PRIMEFOCUS

Tri-Valley Stargazers

April 2012

Meeting Info

What:
Searching for Other Earths: Latest Results from the Kepler Mission

Who:
Dr. Jessie Christiansen

When:
April 20, 2012
Doors open at 7:00 p.m.
Lecture at 7:30 p.m.

Where:
Unitarian Universalist Church in Livermore
1893 N. Vasco Road

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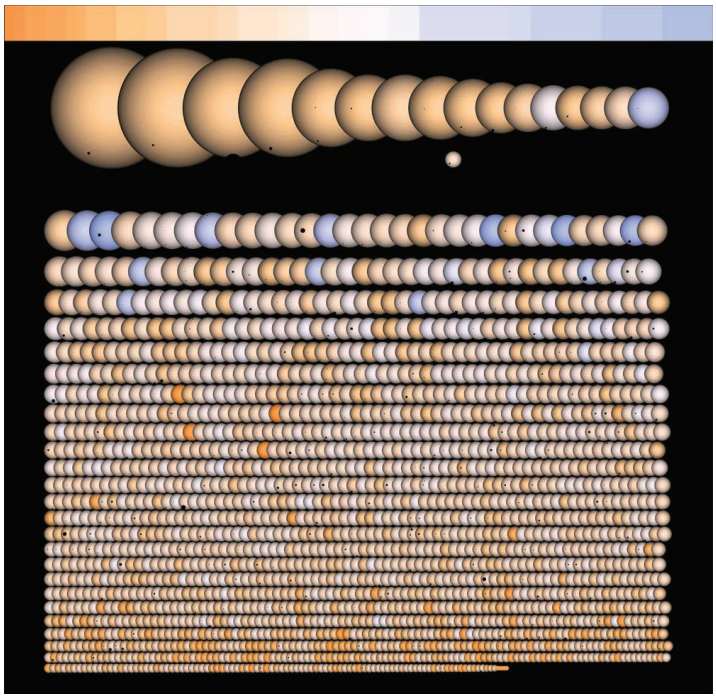
April Meeting

Searching for Other Earths: Latest Results from the Kepler Mission

NASA's Kepler Mission is designed to determine how common planets like our Earth - rocky, with liquid water on the surface - are throughout the Galaxy. I will introduce the transit method, by which we detect planets, and also describe the design of the spacecraft. Then I will discuss the results of our first few years' operation, including the many different types of planetary systems we are discovering that are extremely unlike our own. Finally, I will detail some ways that everyone can get involved in the hunt for other Earths.



Caption: Kepler's planet candidates are shown in transit with their parent stars ordered by size from top left to bottom right. Simulated stellar disks and the silhouettes of transiting planets are all shown at the same relative scale, with saturated star colors. Image Credit: NASA; see http://kepler.nasa.gov/Mission/discoveries/candidates/

Jessie Christiansen is an astronomer working in the Kepler Science Office, at NASA Ames Research Center. Her previous position was at the Harvard-Smithsonian Center for Astrophysics, working on another NASA mission called EPOXI. Prior to that she was completing her graduate studies at the University of New South Wales, searching for transiting planets from Antarctica.

News & Notes

2012 TVS Meeting Dates

The following lists the TVS meeting dates for 2012. The lecture meetings are on the third Friday of the month, with the Board meetings on the Monday following the lecture meeting.

Lecture Meeting	**Board Meeting**	Prime Focus **Deadline**
Apr. 20	Apr. 23	
May 18	May 21	Apr. 27
Jun. 15	Jun. 18	May. 25
Jul. 20	Jul. 23	Jun. 29
Aug. 17	Aug. 20	Jul. 27
Sep. 21	Sep. 24	Aug. 31
Oct. 19	Oct. 22	Sep. 28
Nov. 16	Nov. 19	Oct. 26
Dec. 21	Dec. 24	Nov. 30

Money Matters

Treasurer David Feindel indicates that as of February 17, 2012 the TVS account balances are:

Checking	$13,578.81
CD #1	cashed in as part of consolidating of CD's
CD #2	cashed in as part of consolidating of CD's

Welcome the New TVS Program Director

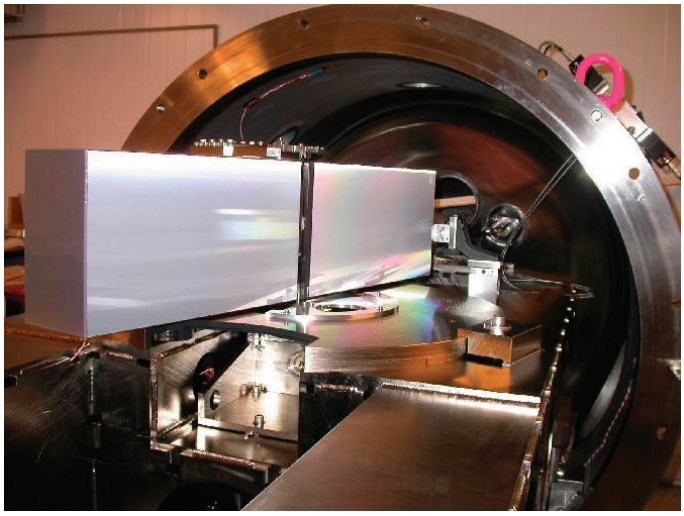
Please welcome Todd Billeci as the new TVS program director. Todd will provide the valuable service of lining up speakers for our monthly meeting. If you have any suggestions for speakers, please contact Todd via e-mail or phone. His contact information is listed in the Officer Block on page 3.

Journal Club by Ken Sperber

Ground-based Search for Exoplanets

Prior to finding out that this month's speaker, Dr. Jessie Christiansen, is going to speak about the latest Kepler mission exoplanet search, I selected an article on the results of a recent ground-based search for extrasolar planets for *Journal Club*. I hope this month's column will provide you with a broader knowledge of the multitude of planet searches that are ongoing, and that you will come to the meeting excited by the prospects for detecting Earth-sized planets in orbits that are favorable for the presence of liquid water, and thus potentially favorable for the development of life.

Bonfils et al. (2011, Astronomy and Astrophysics) used the 3.6-metre telescope at ESO's La Silla Observatory in Chile with the HARPS spectrograph to observe 102 M-dwarf stars in the southern sky. HARPS, the High Accuracy Radial velocity Planet Searcher, measures the Doppler shift of starlight induced by the gravitational tug of a planet on its host star. The Doppler shift method complements the approach taken by Kepler, which uses the transit method to detect extrasolar planets.



Caption: The HARPS high-resolution echelle spectrograph on a test bench. Image Credit: ESA; see http://www.eso.org/sci/facilities/lasilla/instruments/harps/

M-dwarf stars are more commonly known as red dwarf stars. They have temperatures less than 3700K, and masses less than 45% that of our Sun. Amazingly, by number, they are estimated make up more than 75% of all main sequence stars!

From 2003 - 2009 the authors analyzed the light from 102 M-dwarfs using about 500 hours of observing time. After determining whether the observed Doppler shifts were due to surface inhomogeneities of the stars or the pull of orbiting planets, 9 super-Earth sized planets (1-10 Earth masses) were detected. Of these, two were found to be within the habitable zone of their host stars, Gliese 581 and Gliese 667 C. From analyzing the time series of the Doppler shifts, the authors were able to determine the orbital period of the planets. They were also able to estimate the masses of the planets.

The detection of planets around 9 of 102 stars is a conservative detection estimate. This is because detection is sensitive to the inclination of the planets' orbit with respect to our line of sight. If the orbit is edge-on to our line of sight, the Doppler shift would be most easily detectable. If the orbit were perpendicular to our line of sight, we would not observe a Doppler shift no matter how massive the planet since the gravitational tug between the star and planet would not be directed toward and away from us from our perspective. There is no expectation that orbital inclina-

Header Image: Artist's concept of the Kelper spacecraft in orbit. Image Credit: NASA/Ames/JPL-Caltech

Journal Club (continued)

tions of exoplanets should have a preferred direction with respect to our line of sight. As such, statistical corrections are possible to estimate the actual number of stars that have planets. After making such corrections, Bonfils et al. (2011) estimate that 41% of red dwarf stars have super-Earths in the habitable zone. Giant planets, those with masses 100-1000 times that of Earth, are expected only to be found in 12% of red dwarf systems. It is estimated that there are about 100 super-Earths within 30 light years of Earth! In the Milky Way, it is estimated that tens of billions of potentially habitable worlds exist around red dwarfs!!! Compared to the Sun, red dwarf stars are much cooler. Thus, for red dwarfs the habitable zone (where liquid water can exist) is much closer to the host star than for hotter stars. This close proximity may be detrimental to the development of life, as red dwarf stars are "subject to stellar eruptions or flares, which may bathe the planet in X-rays or ultraviolet radiation, and which may make life there less likely."

It will be exciting to hear the latest findings from Kepler. Given the large sampling of stars, it will be useful to determine if the estimated population statistics for habitable worlds around red dwarfs found by Bonfils et al. (2011) can be confirmed. Furthermore, since Kepler is also observing stars of other spectral types, we can expect that (eventually) a fuller accounting of the population of habitable worlds will be determined.

For more information see: http://www.eso.org/public/archives/releases/sciencepapers/eso1214/eso1214a.pdf; http://www.eso.org/public/news/eso1214/; http://www.universetoday.com/94347/billions-of-habitable-worlds-likely-in-the-milky-way/; http://en.wikipedia.org/wiki/Stellar_classification#Cool_red_and_brown_dwarf_classes

Calendar of Events

April 18, 7:00pm

What: The Search for New Particles at the CERN Large Hadron Collider
Who: Michael Peskin, Stanford Linear Accelerator Center
Where: SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA
Cost: Free

The Large Hadron Collider at CERN in Geneva, Switzerland, has begun its study of physics at distances 10,000 times smaller than an atomic nucleus. This accelerator and its experiments are enormous in many respects--in the physical size of the facilities, in the sizes of the experimental teams, but also in the stakes for our understanding of elementary particles, mass, and the universe. In this colloquium, Dr. Peskin will describe the physics questions that motivate the LHC experiments, the detectors that are designed to meet these goals, and the challenges that the experiments must overcome. Dr. Peskin will show some of the first results from the LHC, including the status of the search for the much-anticipated Higgs boson.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

April 21, 8:30pm

What: The May 2012 Annular Solar Eclipse, the June 2012 Transit of Venus, and the Search for Transiting Exoplanets
Who: Dr. Alex Filippenko, UC Berkeley Dept. of Astronomy
Where: Mt. Tamalpais State Park, Cushing Memorial Amphitheater, more commonly known as the Mountain Theater, Rock Spring parking area

continued page 4

Cost: Free

Be prepared to observe two exciting upcoming celestial events and learn their connection to the search for planets orbiting other stars.

For more information see: http://www.mttam.net/astronomy/schedule.html

May 2, Noon-1:00pm

What: Companions to solar-type stars: analysis of a wide variety of planets, brown dwarfs and small stars
Who: Tristan Guillot, Nice Observatory
Where: SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA
Cost: Free

Although they are relatively frequent as free-floating objects, brown dwarfs are scarcely found as companions to solar-type stars. The paucity of brown dwarfs in close-orbits first noticed by radial velocity surveys has led to the concept of the "brown dwarf desert". Dr. Guillot will show that this desert concerns in fact close companions with masses larger than about 3 Jupiter masses orbiting G-type stars. On the other hand, photometric surveys have shown that in fact F-type stars do possess close-in, massive companions. Dr. Guillot will show that this is explained by the loss of an initial population of close-in massive giant planets and brown dwarfs due to tidal interactions: Because stars orbit less rapidly than their close-in companions, the tide raised on the star causes the companion to lose angular momentum and spiral in. The effect is much more pronounced around G-type stars because of a larger magnetic braking and because of increased dissipation, probably by internal gravity waves. Dr. Guillot will use statistical methods to compare observations and model results and derive constraints on the tidal dissipation in stars as a function of their interior properties. This provides a powerful way to analyze the population of exoplanets and tie present observations with initial conditions at the time of the formation of these systems.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

May 7, 7:30pm

What: The First Sources of Light in the Universe
Who: Dr. Aparna Venkatesan, Assistant Professor of Physics and Astronomy, University of San Francisco
Where: California Academy of Science, 55 Music Concourse Dr., Golden Gate Park, San Francisco, CA
Cost: Adults $12, Seniors $10, Academy members $6. Reserve a Space Online or call 415-379-8000

Primordial stars, the first stars in the early universe, are unique objects that could have strongly influenced their environment despite their brief existence. These objects can be identified through their characteristic ionizing properties and the elements created by their supernovae. By combining these two signatures with a variety of current astronomical data, researchers can obtain relatively strong constraints on the masses and formation epochs of the first stars. Dr. Venkatesan will discuss why we have not detected these fascinating objects to date and will discuss the most promising observational programs for detecting these primordial stellar clusters at cosmic ages of less than a billion years.

See http://www.calacademy.org/events/lectures/ for lecture and reservation information.

May 9, 7:00pm

What: Contact with ET using math? Not so fast
Who: Keith Devlin, Stanford University
Where: SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA
Cost: Free

It is often said that mathematics is a universal language that we could use to make contact with another intelligence. But is that really the case? Or is this just a disguised version of anthropocentrism? Dr. Keith Devlin has written 31 mathematics books and over 80 published research articles. He is the recipient of the Pythagoras Prize, the Peano Prize, the Carl Sagan Award, and the Joint Policy Board for Mathematics Communications Award. In 2003, he was recognized by the California State Assembly for his "innovative work and longtime service in the field of mathematics and its relation to logic and linguistics." He is "the Math Guy" on National Public Radio (For more information see http://profkeithdevlin.com).

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

May 11, 6:00pm-7:30pm

What: Future Fridays
Who: Bill Nye the Climate Guy, Scientist, Engineer, Comedian, Author, and Inventor
Where: Chabot Space & Science Center, 10000 Skyline Blvd., Oakland, CA 94619
Cost: $20 Members / $23 Guests, ($29 at the door, no discounts & subject to availability)

Enjoy an entertaining evening with Bill Nye the Climate Guy - scientist, engineer, comedian, author, and inventor, and a man with a mission: to help foster a scientifically literate society and to help people everywhere understand and appreciate the science that makes our world work. And dare we say - Change the World!

Bill Nye is also the Executive Director of the Planetary Society, the world's largest space interest organization. He is the driving force behind Chabot's Bill Nye's Climate Lab exhibi-

Calendar of Events (continued)

tion, where visitors learn how to be a climate scientist, while showcasing the humor and education skills of the Emmy Award-winning personality.

For more information see: http://www.chabotspace.org/events.htm

May 16, Noon - 1:00pm

What: The Climates of the Planet Mars
Who: Francois Forget, Laboratoire de Météorologie Dynamique
Where: SETI Headquarters, 189 N. Bernardo Ave., Mountain View, CA
Cost: Free

Details of the presentation are not available.

For more information see: http://www.seti.org/csc/lectures, e-mail info@seti.org, or phone 650-961-6633.

Caption: Your TVS newsletter editor standing on the edge of Crater Lake, Oregon on the night of April 6, 2012. Karen and I arrived at sunset and watched the rise of the Full moon that illuminated the scene above. Note Venus and the Pleiades (M45) in the background. Image Credit: Karen Harris.

What's Up by Ken Sperber (adapted from S&T and The Year in Space)

All times Pacific Daylight Time.

April

17	Tue	Algol at minimum brightness for ~2 hours centered on 7:44pm
21	Sat	New Moon (12:18am)
21-22	Sat-	Lyrid Meteor shower, peaking after midnight on the 22nd (see p. 53 of S&T April 2012)
22	Sun	Jupiter shines below a thin crescent Moon (evening)
23	Mon	The Pleiades are to the right of the crescent Moon (evening)
24	Tues	Venus to upper-right of crescent Moon
29	Sun	First-Quarter Moon (2:57am)
30	Mon	Mars and Regulus above the Moon
30	Mon	Venus at greatest illumination, peaking at Mag -4.7

May

3-4	Thu-	The Moon, Saturn, and Spica in conjunction
5	Sat	Full Moon, largest of 2012 (8:35pm)
12	Sat	Last-Quarter Moon (2:47pm)
20	Sun	Annular Solar Eclipse, partial phase visible from Bay area (see p.50 S&T May 2012)
20	Sun	New Moon (4:47pm)
28	Mon	First-Quarter Moon (2:57am)

The Planet in the Machine

By Diane K. Fisher and Tony Phillips

The story goes that a butterfly flapping its wings in Brazil can, over time, cause a tornado in Kansas. The "butterfly effect" is a common term to evoke the complexity of interdependent variables affecting weather around the globe. It alludes to the notion that small changes in initial conditions can cause wildly varying outcomes.

Now imagine millions of butterflies flapping their wings. And flies and crickets and birds. Now you understand why weather is so complex.

All kidding aside, insects are not in control. The real "butterfly effect" is driven by, for example, global winds and ocean currents, polar ice (melting and freezing), clouds and rain, and blowing desert dust. All these things interact with one another in bewilderingly complicated ways.

And then there's the human race. If a butterfly can cause a tornado, what can humans cause with their boundlessly reckless disturbances of initial conditions?

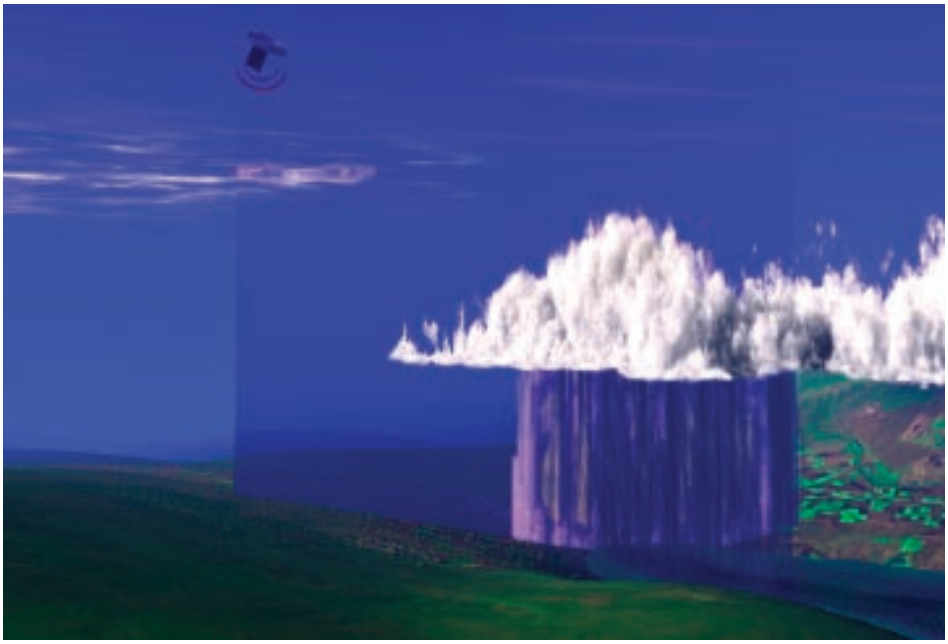
Understanding how it all fits together is a relatively new field called Earth system science. Earth system scientists work on building and fine-tuning mathematical models (computer programs) that describe the complex inter-relationships of Earth's carbon, water, energy, and trace gases as they are exchanged between the terrestrial biosphere and the atmosphere. Ultimately, they hope to understand Earth as an integrated system, and model changes in climate over the next 50-100 years. The better the models, the more accurate and detailed will be the image in the crystal ball.

NASA's Earth System Science program provides real-world data for these models via a swarm of Earth-observing satellites. The satellites, which go by names like Terra and Aqua, keep an eye on Earth's land, biosphere, atmosphere, clouds, ice, and oceans. The data they collect are crucial to the modeling efforts.

Some models aim to predict short-term effects—in other words, weather. They may become part of severe weather warning systems and actually save lives. Other models aim to predict long-term effects—or climate. But, long-term predictions are much more difficult and much less likely to be believed by the general population, since only time can actually prove or disprove their validity. After all, small errors become large errors as the model is left to run into the future. However, as the models are further validated with near- and longer-term data, and as different models converge on a common scenario, they become more and more trustworthy to show us the future while we can still do something about it—we hope.

For a listing and more information on each of NASA's (and their partners') Earth data-gathering missions, visit science.nasa.gov/missions/earth.html. Kids can get an easy introduction to Earth system science and play Earthy word games at http://spaceplace.nasa.gov/ecosphere

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



Caption: CloudSat is one of the Earth-observing satellites collecting data that will help develop and refine atmospheric circulation models and other types of weather and climate models. CloudSat's unique radar system reads the vertical structure of clouds, including liquid water and ice content, and how clouds affect the distribution of the Sun's energy in the atmosphere. See animation of this data simulation at www.nasa.gov/mission_pages/calipso/multimedia/cloud_calip_mm.html.

Tri-Valley Stargazers
P.O. Box 2476
Livermore, CA 94551

PRIMEFOCUS

Tri-Valley Stargazers Membership Application

Member agrees to hold Tri-Valley Stargazers, and any cooperating organizations or landowners, harmless from all claims of liability for any injury or loss sustained at a TVS function.

Name _____ Phone _____ e-mail _____

Address _____

Do not release my: _____ address, _____ phone, or _____ e-mail information to other TVS members.

Membership category:
_____ $5 Student.
_____ $30 Basic. You will receive e-mail notification when the PDF version of Prime Focus is available for download off the TVS web site.
_____ $10 Hidden Hill Observatory (H2O) yearly access fee. You need to be a key holder to access the site.
_____ $20 H2O key holder fee. (A refundable key deposit—key property of TVS).
_____ $40 Patron Membership. Must be a member for at least a year and a key holder.
_____ $34 One year subscription to Astronomy magazine.
_____ $60 Two year subscription to Astronomy magazine.
_____ $32.95 One year subscription to Sky & Telescope magazine. Note: Subscription to S&T is for new subscribers only. Existing subscribers please renew directly through S&T.
$ _____ Tax deductible contribution to Tri-Valley Stargazers.

$ _____ TOTAL – Return to: Tri-Valley Stargazers, P.O. Box 2476, Livermore, CA 94551

Membership information: Term is one calendar year, January through December. Student members must be less than 18 years old or still in high school.