Roanoke Valley Astronomical Society

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How Many Nearby Earthlike Planets?

by Neal Sumerlin, Ph.D.

I have been reading as much as I could get my hands on in the days since **NASA's press conference on February 2nd announcing that over 1200 new exoplanets (planets orbiting stars other than our sun) had been discovered by the Kepler spacecraft.** This announcement is **an analysis of just the first four months of observations—from May to September 2009.** There is an absolute flood of data coming from the spacecraft, and scientists are happily struggling to keep up.

It is amazing how such momentous events pass without comment in what we call the news. On the day of the press conference, I eagerly awaited a report on the national news. Instead, the big news of the day was that it snowed in the Midwest in February! Some of us know that scientist Debra Fischer had it right when she called this "an incredible, historic moment." Absolutely correct. Here are some take-home bullet points:

- 1235 planetary candidates (probably planets but need further confirmation).
- In decreasing order of size: 19 larger than Jupiter, 165 Jupiter-sized, 662 Neptune-sized, 288 bigger than Earth, 68 roughly Earth-sized.
- Bigger planets are easier to find, so this distribution is probably still a little skewed toward bigger planets. As more data are gathered, even more small planets should be found.
- There are a lot of small planets out there!
- **There are now identified a lot of planets (54) with the right conditions to support life as we know it.**
- **This sampling strongly suggests millions of planets in our Milky Way galaxy that are capable of supporting life.**

And here are some details for those of us who like such things . . .

How do we know there are planets around other stars? In almost all cases, we know this because of the planet's influence on the star. The planet tugs the star back and forth as it orbits around it, and this shifts the wavelength of light we see from the star in a regular pattern. If the planet passes directly in front of (transits) the star, the star's light will be dimmed, also in a regular pattern. Kepler detects planets by this transit method, as illustrated below:

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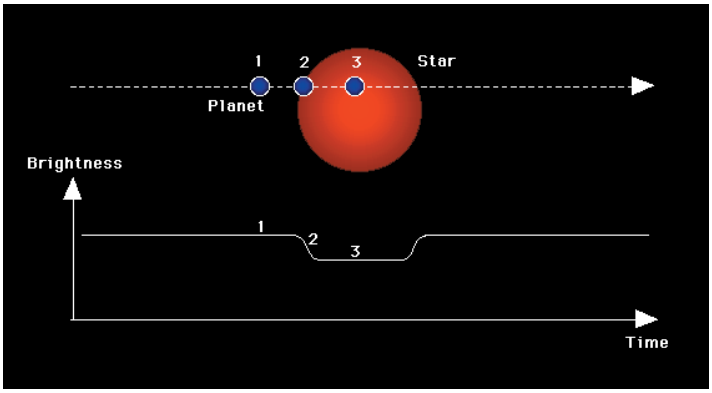
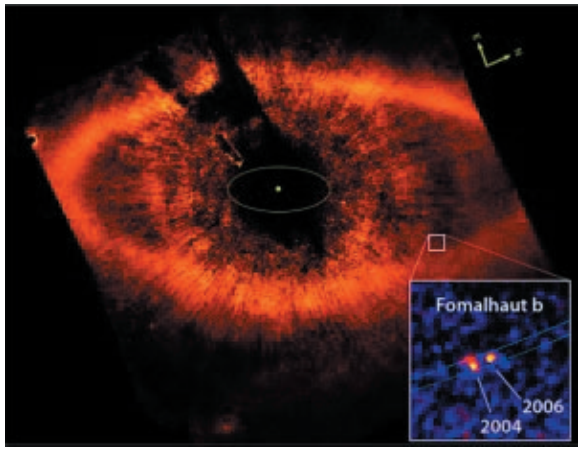
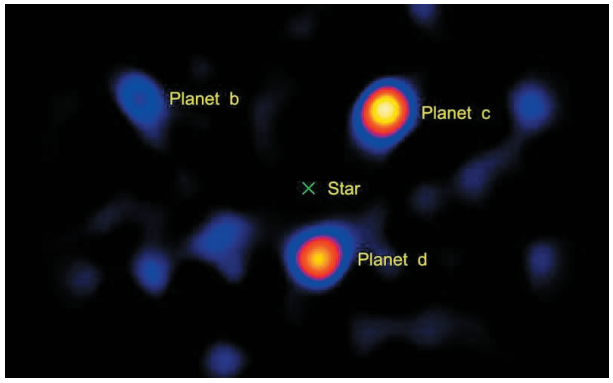
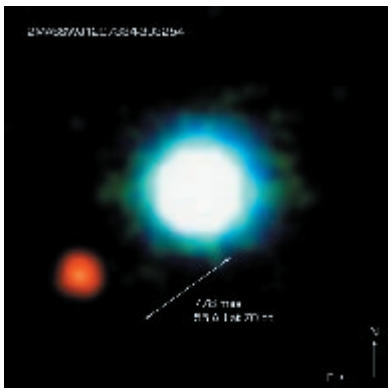


Do we have direct images of an exoplanet? Remarkably, yes, but not very many. Here are three examples (which, as pdfs, can be enlarged-ed.):

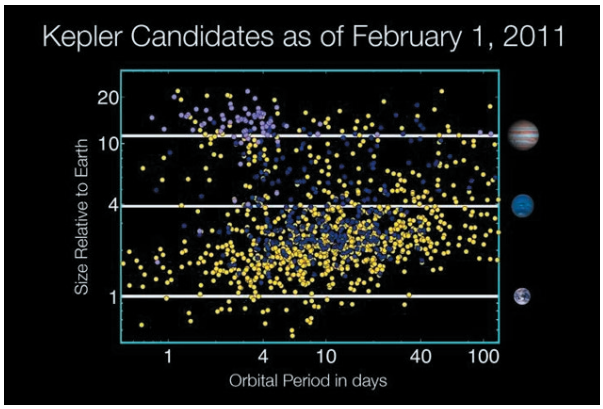






Can we detect all planets that orbit around another star? No. The planetary orbit has to be lined up so that it is edge-on to us for the planet to transit its star. It's easy to determine how likely that is, and from a sampling of many stars, to determine how many more planets are there that we cannot detect. A huge sample size is important to the Kepler mission. If we're trying to learn something about the population of exoplanets, the more members of that population we can detect, the better our information.

Why are Kepler's results so significant? Previous methods of exoplanet detection are strongly biased toward large planets that are close to their parent stars. None of these planets is Earth-like. Imagine Jupiter, a large gaseous planet, orbiting closer to our sun than tiny Mercury. That describes most of the planets discovered before Kepler. Kepler is showing that there are many stars with smaller planets around them, planets that are much more like our own Earth. Here is the key (pdf) graphic from the press conference:



Are any of these planets habitable for life as we know it? Yes—54 of them! Habitability is here defined as having a surface temperature between the freezing and boiling points of water, allowing liquid water to exist, and a planet small enough to be rocky instead of gaseous like Jupiter. Since the data analyzed so far are from only four months of data, only planets with short orbital periods can have transited during that time period. Such planets will orbit close to their stars. For the planets to be habitable, those stars must be smaller and cooler than our sun.

The habitable planets found so far are not quite Earth-like, since they orbit stars that are not quite sun-like. We should not discount another possibility, and that is habitable moons of gas giant planets like Jupiter that orbit close to their suns. Fans of the

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movie *Avatar* may recall that it took place on such a world.

Kepler will continue to monitor these stars for a total of at least three and a half years, and probably longer with a mission extension. The longer it goes, the more planets it will be able to detect, particularly small planets far from their stars. Imagine detecting the Earth, which Kepler could do from over 1000 light years away. It would take at least a year to observe two transits (one at the very beginning and one at the very end of your observing period), and you would really like to observe three just for confirmation. Three and a half years of observation would probably give you those three transits. In other words, as Kepler continues, the habitable planets it finds will orbit stars increasingly like our own sun.

Can we tell if any of these planets actually do have life on them? Not yet. There are proposed space-borne telescopes that would be able to do so, however, by detecting the presence of telltale gases in a planet's atmosphere. Gases like oxygen and methane are quickly removed by chemical processes, unless they are somehow replaced by other processes. On Earth, that "other process" is biological. Plants take in carbon dioxide and produce oxygen; if plants were to disappear from the planet, oxygen would disappear from its atmosphere. I've told my students that such detection on exoplanets will almost certainly happen in their lifetimes. I'd like to live long enough for it to happen in mine!

Editors note:
Neal G. Sumerlin, Ph.D., Director, Lynchburg College Observatory, was born in Texas. He is the son of a college professor of journalism and a college librarian. He can trace his keen interest in astronomy to the specific night of August 12, 1954, when his maternal great-grandmother allowed him to stay up late to view the Perseid meteor shower. Although he was only four years old at the time, Neal was hooked, and while he chose to earn a B.S. in chemistry at Ouachita Baptist University and a Ph.D. in nuclear chemistry at The University of Arkansas, astronomy has always been a central intellectual pursuit and hobby in his life. Since earning his doctorate, Neal has taught in the Department of Chemistry at Lynchburg College. Currently he teaches solar system and stellar astronomy, both laboratory based courses he developed while on sabbatical during the 2003-2004 academic year. His astronomical research interests involve the study of stellar nucleosynthesis and gamma-ray bursts. The astronomical observatory project is Neal's brainchild, and its construction is his way of "paying it forward" to perhaps inspire others the same way his great-grandmother inspired him. In his off time, Neal enjoys reading (mostly history, science, classic novels and current affairs), listening to music, messing around with computers, and any activity involving his wife Jane and their two children. **Dr. Sumerlin has a blog with an astronomy theme at *http://starstruck.lynchburg.edu/***

The Roanoke Valley Astronomical Society is a membership organization of amateur astronomers dedicated to the pursuit of astronomical observational and photographic activities. **Meetings are held at 7:30 p.m. on the third Monday of each month, at the Center in the Square in downtown Roanoke, Virginia. Meetings are open to the public.** Observing sessions are held one or two weekends a month at a dark-sky site. Yearly individual dues are $20.00. Family dues are $25.00. Student dues are $10.00. Articles, quotes, etc. published in the newsletter do not necessarily reflect the views of the RVAS or its editor.

RVAS web page: *http://rvasclub.org*

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GLOBE AT NIGHT PROJECT

by John Goss

Join the 6th worldwide GLOBE at Night campaign:
Feb. 21 — March 6
March 22 — April 4

What: The Globe at Night Campaign, which measures light pollution
When: 8 p.m. to 10 p.m. local time, February 21 — March 6, March 22 — April 4, 2011
Where: Everywhere
Who: Everyone
How: See **http://www.globeatnight.org**

GLOBE at Night encourages the public, acting as citizen-scientists, to record the brightness of the night sky. During two weeks of moonless evenings, children and adults match the appearance of the constellation Orion with seven reference star charts showing progressively fainter stars. They then submit their choice of star chart on-line with their date, time, and location to help create a worldwide light pollution map. Complete instructions are found on the GLOBE at Night website, www.globeatnight.org.

The GLOBE at Night 2011 campaign dates are February 21 — March 6 and March 22 — April 4. Over 52,000 measurements have been contributed from more than 100 countries during the campaigns of the last five years, thanks to everyone who participated!

This year children and adults can submit their measurements in real time, if they have a smart phone or tablet. To do this, simply use the web application at **www.globeatnight.org/webapp/**. With smart phones and tablets, the location, date and time are inserted automatically. If a smart phone is not available, there are user-friendly tools on the GLOBE at Night report page to find latitude and longitude.

Through GLOBE at Night, students, teachers, parents and community members are amassing a data set from which they can explore the nature of light pollution locally and across the globe. Please make a difference and join our efforts in 2011. For activity packets, one-page flyers and postcards advertising the campaign, visit **www.globeatnight.org/pdf/**.

Venus, Vesta, and M42

by Michael Good

We had nice clear weather for the close pass of Venus and Asteroid Vesta. Using a Canon Rebel DSLR, I had the mirror already flipped up, and used a self-timer to reduce motion blur, but I was using a tiny table top tripod perched on the roof of my wife's minivan, and you can see shaking in the trailed motion of Vesta in particular, but I don't think it takes away from the overall effect of the close pass of these two. Venus is so bright that it created an internal reflection in the center of the image, which I decided not to process out. [Enlarge to 300% to better see Vesta.]

Reprocessed: M42 and Running Man

The beauty of astrophotography is the infinite number of ways the data can be processed. This is my third attempt at a nice wide-field dataset obtained from Roanoke, a block from Patrick Henry HS at Paul Caffrey's home.

My heavy ST10xme+CFW8+AO7 were attached to Paul's little William Optics Megrez 80mm refractor, which rode bolted to the top of his Meade 8" LX200. Paul fashioned a new weight to add to his other weights on the bottom front side of the LX200 to get the balance such that the auto-guider could adjust in both directions for Declination. This configuration was extremely back-heavy for this telescope.

In the January newsletter, we ran a "normal" processing for this image, showing the M42 and Running Man nebulosity surrounded by darker skies and smaller stars. This was actually my second attempt. My first attempt had been drastically stretched to show outer envelopes of nebulosity. So, in this "third" attempt, I have tried to keep the more true colors of the nebular regions, while stretching to reveal the outer envelopes of data. The game is trying to estimate what this will look like on OTHER people's monitors. You see, it varies dramatically, according to

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the gamma adjust of each person's monitor. On some, it will appear very dark, and on others it will appear overly bright. In this sense, creating a paper PRINT of the image is the best way astrophotographers can control the view of their work!

At the February meeting I presented a "movie" showing the almost ridiculous number of satellites that streaked through this dataset during the hour that data was being captured (one minute subs). For this reason, this data was combined using a technique called sigma clip averaging. Note that this image has only between 8 and 10 minutes of color data per channel, showing the potential for dramatic future improvement should a larger set of data be amassed pointing to this gorgeous jewel of our night sky.

Frank Baratta's Astro-Quiz

Otto Struve called her brilliant, yet Henry Norris Russell rejected her 1925 doctoral thesis' conclusion that hydrogen is the dominant constituent of stars. Who was this important female astronomer?

Answer to Last Month's Astro-Quiz: Modern astronomy recognizes 88 constellations. Of these, 48 were included in the Almagest, the astronomical treatise written in about 150 C.E. by the Alexandrian Greek astronomer, astrologer and geographer Ptolemy (Claudius Ptolemaeus). All of these constellations are still in use, though the Ptolemaic constellation Argo Navis has been separated into Carina, Puppis and Vela. Coma Berenices was the first constellation added to Ptolemy's list. This addition is usually credited to Tycho Brahe, who listed it in his star catalogue of 1602, but it originally appeared on a celestial globe made by the German cartographer Caspar Vopel in 1536. reach the location of the Sun at the Winter Solstice.

"The Open Cluster"

The silly season is again upon us. Come to think of it, the silly season is always upon us. Nevertheless, consider these current jewels:

◆ **Betelgeuse** is predicted to go supernova in 2012. Remember the Mayan tragedy set for 2012? Better buy a big term policy now, or not. Your insurance company may disappear in 2012, or not. Decisions, decisions.

Here is a recent story about the predicted 2012 supernova: *http://www.foxnews.com/scitech/2011/01/21/betelgeuse-explode-scientists-say/*

Quasi-credible science fiction involves mixing facts with fake facts. As for the Orion monster, Phil Plait (the "bad astronomer") says it could be tomorrow, or in 100,000 years. But it will happen. Consider that Betelgeuse is so far away that it would have had to go supernova in our Middle Ages to arrive in 2012.

◆ **Asteroid Apophis 99942** could hit Earth in 2036. Why worry about it now? We worry about body odors, so why not this? Who cares if the odds are 1 in 250,000? Run for the hills!

Go to a search engine and type in "Apophis Asteroid Videos." You will be presented with an assortment of scary YouTube videos, complete with ominous soundtracks, depicting what "could happen" in 2036. The YouTube asteroids are half way in size between the dinosaur killer and the really great one that hit Earth just over four billion years ago, creating the Moon.

Apophis is tiny, relatively speaking, but it could destroy a city with a direct hit. These videos often show a hit just off New York City. The Hollywoodization of astronomy keeps the masses involved in astronomy — as astrology has kept the stars alive in our eyes for centuries.

◆ An event centuries in the making has recently cought the mass media's eye. There is a new defacto member of the Zodiac, the constellation **Ophiuchus**.

Our Earth has a regular wobble, called precession of the equinoxes, wherein true north moves around a circle in the heavens. For now Polaris is the north star, but in several thousand years Vega will be the north star. This wobble affects the relative position of the zodiac, wherein the planets wander. Ophiuchus was not in the ancient astrological zodiac, but for centuries it actually has been.

Nature abhors a vacuum, and so does the silly side of our media. In a "slow news year" what could be more horrible than to suddenly learn that your sign might really be wrong. That means you aren't who you think you are!!

◆ Common decency moves your editor to conclude with something that is real. I often think about the thousands of not-famous scientific workers behind the glories of professional astronomy. How about the few great minds who envision Truth before the famous ones get their names enshrined in the Smithsonian? Great terrestrial observatories and deep space vehicles don't just pop off some Walt Disney draft board. Anonymous people, increasingly backed by anonymous taxpayers, provide the framework and energy for the glory march of astronomical science.

I would like to recognize my former father in law, Kip Evans, as one of those unsung people. He was the man at Grumman responsible for grinding the **lunar laser reflectors** that Apollo 11, 14, and 15 left on the Moon. That elegant experiment is still in use today. Here is an article worth reading: *http://en.wikipedia.org/wiki/Lunar_Laser_Ranging_experiment*

An Alien Visit To Our Galaxy

by Jack Gross

Astronomers suspect that our galaxy has been visited by a stranger from the Canis Major Dwarf Galaxy! Evidence of this extra-galactic foray has not been widely covered by the popular press, and largely ignored by amateur astronomers, but this month you have the opportunity to see the space invader for yourself.

This intruder is hiding out just below Orion's feet in the constellation of Lepus, the Hare. It was first discovered by Pierre Méchain on October 26, 1780. Messier confirmed the find and added it to his list on December 17, 1780 calling it "M79." The alien also uses the alias "NGC 1904."

This unusual globular cluster is strange in two ways: First, globular clusters outnumber open clusters 29 to 27 in the Messier Catalog, yet M79 is the only globular cluster that we can see in the group of 23 in Winter Messier Objects.

The second bizarre fact about this guy is that it is hiding out in a very unusual place. Nearly all of the other globular clusters are found near the center of the Milky Way, and when we look at them through our telescopes, we are looking into the heart of the galaxy. M79, on the other hand, is located about 60,000 light years out from the galactic center - nearly at the edge of the galaxy - so when

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we look at M79, we're looking out toward intergalactic space.

The best explanation for this is that M79 is not a part of our Milky Way, but instead, it is a visitor from the nearby Canis Major Dwarf Galaxy – one of several dwarf galaxies that are members of our local group. Most of the galaxies are rushing away from us as the Universe expands, but gravitational forces are drawing others together. For example, the Andromeda Galaxy and our Milky Way are closing on each other at a million miles an hour (300 times faster than a rifle bullet) and could converge within fewer than 4 billion years!

The vast distances between stars make actual collisions improbable, but the overall shape of our combined galaxy will probably change to that of an elliptical galaxy. However, the gas and dust that lies between the stars can actually collide, heat up and trigger the formation of new stars. This interstellar gas and dust could also get sucked up by existing stars, increasing their mass to the point where they may go supernova adding at least some fireworks to the event.

Astronomers believe that M79 is actually a part of the Canis Major Dwarf Galaxy which is in the process of being pulled (cannibalized) by the gravitational field of our more massive Milky Way galaxy. The main body of the dwarf galaxy is being ripped apart by tidal forces causing a long filament of stars to trail behind it as it orbits the Milky Way. This forms a complex ringlike structure, which wraps around our galaxy three times. This discovery, and subsequent number crunching, has provided support for the current theory that galaxies grow in size by swallowing up their smaller neighbors.

Why not venture out tonight to greet the faint, round, fuzzy extragalactic alien at RA 05 24 10 Dec +24 31 27? And, if you hear a faint call that sounds like, "I come in pieces," don't tell anyone.

*Tri*Star*

A Day of Astronomy Speakers & Displays

The upcoming edition of *Tri*Star* will take place on **Saturday, 5 March** 2011 in the Percy H. Sears Applied Technologies Center on the campus of Guilford Technical Community College in Jamestown, NC.

In addition to a series of speakers scheduled throughout the day, there will be a wide range of astronomical displays, assorted astronomy-related vendors, prize drawings, "how-to" help for astronomy beginners, an astrophotography exhibition, and daytime and nighttime observing sessions (weather permitting).

Presentation Topics Include Galaxy Mergers & Evolution, Supernovae, and Titan's Geology.

Triad Starfest, *Tri*Star* for short, is a gathering of astronomers of all types, from novice to professional, for a full day of presentations, displays, and observing. The event allows astronomy enthusiasts to share ideas, learn about a range of astronomical topics, get together with old friends, and make new ones. The event will draw astronomers from North Carolina and surrounding states.

Over the past ten years RVAS has been well represented at this annual event. The drive is just over one hour each way, and folks generally carpool and convoy. **Contact John Goss if you are planning on going.** Remember: it's free and fun on a nice Saturday.

Calendar of Events

by Frank Baratta

MONTHLY MEETING:

Monday, March 21st, 7:30 p.m., Center in the Square, Roanoke.

The featured program for the evening will be a unique presentation of rocket photography from a Roanoke family. You will see what the sky looks like many thousands of feet above Roanoke. More surprises await all who attend this unique meeting.

RVAS WEEKEND OBSERVING SESSIONS: Unless otherwise indicated, observing sessions are held at Cahas Mountain Overlook, milepost 139 on the Blue Ridge Parkway.

- **Friday and Saturday, 4th and 5th. Sunset is at 6:17 p.m. Astronomical twilight ends at 7:44 p.m. The Moon sets at 6:23 and 7:20 p.m., respectively.**

- **Friday and Saturday, 25th and 26th. Sunset is at 7:37 p.m. Astronomical twilight ends at 9:05 p.m. The Moon rises at 1:40 and 2:33 a.m., respectively.**

- **April Sessions: 1st and 2nd; 22nd and 23rd; 29th and 30th.**

ROANOKE CITY PARKS and RECREATION PUBLIC STARGAZE: Saturday, March 26th, 8:15 p.m., Cahas Overlook, Milepost 139 Blue Ridge Parkway. Nonmembers must register with Parks & Rec. at 540-853-2236. Members can call 540-774-5651 for information. (Next session: April 30th, 8:45 p.m., Cahas Overlook.)

FRANKLIN COUNTY PARKS DEPT. PUBLIC STARGAZE: No sessions scheduled at this time.