YEARBOOK OF ASTRONOMY 2024

Edited by
Brian Jones

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Front Cover: Hoag's Object: This unusual galaxy was discovered in 1950 by astronomer Art Hoag. Hoag initially thought the smoke-ring-like object resembled a planetary nebula, the glowing remains of a Sun-like star, but he quickly discounted that possibility, suggesting that the mysterious object was most likely a galaxy. Hoag's Object lies at a distance of 600 million light-years away in the constellation Serpens. The Hubble Wide Field and Planetary Camera 2 took this image on 9 July 2001. For more information on this and other unusual galaxies, see the article *Recent Advances in Astronomy*. (NASA and the Hubble Heritage Team (STScI/AURA); Acknowledgment: Ray A. Lucas (STScI/AURA))

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WHITE OWL
AN IMPRINT OF PEN & SWORD BOOKS LTD.
YORKSHIRE – PHILADELPHIA

First published in Great Britain in 2023 by
WHITE OWL
An imprint of
Pen & Sword Books Ltd
Yorkshire – Philadelphia

ISBN 978 1 39904 401 1

A CIP catalogue record for this book is available from the British Library.

Typeset in Dante By Mac Style
Printed and bound by Short Run Press Limited, Exeter.

Pen & Sword Books Ltd incorporates the Imprints of Pen & Sword Books Archaeology, Atlas, Aviation, Battleground, Discovery, Family History, History, Maritime, Military, Naval, Politics, Railways, Select, Transport, True Crime, Fiction, Frontline Books, Leo Cooper, Praetorian Press, Seaforth Publishing, Wharncliffe and White Owl.

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Editor's Foreword

The *Yearbook of Astronomy 2024* is the latest edition of what has long been an indispensable publication, the annual appearance of which has been eagerly anticipated by astronomers, both amateur and professional, for well over half a century. As ever, the *Yearbook* is aimed at both the armchair astronomer and the active backyard observer. Within its pages you will find a rich blend of information, star charts and guides to the night sky coupled with an interesting mixture of articles which collectively embrace a wide range of topics, ranging from the history of astronomy to the latest results of astronomical research; space exploration to observational astronomy; and our own celestial neighbourhood out to the farthest reaches of space.

The *Monthly Star Charts* have been compiled by David Harper and show the night sky as seen throughout the year. Two sets of twelve charts have been provided, one set for observers in the Northern Hemisphere and one for those in the Southern Hemisphere. Between them, each pair of charts depicts the entire sky as two semi-circular half-sky views, one looking north and the other looking south. Commencing with this edition of the *Yearbook*, the charts use the stereographic map projection, which noticeably reduces the distortion of the shapes of the constellations, especially near to the semi-circular edge of each chart.

Lists of *Phases of the Moon in 2024*, *Lunar Occultations in 2024* and *Eclipses in 2024* are also provided, together with general summaries of the observing conditions for each of the planets in *The Planets in 2024*. Apparition charts for all the major planetary members of our Solar System have been compiled by David Harper. Further details of these are given in the article *Using the Yearbook of Astronomy as an Observing Guide*, the apparition charts themselves following the article *The Planets in 2024*.

As with *The Planets in 2024*, the *Monthly Sky Notes* have been compiled by Lynne Marie Stockman and give details of the positions and visibility of the planets for each month throughout 2024. At the beginning of each of the monthly notes is a list of the significant Solar System events occurring during that particular month, and which collectively replace the single list of events that has been a feature in previous editions of the *Yearbook of Astronomy*. Each section of the *Monthly Sky Notes* is accompanied by a short article, the range of which includes items on a variety of astronomy- and space-related topics including an interesting item by Lynne Marie Stockman, in which we discover that, although constellations come and constellations go, some leave behind traces of their former existence. In the first instalment of her *Gone But Not Forgotten* series, Lynne examines the many lives of a small faint asterism in Aries known most recently in the West as Musca Borealis.

The *Monthly Sky Notes and Articles* section of the book concludes with a trio of articles penned by Neil Norman, these being *Comets in 2024*, *Minor Planets in 2024* and *Meteor Showers in 2024*, all three titles being fairly self-explanatory describing as they do the occurrence and visibility of examples of these three classes of object during and throughout the year.

In his article *Recent Advances in Astronomy* Rod Hine has selected just few of the many notable events and papers published during the year. From unusual "Ring Galaxies" to the first spectacular images from the James Webb Space Telescope, via possibly the oldest galaxy, Rod discusses the exciting work done by a variety of astronomers and their colleagues. A common theme is the multidisciplinary nature of astronomy today where a review of old observations leads to new ideas which are then refined with the latest observations from new instruments.

This is followed by *Recent Advances in Solar System Exploration* in which Peter Rea updates us on the progress of a number of planetary missions. In a change from previous yearbooks, this will not be done mission by mission but rather start at the Sun and move outward to the Kuiper belt. We will stop off at each planet in turn to explain what planetary missions are currently operating or en route. We will pause in the asteroid belt between Mars and Jupiter as a number of missions to asteroids are currently on their way to explore this fascinating region of the solar system.

One of the cornerstones of modern cosmology was laid a century ago, when Edwin Hubble determined the distance of M31, proving that "spiral nebulae" are other galaxies outside our own. In his article *Anniversaries in 2024* Neil Haggath commemorates this event. He also notes the pioneering space probe Mariner 10, the birth of Sir William Huggins and the death of Fritz Zwicky, the "grumpy genius" who predicted neutron stars decades before they were found to exist.

The Antarctic Plateau is the driest and coldest region on the surface of our planet. This offers superlative conditions for many kinds of astronomical observations, especially across infrared to millimetre wavelengths. The vast quantity of pure ice also enables imaging of cosmic sources of neutrinos. In the article *Astronomy from Antarctica* Michael Burton, Antarctic astronomer and Director of the UK's oldest observatory in Armagh, overviews astronomy on this frozen continent and the remarkable science it has engendered.

In *Things Fall Apart: Chaos in the Solar System*, David Harper discovers that the Solar System was an exciting and dynamic place in its very early years, as Jupiter and Saturn tacked inwards and veered outwards across hundred of millions of kilometres before settling into their present orbits. In the far future, as the Sun enters its planetary nebula phase, further dramatic changes are likely to happen, as passing stars disrupt the Solar System, ejecting the gas and ice giants into interstellar space.

In the third and final part of her *Male Mentors for Women in Astronomy* series, Mary McIntyre brings the story forward, telling the fascinating tales of some the exceptional female astronomers who were working during the late-eighteenth century, through to the "Lady Computers" who worked at Harvard College and the Royal Greenwich Observatory during the nineteenth century.

In his article *Communicating from the Edge of the Solar System* Peter Rea explains how signals from spacecraft a long way away from Earth get their information back. Talking to spacecraft in Earth orbit only takes a fraction of a second but from Pluto or beyond it can take many hours one way. This becomes significant if a spacecraft emergency occurs as happened with the New Horizons spacecraft as it was approaching Pluto in 2015. Signals to New Horizons were taking nine hours, and when your spacecraft is in trouble, the speed of light seems agonisingly slow.

We now know that prehistoric cultures in North America developed methods of time keeping – calendars – to predict the passage of time. But to what extent? In the second of his three-part series of articles *Skies over Ancient America*, astronomer and archaeologist P. Clay Sherrod discusses our attempts to study the huge stone-covered earthen mounds, calendar monuments. Are these curious structures and markers indeed predictors of the passages of the seasons or – as we assume in many prehistoric cultural sites – merely a coincidental arrangement that modern mankind has assigned to be ancient celestial time pieces?

SpaceX satellite cluster launches seem to have dominated the press recently. However, thanks to the Space Race, satellites have been orbiting the planet for well over 60 years. It may be interesting to know that some of the very earliest satellites are still in orbit (although not necessarily operating as originally intended). In the article *Tracking Older Artificial Satellites* by Steve Harvey, we take a look at both the software and hardware needed to enable us to track and observe these relics of the Space Age.

As we learn from his article *Inner Lives of Dead Stars* by Matt Caplan, dead stars are far from dead. Deep inside the cores of white dwarfs, the incredible pressures and strange mixtures of elements produce new phases of matter unlike any that existed during the star's life. But while their cores try to hide these phases from us deep inside the star, the starlight gives away the rich secrets of their inner lives.

In his article *Riccardo Giacconi: X-ray Astronomy Pioneer*, regular contributor David M. Harland looks back at the work of the Italian-born physicist Riccardo Giacconi who, after moving to America in the 1950s, made pioneering observations of cosmic rays. Giacconi subsequently developed instruments to measure X-rays which he sent aloft – initially on sounding rockets and later on satellites – to study the Sun and to make the first all-sky survey of X-ray sources with the Uhuru satellite, launched in 1970.

Lynne Marie Stockman continues her exploration of the unusual stars named after the astronomers who discovered them as she visits the solar neighbourhood in her article *The Astronomers' Stars: In the Neighbourhood*. From van Maanen's Star, the nearest solitary white dwarf, to tiny Teegarden's Star which is just large enough to initiate nuclear fusion in its core, to the solar-system-skimming Scholz's Star, our nearest neighbours are an eclectic collection of astronomical oddballs.

This is followed by *Mission to Mars: Countdown to Building a Brave New World* by Martin Braddock, the fourth in a series of articles scheduled to appear in the *Yearbook of Astronomy* throughout the 2020s and which will keep the reader fully up to date with the ongoing preparations geared towards sending a manned mission to Mars at or around the turn of the decade.

Penned by John McCue, an enthusiast of astronomical history, and John Nichol, a renowned telescope maker of long experience, the article *A Triumvirate of Telescope Makers: Thomas Cooke, Howard Grubb and Alvan Clark* brings together the tales of arguably the greatest makers of refractors in history. The stories of Englishman Thomas Cooke, Irishman Howard Grubb and American Alvan Clark, are intertwined and contemporary and they probably spurred each other to greater heights. Their legacy is the 40-inch Yerkes refractor, still a giant among refractors.

The final section of the book starts off with *Some Interesting Variable Stars* by Tracie Heywood which contains useful information on variables as well as predictions for timings of minimum brightness of the famous eclipsing binary Algol for 2024. *Some Interesting Double Stars* and *Some Interesting Nebulae, Star Clusters and Galaxies* present a selection of objects for you to seek out in the night sky. The lists included here are by no means definitive and may well omit your favourite celestial targets. If this is the case, please let us know and we will endeavour to include these in future editions of the *Yearbook of Astronomy.*

Next we have a selection of *Astronomical Organizations*, which lists organizations and associations across the world through which you can further pursue your interest and participation in astronomy (if there are any that we have omitted please let us know) and *Our Contributors*, which contains brief background details of the numerous writers who have contributed to this edition of the *Yearbook*.

New topics and themes are occasionally introduced into the *Yearbook of Astronomy*, allowing it to keep pace with the increasing range of skills, techniques and observing methods now open to amateur astronomers, this in addition to articles relating to our rapidly-expanding knowledge of the Universe in which we live. There is always an interesting mix, some articles written at a level which will appeal to the casual reader and some of what may be loosely described as at a more academic level. The intention is to fully maintain and continually increase the usefulness and relevance of the *Yearbook of Astronomy* to the interests of the readership who are, without doubt, the most important aspect of the *Yearbook* and the reason it exists in the first place. With this in mind, suggestions from readers for further improvements and additions to the *Yearbook* content are welcomed. All thoughts and comments can be sent via the *Yearbook of Astronomy* website at **yearbookofastronomy.com** After all, the book is written for you …

As ever, grateful thanks are extended to those individuals who have contributed a great deal of time and effort to the *Yearbook of Astronomy 2024*, including David Harper, who has provided updated versions of his *Monthly Star Charts*. These were generated specifically for what has been described as the new generation of the *Yearbook of Astronomy*, and the charts add greatly to the overall value of the book to star gazers. Equally important are the efforts of Lynne Marie Stockman who has put together the *Monthly Sky Notes*. Their combined efforts have produced what can justifiably be described as the backbone of the *Yearbook of Astronomy*. Also worthy of mention is Mat Blurton, who has done an excellent job typesetting the *Yearbook*. Also Jonathan Wright, Charlotte Mitchell, Lori Jones, Janet Brookes, Paul Wilkinson, Charlie Simpson and Rosie Crofts of Pen & Sword Books Ltd for their efforts in producing and promoting the *Yearbook of Astronomy 2024*, the latest edition of this much-loved and iconic publication.

Brian Jones – Editor
Bradford, West Riding of Yorkshire
October 2022

Preface

The information given in this edition of the *Yearbook of Astronomy* is in narrative form. The positions of the planets given in the *Monthly Sky Notes* often refer to the constellations in which they lie at the time. These can be found on the star charts which collectively show the whole sky via two charts depicting the northern and southern circumpolar stars and forty-eight charts depicting the main stars and constellations for each month of the year. The northern and southern circumpolar charts show the stars that are within 45° of the two celestial poles, while the monthly charts depict the stars and constellations that are visible throughout the year from Europe and North America or from Australia and New Zealand. The monthly charts overlap the circumpolar charts. Wherever you are on the Earth, you will be able to locate and identify the stars depicted on the appropriate areas of the chart(s).

There are numerous star atlases available that offer more detailed information, such as *Sky & Telescope's POCKET SKY ATLAS* and *Norton's STAR ATLAS and Reference Handbook* to name but a couple. In addition, more precise information relating to planetary positions and so on can be found in a number of publications, a good example of which is *The Handbook of the British Astronomical Association*, as well as many of the popular astronomy magazines such as the British monthly periodicals *Sky at Night* and *Astronomy Now* and the American monthly magazines *Astronomy* and *Sky & Telescope*.

About Time

Before the late eighteenth century, the biggest problem affecting mariners sailing the seas was finding their position. Latitude was easily determined by observing the altitude of the pole star above the northern horizon. Longitude, however, was far more difficult to measure. The inability of mariners to determine their longitude often led to them getting lost, and on many occasions shipwrecked. To address this problem King Charles II established the Royal Observatory at Greenwich in 1675 and from here, Astronomers Royal began the process of measuring and cataloguing the stars as they passed due south across the Greenwich meridian.

Now mariners only needed an accurate timepiece (the chronometer invented by Yorkshire-born clockmaker John Harrison) to display GMT (Greenwich Mean Time). Working out the local standard time onboard ship and subtracting this from GMT gave the ship's longitude (west or east) from the Greenwich meridian. Therefore mariners always knew where they were at sea and the longitude problem was solved.

Astronomers use a time scale called Universal Time (UT). This is equivalent to Greenwich Mean Time and is defined by the rotation of the Earth. The *Yearbook of Astronomy* gives all times in UT rather than in the local time for a particular city or country. Times are expressed using the 24-hour clock, with the day beginning at midnight, denoted by 00:00. Universal Time (UT) is related to local mean time by the formula:

Local Mean Time = UT – west longitude

In practice, small differences in longitude are ignored and the observer will use local clock time which will be the appropriate Standard (or Zone) Time. As the formula indicates, places in west longitude will have a Standard Time slow on UT, while those in east longitude will have a Standard Time fast on UT. As examples we have:

Standard Time in

New Zealand	UT +12 hours
Victoria, NSW	UT +10 hours
Japan	UT + 9 hours
Western Australia	UT + 8 hours
India	UT + 5 hours 30 minutes
Pakistan	UT + 5 hours
Kenya	UT + 3 hours
South Africa	UT + 2 hours
British Isles	UT
Newfoundland Standard Time	UT −3 hours 30 minutes
Atlantic Standard Time	UT −4 hours
Eastern Standard Time	UT −5 hours
Central Standard Time	UT −6 hours
Mountain Standard Time	UT −7 hours
Pacific Standard Time	UT −8 hours
Alaska Standard Time	UT −9 hours
Hawaii-Aleutian Standard Time	UT −10 hours

During the periods when Summer Time (also called Daylight Saving Time) is in use, one hour must be added to Standard Time to obtain the appropriate Summer/Daylight Saving Time. For example, Pacific Daylight Time is UT −7 hours.

Using the Yearbook of Astronomy as an Observing Guide

Notes on the Monthly Star Charts

The star charts on the following pages show the night sky throughout the year. There are two sets of charts, one for use by observers in the Northern Hemisphere and one for those in the Southern Hemisphere. The first set is drawn for latitude 52°N and can be used by observers in Europe, Canada and most of the United States. The second set is drawn for latitude 35°S and show the stars as seen from Australia and New Zealand. Twelve pairs of charts are provided for each of these latitudes.

Each pair of charts shows the entire sky as two semi-circular half-sky views, one looking north and the other looking south. A given pair of charts can be used at different times of year. For example, chart 1 shows the night sky at midnight on 21 December, but also at 2am on 21 January, 4am on 21 February and so forth. The accompanying table will enable you to select the correct chart for a given month and time of night. The caption next to each chart also lists the dates and times of night for which it is valid.

The charts are intended to help you find the more prominent constellations and other objects of interest mentioned in the monthly observing notes. To avoid the charts becoming too crowded, only stars of magnitude 4.5 or brighter are shown. This corresponds to stars that are bright enough to be seen from any dark suburban garden on a night when the Moon is not too close to full phase.

Each constellation is depicted by joining selected stars with lines to form a pattern. There is no official standard for these patterns, so you may occasionally find different patterns used in other popular astronomy books for some of the constellations.

Any map projection from a sphere onto a flat page will by necessity contain some distortions. This is true of star charts as well as maps of the Earth. The distortion on the half-sky charts is greatest near the semi-circular boundary of each chart, where it may appear to stretch constellation patterns out of shape.

The charts also show selected deep-sky objects such as galaxies, nebulae and star clusters. Many of these objects are too faint to be seen with the naked eye, and you will need binoculars or a telescope to observe them. Please refer to the table of deep-sky objects for more information.

Planetary Apparition Diagrams

The diagrams of the apparitions of Mercury and Venus show the position of the respective planet in the sky at the moment of sunrise or sunset throughout the entire apparition. Two sets of positions are plotted on each chart: for latitude 52° North (blue line) and for latitude 35° South (red line). A thin dotted line denotes the portion of the apparition which falls outside the year covered by this edition of the *Yearbook*. A white dot indicates the position of Venus on the first day of each month, or of Mercury on the first, eleventh and 21st of the month. The day of greatest elongation (GE) is also marked by a white dot. Note that the dots do NOT indicate the magnitude of the planet.

The finder chart for Mars shows its path from April to December of 2024. In April it is a morning object as it emerges from conjunction with the Sun in November of last year. By December, it is visible for most of the night, and it is approaching opposition in January 2025. Mars traverses 150° in ecliptic longitude during this period, moving from Aquarius in April to Cancer in December, so the chart is based upon the ecliptic, which runs across the centre of the chart from right to left. The position of Mars is indicated on the 1st of each month, and at its most easterly on 7 December, when its motion becomes retrograde. Stars are shown to magnitude 5.5. Note that the sizes of the Mars dots do NOT indicate its magnitude.

The finder charts for Jupiter, Saturn, Uranus and Neptune show the paths of the planets throughout the year. The position of each planet is indicated at opposition and at stationary points, as well as the start and end of the year and on the 1st of each month (1st of April, July and October only for Uranus and Neptune) where these dates do not fall too close to an event that is already marked. Stars are shown to magnitude 5.5 on the charts for Jupiter and Saturn. On the Uranus chart, stars are shown to magnitude 8; on the Neptune chart, the limiting magnitude is 10. In both cases, this is approximately two magnitudes fainter than the planet itself. Right Ascension and Declination scales are shown for the epoch J2000 to allow comparison with modern star charts. Note that the sizes of the dots denoting the planets do NOT indicate their magnitudes.

Selecting the Correct Charts

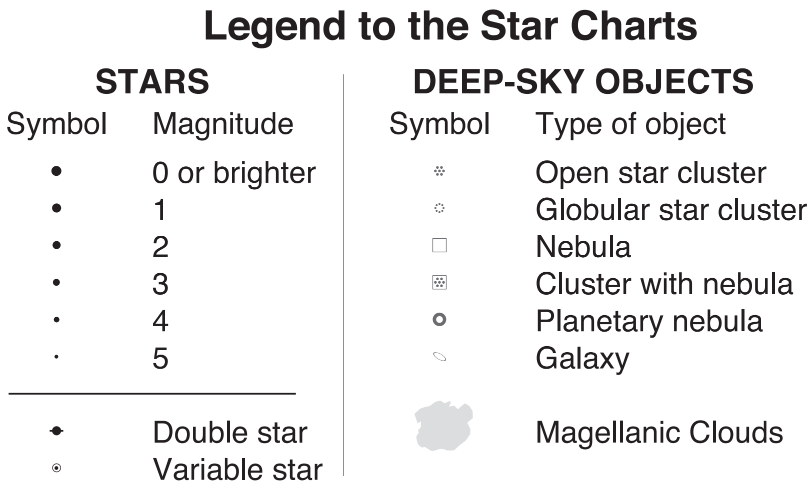
The table below shows which of the charts to use for particular dates and times throughout the year and will help you to select the correct pair of half-sky charts for any combination of month and time of night.

The Earth takes 23 hours 56 minutes (and 4 seconds) to rotate once around its axis with respect to the fixed stars. Because this is around four minutes shorter than a full 24 hours, the stars appear to rise and set about 4 minutes earlier on each successive day, or around an hour earlier each fortnight. Therefore, as well as showing the stars at 10pm (22h in 24-hour notation) on 21 January, chart 1 also depicts the sky at 9pm (21h) on 6 February, 8pm (20h) on 21 February and 7pm (19h) on 6 March.

The times listed do not include summer time (daylight saving time), so if summer time is in force you must subtract one hour to obtain standard time (GMT if you are in the United Kingdom) before referring to the chart. For example, to find the correct chart for mid-September in the northern hemisphere at 3am summer time, first of all subtract one hour to obtain 2am (2h) standard time. Then you can consult the table, where you will find that you should use chart 11.

The table does not indicate sunrise, sunset or twilight. In northern temperate latitudes, the sky is still light at 18h and 6h from April to September, and still light at 20h and 4h from May to August. In Australia and New Zealand, the sky is still light at 18h and 6h from October to March, and in twilight (with only bright stars visible) at 20h and 04h from November to January.

Local Time	**18h**	**20h**	**22h**	**0h**	**2h**	**4h**	**6h**
January	11	12	1	2	3	4	5
February	12	1	2	3	4	5	6
March	1	2	3	4	5	6	7
April	2	3	4	5	6	7	8
May	3	4	5	6	7	8	9
June	4	5	6	7	8	9	10
July	5	6	7	8	9	10	11
August	6	7	8	9	10	11	12
September	7	8	9	10	11	12	1
October	8	9	10	11	12	1	2
November	9	10	11	12	1	2	3
December	10	11	12	1	2	3	4



Star Names

There are over 200 stars with proper names, most of which are of Roman, Greek or Arabic origin although only a couple of dozen or so of these names are used regularly. Examples include Arcturus in Boötes, Castor and Pollux in Gemini and Rigel in Orion.

A system whereby Greek letters were assigned to stars was introduced by the German astronomer and celestial cartographer Johann Bayer in his star atlas *Uranometria*, published in 1603. Bayer's system is applied to the brighter stars within any particular constellation, which are given a letter from the Greek alphabet followed by the genitive case of the constellation in which the star is located. This genitive case is simply the Latin form meaning 'of' the constellation. Examples are the stars Alpha Boötis and Beta Centauri which translate literally as 'Alpha of Boötes' and 'Beta of the Centaur'.

As a general rule, the brightest star in a constellation is labelled Alpha (α), the second brightest Beta (β), and the third brightest Gamma (γ) and so on, although there are some constellations where the system falls down. An example is Gemini where the principal star (Pollux) is designated Beta Geminorum, the second brightest (Castor) being known as Alpha Geminorum.

There are only 24 letters in the Greek alphabet, the consequence of which was that the fainter naked eye stars needed an alternative system of classification. The system in popular use is that devised by the first Astronomer Royal John Flamsteed in which the stars in each constellation are listed numerically in order from west to east. Although many of the brighter stars within any particular constellation will have both Greek letters and Flamsteed numbers, the latter are generally used only when a star does not have a Greek letter.

The Greek Alphabet

α	Alpha	ι	Iota	ρ	Rho
β	Beta	κ	Kappa	σ	Sigma
γ	Gamma	λ	Lambda	τ	Tau
δ	Delta	μ	Mu	υ	Upsilon
ε	Epsilon	ν	Nu	φ	Phi
ζ	Zeta	ξ	Xi	χ	Chi
η	Eta	ο	Omicron	ψ	Psi
θ	Theta	π	Pi	ω	Omega

The Names of the Constellations

On clear, dark, moonless nights, the sky seems to teem with stars although in reality you can never see more than a couple of thousand or so at any one time when looking with the unaided eye. Each and every one of these stars belongs to a particular constellation, although the constellations that we see in the sky, and which grace the pages of star atlases, are nothing more than chance alignments. The stars that make up the constellations are often situated at vastly differing distances from us and only appear close to each other, and form the patterns that we see, because they lie in more or less the same direction as each other as seen from Earth.

A large number of the constellations are named after mythological characters, and were given their names thousands of years ago. However, those star groups lying close to the south celestial pole were discovered by Europeans only during the last few centuries, many of these by explorers and astronomers who mapped the stars during their journeys to lands under southern skies. This resulted in many of the newer constellations having modern-sounding names, such as Octans (the Octant) and Microscopium (the Microscope), both of which were devised by the French astronomer Nicolas Louis De La Caille during the early 1750s.

Over the centuries, many different suggestions for new constellations have been put forward by astronomers who, for one reason or another, felt the need to add new groupings to star charts and to fill gaps between the traditional constellations. Astronomers drew up their own charts of the sky, incorporating their new groups into them. A number of these new constellations had cumbersome names, notable examples including Officina Typographica (the Printing Shop) introduced by the German astronomer Johann Bode in 1801; Sceptrum Brandenburgicum (the Sceptre of Brandenburg) introduced by the German astronomer Gottfried Kirch in 1688; Taurus Poniatovii (Poniatowski's Bull) introduced by the Polish-Lithuanian astronomer Martin Odlanicky Poczobut in 1777; and Quadrans Muralis (the Mural Quadrant) devised by the French astronomer Joseph-Jerôme de Lalande in 1795. Although these have long since been rejected, the latter has been immortalised by the annual Quadrantid meteor shower, the radiant of which lies in an area of sky formerly occupied by Quadrans Muralis.

During the 1920s the International Astronomical Union (IAU) systemised matters by adopting an official list of 88 accepted constellations, each with official spellings and abbreviations. Precise boundaries for each constellation were then drawn up so that every point in the sky belonged to a particular constellation.

The abbreviations devised by the IAU each have three letters which in the majority of cases are the first three letters of the constellation name, such as AND for Andromeda, EQU for Equuleus, HER for Hercules, ORI for Orion and so on. This trend is not strictly adhered to in cases where confusion may arise. This happens with the two constellations Leo (abbreviated LEO) and Leo Minor (abbreviated LMI). Similarly, because Triangulum (TRI) may be mistaken for Triangulum Australe, the latter is abbreviated TRA. Other instances occur with Sagitta (SGE) and Sagittarius (SGR) and with Canis Major (CMA) and Canis Minor (CMI) where the first two letters from the second names of the constellations are used. This is also the case with Corona Australis (CRA) and Corona Borealis (CRB) where the first letter of the second name of each constellation is incorporated. Finally, mention must be made of Crater (CRT) which has been abbreviated in such a way as to avoid confusion with the aforementioned CRA (Corona Australis).

The table shown on the following pages contains the name of each of the 88 constellations together with the translation and abbreviation of the constellation name. The constellations depicted on the monthly star charts are identified with their abbreviations rather than the full constellation names.

The Constellations

Andromeda	Andromeda	AND
Antlia	The Air Pump	ANT
Apus	The Bird of Paradise	APS
Aquarius	The Water Carrier	AQR
Aquila	The Eagle	AQL
Ara	The Altar	ARA
Aries	The Ram	ARI
Auriga	The Charioteer	AUR
Boötes	The Herdsman	BOO
Caelum	The Graving Tool	CAE
Camelopardalis	The Giraffe	CAM
Cancer	The Crab	CNC
Canes Venatici	The Hunting Dogs	CVN
Canis Major	The Great Dog	CMA
Canis Minor	The Little Dog	CMI
Capricornus	The Goat	CAP
Carina	The Keel	CAR
Cassiopeia	Cassiopeia	CAS
Centaurus	The Centaur	CEN
Cepheus	Cepheus	CEP
Cetus	The Whale	CET
Chamaeleon	The Chameleon	CHA
Circinus	The Pair of Compasses	CIR
Columba	The Dove	COL
Coma Berenices	Berenice's Hair	COM
Corona Australis	The Southern Crown	CRA
Corona Borealis	The Northern Crown	CRB
Corvus	The Crow	CRV
Crater	The Cup	CRT
Crux	The Cross	CRU
Cygnus	The Swan	CYG

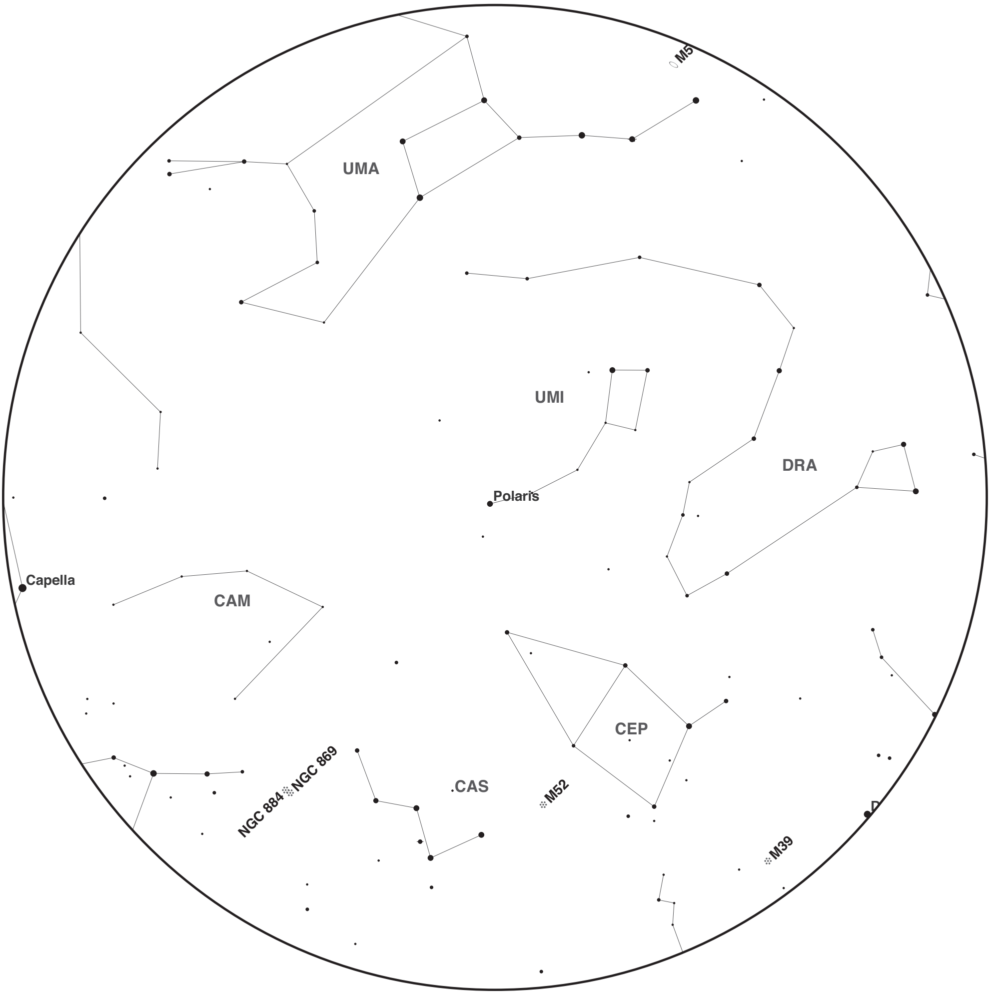
Delphinus	The Dolphin	DEL
Dorado	The Goldfish	DOR
Draco	The Dragon	DRA
Equuleus	The Foal	EQU
Eridanus	The River	ERI
Fornax	The Furnace	FOR
Gemini	The Twins	GEM
Grus	The Crane	GRU
Hercules	Hercules	HER
Horologium	The Pendulum Clock	HOR
Hydra	The Water Snake	HYA
Hydrus	The Lesser Water Snake	HYI
Indus	The Indian	IND
Lacerta	The Lizard	LAC
Leo	The Lion	LEO
Leo Minor	The Lesser Lion	LMI
Lepus	The Hare	LEP
Libra	The Scales	LIB
Lupus	The Wolf	LUP
Lynx	The Lynx	LYN
Lyra	The Lyre	LYR
Mensa	The Table Mountain	MEN
Microscopium	The Microscope	MIC
Monoceros	The Unicorn	MON
Musca	The Fly	MUS
Norma	The Level	NOR
Octans	The Octant	OCT
Ophiuchus	The Serpent Bearer	OPH
Orion	Orion	ORI
Pavo	The Peacock	PAV
Pegasus	Pegasus	PEG
Perseus	Perseus	PER

Phoenix	The Phoenix	PHE
Pictor	The Painter's Easel	PIC
Pisces	The Fish	PSC
Piscis Austrinus	The Southern Fish	PSA
Puppis	The Stern	PUP
Pyxis	The Mariner's Compass	PYX
Reticulum	The Net	RET
Sagitta	The Arrow	SGE
Sagittarius	The Archer	SGR
Scorpius	The Scorpion	SCO
Sculptor	The Sculptor	SCL
Scutum	The Shield	SCT
Serpens Caput and Cauda	The Serpent	SER

Sextans	The Sextant	SEX
Taurus	The Bull	TAU
Telescopium	The Telescope	TEL
Triangulum	The Triangle	TRI
Triangulum Australe	The Southern Triangle	TRA
Tucana	The Toucan	TUC
Ursa Major	The Great Bear	UMA
Ursa Minor	The Little Bear	UMI
Vela	The Sail	VEL
Virgo	The Virgin	VIR
Volans	The Flying Fish	VOL
Vulpecula	The Fox	VUL

The Monthly Star Charts

Northern Hemisphere Star Charts

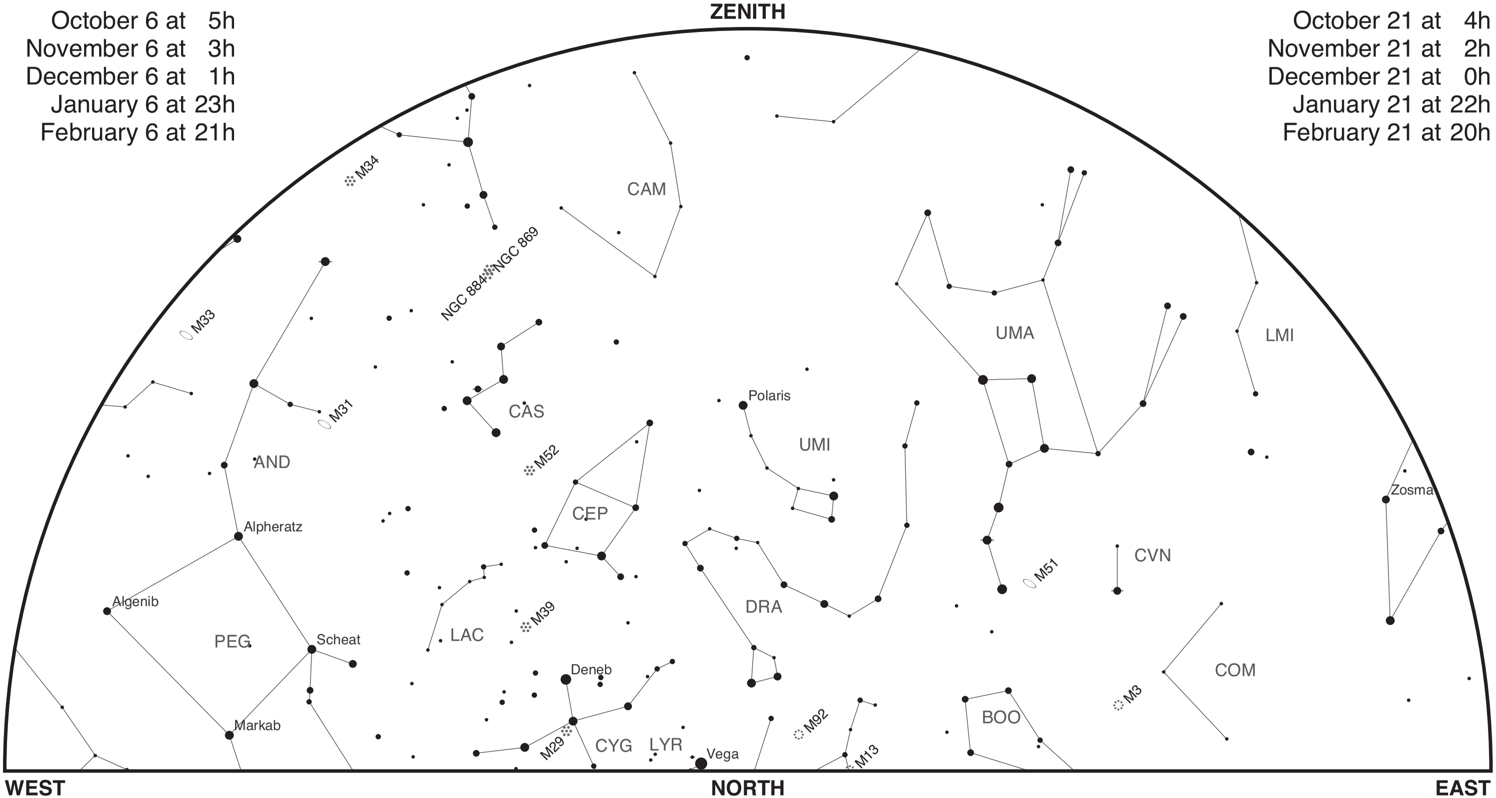


This chart shows stars lying at declinations between +45 and +90 degrees. These constellations are circumpolar for observers in Europe and North America.

1N

October 6 at 5h
November 6 at 3h
December 6 at 1h
January 6 at 23h
February 6 at 21h

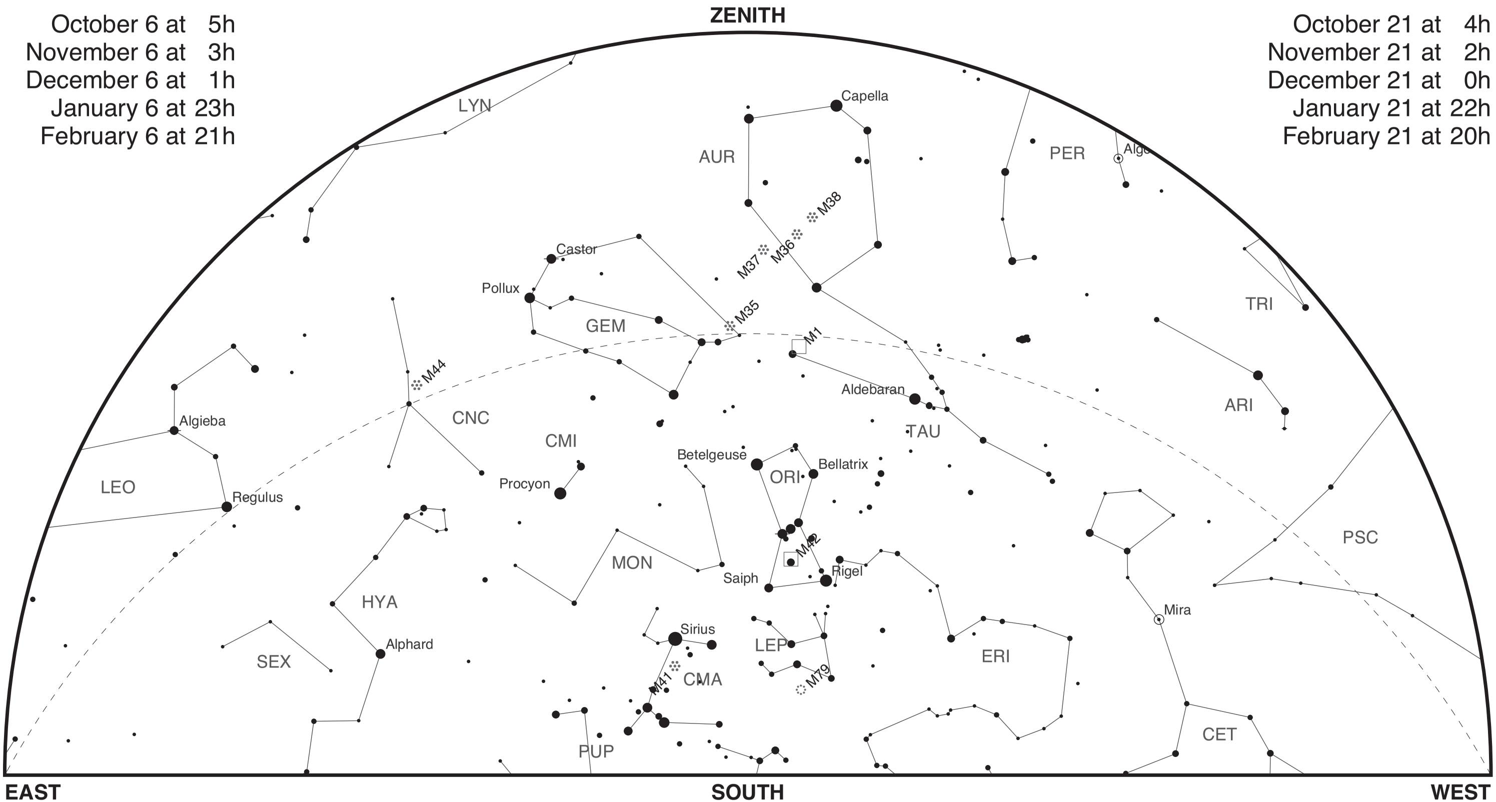
October 21 at 4h
November 21 at 2h
December 21 at 0h
January 21 at 22h
February 21 at 20h



1S

October 6 at 5h
November 6 at 3h
December 6 at 1h
January 6 at 23h
February 6 at 21h

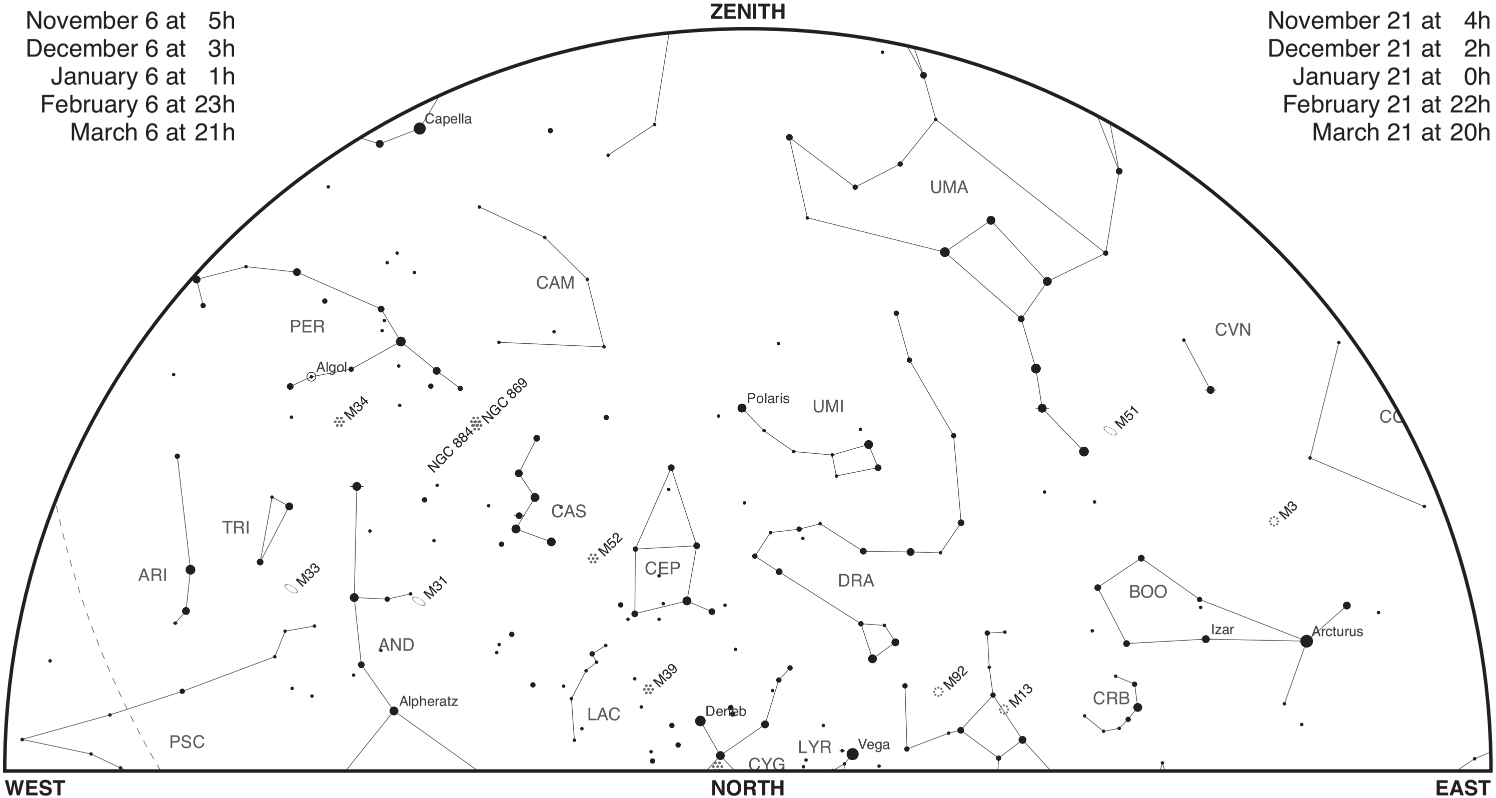
October 21 at 4h
November 21 at 2h
December 21 at 0h
January 21 at 22h
February 21 at 20h



2N

November 6 at 5h
December 6 at 3h
January 6 at 1h
February 6 at 23h
March 6 at 21h

November 21 at 4h
December 21 at 2h
January 21 at 0h
February 21 at 22h
March 21 at 20h



November 6 at 5h
December 6 at 3h
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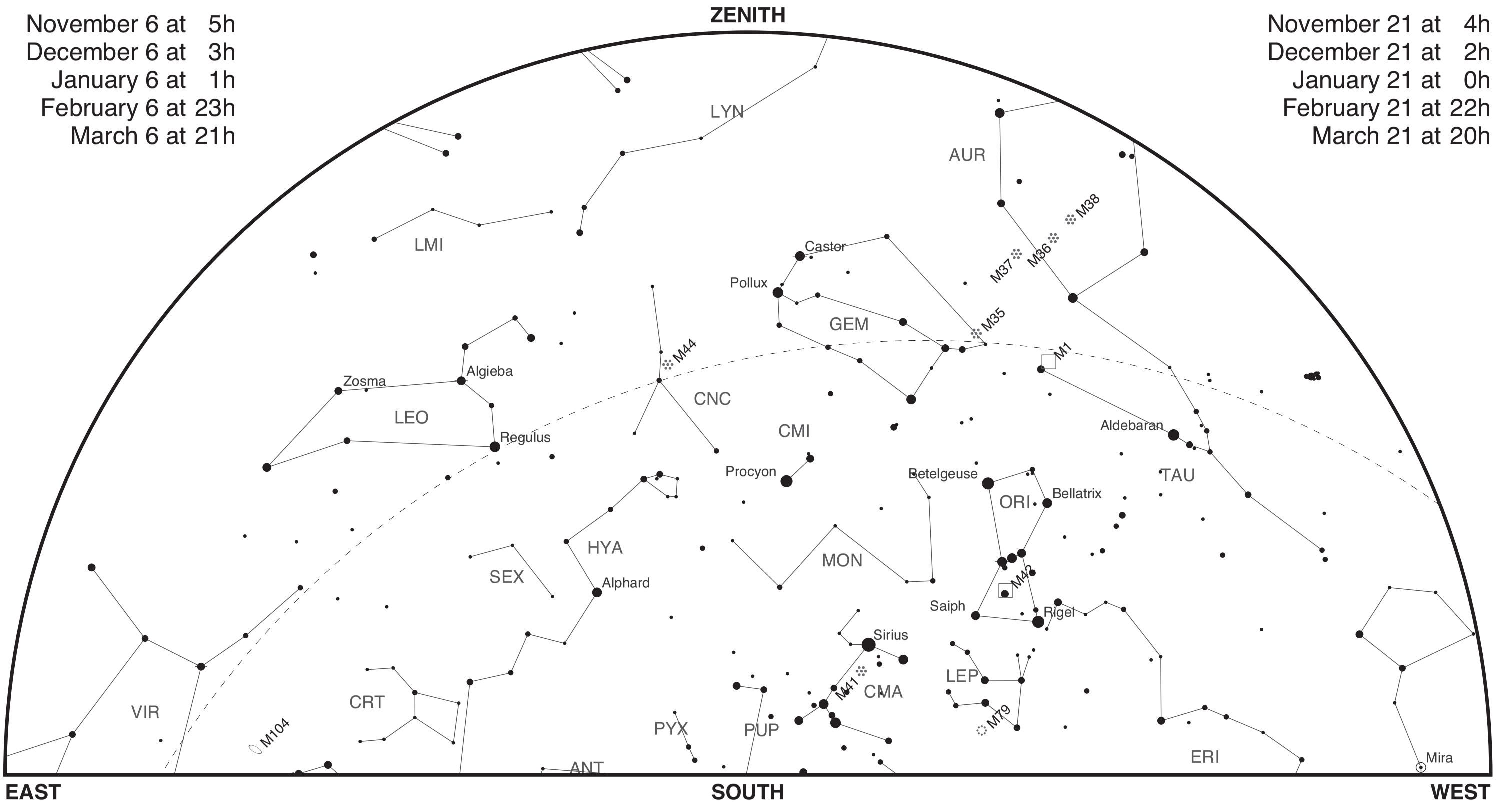
December 21 at 2h
January 21 at 0h
February 21 at 22h
March 21 at 20h

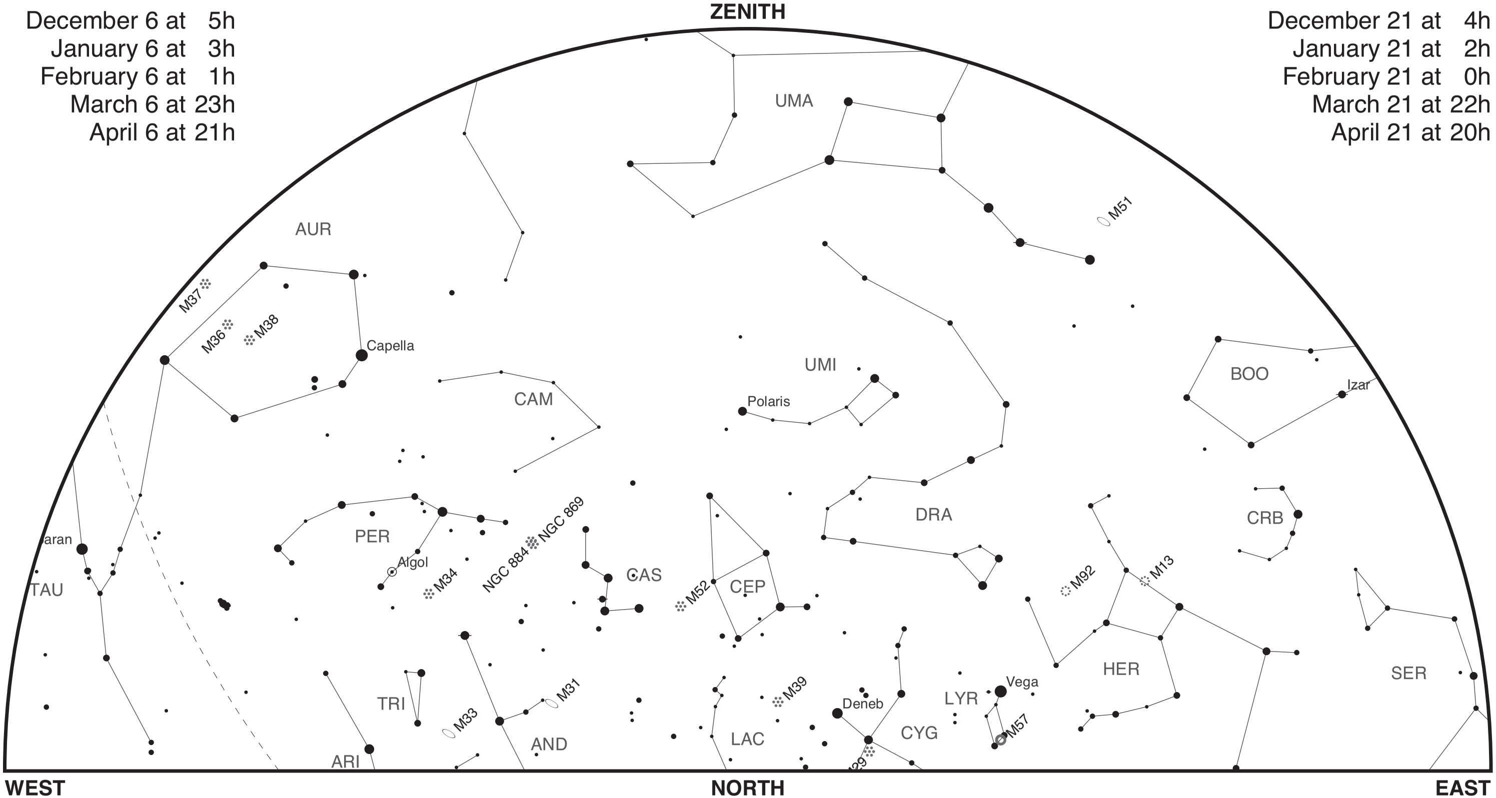


2S

3N

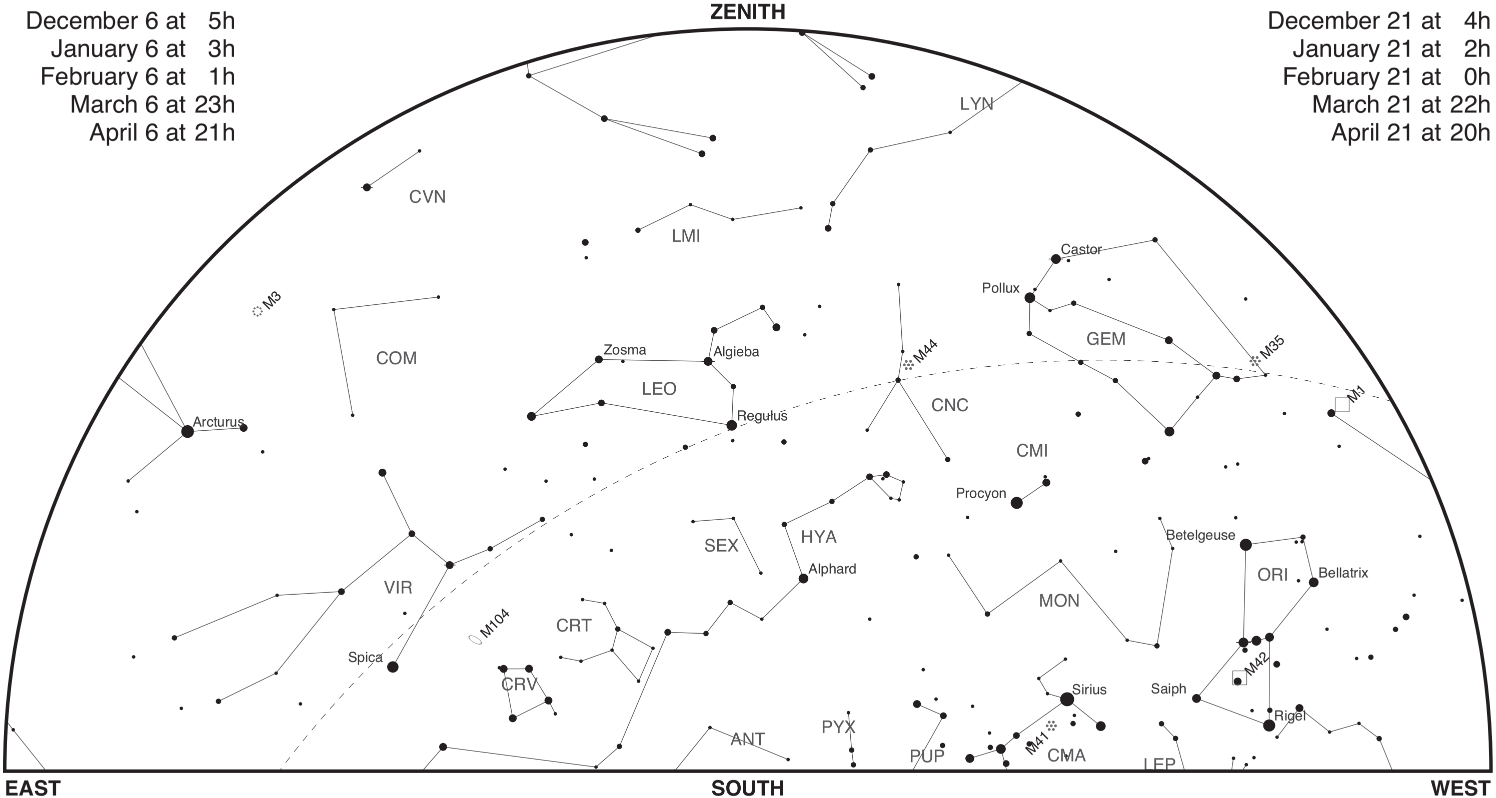
December 6 at 5h
January 6 at 3h
February 6 at 1h
March 6 at 23h
April 6 at 21h

December 21 at 4h
January 21 at 2h
February 21 at 0h
March 21 at 22h
April 21 at 20h



December 6 at 5h
January 6 at 3h
February 6 at 1h
March 6 at 23h
April 6 at 21h

December 21 at 4h
January 21 at 2h
February 21 at 0h
March 21 at 22h
April 21 at 20h

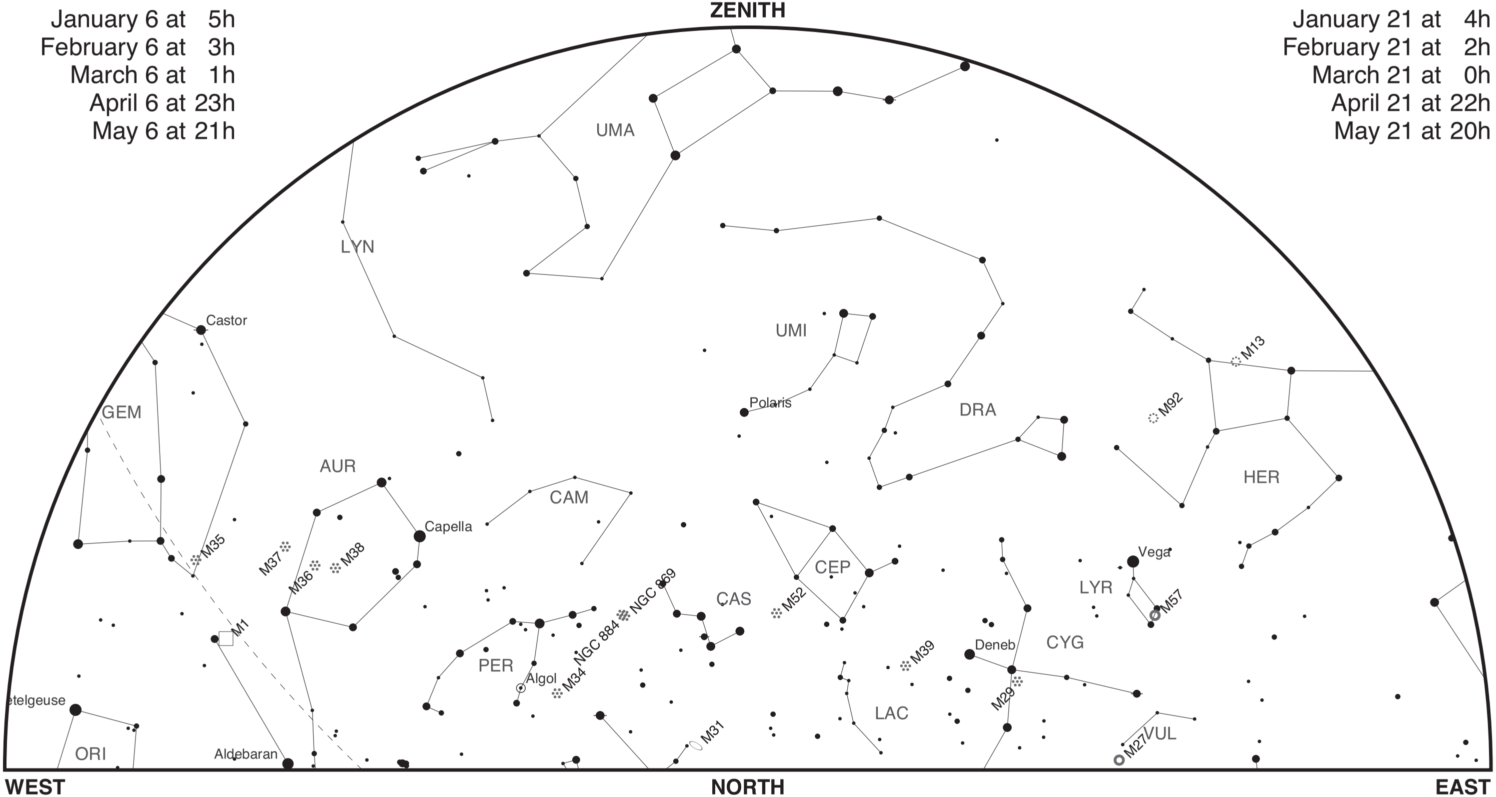


3S

4N

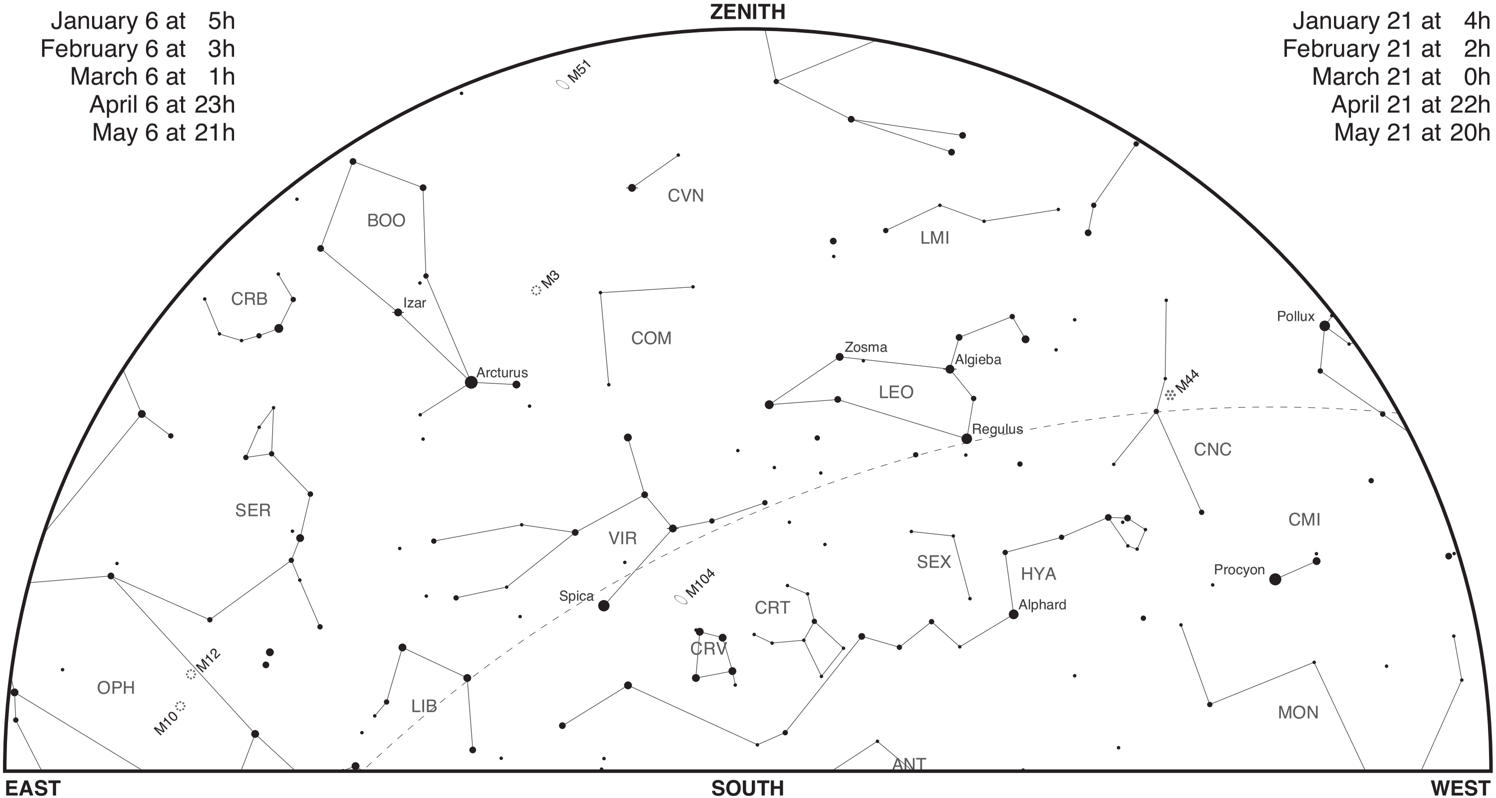
January 6 at 5h
February 6 at 3h
March 6 at 1h
April 6 at 23h
May 6 at 21h

January 21 at 4h
February 21 at 2h
March 21 at 0h
April 21 at 22h
May 21 at 20h



January 6 at 5h
February 6 at 3h
March 6 at 1h
April 6 at 23h
May 6 at 21h

January 21 at 4h
February 21 at 2h
March 21 at 0h
April 21 at 22h
May 21 at 20h



4S