nightwatch

Newsletter of the Pomona Valley Amateur Astronomers

The October meeting will convene in Beckman Hall

Volume 34 Number 10 *nightwatch* **October 2014**

President's Message

October is shaping up to be a busy month, sky-wise.

Early in the morning of Wednesday, Oct. 8, there will be a total lunar eclipse. It will be done and gone by the time you read this, so hopefully it was a good one and we didn't get clouded out. It would be horribly ironic if after a sweltering first week of October, the clouds rolled in just in time to kill the eclipse, but one never knows.

Comet 2013/A1 Siding Spring will fly past Mars on October 19. As we learned at last month's general meeting, NASA and the other space agencies with probes orbiting Mars are doing everything possible to both protect the orbiters and get as much data as possible from the comet.

On Thursday, Oct. 23, a partial eclipse of the sun will be visible from the Western US. According to NASA's eclipse website (http://eclipse.gsfc.nasa.gov/OH/OH2014.html#SE2014Oct23P), the eclipse will start at 2:08 PM, max out at 3:28, and end at 4:40 for observers in the Los Angeles area (all times in PDT).

Just two days after the eclipse, the PVAA monthly star party will be at Cottonwood Springs in Joshua Tree National Park. I'll miss it—I have a longstanding agreement to meet up with some observing buddies at the All-Arizona Star Party, which takes place that same weekend. Hopefully clear, dark skies will be enjoyed by all, no matter where they are.

Some catch-up from last month: our annual trip to Mount Wilson was clouded out. We're going to reschedule, but it is likely that the earliest good date we'll be able to get is June, 2015. If you paid for this attempt and want to stay paid up for next time, you don't need to do anything, but if you'd like a refund, please let Gary Thompson know at the next general meeting, or email me (mathew.wedel@gmail.com).

Our speaker this month is Mike Simmons of Astronomers Without Borders, who will speak about AWB's global outreach efforts.

Matt Wedel

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PVAA General Meeting 09/12/14

PVAA president Mathew Wedel opened the meeting welcoming everyone, and went over the club calendar. Eldred Tubbs then gave a demonstration of water rockets. He used a water nozzle and a water hose with a plastic bottle. You can go on YouTube and type in water bottle rocket and see a bunch of different ways to do this.

Our speaker for the evening was Dr. L. Alberto Cangahuala of JPL and Cal Tech. His subject was Deep Space Navigation. Deep Space is pretty much anything beyond earth orbit. After you leave earth orbit, there isn't any GPS to tell you where you are. Typically we can say within 1.5 kilometers how far away Mars is and within 2300 kilometers where Neptune is. (2300 km out of 30 AU – Astronomical Units, which is the average distance from the sun to the earth.) Getting from A to B using the least amount of energy requires a lot of planning. Unlike Star Trek and Star Wars, you have to follow Kepler's 3 laws of planetary motion:

1. The orbit of a planet is an ellipse with the Sun at one of the two foci.
2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time.[1]
3. The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit.

Then there is absolutely no getting around Newton's 3 laws:

1. When viewed in an inertial reference frame, an object either remains at rest or continues to move at a constant velocity, unless acted upon by an external force.
2. Second law: The vector sum of the forces F on an object is equal to the mass M of that object multiplied by the acceleration vector A of the object.
3. Third law: When one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body.

He showed a "pork chop plot." (The amount of energy a rocket has doesn't change. - The Launch Date/Arrival Date are the variables.)

When a spacecraft is in motion, there are several things we can do to figure out its location. We use the round trip time a signal takes to go to the spacecraft and return to earth. Factoring in the amount of time it takes the spacecraft to process the signal before returning it (dwell), earth's wobble and spurious events; you can accurately determine its distance from earth. This actually takes about 2 weeks to get rid of spurious events. The Doppler Shift (frequency shift) will tell us the speed of the spacecraft relative to earth. Currently we can tell how fast a spacecraft is traveling within 1/10th of a millimeter per second.

There are several things you need to do instead of going straight to Mars. 1st you aim past the planet so the booster does not hit Mars and contaminate it, or hit something operational on the surface or in orbit. After you get rid of the booster, you then need to correct your trajectory so you actually make it to Mars.

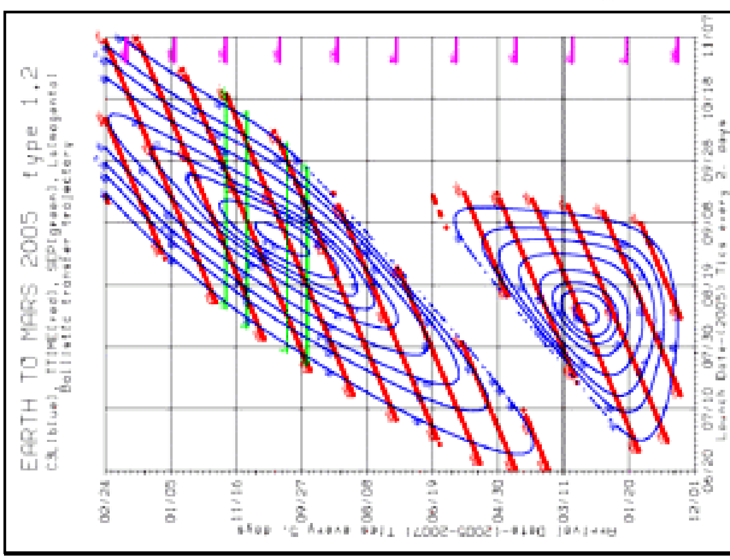
Dr. Cangahuala gave a quick run-down of the Ranger spacecrafts 5-7 that hit the moon in '64 & '65, Mariner 10's slingshots in 1974, the 1976 Viking landing on Mars, Magellan's 1993 aero-braking, Galileo's '95-'03 mission, Cassini's '04-present (until '18) mission, ESA's current Rosetta mission, and a glimpse of a few upcoming events. (Like Dawn's solar-electric propulsion being enhanced on future spacecraft.)

With everything you have to consider: how much fuel you have, how much change in velocity (Delta-V), and what the mass of your spacecraft is - it is quite a balancing act. While the public would like to land humans on Mars, we just cannot do it with what is currently available. NASA is working on it. Just to land the one ton MSL rover (Curiosity) took a radical and ingenious approach. Landing humans will take a landing craft of several tons. (Plus they would like to get back to Earth.) Getting to Mars is easy to say, and very hard to do. Kudos to India for making it on their very first try.

You can read some of Dr. Cangahuala's work at:

http://www.jpl.nasa.gov/search.php?q=L+Alberto+Cangahuala#gsc.tab=0&gsc.q=L%20Alberto%20Cangahuala&gsc.page=1

Gary Thompson



Representative pork chop plot for the 2005 Mars launch opportunity. The horizontal axis is departure dates, and the vertical axis is arrival dates. A given contour represents a constant C3 solution. The center of the pork chop is the optimal solution for the lowest C3 (Wikipedia)

What's Up? - Saturn's Rings

Rings around planets are disks of dust accompanied by tiny shepherd moonlets. In our solar system the four gas giants, Jupiter, Saturn, Uranus and Neptune have planetary rings. But the grandest of all are Saturn's rings.

Saturn's extensive ring system was discovered by Galileo in 1610. Viewing it with a very simple telescope he thought he saw three planets or a planet with "ears." When the plane of the rings turned toward him the "ears" disappeared only to reappear again. Galileo was bewildered. In 1655, Christiaan Huygens was able to see rings with a superior telescope he made himself. In 1675, Giovanni Cassini decided there were multiple rings since he spotted a gap in the middle. This would be called Cassini's Division. It would be the first of over a dozen gaps, many named after pioneer observers. In 1859, James Clerk Maxwell declared that physics dictated that the rings could not be solid. They had to be made up of many small frozen particles.

Saturn's rings are indeed made entirely of solid water ice. Tiny moons open up gaps or compress a ring. Other gaps and odd shaped rings are formed by destabilizing orbital resonances with Saturn's larger moons. The rings are alphabetized in the order of discovery. Going inward along two major bright rings, the A ring, then Cassini's division, B (brightest) ring, transparent C ring, and a faint D ring. Confusingly as you go outward from the B ring there's the braided F ring, faint G ring, and E ring. The E ring is fittingly formed by geyser material from the moon Enceladus. Way beyond the main ring system is the dusty Phoebe ring. It's tilted and orbits retrograde like the moon Phoebe that forms it.

These rings are named alphabetically in the order they were discovered rather than the logical way in which they're placed. There're also dozens of gaps, most named after pioneer Saturn observers.

These rings stretch out from 7,000 to 80,000 km but can be as thin as 10 meters. Their total mass is about the same as Saturn's moon Minas. This gives rise to the theory that the rings were formed by a small icy moon that came too close to Saturn and was ripped apart by tidal forces or disintegrated after a collision with a rocky asteroid.

In 1980 the Voyager space craft discovered radial "spokes" in the rings. These ghostly ripples are apparently the result of dust particles suspended away from the main ring by electrostatic repulsion as they are synchronized with the magnetosphere of Saturn.

Saturn's rings contain a number of unusual shepherd moons. These are moons that shape and constrain the size of rings through their gravitational influence. Two of these small moons Prometheus and Pandora were newly discovered (1980) by Voyager. They shepherd either side of the outer F ring making it a multithreaded kinked ring. Working together they hold the complex F ring together like cosmic bookends. Another small moon, Daphnis opens up the Keeler Gap much like a speedboat opens up water on the surface of a lake. It leaves behind gravitational ripples along inner "shore" edge proceeding it and along outer "shore" edge following it. Larger in size, the moon Pan keeps the Encke Gap free of debris by pushing dust aside like a street sweeper. In addition, a complex relationship between shepherd moons Janus and Epimetheus as they form their rings causes them to swap orbits every four years. The shepherd moon Atlas has shaped its own ring for so long that it's been smoothed into the shape of an icy flying saucer. Some of the shepherd moons that open gaps in the ring system are so small they've been worn down to a mere 300 meters. They have only been discovered because we know they exist by their effects on the surrounding rings. Others are known by brief shadows they cast.

The Cassini-Huygens spacecraft's backlit views of Saturn's rings show details that reveal phenomena known as density bending waves. These are caused by ripples when a passing moon exchanges gravitational energy with materials in the rings. Recent pictures also show tiny lumpy moons being born then destroyed within the rings over a year or less.

The F ring shows a lot of changes between pictures taken by Voyager (1980) and those taken recently by Cassini-Huygens. It's at a distance known as the Roche limit (a theory of French astronomer Edouard Roche). This is the point at which the difference in the gravitational tug of the near and far side of a moon can tear it apart. In regard to ring formation theories, all the major rings exist within this destructive limit.

Lee Collins

Club Events Calendar

September 12, General meeting
September 27, Mt Wilson Observing

October 2, Board meeting 6:15
October 10, General meeting
October 25, Star Party

October 30, Board meeting, 6:15
October 31, Star Party. Mtn View Elementary, Claremont
November 7, General meeting
November 22, Star Party

December 4, Board meeting, 6:15
December 12, Christmas Party, Sizzlin' Skillets 7:00pm
No scheduled Star Party

No January Board meeting
January 9, 2015, General meeting
January 17, 2015, Star Party, Afton Canyon

January 29, 2015, Board meeting, 6:15
February 6, 2015, General meeting
February 21, 2015, Star Party, Mecca Beach, Salton Sea

Feb 26, 2015, Board meeting, 6:15
March 6, 2015, General meeting
March 21, 2015, Star Party, Cottonwood Springs, Joshua Tree

March 26, 2015, Board meeting, 6:15
April 3, 2015, General meeting
April 18, 2015, Star Party

April 23, 2015, Board meeting, 6:15
May 1, 2015, General meeting
May 21-25, 2015, RTMC (anticipated date)
No scheduled Star Party.

May 28, 2015, Board meeting, 6:15
June 5, 2015, General meeting
June 13, 2015, Star Party

July 23, 2015, Board meeting, 6:15
July 31, 2015, General meeting
July 18, 2015, Star Party

August 20, 2015, Board meeting, 6:15
August 28, 2015, General meeting
August 15, 2015, Star Party

September 17, 2015, Board meeting, 6:15
September 25, 2015, General meeting
September 12, 2015, Star Party or Annual Mt. Wilson

Space Place Kids

Why did it take so long to discover Uranus?

A carefully trained eye in perfect conditions can spot the dim light of Uranus without a telescope. Despite this fact, it wasn't officially discovered until 1781—thousands of years after the other visible planets were documented. Part of the problem was not finding it, but correctly identifying it. Read all about it in the Space Place's latest column:

http://spaceplace.nasa.gov/uranus.

The Space Place is a NASA educational website about space and Earth sciences and technologies. It targets upper-elementary-aged-children.

NEWS FLASH

Our application to incorporate the PVAA as a 501(c)(3) charitable organization has been approved by the state of California! Now there will be a little more paperwork to secure our tax-exempt status, but this is a big, positive step forward for the club. Many thanks to you all for your support and patience during the incorporation process.

Matt Wedel

Twinkle, twinkle, variable star

As bright and steady as they appear, the stars in our sky won't shine forever. The steady brilliance of these sources of light is powered by a tumultuous interior, where nuclear processes fuse light elements and isotopes into heavier ones. Because the heavier nuclei up to iron (Fe), have a greater binding energies-per-nucleon, each reaction results in a slight reduction of the star's mass, converting it into energy via Einstein's famous equation relating changes in mass and energy output, $E = mc^2$. Over timescales of tens of thousands of years, that energy migrates to the star's photosphere, where it's emitted out into the universe as starlight.

There's only a finite amount of fuel in there, and when stars run out, the interior contracts and heats up, often enabling heavier elements to burn at even higher temperatures, and causing sun-like stars to grow into red giants. Even though the cores of both hydrogen-burning and helium-burning stars have consistent, steady energy outputs, our sun's overall brightness varies by just ~0.1%, while red giants can have their brightness's vary by factors of thousands or more over the course of a single year! In fact, the first periodic or pulsating variable star ever discovered—Mira (omicron Ceti)—behaves exactly in this way.

There are many types of variable stars, including Cepheids, RR Lyrae, cataclysmic variables and more, but it's the Mira-type variables that give us a glimpse into our Sun's likely future. In general, the cores of stars burn through their fuel in a very consistent fashion, but in the case of pulsating variable stars the outer layers of stellar atmospheres vary. Initially heating up and expanding, they overshoot equilibrium, reach a maximum size, cool, then often forming neutral molecules that behave as light-blocking dust, with the dust then falling back to the star, ionizing and starting the whole process over again. This temporarily neutral dust absorbs the visible light from the star and re-emits it, but as infrared radiation, which is invisible to our eyes. In the case of Mira (and many red giants), it's Titanium Monoxide (TiO) that causes it to dim so severely, from a maximum magnitude of +2 or +3 (clearly visible to the naked eye) to a minimum of +9 or +10, requiring a telescope (and an experienced observer) to find!

Visible in the constellation of Cetus during the fall-and-winter from the Northern Hemisphere, Mira is presently at magnitude +7 and headed towards its minimum, but will reach its maximum brightness again in May of next year and every 332 days thereafter. Shockingly, Mira contains a huge, 13 light-year-long tail -- visible only in the UV -- that it leaves as it rockets through the interstellar medium at 130 km/sec! Look for it in your skies all winter long, and contribute your results to the AAVSO (American Association of Variable Star Observers) International Database to help study its long-term behavior!

Dr. Ethan Siegel

Check out some cool images and simulated animations of Mira here: http://www.nasa.gov/mission_pages/galex/20070815/v.html

Kids can learn all about Mira at NASA's Space Place: http://spaceplace.nasa.gov/mira/en/

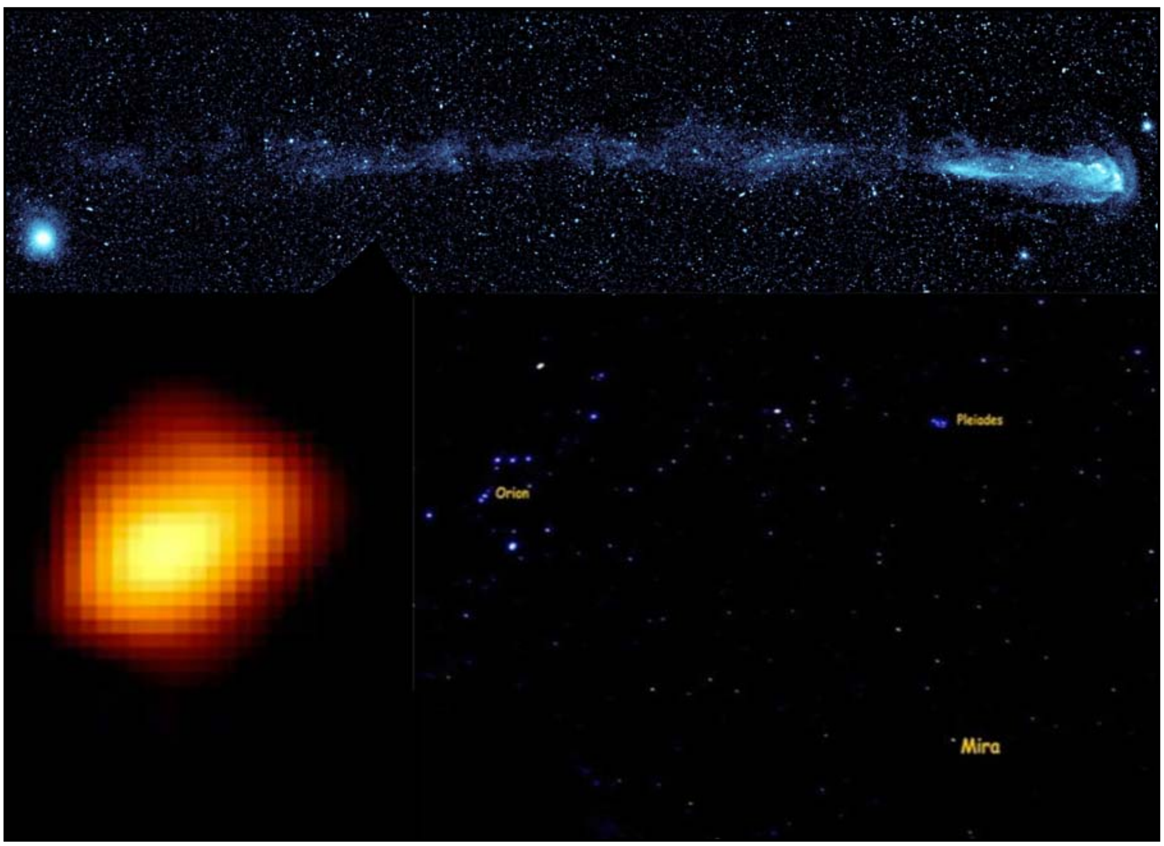


Image credit: NASA's Galaxy Evolution Explorer (GALEX) spacecraft, of Mira and its tail in UV light (top); Margarita Karovska (Harvard-Smithsonian CfA) / NASA's Hubble Space Telescope image of Mira, with the distortions revealing the presence of a binary companion (lower left); public domain image of Orion, the Pleiades and Mira (near maximum brightness) by Brocken Inaglory of Wikimedia Commons under CC-BY-SA-3.0 (lower right).