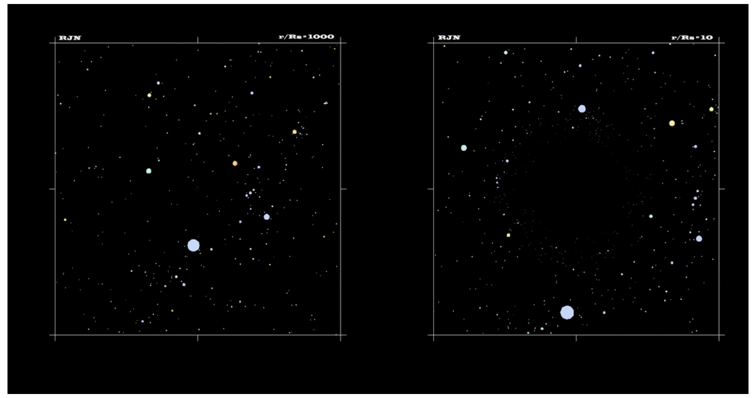
Temecula Valley Astronomer

The monthly newsletter of the Temecula Valley Astronomers   Feb 2017

Events:

General Meeting : Monday, Feb 6, 2017 at the Temecula Library, Room B, 30600 Pauba Rd, at 7 pm. What's Up by Skip Southwick. We are still confirming the main speaker. Check the web page for updates.

For the latest on Star Parties, check the web page.



NASA APOD 8 Sep 2002 - Too Close to a Black Hole
Credit & Copyright: Robert Nemiroff (MTU)

WHAT'S INSIDE THIS MONTH:

Send newsletter submissions to Mark DiVecchio <markd@silogic.com> by the 20th of the month for the next month's issue.

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General information:
Subscription to the TVA is included in the annual $25 membership (regular members) donation ($9 student; $35 family).

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Cosmic Comments – Feb/2017
by President Mark Baker

The Eagle Has Landed… this is an iconic phrase that has stayed with me my whole life, in all that I've done. It implies ultimate success, usually after extraordinary effort…

The Eagle Has Landed…today it applies to the building permit that I just received, almost a year and a half after initial expectations!!! For us, this is more than just getting a house built… even more than getting an observatory complex in place. It is a way to give back to the community that we have chosen to reside in, a way to enhance our efforts to stimulate interest in the Cosmos and science in general, and Astronomy in particular.

The Eagle Has Landed…of course, we hope to initiate some aspects of the complex once the house has progressed to a certain point, such as several permanent pads and even some temporary ones. That is when we can say we took our first steps for Man…

I don't know why I am so excited to make this so, but I hope that most of you will share my joy as this good thing happens in the near future. And who knows, TVA can maybe make a contribution that leads to a great Leap for Mankind!!!

Clear, Dark Skies my Friends…

Looking Up – Feb 2017
by Curtis Croulet

First Quarter Moon is February 3 at 8:19 PM PST; **Full Moon** is February 10 at 4:33 PM PST; **Last Quarter Moon** is February 18 at 11:33 AM PST; **New Moon** is February 26 at 6:58 AM PM PST.

Mercury is in the morning sky. It reached greatest western elongation on January 19. In February it is closer to the Sun as the month begins, but it continues to be visible until about February 24.

Venus reached greatest eastern elongation in the evening sky on January 12, but it actually gets a bit higher in the sky, measured from the horizon at sunset, peaking on February 3. Then Venus starts to decline toward the Sun. This is a good time to see Venus as a crescent. Enjoy it, because Venus reaches inferior conjunction on March 25. Venus reaches greatest brilliancy on February 18 at mag -4.8.

Mars remains in the evening sky in Pisces throughout February. Mars fades further from mag +1.1 to +1.3. It's too small to see visible detail in amateur telescopes.
Jupiter rises a bit before 11 PM on February 1 and as early as a bit before 9 PM on February 28. Opposition is April 7.

Saturn is a morning object in southern Ophiuchus at the beginning of February. It moves into Sagittarius by the end of the month. Opposition is June 14.

Uranus is an early evening object in Pisces.

Neptune is an evening twilight object. You could conceivably catch it at the beginning of February, but by month's end it'll be too close to the Sun. The Oct 2016 issue of *Sky & Telescope*, p.50, has excellent finder charts for both Uranus and Neptune.

Pluto is unavailable for viewing this month. It's in the morning sky, but not in a *dark* morning sky.

There are no significant meteor showers this February.

Let's look up.

During the early 17th Century, astronomers gradually came accept the heliocentric universe proposed by Copernicus and Galileo. But a significant scientific objection to the heliocentric universe was the failure to observe stellar parallax. If the Earth were revolving around the Sun, then we should observe the stars to change their positions slightly as the Earth moves from one side of its orbit to the other. No stellar parallax was observed. The heliocentric universe lacked proof.

It was James Bradley (1693-1762), the most important astronomer you've never heard of, who provided the necessary proof. Bradley was originally an Anglican cleric. But astronomy became his passion. He resigned from his congregation at Bridstow and embarked on a career as an astronomer. In the beginning of his research, Samuel Molyneux was Bradley's companion and mentor. Molyneux' sudden death in 1728 left Bradley to continue his research alone.

It so happens that the star Eltanin passes directly overhead at the latitude of London, England. Eltanin, despite its Bayer designation as Gamma Draconis, is the brightest star in Draco. Its magnitude is 2.24. One can rigidly mount a telescope vertically to observe Eltanin as it passes overhead. The astronomer would sit indoors, looking through the telescope, which poked through a hole in the roof. The telescope would be equipped with fine adjustments so that Eltanin could be precisely centered on crosshairs. The telescope's deviation from an exactly vertical position would be measured by comparison with a plumb weight and line.

Bradley expected Eltanin to move a tiny bit north and a tiny bit south through the year. It would be at its northernmost position at the Summer Solstice, and it would be at its southernmost position at the Winter Solstice. Such deviations would be due to the long-sought stellar parallax.

Bradley began his observations in early December 1727. He was observing in daytime, because that's when Eltanin passes overhead in December. Bradley noted the position of Eltanin, which he thought was almost as far south as it would go. But as he continued to observe Eltanin on later days, the star kept moving south. It didn't reach its southernmost point until March. Then it reversed, and instead of its northern movement stopping in June, it kept going until September.

Bradley couldn't explain why Eltanin moved as it did, in seeming contradiction to the predicted effect of stellar parallax. The solution came to him during a boating excursion on the Thames. He noticed that the weather vane on the mast of the boat would change direction as the boat turned about. The weather vane was responding to the wind, but it didn't point in exactly the same direction as the boat reversed course. In a flash Bradley realized that the weather vane wasn't simply responding to the direction of the wind, but also to the motion of the boat. The boat was creating its own wind as it moved, supplementing or detracting from the natural wind. The motion of the boat, not just its orientation or position, was altering the observed direction of the wind.

In the 1660s, Danish astronomer Ole Roemer, timing the motions of Jupiter's moon, Io, found that Io didn't seem to follow its predicted schedule, pushing ahead or falling behind. He proposed that the variation was caused by the length of time required for Io's light to cross different segments of the Earth's orbit, sometimes shorter, sometimes longer, as the Earth moved. Christian Huygens used Roemer's collected data to calculate the speed of light. His calculated value was equivalent to about 220,000,000 meters per second (the modern value is 299,792,458 meters per second). Roemer's observations required something to be moving, but it could have been Jupiter, not the Earth.

The idea that light had a finite speed found particular acceptance in England. Bradley realized that the light from Eltanin was taking a finite length of time to travel the length of his telescope tube, in accordance with Roemer's and Huygens' discovery of the finite speed of light. Bradley had to alter the pointing of his telescope slightly to compensate for the apparent movement of Eltanin while it traveled from the objective to the eyepiece of his telescope. Bradley sent a report of his observations to the Astronomer Royal, Edmund Halley, in 1729, and it was subsequently published in the Royal Society's *Philosophical Transactions*.

Bradley hadn't found Eltanin's parallax, which was far smaller than he imagined. In fact, it would be another century before Friedrich Bessel would successfully measure the parallax of 61 Cygni. But Bradley had found direct observational evidence that the Earth orbits the Sun.

Clear skies.

Random Thoughts
by Chuck Dyson

This month I want to tackle a very scary topic and one you cannot throw any light on, O.K. you can throw light on it but you still will not see anything or illuminate the problem with this type of object. Yes we are talking about the darkest and the brightest objects in the sky. Now if everything that I have said so far sounds to you to be completely contradictory, well, welcome to the wonderful world of black holes. And as we all know the concept of black holes comes from an interpretation of Einstein's 1915 work on general relativity by Karl Schwarzschild in 1916, that Schwarzschild boy was quick on the uptake, who said that if, and it was a big if, gravity could bend light then a lot of gravity could bend light back on itself and no light could escape from the object. Unfortunately what we all know is wrong. As soon as Newton published Principia in 1687 John Mitchell started working on a hypothesis based on Newton's cannon ball analogy for producing an object that could go into orbit around another object. Mitchell, using a 1676 report by the Danish astronomer Ole Romer who has used the differences in appearance times of Jupiter's moons to measure the speed of light, said that if light has a finite speed then the speed needed by light to escape a star would go up as the star's mass and gravity increased until the escape speed was greater than the speed of light and in that case no light could escape the star and it would be a dark star. The consensus was that Mitchell's and later Laplace's idea of a dark star was a crazy but a novel thought experiment. In 1919 with the measurement of starlight being bent by the sun's mass all of that changed and the hunt for dark stars was on. It is also worth noting that the term black hole was only coined in 1964 when a journalist named Ann Ewing wrote an article for a paper and used the term and it stuck much to the disgust of the Russians who had coined the term frozen star and wanted their term used.


Karl Schwarzschild

So much for the history lesson and it is now time to ask the big question, are black holes real and what do they, please pardon the pun, look like. First black holes are real and thanks to advances made in adaptive optics, the spectrograph that was installed in Hubble in 2009, and the improved distance measurements we have gotten from Hipparcos and Gaia satellites astronomers have found and identified three of the four types of black holes. The two easiest black holes to find have been the stellar mass black holes (3 to 100 solar masses) and the supermassive black holes (10^5 to 10^9 solar masses) our galaxy has a black hole of $4.3X10^6$ solar masses at its center. The intermediate size black hole (10^2 to 10^5 solar masses) is found at the center of galaxies but is just a rarity, at this time I am aware of only two intermediate sized candidates. The last class of black holes is the micro or mini (0.01 lunar to about 3 solar masses) they are thought to have been formed during the Big Bang but no evidence of them existing has ever been found and it is not from lack of trying to find the little suckers either.

So what is a black hole? It all starts with the singularity and the singularity is just normal matter that has been squished to the point where there is no time, density is infinite, and we really need a working model for quantum gravity. And the short answer is, we really have no good description for a singularity. Next up is the inner event horizon and that is the place in the Schwarzschild sphere where matter has no future, once you are inside the Schwarzschild radius physicists tend to say that there is no time so the singularity cannot be here or there it can only be in the future, so as your radius distance from the singularity decreases you approach your future. Unfortunately pretty much all of the people working on what happens inside of a black hole agree that when you reach your future you have no future you are just toast. If you are going to use black holes for faster-than-light travel or time travel you must, at all costs, avoid bumping into the singularity. Now we come to the event horizon itself and this is the exact spot were the acceleration due to gravity is exactly equal to the speed of light. The event horizon is a very special place because it is the point where gravity is exactly equal to the speed of light and this means that when something enters the black hole its photons that are emitted as it goes into the black hole stay at the event horizon and so no information about the object is lost, this a very big thing in theoretical physics. Also at the event horizon it is possible for virtual particles to pop into and out of existence and if one of the pair is just inside of the event horizon and one of the pair is just outside of the event horizon then when the outside particle evaporates mass is lost from the black hole and the black hole will eventually evaporate; although, this process for stellar size black holes takes a very long time and for supermassive black holes, a very, very long time. Just outside of the event horizon is the photo sphere were photons circle the black hole just like satellites circling the earth. Above the photo sphere for about 1000 Schwarzschild radii out from the center of the black hole is the ergo sphere and in the ergo sphere there is no standing still as space and time is being dragged around by gravity. I have seen computer simulations of what it would be like to be in the ergo sphere of a black hole and I can honestly say that if you have any tendency toward motion sickness do not go there. The physical characteristics that black holes have are so simple that we say that it has no hair that is to say nothing fuzzy or unclear. The Black hole has exactly three features mass, spin, if the collapsing object has spin then that angular momentum is conserved and the black hole has spin, and charge but because the black hole “eats” positively and negatively charged particles with equal gusto we think black holes have a neutral charge.

Now that we have looked at black holes, how do we “build” one? Let’s start with a mini and because we have never found one or evidence of one tends to see sentences that say “density fluctuations in the early universe may have formed them” and then move on to the next subject. The appeal of mini black holes is that if enough of them are created then they could be the dark matter that is giving everybody headaches trying to explain. The trouble with the mini black hole theory is how does one go about detecting them as their area of influence where objects rotate around them at high speed is about the size of the Earth or even less. In the 1970’s we started to detect GRBs (gamma ray bursts) and the Hawking black hole radiation model predicts that as the black hole gets smaller its evaporation rate gets faster and just before or just as the black hole completely evaporates the rate of evaporation is so fast that it releases a burst of gamma radiation with a very specific energy profile. Satellites have now found thousands of GRBs and none of them have the required energy profile, sorry Steven no Nobel prize for you.

With solar mass black holes the story is entirely different story we have about 15 or so binary star candidates that emit x-rays and the visible stars have an unseen companion of over 2 solar masses, if the unseen companion is under two solar masses it is most likely a neutron star. In addition we have two stars that are being observed as possible black hole candidates. First is the supernova 1987a eruption that occurred I the Large Magellanic Cloud and was a 20 solar mass blue giant star there has been no sign of a neutron star forming in the center of the nebula formed by the explosion so the hope is that a black hole can be detected and verified. The second candidate star for forming a black hole is N6946-BH1 and it is just at the lower mass limit for the direct formation of a black hole without a supernova and the progenitor star was seen and cataloged by the Palomar survey group and it subsequently flared and then just disappeared leaving only a faint afterglow; this is what the theorists predicted a direct stellar core collapse would look like. Remember those GRBs that were not from evaporating mini black holes; well in several cases they are associated with supernova of the type that we know can produce black holes and one type of GRB, the relatively rare short duration type, has a radiation signature that is predicted to come from merging neutron stars and the mostly likely outcome from that event is a black hole.

Are supermassive black holes real? OH YA! And thanks to Hubble and its cosmic origins spectrograph that was installed in 2009 we have oodles of evidence that almost all galaxies have supermassive black holes at their centers. The problem that we have with supermassive black holes is not are they real but how did they form so rapidly in the young universe. The Big Bang theory is fairly well established and understood. Conventional wisdom based on what we think the very early universe was like suggest that stars started forming 600 million years after the Big Bang and galaxies were formed and had quasars 900 million years after the Big Bang and this was a huge problem because Chandrasekhar, you know the guy who loved to put limits on everything, said that there was a limit on how fast black holes could take in matter because as the accretion disk grew its temperature would grow and the outward pressure from the hot gas would shut off the in-flowing material. The Chandrasekhar limit of growth of black holes does not allow supermassive black holes in 300 million years. Please note that in just the last few months there has been a release of data analysis from Hubble that shows a dwarf galaxy that is formed only 400 million years after the Big Band and this is 200 million years before the first stars were supposed to have formed, obviously our early universe timeline will be undergoing some serious revision. For an excellent description of the supermassive black hole problem there is in the January edition of Sky and Telescope an article entitled “The First Black Holes” and is discusses at some length the problem and putative solutions. I especially like this article because the author points out the absolute need for dark matter to be present for the formation of any objects to occur.

I think I can sum up our black hole situation as follows: Mini black holes exist in equations describing the Big Bang but nowhere else. Stellar mass black holes exist but the supernova process that forms them is a little more complicated than we thought. Intermediate black holes exist but almost no one cares. Supermassive black exist in abundance, quasars tell us they have existed from the earliest of times, Chandrasekhar tells us they cannot, and the theorists are happy because they have job security.

And last but not least; we can go with the short explanation of black holes supplied by the comedian Steve Wright "Black holes are where God divided by zero". I do not know about you but it works for me.

Cheers,
Chuck

Random Thoughts (part 2) - The Book Report
by Chuck Dyson

In the 2017 January-February issue of American Scientist there is an article entitled Photoshopping the Universe by Travis A. Rector, Kimberly Arcand and Megan Watzke. The article explains why and how digital photographs are modified by the processors to make visible to human eyes what the telescope and camera see with there their eyes. The article goes into detail of what is done to the digital data and what should not be done to the digital data to produce the image. All science requires the researcher to handle, arrange, and organize the raw data this article is a good tutorial on what is and what is not responsible manipulation of data. A plus with this article is the example pictures are really stunning.

Cheers
Chuck

Mission Euclid Update
by Claire Chambers

12/17/15 - most recent update I found

Euclid, a planned mission to investigate the profound cosmic mysteries of dark matter and dark energy, has passed its preliminary review. This clears the way for construction to begin. Euclid is an all-sky space mission designed to map the geometry of the dark universe. Its primary objectives are to understand the nature of dark energy and dark matter by accurate measurement of the accelerated expansion of the universe through different independent methods.

Euclid is a European Space Agency (ESA) mission designed to accurately measure the expansion history of the universe and the growth of cosmic structures. The Euclid instruments are provided by the ESA member states with NASA contributing to the NISP (near-infrared spectrometer and imaging photometer). The mission will carry out a large-area optical and near infrared imaging survey and a spectroscopic survey in he wavelength range 1.1-2.0 microns. Euclid will serve to constrain dark energy, general relativity, dark matter, and the initial conditions of the universe with unprecedented accuracy.

This mission will launch in 2020 and spend six years mapping the locations of, and measuring the shapes of as many as two billion galaxies spread over more than one third of the sky. It will study the evolution of our universe and the dark matter and dark energy that influence its evolution in ways that are still poorly misunderstood. The telescope will launch to an orbit around the sun - Earth (Lagrange point L2). The Lagrange point is a location where the gravitational pull of two large masses, the sun and the Earth, in this case, precisely equals the force required for a small object, such as the Euclid spacecraft, to maintain a relatively stationary position behind the Earth as seen from the sun.

NASA is very proud to contribute to ESA's mission to understand one of the greatest scientific mysteries of our time. NASA will contribute 16 state-of-the-art infrared detectors, with four spares, for one of two scientific instruments planned for Euclid.

Dark matter was first postulated in 1932, but still has not been detected directly. It is called dark matter because it does not interact with light. Dark matter interacts with ordinary matter through gravity and binds galaxies together like an invisible glue. While dark matter pulls matter together, dark energy pushes the universe apart at ever-increasing speeds. In terms of the total mass-energy content of the universe, dark energy dominates. Even less is known about dark energy, than dark matter.

Euclid will use two techniques to study the dark universe, both involving precise measurements of galaxies billions of light-years away. The observations will yield the best measurements yet of how the acceleration of the universe has changed over time, providing new clues about the evolution and fate of the cosmos.

How to Use *Position* in the TVA App

by Clark Williams

The TVA App is in the Apple App Store. Here is a link:

Quick Overview

The app currently runs on iPhone 5 and above running iOS 9.0 or above and iPads from iPad Air through iPad Pro (12” & 9”) with and without Retina. The app looks the same on an iPhone and on the iPad although it is intended mostly for use on the iPhone.

Most of the app operations are self explanatory. You can take a quick static walk through via the help site set up for the App at: http://www.http://s-i-g-h.com/iosApps/Help/TVA/index.html

Before you do that you might want to review the Privacy Policy at: http://s-i-g-h.com/TVA/PrivacyPolicy/TVA-App-mobile-privacy-policy.html

The App is approximately 4.6 MB of download and is located in App Store – Entertainment – Software Industry & General Hardware (aka S.I.G.H.).

Software Industry & General Hardware is my personal company and I did the development of the app mostly for myself since I found a need to have the information on the WEB site on my phone. I did however need a more mobile presentation. I also planned to allow Maps to read Star Party addresses and automatically make them available on my phone so I could easily map myself to the Star Parties. I figured maybe club equipment sign-out could be automated and perhaps even an updated online WEB addition for PayPal dues payment and donations. That is for the future. For now we have a start on what is OUR App. We can make it into what the club needs, within reason, over time.

The code for the app is owned by the club not I. Currently I am the custodian of the code and the App is in the App Store via my developer credentials. That is just because the club doesn't have to pay for anything if we do it just this way.

Layout

The overall layout is designed to emulate the club's WEB site:

- Outreach
- Meetings
- Event Calendar
  - Lunar Phases to 2051
  - Online Events
  - Position
    - current latitude and longitude
    - altitude (m/ft)
    - heading (true/magnetic)
- Newsletter
- Equipment Sign-out
- Contact TVA
- Board Members

If you have visited the club WEB site these should be familiar as the general tabs available in the menu. Well, everything except the ***Event Calendar*** section should be familiar. There are two unfamiliar buttons available here. ***Online*** is familiar as it is on the WEB site but ***Lunar Phases to 2051*** and ***Position*** are new.

Event Calendar Buttons

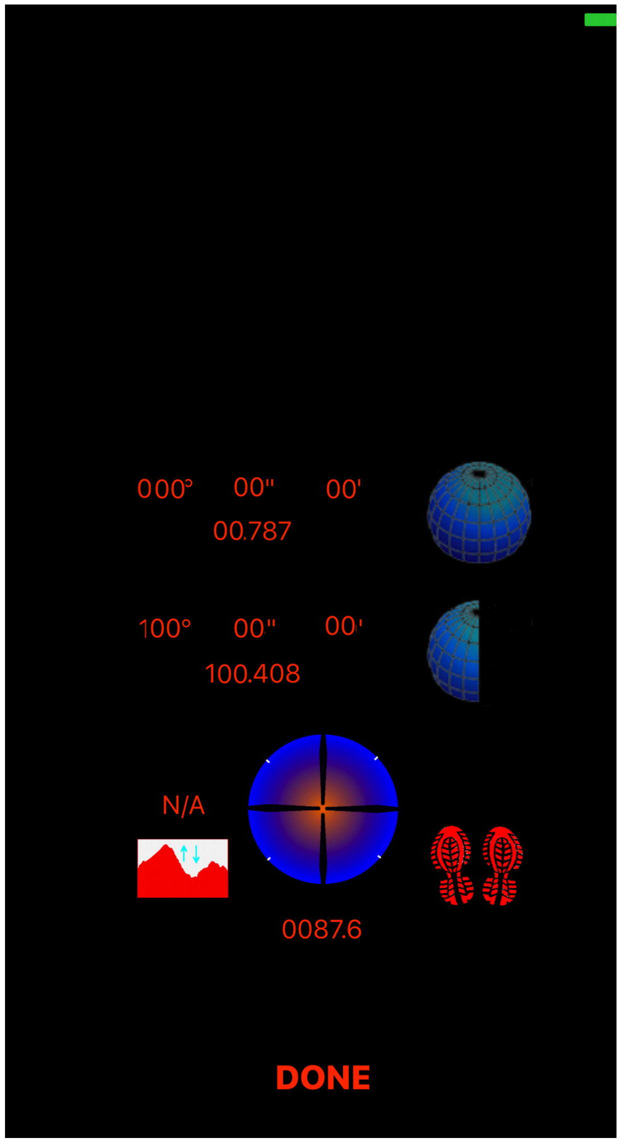
Lunar Phases to 2051

Lunar Phases to 2051 allows you to select a year and a month an get the Lunar Phases (local times including DST where appropriate) day, hour and minute. Accuracy is about ±3 minutes. The method is from Meuse and I believe he indicates that this is the accuracy of the method. I would have to look it up to be certain and it has been years since I first wrote the code used in the app.

If you want to mail the phases to someone just click the email icon fill in the email information and press the send button.

Position

Position is a little more involved.



TVA Position Page

Lets start from the top-left and work down.

The numbers shown in the above image are for identification only and are not valid latitude, longitude, altitude or heading info.

Your Current Location

The first grouping of numbers: **000° 00' 00”** represents the current latitude in degrees, minutes and seconds. Continuing to the right the icon of a globe with gridlines indicates if the latitude is

North (shown above) or South. The numbers below the degrees, minutes, seconds, latitude shown as a decimal value of **00.787** is the current latitude in decimal degrees.

The next group of numbers **100° 00' 00"** is the current longitude in degrees minutes and seconds. The icon to the right represents either West (shown above) or East. The decimal value **100.408** is the longitude in decimal degrees.

These values are static and only show your current position. They won't change as you walk.

Altitude

The red-white rectangle icon is intended to be mountains and represents your current altitude. Not all iOS devices are capable of doing altitude nor heading. If an invalid altitude is found an **N/A** is displayed. Otherwise the current value is displayed appended with an m for meter or ft for feet. You set which by changing the TVA Settings value Altitude in meter switch in the iOS devices settings.

Heading

The icon that looks like a big circle with the **0087.6** represents a compass rose and the value is your current heading in either true or magnetic north. You choose which by changing the TVA settings in your iOS devices settings.

To the right of the compass rose is a shoe-sole icon. This allows you to either set static (meaning current value when you first pressed the ***Position*** button) or tracking (follow you by updating the latitude/longitude and altitude). The shoe sole icon is actually a button. Press it and it will change to show you whether you are tracking your position (walking) or standing still (static).

That is pretty much all. Everything else is a link to the WEB site equivalent.

Known Problems

There is one more thing. The first TVA App uploaded has version **1.0 (14)** and it has an error that allows you to choose a Lunar Phase year larger than 2051. There is no output for the year but you can choose the year. That has been fixed in version **1.1 (0)**. That version is being for reviewed for approval by Apple and won't show up until Tuesday or Wednesday of January 17 or 18. The app shouldn't crash but won't show any phases beyond 2051. The update will only display the proper number of years you may select.

The Android App is being worked on. It is not as easy as generating an iOS app. There are a lot more versions and a huge number of possible platforms that making testing and debugging a nightmare. It will happen.

Comet Campaign: Amateurs Wanted
by Marcus Woo

In a cosmic coincidence, three comets will soon be approaching Earth—and astronomers want you to help study them. This global campaign, which will begin at the end of January when the first comet is bright enough, will enlist amateur astronomers to help researchers continuously monitor how the comets change over time and, ultimately, learn what these ancient ice chunks reveal about the origins of the solar system.

Over the last few years, spacecraft like NASA's Deep Impact/EPOXI or ESA's Rosetta (of which NASA played a part) discovered that comets are more dynamic than anyone realized. The missions found that dust and gas burst from a comet's nucleus every few days or weeks—fleeting phenomena that would have gone unnoticed if it weren't for the constant and nearby observations. But space missions are expensive, so for three upcoming cometary visits, researchers are instead recruiting the combined efforts of telescopes from around the world.

"This is a way that we hope can get the same sorts of observations: by harnessing the power of the masses from various amateurs," says Matthew Knight, an astronomer at the University of Maryland.

By observing the gas and dust in the coma (the comet's atmosphere of gas and dust), and tracking outbursts, amateurs will help professional researchers measure the properties of the comet's nucleus, such as its composition, rotation speed, and how well it holds together.

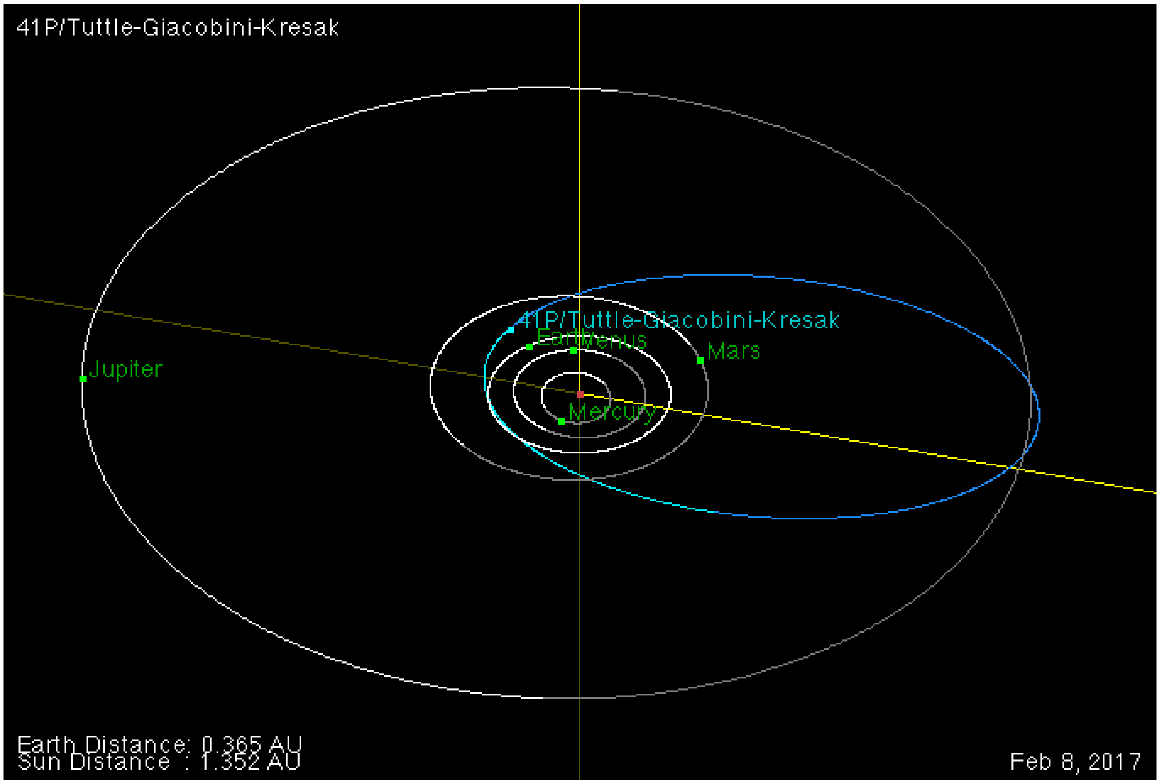
The observations may also help NASA scout out future destinations. The three targets are so-called Jupiter family comets, with relatively short periods just over five years—and orbits that are accessible to spacecraft. "The better understood a comet is," Knight says, "the better NASA can plan for a mission and figure out what the environment is going to be like, and what specifications the spacecraft will need to ensure that it will be successful."

The first comet to arrive is 41P/Tuttle-Giacobini-Kresak, whose prime window runs from the end of January to the end of July. Comet 45P/Honda-Mrkos-Pajdusakova will be most visible between mid-February and mid-March. The third target, comet 46P/Wirtanen won't arrive until 2018.

Still, the opportunity to observe three relatively bright comets within roughly 18 months is rare. "We're talking 20 or more years since we've had anything remotely resembling this," Knight says. "Telescope technology and our knowledge of comets are just totally different now than the last time any of these were good for observing."

For more information about how to participate in the campaign, visit http://www.psi.edu/41P45P46P.

Want to teach kids about the anatomy of a comet? Go to the NASA Space Place and use Comet on a Stick activity! http://spaceplace.nasa.gov/comet-stick/



An orbit diagram of comet 41P/Tuttle-Giacobini-Kresak on February 8, 2017—a day that falls during the comet's prime visibility window. The planets orbits are white curves and the comet's orbit is a blue curve. The brighter lines indicate the portion of the orbit that is above the ecliptic plane defined by Earth's orbital plane and the darker portions are below the ecliptic plane. This image was created with the Orbit Viewer applet, provided by the Osamu Ajiki (AstroArts) and modified by Ron Baalke (Solar System Dynamics group, JPL). http://ssd.jpl.nasa.gov/sbdb.cgi?orb=1;sstr=41P

This Article is provided by NASA Space Place.
With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology.
*Visit **spaceplace.nasa.gov** to explore space and Earth science!*

The TVA is a member club of The Astronomical League.