Volume 25 Issue 12

December 2011

The Observer

East Valley Astronomy Club

From the Desk of the President

by Steven Aggas

Happy holidays and clear skies…

First, I'd like to thank those who've run the club in this year. Next year my wife and I will enjoy attending meetings instead of organizing them.

I hope you all have enjoyed the meetings of 2011 as much as we have!

We've had great meeting speakers on a variety of topics. I have already lined up speakers for January, March and April to speak on the Atacama desert of Chile, an expert on meteorites we've not had as a speaker before, and, a presentation on near Earth asteroids. I think you'll like them…

Best regards and have a great new year!

Upcoming Events:

Public Star Party - December 9

Holiday Dinner - December 16

Local Star Party - December 17

Deep Sky Observing Night - December 24

Check out all of the upcoming club events in the Calendars on page 8

Inside this Issue:

The Backyard Astronomer

December Skies & More *by Bill Dellinges*

I must be getting old. When driving freeways in this town, I always feel like I'm participating in the Indianapolis 500. But I digress.

A friend asked me the other day, "If I were at the equator, would I be able to see all the stars in both hemispheres?" I answered yes.

At least during the course of a full year, you'd see every star visible from Earth. Furthermore, the celestial poles would be on your north and southern horizons and the stars would make 180° concentric tracks across the sky. They would start with small semicircles at the poles and enlarge till the biggest was over your head.

If you were at the poles (good luck finding ice to stand on at the North Pole) the north star Polaris would be over your head and stars would travel across the sky in paths parallel to your horizon. You would see no stars below the celestial equator (which would coincide with your horizon).

The familiar slanted stellar paths we're accustomed to seeing in mid-latitudes happen only at latitudes between the equator and poles. But I digress.

Most of this month's stars were discussed in October's *Backyard Astronomer* column. Only in the east do we see changes. M45, the Pleiades or Seven Sisters, draws our attention there as a tight little knot of stars just off the foot of Perseus. Can you count seven? I can't. Most folks see six. I have seen the number of stars in this open cluster vary from

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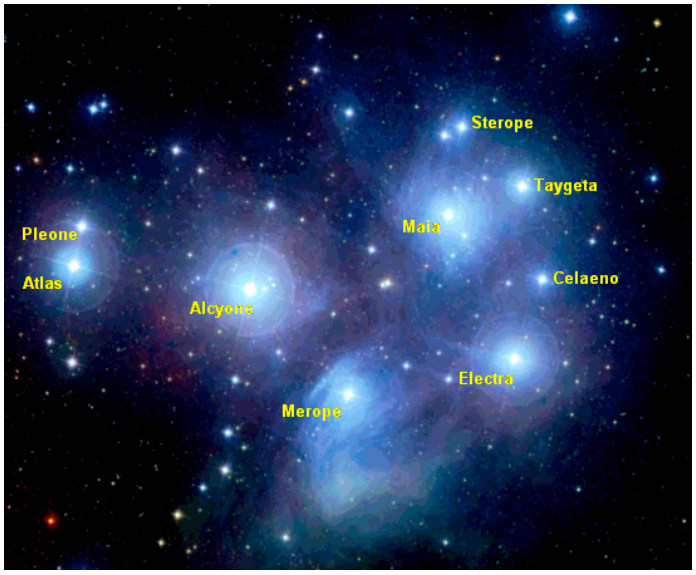
The Backyard Astronomer

Continued from page 1

50 to 2000 (!) in different books, but I count about 50. The cluster is 380 light years away, pretty close for a star cluster – which explains why the human eye can resolve it without optical aid and why it's so large.

M45 spans two degrees of sky (4 full moons), too big to fit in the fields of most telescopes. Some telescopes can just squeeze them in at low power, but it's like magnifying the Mona Lisa till you just see her lips and nostrils. You want to see her entire "face". Here is where binoculars can strut their stuff. I would argue the Pleiades in binoculars is the finest thing in the night sky to view with optical aid. I have spoken. My favorite view is in the 5º field of my 10x70's. They're perfectly framed with just enough space around the cluster.



Now is a good time to view M45 in binoculars because it's low in the east and easy to view. For the best view of these "Fireflies in a tangled braid", mount your binoculars on a tripod; it makes a huge difference. M45 represents Taurus the Bull's shoulder. Just under it you'll find another "visual" cluster, the Hyades. This is the Bull's face. At a distance of 150 light years, this cluster is even closer to us than the Pleiades; thus it occupies (Occupy Taurus!) a larger chunk of sky and requires a binocular field of 7 to 8 degrees to view it all at once. Its brightest star is Aldebaran, not a member of the group, but a foreground star 65 light years away. Note just to Aldebaran's west within the Hyades is a cute group of stars forming three double stars, each 120 degrees apart!

Double Cluster in Perseus. Image credit: Roth Ritter, Dark Atmospheres

Use your binocular setup to capture the Double Cluster (NGC 884/869) in nearby Perseus, always a rewarding object. Drop down a short ways to an overlooked beauty hovering below Mirphak (Alpha Persei), the Perseus OB Association or Melotte 20. I think this stellar group gives the Pleiades a run for its money. Check it out; you won't be sorry. Below Perseus resides a beacon that certainly attracts your attention. Capella, magnitude 0.08, is the 6th brightest star in the sky (4th in the northern hemisphere). It's the brightest star in Auriga, the Charioteer. If you borrow Beta Tauri from Taurus, Auriga becomes a conspicuous pentagon. Within it lie M38, M36, and just outside the pentagon, M37. All three conveniently lined up in a straight line. M37 is my favorite because of its powdery nature.

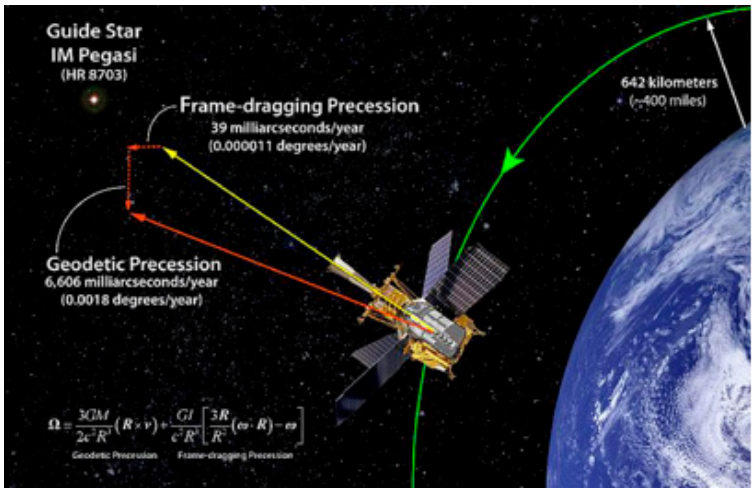
Two bright planets grace December's sky. Mighty Jupiter reigns supreme in the east at magnitude -2.8. Even brighter in the west is Venus at magnitude -3.9. It's beginning its evening apparition which will last till next April. Don't confuse it with Sky Harbor air traffic!

Double star of the month: 8 Lacertae. [aka Struve 2922, SAO 72509.RA 22h 35m 52s DEC+39 38′]. This is a five star system, though one star is an optical (not a true member of the group). But what the heck, enjoy it anyway. Magnitudes range 5.7 through 10.4. This double can be difficult to find star hopping, but it's worth the sore neck.

Gravitomagnetism
by Henry De Jonge IV

Introduction

This term first struck my eye in an APOD picture from 5/10/11 and I was intrigued as to exactly what is the connection between General Relativity, (GR) and magnetism. It turns out that the use of the term gravitomagnetism is a bit loose but there is a connection (analogy) none the less and the concept has recently been tested to a high degree by the Gravity Probe B satellite, (GPB). Once again Einstein's GR theory has been tested in a new manner and come through with flying colors. We will examine the GPB satellite and its further confirmation of GR in this article.



APOD picture of GPB May 10, 2011 showing overview and results

The GPB Satellite

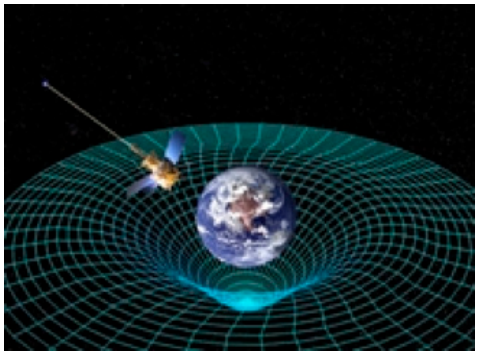
The GPB satellite was designed to test two key predictions of GR and has confirmed both of them, (albeit to varying degrees). This satellite was designed from the beginning to measure both the warpage of space-time and the dragging of space-time. GPB was launched in April of 2004 for an originally planned 16 month mission but was used for another 5 years to carefully filter out the effects of GR from all other possible disturbances. It used 4 ultra precise gyroscopes, (the most precise ever produced to date) to detect and measure the geodetic effect which is the warping of the space-time around a massive body and the frame dragging effect which is the pulling or dragging of space-time by a moving or spinning massive body. Essentially the gyroscopes experienced a measurable minute change in the direction of their spin under the influence of Earth's gravity.

The satellite was aligned by pointing a telescope at the star IM Pegasi while in a polar orbit around the Earth. The orbital distance was about 400 miles, (642km) above the earth. The degree of error elimination was needed to be extremely high for the planned tests. Even the proper motion of the guide star was eliminated as a source of error by monitoring the guide star with respect to distant quasars by using VLBI.

The 4 gyroscopes in the satellite are spheres of fused quartz 1.5in in diameter, (the roundest objects made to date, to within 0.01um of perfect sphericity) and coated with niobium. Each gyroscope was electrostatically suspended in a lead housing and spun up by He gas entering the housing. After reaching 150Hz the gas was let out and the spheres spun freely. To keep them in a "free fall" condition one gyroscope was used as a proof mass. Thrusters controlled by feedback loops, keep the case centered (and cancelled out any undesired outside influences like accelerations) on the freely falling gyro maintaining a free fall environment for the other 3. The entire assembly is kept super cooled, (which made the niobium and lead superconducting) with liquid He at 1.8 degrees K. This allowed SQUID devices to read out the direction of the gyro based upon the orientation of the gyro's magnetic moments without disturbing the rotation. It also acted as a shield for external electromagnetic fields. The 4 gyros signals were each analyzed independently, cross checked, and compared.

Residual atmospheric drag, radiation pressure, and other forces also had to be compensated for. Drag free satellites are a key method to making a freely falling frame as they float freely inside the satellite. The sheltered frame follows a geodesic in space-time while the sensors detect the location of the platform to the satellite. The technological advances needed for all of this to perform were very demanding and they can produce a very realistic approximation to a freely falling frame. The laboratory on the space shuttle also approximates this freely falling frame but to a lesser degree. These outer effects, (modeled) on the gyros had to be kept at or below 1/100,000,000,000g.

In a flat space-time the whole gyroscope can be moved without altering the momentum of the disk so the axis of rotation will indicate a fixed direction in space. In a curved space-time the center of mass of a freely falling gyroscope will move along a geodesic and the angular momentum of the gyroscope will be transported along that geodesic. Thus the presence of curvature will cause the direction of the spin angular momentum to change. The space-time of the gyroscope can be described by the Schwarzschild metric and this shows that the angular momentum vector of the gyroscope will have processed by a small angle in the plane of orbit. This is called geodesic gyroscopic procession or the geodetic effect. Despite it being extremely small it is cumulative and thus can be detected after many orbits.



The warping of space-time around the earth.

Basically, after years of operation scientists measured the gyroscopes shift and compared it to the predictions of GR. NASA announced the results of the GPB on May 4, 2011. In total since inception,

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Gravitomagnetism

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it was 47 years and $750,000,000 in the making. GPB was then decommissioned in December 2010 after completing its mission.

Frame Dragging, (Gravitomagnetism)

The term gravitomagnetism comes from the analogy between Maxwell's equations and Einstein's field equation under specific conditions, (a weak gravitational field or relatively flat space-time-this is a common assumption in GR). In breaking down the usual 4 dimensional metric in GR in such special cases, it can be reduced to a form that resembles Maxwell's equations and has components that are analogous with the electric and magnetic potential.

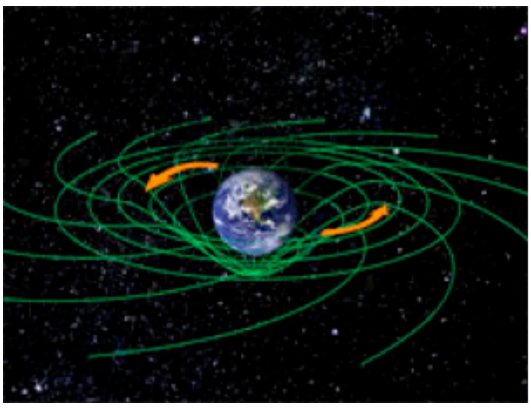
The magnetic field exerts a force only on moving charges and the direction of the force is perpendicular to the direction of the magnetic field and the direction of the charge's velocity. A moving or spinning mass has a similar effect on the space-time surrounding it, thus the GR analogy.

Since moving (accelerating) charges produce a magnetic field, moving (accelerating) bodies of mass produce a gravitomagnetic field. In another view, a free falling body in the gravitational field of a massive rotating body will experience rotation, (wobble) as well, however small, (in the case of the Earth). This is sort of a force between currents of flowing matter. GPB was to measure this spin-spin gravitational interaction.

For a rotating body the space-time metric is better described by the Kerr metric which implies the dragging of inertial frames around a rotating body. This causes gyroscopic precession which is distinct from geodetic precession, (Schwarzschild metric). This rotational dragging of inertial frames is a particular case of the more general case of frame dragging that happens whenever there is a major movement of matter, (a mass current) in the vicinity of a local inertial frame.

This rotational dragging of inertial frames is also known as the Lense-Thirring effect after two scientists Josef Lense and Hans Thirring who predicted this in 1918. It had not been measured prior to GPB. The Lense-Thirring effect is the effect that a local inertial frame is dragged with respect to infinity alongside a free falling spinning body. Basically it would cause a gyroscope to precess in the same direction as the body it is rotating, (recall that the earth rotates about an axis thru the poles). It arises from the spin-spin interaction between the gyroscope and the rotating central mass, (the earth) and is analogous to the interaction of a magnetic dipole with a magnetic field, exactly like the basis for an MRI scan. This effect should cause the gyroscopes to precess in the E-W direction by 39 milli arc seconds/year, equivalent in arc size to viewing Pluto from the earth.

This effect was discussed years ago by GR scientists including Roger Penrose as a likely mechanism for the relativistic jets of rotating SMBH including quasars which produce extremely high energy and luminosities. These jets can hold their position for millions of years and the gyroscopic spin of SMBH can enable these jets by their gravitomagnetic field. This also causes the driving, (and wobbling) of the accretion disk into the equatorial plane of the SMBH enabling the jets to be formed in only 2 directions-the N and S poles. This is called the Bardeeb-Petterson effect and is thought to be the reason for the amazing alignment of the jets.



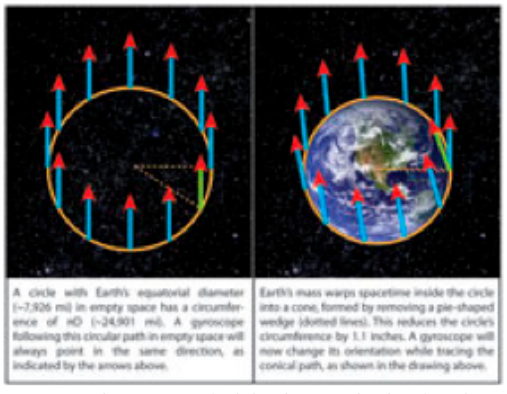
Frame Dragging around the earth.

Gravitomagnetism is one of the last basic predictions of GR to be tested and GPB detected it directly.

Geodetic Precession

This is a combination of the spin orbit coupling and the space-time curvature. Prior to GPB this has been measured to within 2% of the predictions in GR by laser range probing to our Moon. This effect comes from partly as a spin-orbit interaction between the spin of a test body, (the gyroscope) and the "mass current" of the central body, (the Earth). This is analogous to the precession of the electron in an induced magnetic field due to the motion of the nucleus. In GR the orbiting gyroscope feels the earth moving around it and experiences an induced gravitomagnetic torque causing the precession. This effect is predicted to be about 1/3 of the total geodetic precession, while the other 2/3 is the result of the space curvature alone. In the case of GPB this curvature shortens the circumference of the orbital path around the earth by 1.1 inches, (the "missing inch").

The total geodetic effect comprised up of the spin orbit and the space curvature effects causes a precession in the N-S direction of 6.606 milli arc seconds/year, (about the angular size of Mercury as seen from earth or 1.8 thousandths of a degree). The detection, (or not detection) of this parameter and its value has profound consequences for alternative theories of gravity.



A circle with Earth's equatorial diameter (~7,926 mi) in empty space has a circumference of πD (~24,901 mi). A gyroscope following this circular path in empty space will always point in the same direction, as indicated by the arrows above.

Earth's mass warps spacetime inside the circle into a cone, formed by removing a pie-shaped wedge (dotted lines). This reduces the circle's circumference by 1.1 inches. A gyroscope will now change its orientation while tracing the conical path, as shown in the drawing above.

A graphic portrayal of the shortened orbital path around the earth.

Conclusions

The final results were that GPB measured the geodetic precession at 6.602 +/- 0.018 arc seconds, (the prediction by GR was 6.606) and the frame dragging at 37.2 +/- 7.2 arc seconds, (predicted at 39.2). We see

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EVAC Holiday Pot Luck Dinner

Friday, December 16th 7:30 pm

As is the club's custom, the December general meeting will be replaced by a Holiday Pot Luck dinner. EVAC will provide the meat, soft drinks, utensils and plates. Please bring a side dish or a dessert to share. The festivities this year will be held at the site of our monthly meetings, the Southeast Regional Library in Gilbert.

Do you like getting involved with the general public and sharing both your knowledge and love of astronomy?

Would you like to learn the operations of an amateur observatory?

Like to become more familiar with a Paramount ME mount, a 16" Meade SCT and The Sky X?

Then please volunteer to join the staff at Gilbert Rotary Centennial Observatory

To avail yourself of this wonderfully rewarding opportunity, please contact the observatory manager, Martin Thompson
grco@eastvalleyastronomy.org

◐ First Quarter Moon on December 2 at 02:53

● Full Moon on December 10 at 07:36

◑ Last Quarter Moon on December 17 at 17:48

○ New Moon on December 24 at 11:07

Upcoming Meetings

December 16
January 20
February 17
March 16
April 20
May 18

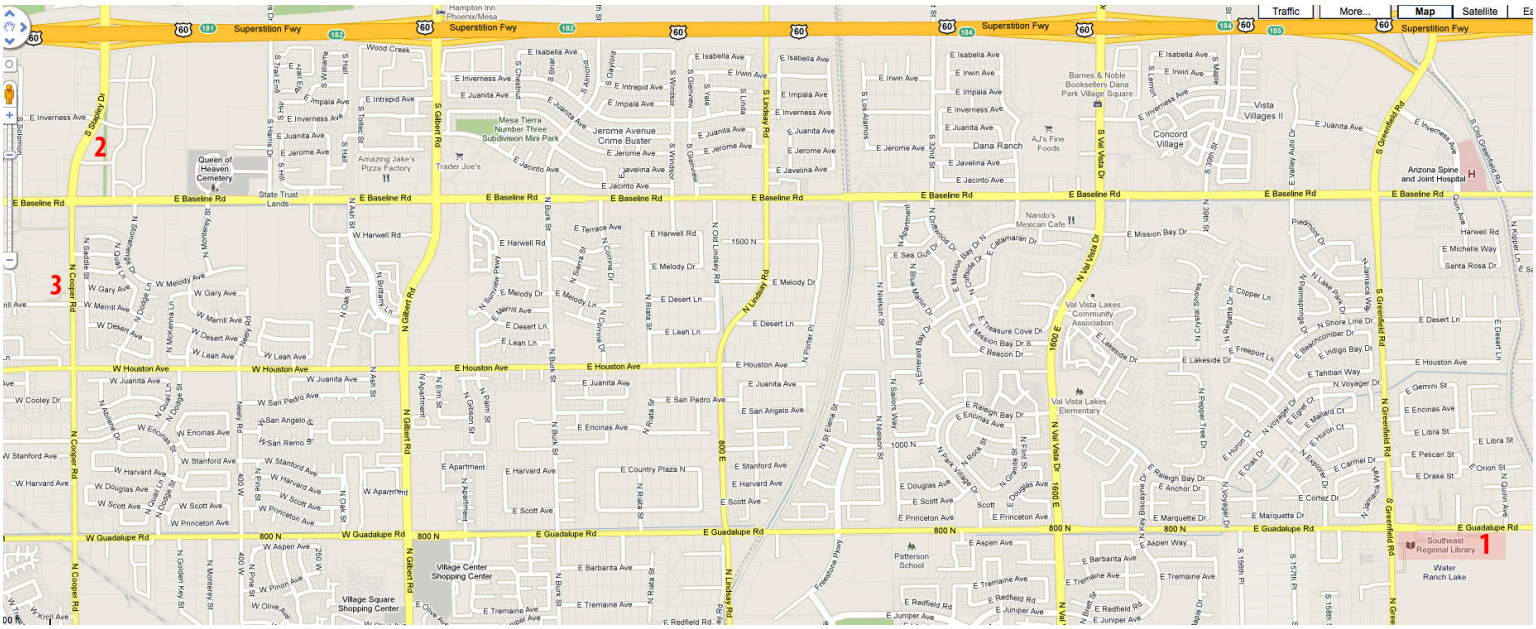
The monthly general meeting is your chance to find out what other club members are up to, learn about upcoming club events and listen to presentations by professional and well-known amateur astronomers.

Our meetings are held on the third Friday of each month at the Southeast Regional Library in Gilbert. The library is located at 775 N. Greenfield Road; on the southeast corner of Greenfield and Guadalupe Roads. Meetings begin at 7:30 pm.

All are welcome to attend the pre-meeting dinner at 5:30 pm. We meet at Old Country Buffet, located at 1855 S. Stapley Drive in Mesa. The restaurant is in the plaza on the northeast corner of Stapley and Baseline Roads, just south of US60.

Likewise, all are invited to meet for coffee and more astro talk after the meeting at Denny's on Cooper (Stapley), between Baseline and Guadalupe Roads.

Visitors are always welcome!



2 **Old Country Buffet**
1855 S. Stapley Drive
Mesa, Az. 85204

Southeast Regional Library
1 **775 N. Greenfield Road**
Gilbert, Az. 85234

3 **Denny's**
1368 N. Cooper
Gilbert, Az. 85233

December 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

December 1 - Akimel A-al Middle School Star Party

December 2 - School Solar Event at GRCO

December 2 - Kino Junior High School Star Party

December 7 - Edu-Prize Elementary School Star Party

December 8 - Brimhall Junior High School Star Party

December 9 - Public Star Party & SkyWatch

December 11 - Citizen Scientist Meeting

December 16 - EVAC Holiday Party at SE Library

December 17 - Local Star Party at Boyce Thompson

December 24 - Deep Sky Observing Night

January 2012

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

January 10 - Centennial Middle School Star Party

January 13 - Public Star Party & SkyWatch at Riparian Preserve

January 18 - Kyrene Middle School Star Party

January 19 - Settlers Point Elementary School Star Party

January 20 - General Meeting at SE Library

January 21 - Local Star Party at Boyce Thompson Arboretum

January 24 - CTA Freedom School Star Party

January 26 - CTA Independence School Star Party

January 27 - Girl Scout Troop 1109 Star Party

January 28 - Veterans Oasis Park / Environmental Center Star Party

January 28 - Deep Sky Observing Night. Head out to your favorite dark sky site and observe!

East Valley Astronomy Club -- 2012 Membership Form

Please complete this form and return it to the club Treasurer at the next meeting or mail it to EVAC, PO Box 2202, Mesa, Az, 85214-2202. Please include a check or money order made payable to EVAC for the appropriate amount.

IMPORTANT: All memberships expire on December 31 of each year.

Select one of the following:

☐ New Member ☐ Renewal ☐ Change of Address

New Member Dues (dues are prorated, select according to the month you are joining the club):

☐ **$30.00 Individual** January through March

☐ **$35.00 Family** January through March

☐ **$15.00 Individual** July through September

☐ **$17.50 Family** July through September

☐ **$22.50 Individual** April through June

☐ **$26.25 Family** April through June

☐ **$37.50 Individual** October through December

☐ **$43.75 Family** October through December

Includes dues for the following year

Renewal (current members only):

☐ **$30.00 Individual** ☐ **$35.00 Family**

Name Badges:

☐ **$10.00** Each (including postage) Quantity: _____

Name to imprint: _____

Total amount enclosed: _____

Please make check or money order payable to EVAC

☐ Payment was remitted separately using PayPal ☐ Payment was remitted separately using my financial institution's online bill payment feature

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Name: _____ Phone: _____

Address: _____ Email: _____

☐ Publish email address on website

City, State, Zip: _____ URL: _____

How would you like to receive your monthly newsletter? (choose one option):

☐ Electronic delivery (PDF) *Included with membership* ☐ US Mail **Please add $10 to the total payment**

Areas of Interest (check all that apply):

☐ General Observing ☐ Cosmology

☐ Lunar Observing ☐ Telescope Making

☐ Planetary Observing ☐ Astrophotography

☐ Deep Sky Observing ☐ Other

Please describe your astronomy equipment:

Would you be interested in attending a beginner's workshop? ☐ Yes ☐ No

How did you discover East Valley Astronomy Club? _____

PO Box 2202
Mesa, AZ 85214-2202
www.evaconline.org

All members are required to have a liability release form (waiver) on file. Please complete one and forward to the Treasurer with your membership application or renewal.

Liability Release Form

In consideration of attending any publicized Star Party hosted by the East Valley Astronomy Club (hereinafter referred to as "EVAC") I hereby affirm that I and my family agree to hold EVAC harmless from any claims, liabilities, losses, demands, causes of action, suits and expenses (including attorney fees), which may directly or indirectly be connected to EVAC and/or my presence on the premises of any EVAC Star Party and related areas.

I further agree to indemnify any party indicated above should such party suffer any claims, liabilities, losses, demands, causes of action, suits and expenses (including attorney fees), caused directly or indirectly by my negligent or intentional acts, or failure to act, or if such acts or failures to act are directly or indirectly caused by any person in my family or associates while participating in an EVAC Star Party.

My signature upon this form also indicates agreement and acceptance on behalf of all minor children (under 18 years of age) under my care in attendance.

EVAC only recognizes those who are members or invitees and who also have a signed Liability Release Form on file as participants at an EVAC Star Party.

Please print name here ***Date***

Please sign name here

PO Box 2202
Mesa, AZ 85214-2202
www.eastvalleyastronomy.org

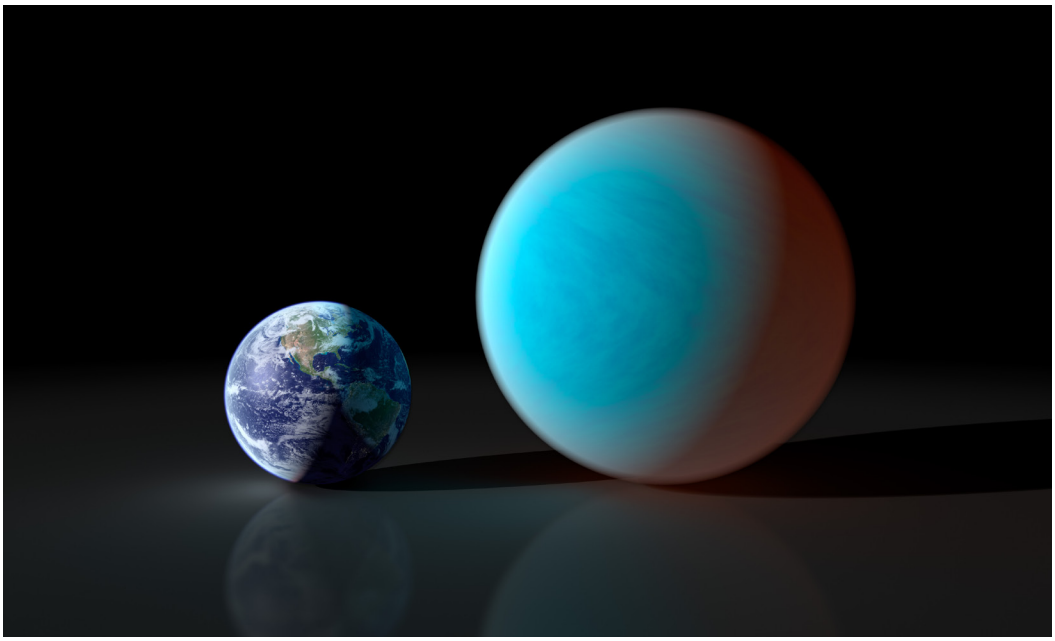
NASA's Space Place

Rethinking an Alien World: The Strange Case of 55 Cancri e

Forty light years from Earth, a rocky world named "55 Cancri e" circles perilously close to a stellar inferno. Completing one orbit in only 18 hours, the alien planet is 26 times closer to its parent star than Mercury is to the Sun. If Earth were in the same position, the soil beneath our feet would heat up to about 3200 F. Researchers have long thought that 55 Cancri e must be a wasteland of parched rock.

Now they're thinking again.

New observations by NASA's Spitzer Space Telescope suggest that 55 Cancri e may be wetter and weirder than anyone imagined. Spitzer recently measured the extraordinarily small amount of light 55 Cancri e blocks when it crosses in front of its star. These transits occur every 18 hours, giving researchers repeated opportunities to gather the data they need to estimate the width, volume and density of the planet.



Artist's rendering compares the size Earth with the rocky "super-Earth" 55 Cancri e. Its year is only about 18 hours long!

According to the new observations, 55 Cancri e has a mass 7.8 times and a radius just over twice that of Earth. Those properties place 55 Cancri e in the "super-Earth" class of exoplanets, a few dozen of which have been found. Only a handful of known super-Earths, however, cross the face of their stars as viewed from our vantage point in the cosmos, so 55 Cancri e is better understood than most.

When 55 Cancri e was discovered in 2004, initial estimates of its size and mass were consistent with a dense planet of solid rock. Spitzer data suggest otherwise: About a fifth of the planet's mass must be made of light elements and compounds—including water. Given the intense heat and high pressure these materials likely experience, researchers think the compounds likely exist in a "supercritical" fluid state.

A supercritical fluid is a high-pressure, high-temperature state of matter best described as a liquid-like gas, and a marvelous solvent. Water becomes supercritical in some steam turbines—and it tends to dissolve the tips of the turbine blades. Supercritical carbon dioxide is used to remove caffeine from coffee beans, and sometimes to dry-clean clothes. Liquid-fueled rocket propellant is also supercritical when it emerges from the tail of a spaceship.

On 55 Cancri e, this stuff may be literally oozing—or is it steaming? —out of the rocks.

With supercritical solvents rising from the planet's surface, a star of terrifying proportions filling much of the daytime sky, and whole years rushing past in a matter of hours, 55 Cancri e teaches a valuable lesson: Just because a planet is similar in size to Earth does not mean the planet is like Earth.

It's something to re-think about.

Get a kid thinking about extrasolar planets by pointing him or her to "Lucy's Planet Hunt," a story in rhyme about a girl who wanted nothing more than to look for Earth-like planets when she grew up. Go to http://spaceplace.nasa.gov/story-lucy.

The original research reported in this story has been accepted for publication in Astronomy and Astrophysics. The lead author is Brice-Olivier Demory, a post-doctoral associate in Professor Sara Seager's group at MIT.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

If It's Clear...

by Fulton Wright, Jr.
Prescott Astronomy Club

December 2011

Celestial events (from Sky & Telescope magazine, Astronomy magazine, and anywhere else I can find information) customized for Prescott, Arizona. Remember, the Moon is ½ degree or 30 arcminutes in diameter. All times are Mountain Standard Time.

Comet C/2009 P1 (Gerradd) continues to be visible this month. It should be getting brighter but lower in the west after sunset. See Sky & Telescope, November 2011, p. 52; or Astronomy, December 2011, p. 46 for a finder chart.

On Thursday, December 1, the Moon is at first quarter phase and sets at 12:09 AM (December 2). For this night and the the next 2 you can see the south part of the Moon at its best because libration tips that part toward us. Also on this night, about 8:24 PM, you can see the Moon occult 51 Aquarii. This is a close (0.4"), equal (5.8 & 6.0) double star. It's probably too close to see as a double star, but there should be two drops in brightness, maybe one second apart, as the Moon covers the two components.

On Friday, December 2, about 7:00 PM, you can see two 9th magnitude objects near each other. Comet P/2006 T1 (Levy) will be passing by the spiral galaxy NGC 7331.

On Saturday, December 3, about 10:27 PM, you can watch another double star occultation by the Moon. This is very much like the December 1 event described above. The star, HD 224315, is somewhat dimmer (6.7 & 7.4) but the same separation (0.4").

On Wednesday, December 7, you can see one of the Moon's low mountains at its best. Look for Mons Rumker along the planetary northwest of the Moon's terminator in the middle of Sinus Roris.

On Friday, December 9, at 4:47 PM (32 minutes before sunset) the full Moon rises, spoiling any chance of seeing faint fuzzies for the night. Later that night there is a total eclipse of the Moon. The conditions aren't very favorable for Arizona. Here is the schedule of events which happen just before sunrise on December 10:

4:31 AM Peneumbral phase starts (unobservable).
5:05 AM Peneumbral phase maybe visible.
5:45 AM Partial phase starts.
5:56 AM Astronomical twilight starts (first light in east).
6:27 AM Nautical twilight starts (many stars still visible).
6:58 AM Civil twilight starts (only a very few stars still visible).
7:05 AM Total phase starts.
7:27 AM Sun rises.
7:29 AM Moon sets.

On Saturday, December 10, at 6:46 PM, you can observe a minimum of the variable star, Algol. This star will rise in brightness from magnitude 3.4 to 2.1 over the next few hours. The web site: http://www.skyandtelescope.com/observing/objects/variablestars/Minima_of_Algol.html has a finder chart with magnitudes of nearby stars for comparison.

On Saturday, December 17, the Moon is at last quarter phase and rises at 12:48 AM (December 18). For this night and the the previous 2 you can see the north part of the Moon at its best because libration tips that part toward us.

On Wednesday, December 21, it is the winter solstice and you have the longest night of the year for observing.

On Friday, December 23, about 6:45 AM, you can see Mercury at it's greatest western elongation. For a week before and a week after this date you should be able to spot the magnitude -0.4 planet low in the southeast.

On Saturday, December 24, it is new Moon and you have all night to look for faint fuzzies and Santa Claus.

On Monday, December 26, about 8:20 PM, you can see three of Jupiter's satellites (Europa, Ganymede, and Callisto) lined up north to south. Io is between these three and Jupiter.

On Tuesday, December 27, starting in the early evening, you can catch Jupiter's moons swirling around the planet. Here is a schedule:

5:26 PM Sun sets.
6:23 PM Europa moves in front of Jupiter.
7:03 PM Ganymede's shadow falls on Jupiter

(Callisto {south of the planet}, Ganymede's shadow, and Europa {now in front of the planet and hard to see} stay lined up as they move west across the sky.)

8:44 PM Io moves behind Jupiter.
8:49 PM Ganymede's shadow leaves Jupiter.
8:50 PM Europa's shadow falls on Jupiter.
8:52 PM Europa moves from in front of Jupiter.
11:12 PM Europa's shadow leaves Jupiter.
12:08 AM Io appears from Jupiter's shadow.
2:31 AM Jupiter sets.

On Saturday, December 31, the Moon is at first quarter phase and sets at 12:45 AM (January 1).

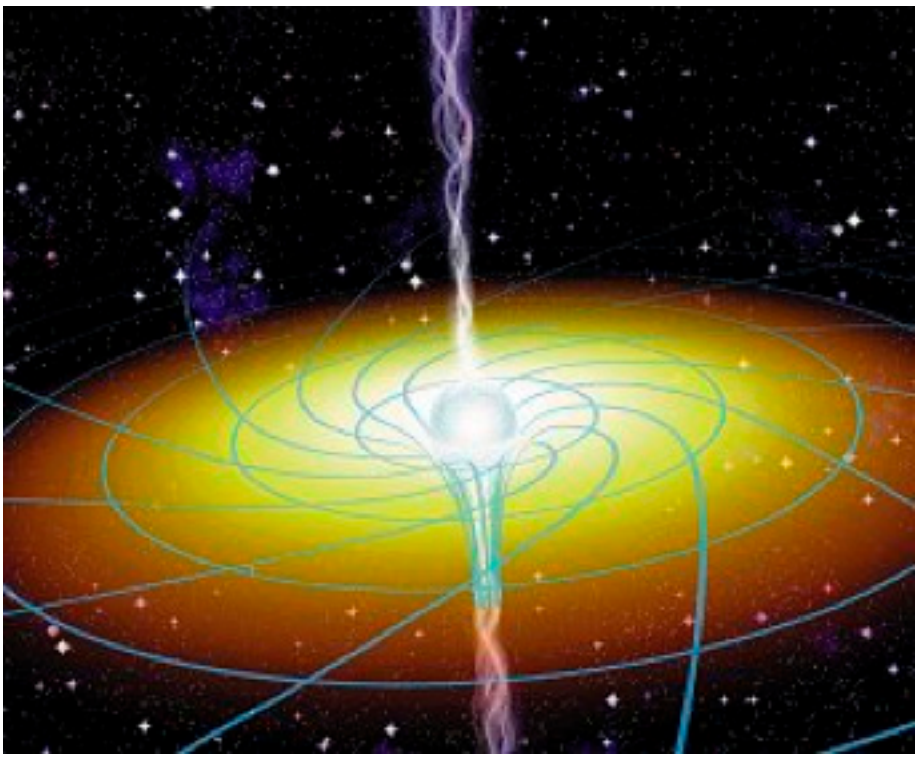
Gravitomagnetism

Continued from page 4

once again that Einstein's GR has passed these 2 definite predictions with fine precision, (although the 19% error of the frame dragging was considered high but valid) while the GPB satellite has greatly helped technological innovation in a variety of areas. It was one of the longest running projects in NASA history beginning in 1963. The theoretical implications will keep scientists busy for years while the drive to test GR even more precisely will continue to push technological innovation in a variety of fields.

The scientists and engineers that worked for so long on GPB helped develop basic physics and technology as well as demonstrated creative and brilliant thinking to make this one of the most sensitive and advanced physics experiments to date. Innovations developed in basic research and used in GPB now help autopilot airplanes during landing, were applied to the COBE mission, help Earth observing satellites, improved scientific clocks, enabled progress in superconducting technology, and helped GPS systems. It has also helped us build better detectors and systems to find gravitational waves, (which are also extremely sensitive). It was the first time a drag free satellite, (free falling frame) was built from the ground up and tested.

The better understanding of gravitomagnetism and frame dragging has helped us understand the magnetically driven, highly collimated, and near light velocities of relativistic jets from SMBH's found in Quasars and other AGN.



The formation of jets around a SMBH from the accretion disk.

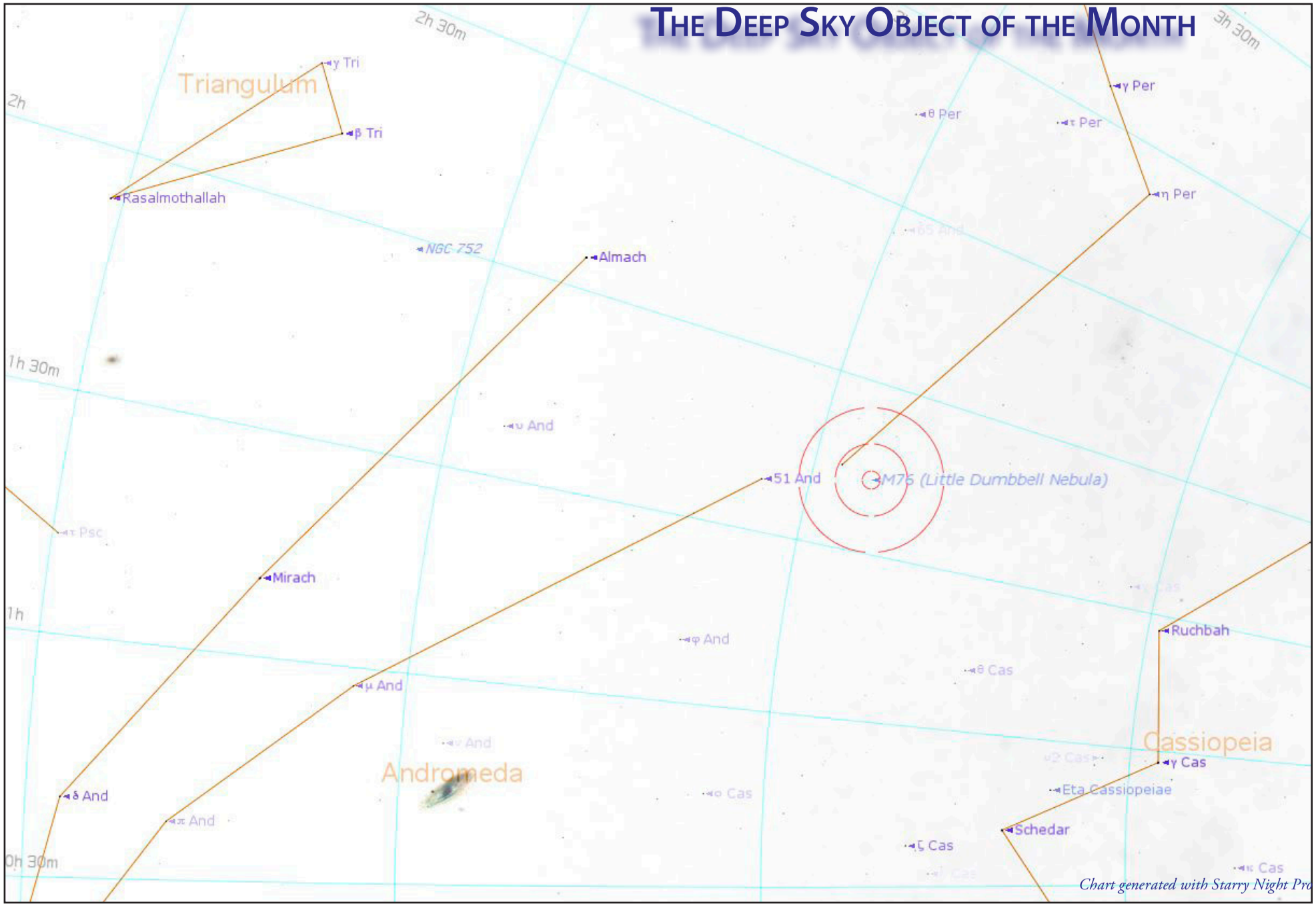
It is important in my opinion to continue testing the fundamental laws of Mother Nature to an ever demanding degree, especially with respect to gravitation which is the weakest of the four fundamental forces. If our understanding of gravity is to progress then continual testing of GR and alternative theories should continue. Many scientists thought before the final results of GPB were in that this experiment could possibly show some disagreement with GR and thus lead the way for more inclusive theories. As we have seen Einstein has been once again verified and any alternative theories must also account for these results.

From a cosmological and philosophical perspective, (just lightly touched upon here as this aspect alone is still debated and not fully clear-look up Mach's Principle) it is interesting to note that the results from GBP and GR shows that our local inertia is aligned to the rest of the universe via a frame dragging effect. This is called total or perfect dragging and is like when a massive object totally controls and dominates a smaller mass so that the smaller mass feels only the reference frame defined by the larger mass. Basically when we turn around we feel a tug from the rest of the universe. Think about that the next time you are out observing.

As a final thought remember that the term gravitomagnetism should not be confused with normal electricity or magnetism and is not an exact gravitational equivalence. I hope you are now as enlightened and a bit confounded still as I am.

Happy Holidays!

The Deep Sky Object of the Month



M 76 (Little Dumbbell) Planetary Nebula in Perseus

RA: 01h 42m 19.9s Dec: +51° 34′ 31″ Size: 2.7′ Mag: 10.1 Central Star: 15.9

As one of the many benefits to becoming an East Valley Astronomy Club member, we have an 8 inch Dobsonian reflector with eyepieces available for monthly check-out to current EVAC members. Have any questions, or interested?

Call or see David Hatch, EVAC Properties Manager
480-433-4217

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