Astronomers' Observing Guides

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Mars and How to Observe It

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To Auntie Pat, a rock firmer than Mars itself

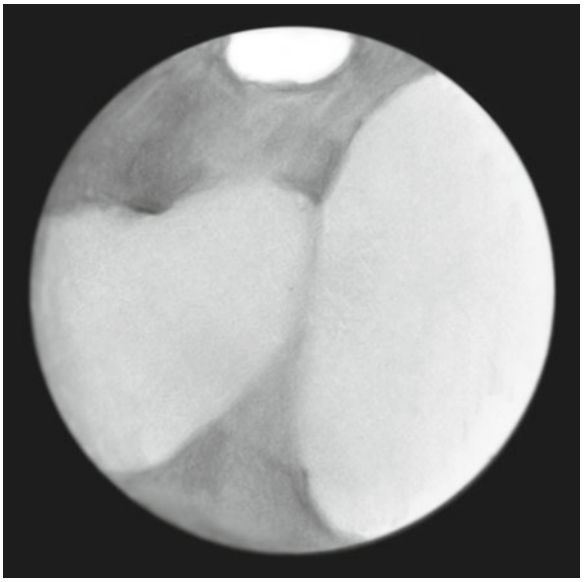
Introduction: A Perspective on Mars

Discover Mars

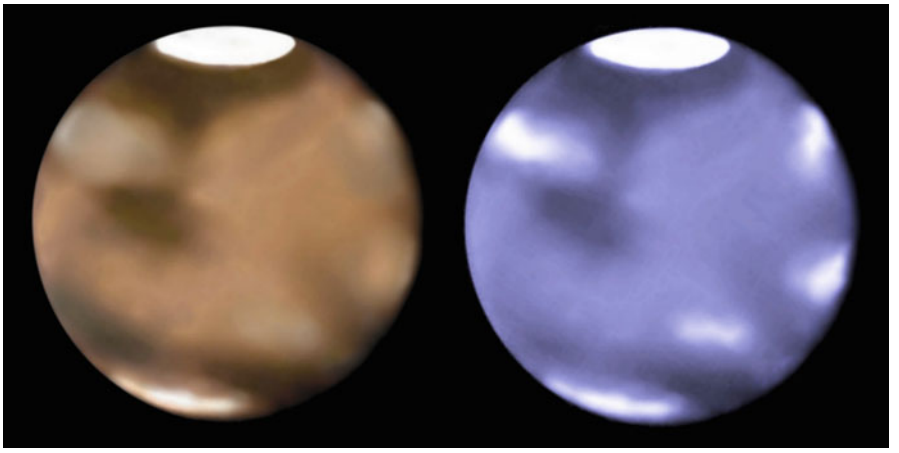
Mars was discovered way back in the spring of 1982 – April 10th at 10.15 pm, to be precise. Following a pleasant evening's observations of Jupiter and Saturn, and looking forward to a later view of the rising waning gibbous Moon, a young amateur astronomer delighting in the thrills afforded him by his modest 60 mm refractor, swung the little instrument towards a bright orange star, high in the south. Being relatively new to the heavens, the novice stargazer did not suspect the true nature of this amber-tinted luminary which shone in western Virgo, trailing the feet of mighty Leo.

Using the highest magnification available – a giddying power of 100× – the gleaming orange fleck was brought into focus. Contrary to expectations, this was no star; instead, a tiny disk presented itself, a marvelous ruddy circle upon whose face was arrayed a set of distinct dusky markings. Instantly recognizable as the planet Mars, the young astronomer excitedly fumbled with his pencil and sketchpad while at the same time juggling his red torch, and strained his eye at the telescope eyepiece to discern as much detail as possible and set it down in an observational drawing.

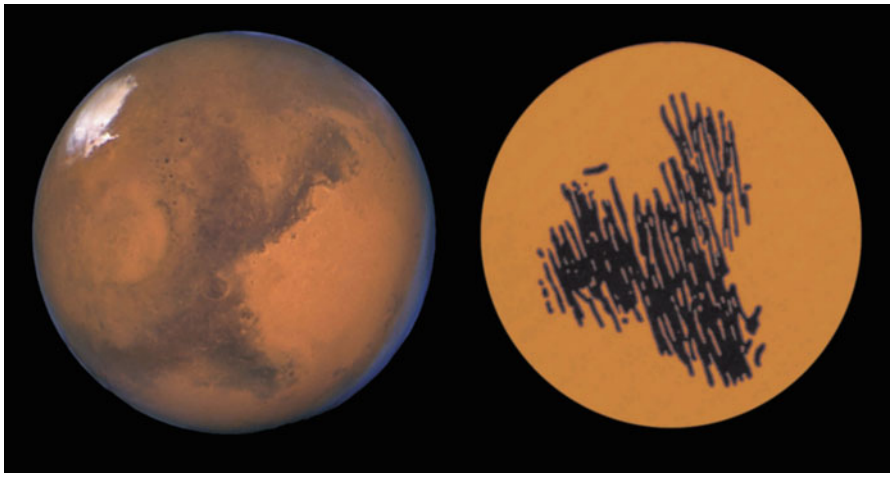
Admittedly, keeping the planet within the somewhat restricted field of view presented by the Huygenian eyepiece by frequent tugs on the tube of un-driven telescope tube presented almost as much of a challenge as the observational drawing itself; but experience had equipped him with the skills necessary to track celestial objects using this shakiest of altazimuth-mounted instruments. Closer examination revealed a broad V-shaped marking at the center of the planet, accompanied by less prominent shadings to its sides and spreading to the north, where a brilliant white spot crowned the disk. My first sighting of Mars closely matches Christiaan Huygens' observation of 28 November 1659, the first known telescopic observation of the planet to show its features. That large 'V-shaped' marking was none other than Syrtis Major, the planet's most prominent feature; the white spot, its north polar ice cap.



The author's first observation of Mars, made on 10 April 1982 at 21:15 UT, with Syrtis Major approaching the CM. CM 279°. P 30°. Tilt 23.3°. Phase 99%. Diameter 14.7″. Magnitude −1.3. Observing notes: A most remarkable sight! My first vision of the Red Planet through a telescope. The cap was underlain by a shady, dusky cusp, the western side being the most markedly defined. The markings at the south certainly seemed to be a dusky finger-like obtrusion (Credit: Grego)



2010 January 13, 23:30 UT. CM 171°. P 1°. Tilt 16.8°. Phase 99%. Diameter 13.7Ð. Magnitude −1.1. In both integrated light and in yellow and blue filters, the large north polar cap is brilliant with a dusky border extending south through Phlegra to a dusky but poorly defined Trivium Charontis. In blue light several other bright areas stand out prominently – one in the Elysium area to the northwest of Trivium Charontis, another in the Memnonia region bordering Mare Sirenum, one in the southern Tharsis region near the terminator and another near the terminator but further north in the vicinity of Ascraeus Lacus. The Electris region along the southern limb was also bright. 200 mm SCT, 250×, integrated light and yellow W12 (*left*) and blue W80A (*right*) (Credit: Grego)



Hubble Space Telescope image of Mars taken on 26 August 2003 compared with Huygens' observational drawing of Mars, made on 28 November 1659 (Credit: NASA/public domain)

Anyone who has ever put their eye to the telescope and viewed the night skies has experienced their own special thrills of astronomical discovery, and few celestial objects are as thrilling to discover as the Mars, the Red Planet, a world of perennial mystery and the inspiration of boundless human speculation and fantasy through the centuries.

Since my own personal 'discovery' of the Red Planet in 1982, described above, I've eagerly followed each apparition – all 14 of them – through the eyepiece of a variety of telescopes, including the memorable apparition of 2003–2004 when Mars swung in to approach the Earth more closely than it had done for 50,000 years. Each apparition has shown a slightly different Mars, with variations in the apparent angular size of the planet at opposition, its position in the heavens, its axial tilt and phase; each apparition brings with it actual differences in the intensity and shape of Mars' surface markings, along with transient atmospheric phenomena including dust storms and cloud features.

Mars is by no means worthy of the epithet once attributed to it by one famous astronomer, who wrote that, observationally, Mars is the biggest disappointment in the Solar System. On the contrary – Mars is an utterly intriguing world with more than enough visual appeal to hold the observer's attention. While its broad features are discernable through small amateur telescopes, its finer features present themselves only to those who give it the time and attention that it deserves.

A World in Dichotomy

In many respects, both literally and figuratively, Mars is a planet of two halves. Our scientific knowledge of the planet can be placed into two broad categories, the line of demarcation beginning in 1971 when NASA's Mariner 9 first imaged the planet from up close in 1971. Before this epoch-making technological achievement, Mars

had really only been known intimately through telescopic observations, beginning in 1636 with Francisco Fontana when he made the first disc drawing of Mars.

To this day the amateur observer still sees Mars as it was known to the eyes of the great observers of the past – observers such as Christiaan Huygens, Gian Domenico Cassini, William Herschel, Giovanni Schiaparelli, Edward Emerson Barnard and Eugene Antoniadi, to name but a few. Indeed, visual observers still use the Martian system of nomenclature established by Schiaparelli in the late nineteenth century; his aim was to produce an unbiased form of nomenclature was based upon ancient Latin and Mediterranean place names, Biblical and other mythological sources. He wrote: 'These names may be regarded as a mere artifice… After all, we speak in a similar way of the seas of the Moon, knowing very well that they do not consist of liquid masses.'

This rich nomenclature, however, was of course given only to telescopically visible features, the albedo features formed from light and dark areas. When Mars is at its largest each apparition, around the time of opposition, the telescopic observer is seeing a planetary disc which is fully illuminated; features of relief aren't visible, as there are no shadows thrown up by the landscape. Once space probes began to explore Mars, they imaged far more than albedo features – the old nomenclature was simply unable to be applied to the new Mars, with its freshly-discovered craters, faults, valleys, hills, mountains and other landscape features. A standard nomenclature based on types of terrain and feature was agreed by the IAU (International Astronomical Union), and there was retained a good deal of congruence with the old nomenclature. For example, the large dark V-shaped feature that visual observers know as Syrtis Major (named after the Mediterranean Gulf of Sidra) was initially renamed Syrtis Major Planitia (Syrtis Major plain) but then, following the discovery that it was actually a large shield volcano of low relief, renamed Syrtis Major Planum (Syrtis Major plateau).

Visual observers had long known that the globe of Mars is split between north and south; extensive bright areas, bound by subtle shadings, spread across the planet's southern hemisphere, while the majority of well-defined dark features dominate the northern hemisphere. Under closer examination by space probes, the north–south dichotomy exists in terms of topographical features and geology. Mars' southern hemisphere is covered with thousands of sizeable impact craters, while the north is relatively crater-free; many ancient craters in the north have been completely obliterated by smooth lava plains. On average, the southern hemisphere is 3 km higher than the northern hemisphere.

In order to be consistent with the system of longitude used by visual observers, and for ease of reference, all longitude co-ordinates in this book are given west of the Martian prime meridian.

In terms of human arts, fantasy and imagination, the Martian split reflects the dichotomy between pre-Space Age Mars and the planet as known to us today. In the past, our relative lack of knowledge about the conditions existing on Mars – the nature of its surface and its atmosphere, the seeming possibility that advanced forms of life might exist there – gave writers virtual *carte-blanche* to create the most elaborate fiction involving Martian civilizations. Generally supposed to be an older planet than the Earth, sometimes looked upon as a planet in physical decline, some of these civilizations were benign, others intent on war, both civil and interplanetary. Perhaps the most famous expression of a belligerent Martian civilization was created by H.G. Wells in his book *The War of the Worlds* (1898) which saw the attempt by a technologically advanced race of Martians to conquer the Earth

and destroy all humans. Ultimately, these 'cool and unsympathetic' aliens were beaten by the lowliest of our planet's life forms – bacteria. In a strange twist of history, it now seems possible that life on Mars, if it exists at all, is in the form of bacteria and other simple life.

Speculation was not restricted to writers of fiction; many astronomers imagined that it was probable that some sort of life existed on Mars. Indeed, observed seasonal changes on Mars appeared to suggest this; we can still observe these seasonal changes, but we now know their cause to be other than life. In the most extreme case, that of the wealthy amateur Percival Lowell, it was speculated that an advanced Martian civilization had created a vast network of interconnected canals to channel melted polar waters in order to irrigate the planet's dry plains. Lowell elaborated on his theories in his books *Mars* (1895), *Mars and its Canals* (1906) and *Mars as the Abode of Life* (1908).

Undeterred by the facts as later revealed by a host of probes – orbiters, landers and rovers – the Mars of the Space Age was (and is being) used as the setting for modern fictional excursions into fantasy. One of the most notable of these, the action-adventure movie *Total Recall* (1990), sees the discovery of a now-extinct Mars civilization whose technology is finally used to convert the hostile Red Planet into a world with comfortable climes and a breathable atmosphere. A long-dead Martian civilization is also the subject of a variety of 'conspiracy theories' which claim that space probe images have revealed extraordinary structures built by the Martians. Most famous of them is the so-called 'Face of Mars', a hill in Cydonia, shown in an image by Viking 1 as resembling an odd sort of face; higher resolution images of the feature demolish any notion that the hill is anything but a natural formation.

Mars, and How to Observe It

Tempting as it is to delve deeply into the rich history of Mars observation, the remit of this series is to present in the first part of the book what is currently known about any particular celestial object or phenomenon, and then in the second part to offer guidance on how best to go about making observations of it. I'm gratified that my works in this series – *The Moon and How to Observe It* (Springer, 2005) and *Venus and Mercury and How to Observe Them* (Springer, 2008) – have been well-received, yet some reviewers appear to have missed this most essential point about this series.

In writing this book, it's been extremely challenging to avoid fully recognizing the hundreds of careful observers of Mars, many of them great visual observers whose contributions to astronomy were been immense. Those observers, some of whom are cited above, have been difficult to avoid, ingrained as they are into the fabric of the history of the planet's observation. Not only has it been a tough call to neglect to liberally mention the accomplishments and insights of these figures throughout the text, it hasn't been possible to present many of their observational drawings, even though their work might be considered to be of direct relevance to visual work today; indeed, their observations remain a topic of discussion by amateur astronomers the world over. To have referred extensively to historical observations would have required a much larger book, and one at variance with the aims of this series. However, should the reader be interested in

finding out more about historical observations of Mars (a pursuit to be thoroughly recommended) I have made a few choice selections for further reading at the end of this book.

Similarly, it has been necessary to omit intricate details about the many space probes that have orbited Mars and investigated its satellites, soft-landed on the Martian surface and roved around hill, dale and crater, imaging, sniffing, scratching, drilling and sampling here and there. Great use has, however, been made of the important data and the highly revealing images obtained by these probes, keeping it as up-to-date as possible with the inclusion of some of the very latest in-situ Mars images and data. Again, I have recommended a number of books for further reading which I think will enlighten the reader on the incredible history of the robotic exploration of the Red Planet.

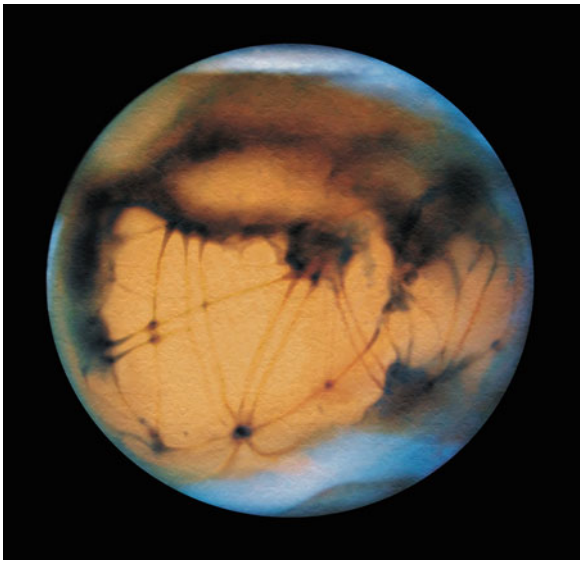
Inspiration from the Red Planet

With all this in mind, this book intends to shed light upon Mars' physical nature and its phenomena, while the means and techniques to make meaningful observations are explained clearly. Importantly, I have attempted to bridge the gap between the physical Mars, as revealed in glorious detail by spaceprobes, and that quite different looking world that hovers in the telescope eyepiece, teasing us with its dusky markings and challenging us to capture its subtleties. I sincerely hope that this modest contribution to the existing literature on Mars inspires a new generation of observers to take to the eyepiece and thereby gain a first-hand view of the most Earth-like planet that we know of.

There can be few more inspirational words written about observing Mars than the following two of my own favorite Mars quotations, both written more than a century ago, one by an astronomer, the other, an author, appropriately enough:

> Almost as soon as magnification gives Mars a disk, that disk shows markings, white spots crowning a globe spread with blue-green patches on an orange ground.
>
> *Percival Lowell*

> I still remember that vigil very distinctly: the black and silent observatory, the shadowed lantern throwing a feeble glow upon the floor in the corner, the steady ticking of the clockwork of the telescope, the little slit in the roof – an oblong profundity with the stardust streaked across it. Ogilvy moved about, invisible but audible. Looking through the telescope, one saw a circle of deep blue and the little round planet swimming in the field. It seemed such a little thing, so bright and small and still, faintly marked with transverse stripes, and slightly flattened from the perfect round. But so little it was, so silvery warm – a pin's-head of light! It was as if it quivered, but really this was the telescope vibrating with the activity of the clockwork that kept the planet in view.'
>
> *From The War of the Worlds, by H.G. Wells*



A planet that captures the imagination. The modern observer is unlikely to have a view of Mars like this one, based upon a Hubble Space Telescope image overlain with observations by Percival Lowell. A century ago, some observers placed great faith in the reality of the planet's 'canals' – features we now know to be largely illusory (Credit: Peter Grego)

Peter Grego
St Dennis, Cornwall, UK
August 2011

About the Author

Peter Grego is an astronomy writer and editor. A regular watcher of the night skies since 1976, he observes from his home in St. Dennis, Cornwall, UK with a variety of instruments. His telescopes include a 102 mm refractor, home-made 150 and 300 mm Newtonians (telescope mirror-making is another of his interests) and a 445 mm Newtonian, but his most-used instrument is his 200 mm SCT. Grego's primary observing interests are the Moon's topography, Mars and Jupiter, but he likes to 'go deep' when there's no lunar glare to contend with. He now likes to use a hand-held computer to make observational drawings.

Grego has directed the Lunar Section of Britain's Society for Popular Astronomy (SPA) since 1984, is the Assistant Director of the Lunar Section of the British Astronomical Association (BAA). He edits and produces three astronomy publications – Luna (journal of the SPA Lunar Section), The BAA Lunar Section Circulars and Popular Astronomy Magazine. He is also layout editor for the Bulletin of the Society for the History of Astronomy.

Grego's astronomical writings and observations have featured in many publications since 1983, including the BAS Newsletter, Popular Astronomy, The New Moon, Amateur Astronomy and Earth Sciences, Gnomon, The Lunar Observer, Yokohama Science Center News and the CD-ROM Window on the Universe. Since 1997 he has written and illustrated the monthly MoonWatch page in UK's Astronomy Now magazine, and he is the observing advisor and columnist for Sky at Night magazine.

He has given many talks to astronomical societies around the UK and has featured on a number of radio and television broadcasts.

Grego is the author of numerous astronomy books, including "Collision:Earth!" (Cassell, 1998), "Moon Observer's Guide" (Philips/Firefly, 2004), "The Moon and How to Observe It" (Springer, 2005), "Need to Know? Stargazing" (Collins, 2005), "Solar System Observer's Guide" (Philips/Firefly, 2005), "Need to Know? Universe" (Collins, 2006), "Exploring the Earth/Exploring the Moon/Discovering the Solar System/ Voyage Through Space/Discovering the Universe" (five book in the QED Space Guides series, 2007), "Venus and Mercury and How to Observe Them" (Springer, 2008), "The Great Big Book of Space" (QED, 2010), "Galileo and 400 Years of Telescopic Astronomy" (Springer, 2010) and "The Star Book" (D&C, 2012).

Grego maintains his own website at www.lunaobservers.com (which occasionally features live webcasts of the Moon and planets and other astronomical phenomena) and is webmaster for the BAA Lunar Section at www.baalunarsection.org.uk.

He is a member of the SPA, ALPO, SHA, and BAA and is a Fellow of the Royal Astronomical Society.

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