Monthly Notices of the Everglades Astronomical Society

Naples, FL
June 2014

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President's Message

This Tuesday is our last regular meeting at the Norris Center till we return in September. We are still planning our casual "coffee" get together at Blueberry's in July and August. Blueberry's is a local restaurant located at 3350 Tamiami Trail N. Last year was our first year at this location. Members indulged in deserts and other menu items while chatting about astronomy and whatever else they felt. The management and staff were very accommodating and deserve extra support from our club. Consider having a meal there also sometime.

Also, as mentioned in the past three newsletters, the EAS is still planning on working with the YMCA Naples to share our passion for astronomy in its summer camp programs. This will likely include providing a daytime solar and nighttime lunar viewing in conjunction other activities. Last time I communicated, the YMCA was working on event schedules. I'll contact them this coming week to solidify dates/times and communicate to all members who would like to help out.

This Tuesday's meeting, member Mike Harden will be giving the presentation on the set-up and use of "All Sky" Cameras. Although Mike has only been doing this for a short time, he already has made great strides in the use of an "All Sky" camera and will share some very interesting image processing techniques. I myself am looking forward to his presentation.

I would also like thank everyone for making this past season probably the highest attended with some of the best presenters coming from within our club. We are very fortunate to have such an interesting group of members willing to share their time, knowledge and talents with others. Enjoy your summer.

Clear Skies,
President Todd Strackbein

Dates for the "Fak"

Usually the best times to go out to the Fakahatchee Strand viewing site are moonless nights. Below is a list of upcoming Saturday nights that you will often find fellow club members out there enjoying the skies with you (weather permitting).

Date	Moonrise	Moonset
June 21	1:22 a.m.	2:22 p.m.
June 28	6:49 a.m.	8:20 p.m.

Sky Events

June 5 - First quarter
June 12 - Full moon
June 19 - Last quarter
June 27 - New Moon

Next Meeting

June 10, 2014: Time 7:00 – 9:00 pm
At the Norris Center, Cambier Park

Camelopardalids Meteor Shower
By Jackie Richards

We didn't see hundreds of meteors per hour during the Camelopardalids meteor shower, but the ones we did were some of the most beautiful meteors I have seen so far. They were green in color and moved across the sky slowly enough to alert others who could then turn around and still see them.

Photo by Tim Lilly taken at the Fak during the Camelopardalids Meteor Shower on 5/24/14 @ 1:52 a.m. Canon EOS 7D; ISO 400; 214 seconds.

The photo above shows the best meteor of the night and other photographers at the Fak caught it on camera, as well.

In last month's newsletter, I incorrectly stated that the Camelopardalis constellation *follows* Ursa Major in its circumpolar path around Polaris, but it actually *precedes* Ursa Major.

Meteors come in all colors. When a meteoroid hits Earth's atmosphere, it heats up the atmospheric pressure and produces a streak of light which is the meteor we see. We can tell a meteor's content by its color: orange/yellow – sodium, yellow – iron, blue/green – magnesium, violet – calcium, and red – silicate.

Over 20 viewers showed up at the Fak for the meteor shower, and although we didn't see as many meteors as we had hoped to see, it was still a great night for viewing and photography (see Chuck Pavlick's photo below of the Dumbbell Nebula taken during the meteor shower).

Fak & Other Photos

Photo taken by Chuck Pavlick. Dumbbell Nebula (M27) taken at the Fak on 5/24/14. William Optics FLT 110 f/7 w/field flattener; AP Mach 1; SBIG 8300c; Orion Mini Guide Scope, Orion Starshoot 1, PHD; captured in Nebulosity; processed in Pixinsight; 10 @ 600 seconds.

Photo by Brian McGaffney, Nutwood Observatory. Crab Nebula (M1) featured in Astronomy Magazine's online "Picture of the Day." Photo taken in February 2014.

The Number of Habitable Planets in the Milky Way

By Dennis C. Albright

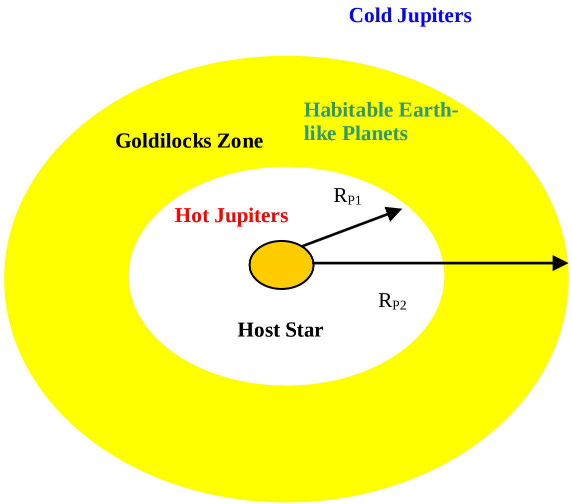
Properties of the Host Star

One of the criteria for the presence of multi-cellular life is that liquid water is available. This criterion severely limits the range of the surface temperature, T_P, of the Earth-like planet on which life can exist:

$$273.0\ ^{o}K \le T_P \le 373.0\ ^{o}K$$

In fact, planets must orbit the star in what is called the Goldilocks zone where the surface temperature of the planet is neither too hot nor too cold, but just right for life. This is shown in Figure 1.

Figure 1 The Goldilocks Zone



Furthermore, this temperature requirement severely limits the type of star that can be the host to an Earth-like planet. Firstly, the temperature of the Earth-like planet must be relatively stable. This means that the luminosity of the host star must also be very stable. This criterion rules out variable stars like Cephied Variables or RR Lyrae stars from being hosts to habitable Earth-like planets.

Also members of close multiple star systems must be excluded due to the extreme variation in the temperature of the planet as it moves in its orbit between the members of the multiple star system. Furthermore, because the planet is subject to the gravitational pull of multiple massive objects, its orbit may unstable.

Stars in the later stages of stellar evolution like hyper giants, super giants, giants and sub giants, which are in luminosity classes I through IV, can also be excluded due to the very short lifetimes and the relatively rapid variation of the luminosity of these types of stars during their lifetimes.

Stellar remnants, white dwarfs, neutron stars and black holes, luminosity classes VII and VIII, can also be excluded as hosts for Earth-like planets due to their very low luminosity. Furthermore, stellar remnants are created in either nova or supernova explosions. These stellar explosions would have easily sterilized or destroyed any planet in an orbit close enough to be in the Goldilocks zone.

Red dwarfs, luminosity class VI, have very long lifetimes but are also excluded from being the host of Earth-like planets due to an effect called tidal locking. The luminosity of a star decreases very rapidly with its deceasing mass. For a red dwarf, if the Earth-like planet is in the Goldilocks zone, it is so close to the star so that it is tidally locked and cannot rotate. Since only one half of the planet faces the star this half becomes extremely hot and the other half becomes extremely cold.

In our solar system, Mercury is tidally locked with the sun and has a very hot half facing the sun and a very cold half facing away from the sun. If the planet has an atmosphere there is some heat transfer by convection but due to the large temperature difference between the two halves of the planet, there are very high-speed winds between the two halves.

Only main sequence stars, luminosity class V, can be the host of Earth-like planets. However, the luminosity of a main sequence star changes slowly during its lifetime. For only about 10% of the lifetime of a main sequence star, the greenhouse gases in the atmosphere of a habitable planet can compensate for the changes in luminosity, keeping the planet's temperature within the Goldilocks range. The other 90% of the lifetime of the main sequence star, the planet is either to hot or too cold.

Also, there are mass limitations for main sequence host stars. The mass, M_S, of the main sequence host star is limited to be the mass greater than the mass for which tidal locking occurs, M_{STidal}. Since the lifetime of the main sequence star goes down as its mass increases, the mass of the main sequence host star must be less than the stellar mass for which the lifetime of the star is too short to evolve multi-cellular life, M_{Smax}. This relationship is shown in the inequality below:

$$M_{STidal} < M_S < M_{Smax}$$

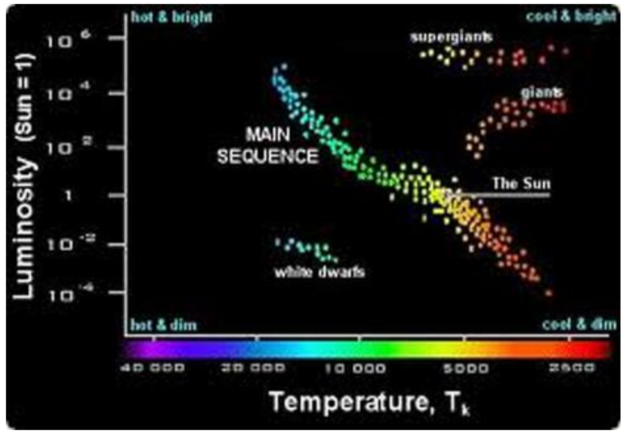
These mass limitations, M_{STidal} and M_{Smax}, have the following values:

$$M_{STidal} = 0.50 \text{ suns}$$

$$M_{Smax} = 1.80 \text{ suns}$$

In order to insure that the spectrum of the light emitted by the host star is compatible with photosynthesis, both the stellar surface temperature, T_S, and the partition of the spectrum into the colors of visible light are also tested by the STARSDAW code. Figure 2 shows the Hertzspung-Russell, H-R, diagram which relates the luminosity of stars to their surface temperature. The **green** bar indicates the approximate range of stellar luminosities and surface temperatures of stars that could have habitable Earth-like planets.

Figure 2 H-R Diagram



The Effect of Planets

In the past few years astronomers have discovered a number of stars with planets by either the gravitational effect of the planet on the motion of the star or by the dimming of the light of the star when the planet passes in front of the star.

Unfortunately, these two techniques cannot easily be used to determine the presence of an Earth-like planet. Rather these techniques are used to determine the presence of giant planets of roughly the size of Jupiter. These exoplanets can be grouped into two types: hot Jupiters and cold Jupiters. Close orbiting faint brown dwarf stars orbiting the host star can also be detected in this manner and will be included in this analysis.

Hot Jupiters are close to the host star with an orbital radius, R, in the range:

$$R < R_{p1}$$

If the total mass of the hot Jupiters in a stellar system is large enough, it can disrupt the orbits of the habitable Earth-like planet decreasing the probability of habitable Earth-like planets.

A giant planet can also be inside or very near to the Goldilocks zone with an orbital radius, R, in the range:

$$R_{p1} \leq R \leq R_{p2}$$

If this is true then the giant planet can readily disrupt the formation or stability of the habitable Earth-like planet reducing its probability to 0.

If the giant planet is a cold Jupiter, it is outside of the Goldilocks zone with an orbital radius, R, in the range:

$$R_{p2} < R$$

If this is the case, the probability of a habitable Earth-like planet is enhanced. This is because the huge mass of the cold Jupiter shields the much smaller Earth-like planet from devastating strikes from the cloud of comets that is around each star. This cloud of comets is equivalent to the Kuiper belt and the Oort cloud in our solar system and was formed from the leftovers after the host star and its planets were formed.

Since brown dwarfs are much more massive than the Jupiter-sized planets, they are assumed to disrupt the orbit of the much smaller Earth-like planet. Furthermore, they may radiate enough energy in the infra-red to destabilize the temperature of the Earth-like planet as well. For these two reasons, the presence of a brown dwarf will drastically decrease the probability of habitable Earth-like planets.

The Calculation

The STARSDAW code models these constraints on the host star and can determine probability that a star can be the host to a habitable Earth-like planet with multi-cellular life. Using this calculated probability, the likelihood of life occurring in a stellar system associated with any of the stars that have been used in the validation of the STARSDAW code, $P_{LifeTot}$, can be determined by summing over the probabilities of life for each of the individual stars, P_{LifeSk}:

$$P_{LifeTot} = \sum_k P_{LifeSk}$$

This extremely high value of the total probability indicates that there may be an Earth-like habitable planet orbiting one of the 425 stars modeled, validating the STARSDAW code. The total number of habitable Earth-like planets likely in 425 stars modeled validating the STARSDAW code database, N_{EL0}, is determined to be:

$$N_{EL0} = 9$$

Since there is a very small probability that each individual star is suitable for a habitable Earth-like planet, the Poisson distribution may be used giving a standard deviation, σ: manner:

$$\sigma = N_{EL0}^{1/2} = 3$$

This analysis also concludes that there is a 95% probability that the total number of habitable Earth-like planets orbiting the stars in the STARSDAW validation database, N_{EL}, lies in the range:

$$N_{EL0} - 2\sigma \leq N_{EL} \leq N_{EL0} + 2\sigma$$

$$3 \leq N_{EL} \leq 15$$

This gives us three values for the probability of a star having habitable Earth-like planets, the minimum, $P_{LifeSmin}$, the average, $P_{LifeSavg}$, and the maximum, $P_{LifeSmax}$:

$$P_{LifeSmin} = .00706$$

$$P_{LifeSavg} = .01412$$

$$P_{LifeSmax} = .02118$$

The calculation of the effect of planets on the probability of habitable Earth-like planets was done in two stages for 39 stars with 24 hot Jupiters and 16 cold Jupiters and 2 brown dwarfs. The effect that giant planets have on the probability of Earth-like habitable planets, f_{LifeP},:

$$f_{LifeP} = \frac{P_{LifeSP}}{P_{LifeS}} = 0.518$$

NASA has calculated that our galaxy, the Milky Way, has between 200 billion and 400 billion stars in it:

$$200 \times 10^9 < N_{MWStars} \leq 400 \times 10^9$$

The total number of host stars for habitable Earth-like planets, N_{MWhost}, is easily calculated from the factors calculated in the analysis performed using the STARSDAW code:

$$N_{MWhostmin} = f_{LifeP}\ P_{LifeSmin}\ N_{MWStarsmin} = 0.731 \times 10^9$$

$$N_{MWhostavg} = f_{LifeP}\ P_{LifeSavg}\ N_{MWStarsavg} = 2.194 \times 10^9$$

$$N_{MWhostmax} = f_{LifeP}\ P_{LifeSmax}\ N_{MWStarsmax} = 4.388 \times 10^9$$

NASA has calculated the total number of host stars for habitable Earth-like planets, $N_{MWhostNASA}$, as

$$N_{MWhostNASA} = 8.800 \times 10^9$$

Considering the inherent inaccuracy of the calculation of the total number of stars by NASA and the possible difference in the assumptions made by NASA and myself, these two sets of results are quite comparable.

The determination of whether Earth-like planets form in the Goldilocks zone of these host stars or whether there is life on these planets is beyond the scope of this calculation done with the STARSDAW code by an amateur astronomer.

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NASA Space Place

The Hottest Planet in the Solar System

By Dr. Ethan Siegel

When you think about the four rocky planets in our Solar System—Mercury, Venus, Earth and Mars—you probably think about them in that exact order: sorted by their distance from the Sun. It wouldn't surprise you all that much to learn that the surface of Mercury reaches daytime temperatures of up to 800 °F (430 °C), while the surface of Mars never gets hotter than 70 °F (20 °C) during summer at the equator. On both of these worlds, however, temperatures plummet rapidly during the night; Mercury reaches lows of -280 °F (-173 °C) while Mars, despite having a day comparable to Earth's in length, will have a summer's night at the equator freeze to temperatures of -100 °F (-73 °C).

Those temperature extremes from day-to-night don't happen so severely here on Earth, thanks to our atmosphere that's some 140 times thicker than that of Mars. Our average surface temperature is 57 °F (14 °C), and day-to-night temperature swings are only tens of degrees. But if our world were completely airless, like Mercury, we'd have day-to-night temperature swings that were *hundreds* of degrees. Additionally, our average surface temperature would be significantly colder, at around 0 °F (-18 °C), as our atmosphere functions like a blanket: trapping a portion of the heat radiated by our planet and making the entire atmosphere more uniform in temperature.

But it's the *second* planet from the Sun -- Venus -- that puts the rest of the rocky planets' atmospheres to shame. With an atmosphere **93 times as thick as Earth's**, made up almost entirely of carbon dioxide, Venus is the ultimate planetary greenhouse, letting sunlight in but hanging onto that heat with incredible effectiveness. Despite being nearly twice as far away from the Sun as Mercury, and hence only receiving 29% the sunlight-per-unit-area, the surface of Venus is a toasty 864 °F (462 °C), with *no difference* between day-and-night temperatures! Even though Venus takes hundreds of Earth days to rotate, its winds circumnavigate the entire planet every four days (with speeds of 220 mph / 360 kph), making day-and-night temperature differences irrelevant.

Catch the hottest planet in our Solar System all spring-and-summer long in the pre-dawn skies, as it waxes towards its full phase, moving away from the Earth and towards the opposite side of the Sun, which it will finally slip behind in November. A little atmospheric greenhouse effect seems to be exactly what we need here on Earth, but as much as Venus? No thanks!

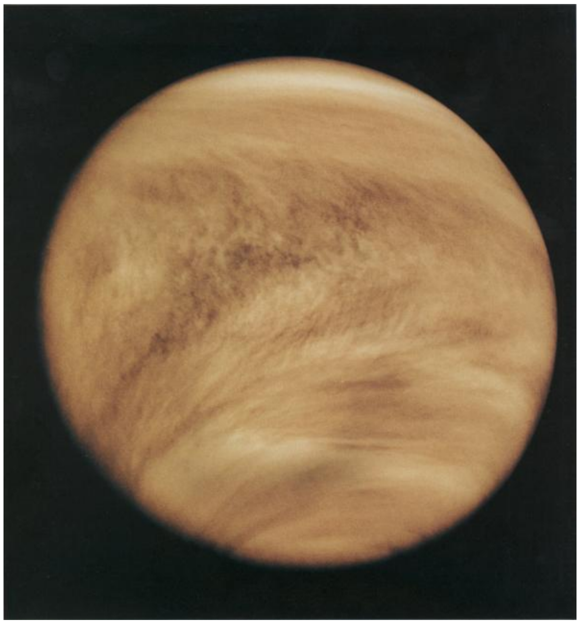

Image credit: NASA's Pioneer Venus Orbiter image of Venus's upper-atmosphere clouds as seen in the ultraviolet, 1979.

Check out these "10 Need-to-Know Things About Venus": *http://solarsystem.nasa.gov/planets/profile.cfm?Object=Venus*

Kids can learn more about the crazy weather on Venus and other placesin the Solar System at NASA's Space Place: *http://spaceplace.nasa.gov/planet-weather*.

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Items For Sale or Trade or Wanted:
http://www.naples.net/clubs/eas/equipment_sales.html

Useful links (software, telescope making, telescope and equipment suppliers, astronomical data sources, iPhone and iPad Apps and more):
http://www.naples.net/clubs/eas/links.html

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