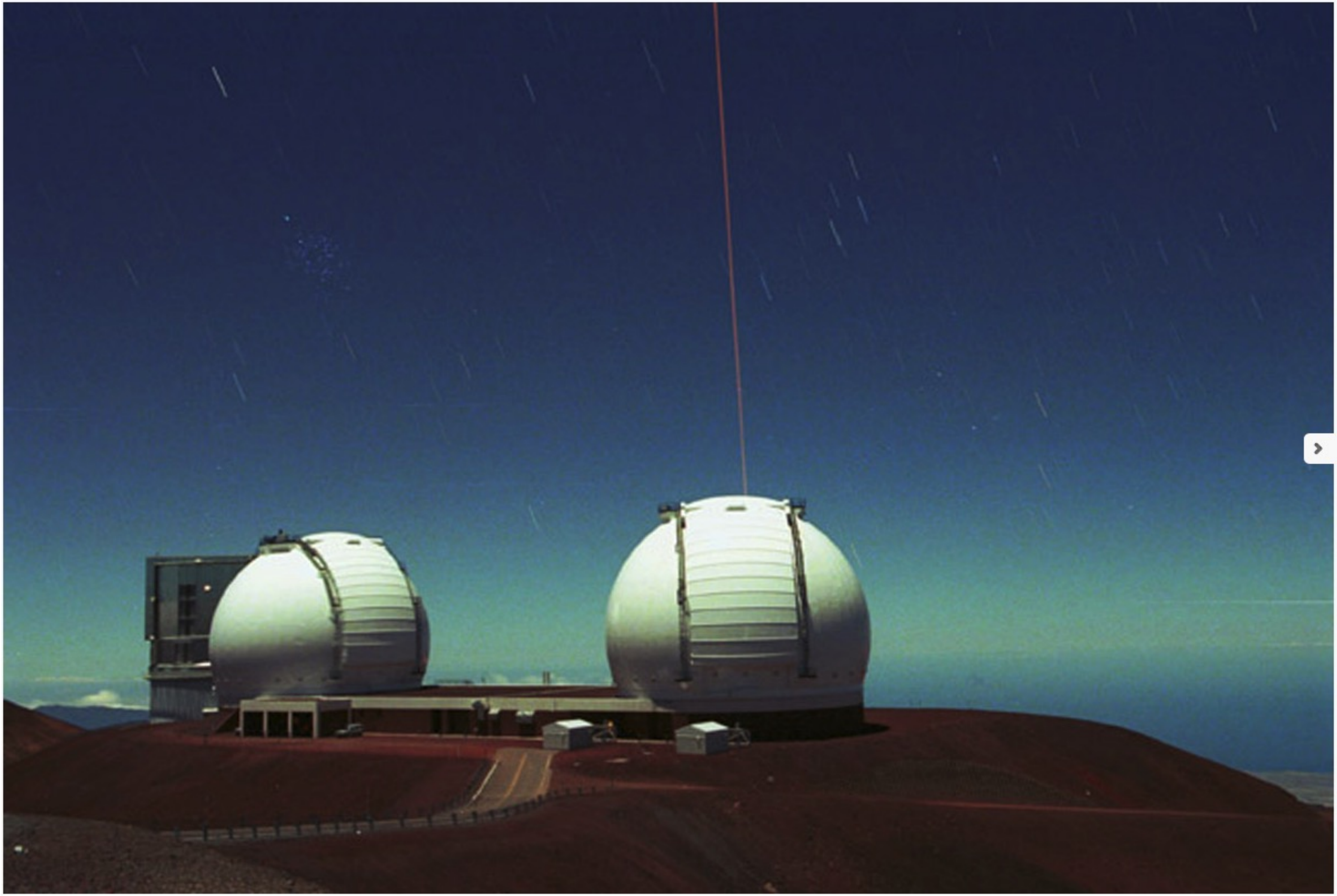
Tweet Like

- Approx $40,000 per night (Kecks)

Double Laser

The twin Keck telescopes shooting their laser guide stars into the heart of the Milky Way on a beautifully clear night on the summit on Mauna Kea. - Ethan Tweedie

Keck II Laser Under Moonlight



15/25 Keck II laser under a full moon. - Sarah Anderson

Like

Keck Crew Mirror

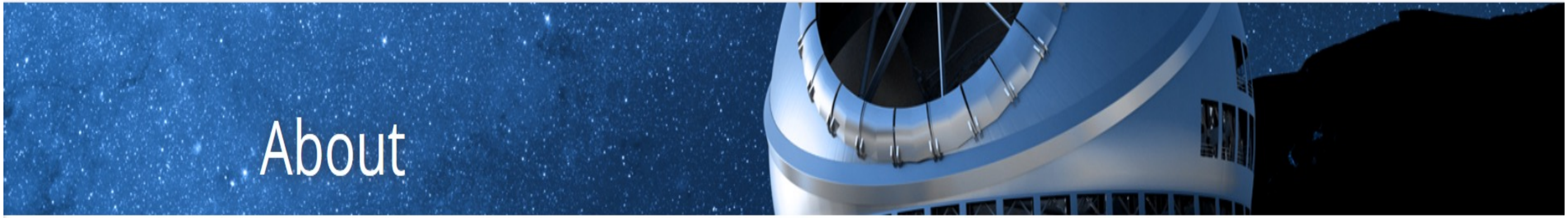
22/25 The Keck summit crew showing off the mirror of the Keck telescope on the summit of Mauna Kea. - Rick Peterson

Telescope Schedule

Select schedule for Both Tels Year: 2018 Month: January GO
Prev Month Next Month Print version Query

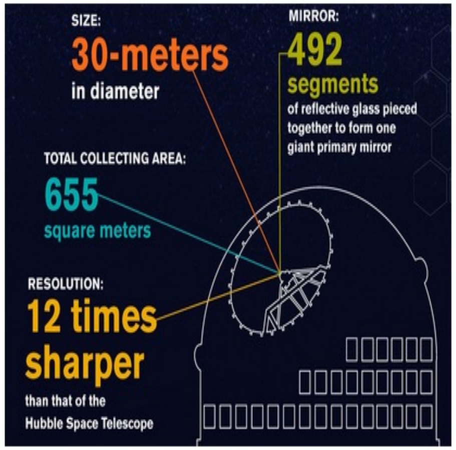
January 2018 - Both Tels

DOW	Date	Dark	TelNr	Principal	Observers	Location	InstrAcc	Institution	OA	SA	NA	ProjCode
Mon	Jan-01	0	1	Shapley	Shapley, (UCLA), R. Sanders, (UCLA)	UCLA	OSIRIS-LGS(2)	UCLA	TS/AH	JL	SJ	U043
Mon	Jan-01	0	2	Treu/de Pater	Shajib/Molter, (UCB)	HQ/UCB	NIRC2-LGS(7)/ NIRC2-NGS(7)	UCLA/UCB	JR	CA	SJ	U049/U040
Tue	Jan-02	1	1	Shapley	Shapley, (UCLA), R. Sanders, (UCLA)	UCLA	OSIRIS-LGS(2)	UCLA	TS/AH	JL	SJ	U043
Tue	Jan-02	1	2	Mawet	Mawet, (CIT), Ruane, (CIT), L. Weiss	CIT/HQ	NIRC2-NGS(8)	CIT	JR	LR	SJ	C367
Wed	Jan-03	10	1	Treu	X. Wang, (UCLA), Shajib	UCLA/HQ	OSIRIS-LGS(3)	UCLA	TS/AH	RC	SJ/NDJ	U032
Wed	Jan-03	10	2	M. Johnson	M. Johnson, Rizzuto	HQ	NIRC2-NGS(9)	NASA	JR	LR	SJ/NDJ	N217
Thu	Jan-04	19	1	Medling	Medling, (CIT), Vivian. U, (CIT)	CIT	OSIRIS-LGS(4)	CIT	TS/CJ	RC	NDJ	C360
Thu	Jan-04	19	2	Max/Ji. Wang	Max, (UCSC), Rudy, (Other)/Ji. Wang, (CIT)	UCSC/CIT	NIRC2-LGS(3)/ NIRSPEC(3)	UCSC/CIT	JR/JMc	LR	NDJ	U054/C322
Fri	Jan-05	28	1	Howard/M. Brown	Isaacson, (UCB), Howard, (CIT)/	UCB/CIT/HQ	HIRESr(1/1)	NASA/CIT	CJ	JW	SJ/JLP	N187/C329
Fri	Jan-05	28	2	Best	Best, (IfA)	IfA	NIRC2-LGS(4)	UH	JMc	RC	SJ/JLP	H337
Sat	Jan-06	36	1	Howard/Dressing	Isaacson, (UCB), Howard, (CIT)/Petigura, (CIT)	UCB/CIT	HIRESr(1/1)	NASA/CIT	CJ	JW	JLP	N187/C374
Sat	Jan-06	36	2	Best	Best, (IfA)	IfA	NIRC2-LGS(4)	UH	JMc	RC	JLP	H337
Sun	Jan-07	44	1	Kasliwal	S. Adams, (CIT)	CIT	MOSFIRE(1)	CIT	CJ/TR	JW	JLP	C332
Sun	Jan-07	44	2	Bolte	Margon*	HQ	ESI(7)	UCSC	JMc/GP	JL	JLP	U067
Mon	Jan-08	52	1	K. Tran	K. Tran, (Swin), Yuan, (Swin), Alcorn	Swin/HQ	MOSFIRE(2)	ANU-AAL	TR	JW	SJ/JLP	Z279
Mon	Jan-08	52	2	Duev	Duev	HQ	ESI(8)	CIT	GP	JL	SJ/JLP	C381
Tue	Jan-09	59	1	Harikane	Harikane, Kikuchihara	HQ	MOSFIRE(3)	Subaru	TR	SY	SJ	S409
Tue	Jan-09	59	2	McPartland	McPartland	HQ	DEIMOS(4)	UH	GP	CA	SJ	H342
Wed	Jan-10	67	1	Harikane	Harikane, Kikuchihara	HQ	MOSFIRE(3)	Subaru	TR	SYoc	SJ	S409
Wed	Jan-10	67	2	Stern	Capak, (CIT), J. Cohen, (CIT), Hemitscheck, (CIT), Stanford, (UCB)	CIT/UCB	DEIMOS(5)	NASA	GP	CA	SJ	N191
Thu	Jan-11	74	1	S. Valenti/Kriek	S. Valenti, (UCD)/Suess, (UCB), Bezanson, (UCB)	UCD/UCB	LRIS-ADC(1/1)	UCD/UCB	TR/JR/AH	JW	SJ/NDJ	U109/U147
Thu	Jan-11	74	2	Stern	Capak, (CIT), J. Cohen, (CIT), Hemitscheck, (CIT), Stanford, (UCB)	CIT/UCB	DEIMOS(5)	NASA	GP/JA	CAoc	SJ/NDJ	N191
Fri	Jan-12	81	1	Heida/Lunnan	/Lunnan, (CIT)	HQ/CIT	LRIS-ADC(2/2)	CIT	JR/AH	JW	NDJ	C439/C366
Fri	Jan-12	81	2	Ebeling	Ebeling, (IfA)	IfA	DEIMOS(6)	UH	JA	CA	NDJ	H402
Sat	Jan-13	89	1	Fong/Lunnan	Lunnan, (CIT), Fong, (CIT), Terreran, (CIT)/Lunnan, (CIT)	CIT	LRIS-ADC(2/2)	Northwestern/CIT	JR/AH	JW	NDJ	NW440/C366
Sat	Jan-13	89	2	Ebeling	Ebeling, (IfA)	IfA	DEIMOS(6)	UH	JA	CAoc	NDJ	H402
Sun	Jan-14	96	1	Foley/Perlmutter	Foley, Siebert, Dimitriadis/Aldering, (UCB), Boone, (UCB), S. Dixon, (UCB), Gupta, (UCB), Hayden, (UCB), Rubin, (USRA), Krolewski, R. Pan	HQ/UCB/USRA	LRIS-ADC(3/3)	NASA	JR/AH	JW	NDJ/JLP	N197/N255
Sun	Jan-14	96	2	Crystal. Martin/de Pater	Crystal. Martin, (UCSB)/de Pater, (UCB), de Kleer, (CIT)	UC/CIT	KCWI(4)/NIRC2-NGS(5)	UCSB/UCB	JA	GD	NDJ/JLP	U095/U040
Mon	Jan-15	100	1	Foley/Perlmutter	Foley, Siebert, Dimitriadis/Aldering, (UCB), Boone, (UCB), S. Dixon, (UCB), Gupta, (UCB), Hayden, (UCB), Rubin, (USRA), Krolewski, R. Pan	HQ/UCB/USRA	LRIS-ADC(3/3)	NASA	JR/AH/TS	JW	JLP	N197/N255
Mon	Jan-15	100	2	M. Rich	M. Rich, (UCLA), Daddi, (UCLA), Niell, (CIT)	UCLA/CIT	KCWI(5)	UCLA	JA/JP	GD	JLP	U107
Tue	Jan-16	100	1	S. Kulkarni		HQ	LRIS-ADC(4)	CIT	TS	LR	JLP	C384



What is TMT?

The Thirty Meter Telescope is a new class of extremely large telescopes that will allow us to see deeper into space and observe cosmic objects with unprecedented sensitivity. With its 30 m prime mirror diameter, the TMT will be three times as wide, with nine times more area, than the largest currently existing visible-light telescope in the world. This will provide unparalleled resolution with TMT images more than 12 times sharper than those from the Hubble Space Telescope. When operational, the TMT will provide new observational opportunities in essentially every field of astronomy and astrophysics. Observing in wavelengths ranging from the ultraviolet to the mid-infrared, this unique instrument will allow astronomers to address fundamental questions in astronomy ranging from understanding star and planet formation to unraveling the history of galaxies and the development of large-scale structure in the universe. Check out the TMT Timeline to find out the current stage of the TMT development. See a comparison between the TMT and other upcoming extremely large telescopes. Learn more about what scientific questions may be answered with the help of TMT.



What will TMT Explore?

TMT will be a unique tool for probing many outstanding open questions in astronomy. Its adaptive optics and spectroscopic capabilities will allow astronomers to explore the mysterious period in the life of the universe when the first stars and galaxies were formed, providing information about the nature of "first-light" objects and their effects on the universe's evolution. TMT will also observe the formation and development of the large-scale structures by looking at faint distant galaxies and the intergalactic medium, providing information on the physics of the early universe and the nature of dark matter that are inaccessible using any other techniques. TMT's high resolution will extend scientists' capability to detect and investigate black holes that reside in the center of many distant galaxies, as well as study in detail the black hole in the center of our own Milky Way. TMT will also play a very important role in advancing our knowledge of the physical processes that lead to star and planet formation. TMT will be able to characterize and study the properties of exoplanets leading us closer to finding out if life exists beyond the Earth. Finally, the advanced capabilities of the TMT will very likely lead to discoveries that we cannot anticipate and scientific impact far beyond what we envision today.

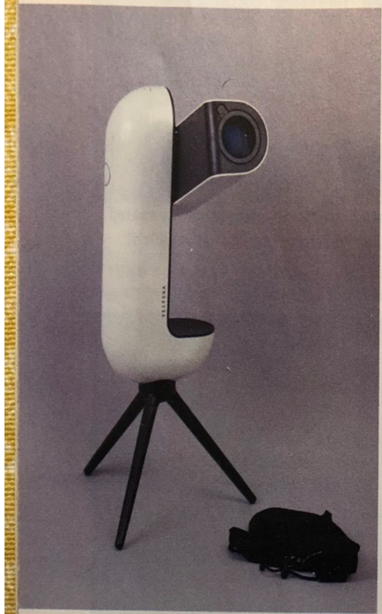
Learn More >>

Farewell from Paradise

Hasten back

The Vespera Digital Telescope

This little refractor makes astrophotography easier than ever. Is it worth the price?



SMART TELESCOPES, observing stations, or whatever you want to call the growing crop of cyborg scopes that meld digital imaging technology with semi-autonomous optics are finding their way into the amateur community. It's not uncommon to see one of these devices on the observing field at your local astronomy club, or particularly at a public outreach event.

These instruments are different than most – for one thing, they don't have a conventional eyepiece at all. Instead, the objective illuminates a tiny camera that sends its images wirelessly to a paired smartphone or tablet, where an image of the targeted nebula, galaxy, or star cluster slowly builds up on the device's screen. The "views" they produce are in most cases far better than you could see in an eyepiece on a much larger scope, and are in color.

Vaonis, the French company that released the first "smart telescope," the Stellina (*S&T:* Mar. 2020, p. 68), follows up on its success with the smaller, lighter, and less costly Vespera Exploration Station. This little device improves upon many of the original model's features while shrinking the package to a truly portable size.

I was loaned a Vespera along with several of its accessories at the end
how well it performs.

Vaonis VE50 Vespera Exploration Station Digital Telescope

U.S. Price: $2,499
vaonis.com

What We Like

Ease of setup and use
User-friendly mobile app
Useful mosaicking feature

What We Don't Like

Limited battery life
Poor focus on Moon and Sun

▲ Vespera is a 50-mm refractor with everything necessary to capture images of the night sky entirely contained within its pill-shaped body.

▶ Vespera's four-element, 50-mm objective is surrounded by a removable filter ring (top) that also covers the mounting position of the optional moisture sensor (seen at right).

Telescopic Jelly

The Vespera is a 50-mr
plet apochromatic refra
integrated color video c
IMX462 CMOS sensor
1,920 × 1,080 pixels, ea
square. Given the telesc
focal length, the system
arcseconds per pixel. Th
chip offers a field of vie
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Moon (or the Sun) with

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timeter (8-inch) tripod
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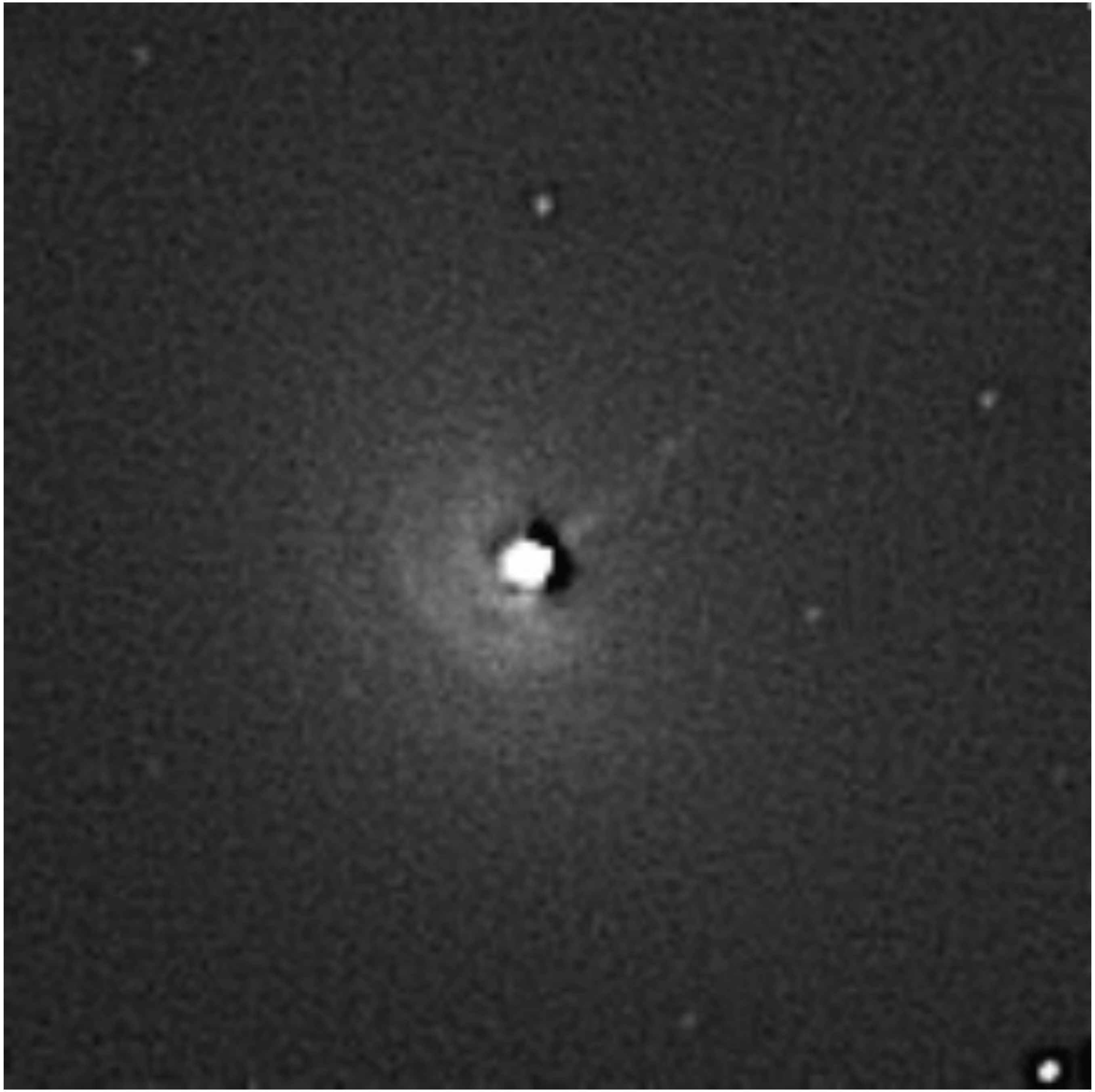


- **<u>2) CREATION ?</u>**

FOREBEARS

Old testament; Dr J Lightfoot (around 1643) proposed 3929 BCE that the ‘Universe’ starts. Archbishop Ussher suggests 22 October 4004 BCE, et al. Labelled Anno Lucis

Contemporary ideas: Joseph Fraunhofer in 1814 discovered dark lines in the Sun’s spectrum. Sirius & other stars had DIFFERING specta. (why?)

Polymath William Thomson(Lord Kelvin)1824-1907 thought Earth 20-40 myo. Proposed Sun a ‘cooling hot liquid’. Others postulated ‘burning coal or oil’

1869 Dmitri Mendeleev produced Periodic table of the then known Elements at St Petersburg State University

1904 Ernest Rutherford suggested sun’s output caused by radioactive decay(fission)

1920 Eddington proposed nuclear fusion H-> He (using Einsteins E=mc2);mass loss

1930 Further developed by Chandrasekhar and 1957 by Hans Bethe (Fe=AtNo 26)

1959 Margaret & Geoffrey Burbridge with William Foster & Fred Hoyle showed Elements synthesized in Stars (Strodes)

The Periodic Table

The periodic table shows the chemical elements ordered by atomic number (number of protons in the nucleus), but arranged in rows (periods) so that elements with similar chemistry occur in the same vertical column (group). Here, elements with the same chemical and physical properties are shown by the colour categories identified in the key at right. In general, members of each category also have a similar chemical valency, a measure of the number of bonds an element can form. Each element is represented by its chemical symbol. Above the symbol is the element's atomic number and below is the element's name.

Element Categories

- Alkali metals
- Alkaline earth metals
- Lanthanides
- Actinides
- Transition metals
- Post-transition metals
- Metalloids
- Other non-metals
- Halogens
- Noble gases
- Unknown chemical properties

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Berylium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Caesium	56 Ba Barium	57-71 Lanthanides	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	80-103 Actinides	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Uut Ununtrium	114 Fl Flerovium	115 Uup Ununpentium	116 Lv Livermorium	117 Uus Ununseptium	118 Uuo Ununoctium

57 La Lanthanum	58 Ce Cerium	59 Pr Praesodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Alkali metals
This 'group 1' of metals occupies the far-left column of the periodic table. They are all soft, but solid metals at room temperature, and are highly reactive – for example, when dropped in water.

Alkaline earth metals
The alkaline earth metals are silver-white metals at room temperature. The name is a term that refers to the naturally occurring oxides of these elements. For example, lime is the alkaline oxide of calcium.

Lanthanides
The lanthanide elements occupy a horizontal strip ...rmally appended at the foot of the periodic table. ...d after lanthanum, the first element in the series, ...e generally found in less common mineral rocks, ... monazite and bastnasite.

Actinides
The actinides fill the second horizontal strip at the foot of the table. Named after their first element, actinium, they are all highly radioactive. So much so, that natural reserves of many of these elements have decayed away to nothing.

Transition metals
The transition metals occupy a broad swathe in the centre of the periodic table. They are harder than the alkali metals, less reactive and are generally good conductors of both heat and electrical current.

Post-transition metals
Lying in a triangular region to the right of the transition metals, the post-transition metals are soft metals that mostly have low melting and boiling points. They also include mercury, which is liquid at room temperature.

Metalloids
The metalloid elements form a line between the metals and non-metals in the periodic table. Their electrical conductivity is intermediate between the two groups, leading to their use in semiconductor electronics.

Other non-metals
In addition to halogens and noble gases, there are other elements that are simply classified as 'other non-metals'. They display a wide range of chemical properties and reactivities. They have high ionization energies and electronegativities, and are generally poor conductors of heat and electricity. Most non-metals have the ability to gain electrons easily. They have lower melting points, boiling points and densities than the metal elements.

Halogens
The halogens, known as group 17, are the only group to contain all three principal states of matter at room temperature: gas (fluorine and chlorine), liquid (bromine) and solid (iodine and astatine) — all non-metals.

Noble gases
The noble gases are non-metals occupying group 18 of the table. They are all gaseous at room temperature and share the properties of being colourless, odourless and unreactive. Including neon, argon and xenon, they have applications in lighting and welding.

Unknown chemical properties
This is a label reserved for elements that can only be manufactured in a laboratory. Very often, only minute quantities of such elements have been created – making it impossible to ascertain their exact chemical classification.

Current theory

'Big bang' 13.7 bya. Baryons ~5%. Dark Matter & Energy ? Nucleosynthesis (elements) in Stars

Galaxy formation. Milky Way ~ 8.8bya

Solar System~ 4.6 bya from ~ 2 preceding supernovae because we have Elements>Mass No 26

****

Carboniferous~300mya coal seams in Pangea, migrated North

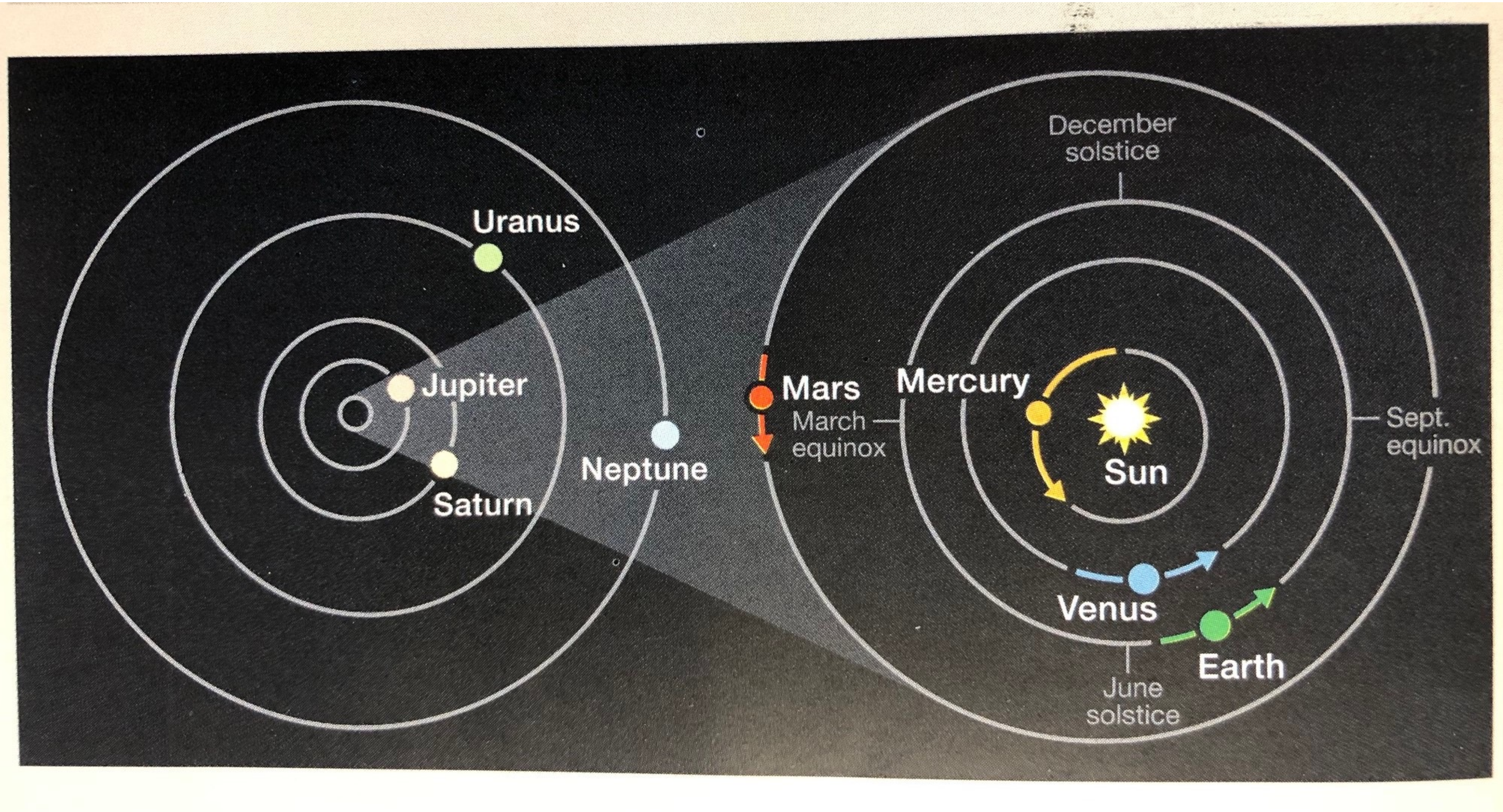
Primates~ 65mya

ALL IS STARDUST

3) Resources

- Space blog.gov.uk/2023/07
- nationaleclipse.com/maps
- www.space.com
- hantsastro.org.uk. Observatories Clan/Horndene
- Planetarium at Chichester
- Numerous sites & phone apps
- Gresham Lectures. Pro Chris Lintott Sept->zoom ?
- RASociety zoom lectures
- Planisphere, latitude dependant
- Sky & Telescope, Sky at Night etc magazines

Planets July 2023



4) In the Sky July 2023 onward

19/20 July in West after sunset Mo Ma Me V

After middle of night Saturn, Neptune, Jupiter, Uranus in East

12/13 August Perseid shower (C. Swift-Tuttle debris)

After midnight best in NE.

~27 August Saturn at opposition

13/14 Dec Geminids (A. Phaethon)

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8 April 2024 TOTAL Eclipse sun, N America

12 Aug 2026 Total eclipse Spain

2 August 2027 Total eclipse Spain

- Happy skygazing

- Ps “There is absolutely nothing to be said in favour of growing old. There ought to be legislation against it” (Sir Patrick Moore)