

# All Of The Above

YOUR MONTHLY DOSE OF SPACE AND TIME



Observe

## VENUS IN THE AFTERNOON

Venus is now favorably positioned for intrepid observers who want to see a planet with the naked eye in broad daylight. Here is how to accomplish this from the comfort of your yard, or anywhere else.

Remember

## THE MOONS OF MARS

141 years ago today, Phobos and Deimos were discovered at the US Naval Observatory by Asaph Hall. These moons have a long history of intrigue, going back much further than their 1877 discovery.

Explore

## TO TOUCH THE SUN

NASA has launched the Parker Solar Probe to pass within 3.8 million miles of the solar surface, 1/10<sup>th</sup> the distance of Mercury from the Sun, and fly through the solar corona.

Consider



## OSTRICH ENVY

The human eye is about an inch in diameter. The ostrich eye is a bit over two inches in diameter, the largest eye of any land animal. Now, imagine you and your flock of ostriches out for a walk on a clear moonless night, staring into the sky.



## VENUS SPOTTING

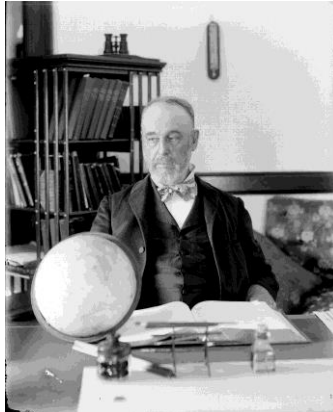
You may have heard that Venus is the third brightest object in the sky (after the Sun and Moon), but did you know it can be seen in broad daylight? Perhaps you recall my story of the “Venus spotter” that worked with me several years ago. This gentleman, past retirement age, routinely went outside on clear days at lunch time to find Venus. I admit that I never succeeded when he tried to point it out to me, but recently I did find Venus with the naked eye, and even got my daughter and son to find it as well. Although it may seem like an anticlimactic exercise, I had goosebumps looking at another world in daylight without an instrument.

Venus currently is near its maximum distance from the Sun in our sky - which is the safest and easiest time to find it in daylight. At 3:30pm in mid-September, Venus will be near the north-south line of the sky (the meridian) about two fist widths above the southern horizon. That description will not get you to find it unless you have incredible luck. Instead, I suggest getting one of the many phone apps that you can point at the sky and “see” the astronomical objects on the screen that lie in that direction. Find Venus on the phone, stare at its screen image against the sky at arm’s length, and slowly move the phone away without shifting your eyes. What you are looking for can be seen in the photo shown above within the red marks to the lower right. A very small star-like dot. The contrail gives a good reference for brightness.

"Soon after the President concluded his address, he entered his carriage, and the procession started up Pennsylvania Avenue to the White House, the escort from our Company following next to his carriage. Shortly after we turned onto Pennsylvania Avenue, west of the Capitol, I noticed the crowd along the street looking intently, and some were pointing to something in the heavens toward the south.

"I glanced up in that direction, and there in plain view, shining out in all her star-like beauty, was the planet Venus. It was a little after midday at the time I saw it, possibly near one o'clock; the sun seemed to be a little west of the median, the star a little east. It was a strange sight. I never saw a star at that time in the day before or since. The superstitious had had many strange notions about it, but of course it was simply owing to the peculiarly clear condition of the atmosphere and the favorable position of the planet at that time. The President and those who were with him in the carriage noticed the star at the same time."

-Sergeant Smith Stimmellater  
Lincoln bodyguard, 1865



## TWO ELUSIVE MOONS: smaismrmilmepoetalemibunenugttauiras

On August 10<sup>th</sup>, 1877, Alaph Hall, an astronomer born in Goshen, CT, working at the US Naval Observatory in the Foggy Bottom section of Washington, observed a small speck of light within the glare of Mars, and moments later the skies filled with... fog. Several nights later Alaph successfully found the same speck again, and was able to confirm the first known satellite of Mars. Two weeks later, he observed a second speck, and both Phobos and Deimos had been discovered.

Phobos and Deimos are exceedingly small objects - 14 and 8 miles in average diameter (they are not round), with Phobos the larger of the two. They orbit very close to the planet, at 6000 and 15000 miles respectively. At a visual magnitude of about 12 when closest to Earth, they would be easily spotted by telescopes of the 19<sup>th</sup> century, but their very low orbits in the intense glare of Mars (at magnitude -2.4) make them a great challenge for the best visual observers. Certainly, I've never seen them. At the time of Alaph's discovery, Mars was at one of its closest approaches to Earth (as it is this summer) at a distance of 38 million miles.

But the story of the two moons of Mars goes back much farther than 1877. In 1610, Galileo had discovered the rings of Saturn, though he described them as "ears". In those early days of science, it was common to write notes in "code" to avoid embarrassment if one was wrong, but have it written down if a discovery turned out to be correct. The ears of Saturn were recorded in this manner. Galileo sent the Latin anagram (see the title) to Kepler, who eventually decoded it, incorrectly, as "welcome, furious twins, sons of Mars". Kepler - a master at finding patterns, even those that don't exist - had previously conjectured that since Mercury and Venus had no moons, Earth one, and Jupiter four, Mars "should" have two.

In 1726, in Jonathan Swift's Gulliver's travels, two moons of Mars are described, one orbiting the planet every 10, the other every 21 and a half hours. Swift likely copied Kepler's error, though the match to the actual orbital periods (7h39m and 30h17m hours) is uncanny. Inspired by Swift, Voltaire's short story Micromegas about an alien visitor to Earth also lists two moons for Mars in 1752.

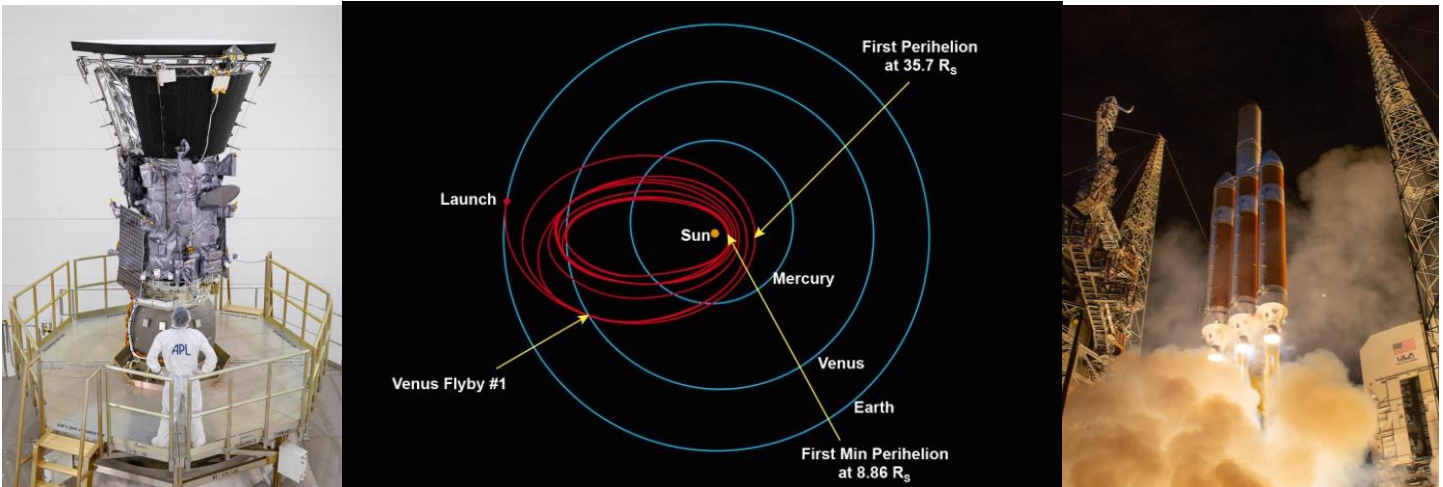
### PHOBOS AND THE FRINGE

In the 1950s, observations of Phobos suggested that it was spiraling slowly inward. Calculations made by a Russia astrophysicist in 1958 concluded that to follow the observed motion, Phobos must be a thin metal shell, leading immediately to speculation that it is an artificial Martian satellite. Subsequent observations of the motion of Phobos and the measured density of Mars have shown that its motion is inconsistent with the idea that it is a hollow metal shell, though it is thought to be about 30% empty in its interior. As if that wasn't enough, a photo of Phobos taken by the Mars Global Surveyor in 1998 (top) shows a monolith some 300 ft across, which has been speculated to be artificial. This (rock) was discovered at about the same time a similar monolith was found on the surface of Mars itself (bottom).



### ON THE OTHER HAND...

A study in 2015 of the orbital dynamics and detailed shape of Phobos concluded that it is indeed steadily approaching Mars, and will suffer a break up due to tidal forces, or collide with the planet within the next 40 million years. No suggestion of an extraterrestrial origin for the moon however.



## SOLAR SCIENCE HEATS UP

On August 11, the Parker Solar Probe launched on a Delta IV Heavy vehicle, off on a seven year mission to pass through the outer atmosphere of the Sun. After using the gravitation of Venus to accelerate it into a long elliptical orbit, Parker will ultimately pass within a mere 3.5 million miles of the solar surface, deep in the Sun's corona.

The solar surface has a temperature of nearly 10000°F, while the corona has a temperature reaching millions of degrees, as determined by spectral measurements of the corona showing emission lines from heavy elements in very high energy states. The mechanism heating the corona to such incredible temperatures remains unexplained, with hypotheses ranging from several electromagnetic explanations involving accelerating plasma, to "micro flares" from the solar surface reaching into the corona.

Because the corona is extremely tenuous compared to the solar surface, the Parker probe will not actually experience million degree heat, but will build up about 2500°F, hotter than volcanic lava. The trick to survival is to not stay close to the Sun for long, but retreat back out to the orbit of Venus to cool down and transmit data back to Earth.

This long elliptical orbit results in a second record for Parker - it will become the fastest-traveling spacecraft in history, reaching a speed of 430,000mph as it falls toward the Sun. (Lest we get too excited, that's 0.06% the speed of light - 6600 years to the nearest star).

Although one would think falling toward the sun is easy, the orbital velocity of Earth about the Sun of 18 miles per second first needs to be overcome. This mission requires about 55 times the energy needed to take a similarly sized craft to Mars.

About 6 weeks from launch, Parker will pass Venus for the first steering maneuver, and will reach its first close approach to the Sun, at 15 million miles, in November.

## THE SPACECRAFT

Instruments on board include:

- **FIELDS:** 5 antennae to measure electric fields in the spacecraft vicinity, and 3 magnetometers to measure magnetic fields.
- **WISPR:** wide field camera to image details of the corona and mass ejections of material from the surface of the sun.
- **SWEAP:** particle counters to assess the flows of solar protons, electrons and helium ions.
- **ISOIS:** Low and high energy particle detectors to determine the atomic elements of ions, and precise energies of atomic and subatomic particles.

## KEEPING IT COOL

Although reaching molten rock temperatures on the outside, the internal instruments are held at a balmy 85°F, behind a shield only 4.5 inches thick. This shield is made of two thin carbon/graphite sheets sandwiching a thicker carbon foam. Though the carbon sheets conduct heat easily, the foam, consisting mostly of air, has few pathways to conduct the heat to the spacecraft, preventing the intense heat from penetrating.



## JEEPERS CREEPERS...

The human adult eye's pupil - the hole where light enters the eye - is at most 7mm in diameter after being in the dark for 20 minutes. It is the size of the pupil that determines how dim of an object we can see in the night sky with our naked eye. A telescope's purpose (for visual astronomy) is to collect light over a much larger area, basically the area of its largest lens or mirror, and focus that light so it will pass through our 7mm pupil to the retina, where the image we see is formed.

But in the animal kingdom, humans do not have the largest eyes. On land, that record goes to the ostrich, who pupils reach to a massive 20mm in diameter. Recalling that area increases as the diameter squared, the ostrich, with its naked eye, collects over 8 times more light onto its retina than the human, enabling it to see objects 8 times fainter. Converting that to the astronomical magnitude scale, that means an ostrich can see objects 2.3 magnitudes higher than man. Since the average human can see stars to about magnitude 6, this means the ostrich can make out objects to magnitude 8.3.

While humans can see about 2500 stars on a perfect night with nothing blocking their horizon, the ostrich is overwhelmed by seeing about 25,000 stars. The Milky Way, tenuous and delicate to our eyes, is a bright band of light casting shadows for the ostrich. The ostrich sees about a dozen glowing clouds in the sky - the nebulae - while we can barely see a few on a perfectly dark night far from lights. The Andromeda galaxy, closest large galaxy to our own, is visible to us as a small gray patch from a dark location, but would be seen to its full extent - 6 times the width of the Moon - by the ostrich. While we can see one other galaxy (in the Northern Hemisphere) on a very dark night, the ostrich can see a total of 6.

So, is the ostrich the ultimate astronomer? Well, there is one small (really small) problem - although the eyes are huge, the brain is not. In fact, the ostrich brain is smaller than its eye! Not much room in there for more than knowing to run fast when they see a predator (since they can't fly), which is actually the reason they have evolved to have not only awesome eyes, but long legs that can run at 45mph and can kill with a kick.

Very recently a product has appeared on the astronomical market that can have you seeing the sky almost like (and actually much better than) an ostrich. Using a very innovative optical design (actually related to the design of Galileo's telescopes), the company Vixen is selling a pair of binoculars with 42mm lenses, and very low (2x) magnification. So these binoculars capture 4 times more light than ostrich eyes, while giving an extremely wide field of view ( $25^\circ$ , about the distance between outstretched thumb and pinky at arm's length). Your natural seeing angle is about  $30^\circ$  in focus,  $60^\circ$  really usable, and  $120^\circ$  at the limit of your peripheral vision. So, these binoculars effectively reduce your field of view by about half. A drawback is the cost - about \$300 for a pair of binoculars that really aren't useful for anything other than star gazing. Out of my range for now.

But my story wouldn't be complete without mentioning one more animal. The colossal squid (not to be confused with the smaller giant squid) has an eye with a pupil 90mm in diameter!! That's 165x more light gathering than our eye, seeing objects down to 13<sup>th</sup> magnitude. Of course, from the bottom of the ocean, the colossus isn't going to be seeing many stars.