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THE YOUNG ASTRONOMERS NEWSLETTER

WE KNOW MORE AND MORE ABOUT THE SMALLEST STATE OF MATTER

It was in 2012 that researchers at the CERN, Large Hadron Collider facility in Switzerland discovered the Higgs boson, an elementary sub-atomic particle predicted by the Standard Model. The Higgs boson is said to be a factor which contributes to how matter has mass. The Higgs boson was added to a long list of particles that includes quarks, leptons and bosons. According to the Standard Model, each particle has a unique charge, mass and spin.

Also, according to the theory, the Higgs boson should decay into various even more fundamental particles. Some of these have already been detected, but the most common (forming 60% of the time), the bottom quarks (normal bottom plus anti-bottom), were not detected until this past spring.

All this sounds like fantasyland verbiage, but like the vitamins in your cereal, they are "in there". And now two teams at CERN have studied the atom-smashing process and observed the formation of bottom quarks by two different experiments.

All you need to do is build a large chamber that can accelerate protons and slam them together at 13 Tara (10^{13}) volts of energy and sort out the cascade of energy and particles that form. The Higgs boson is formed and within a lifetime of 10^{-22} seconds, it decays to the bottom quarks.

This is considered to be an important result that supports the Standard Model theory. So, the nuclear physicists are happy. The puzzle pieces are falling into place. [Science News, Aug. 28, 2018].

(Answers: 1-F; 2-E; 3-G; 4-J; 5-C; 6-L; 7-H; 8-B; 9-K; 10-D; 11-A; 12-I)

POSSIBLE LIFE-SUPPORT CONDITIONS ON PROXIMA CENTAURI-b

The closest star to us is in the skies of the southern hemisphere. It is called Proxima Centauri and it has a planet labeled Proxima Centauri-b. The system is roughly 4 light years away. P. Centauri-b circles very close to its parent star, which might make you think that it would be too hot to sustain life. But Proxima Centauri is a relatively small, cool star.

PC-b (discovered in 2016) has a mass that is 1 to 3 times that of the Earth, and it takes just 11.2 Earth-days to orbit PC. The PC-b to PC distance has been estimated to be in the range of 0.022 to 0.054 AU (AU is an astronomical unit: the distance from the Sun to the Earth -93 million miles, on average). So, the closeness of the red dwarf parent star is offset by the fact that it is much cooler than our Sun (6000 Kelvin compared to 3000 Kelvin). Liquid water could exist on the planet's surface.

The tricky thing about this planet-star system is that their closeness causes Proxima Centauri b to orbit its star without spinning. This is called a gravitational locking effect which we see with the Earth-Moon system. The Moon only shows one side of its surface to us on Earth.

So, astronomers at the NASA Goddard Institute of Space Studies in New York City are trying to use various computer models to predict if there could be regions on the planet that are neither too hot nor too cold.

An equilibrium region would be a narrow band that is at the border between the star-facing and space-facing sides. Further simulations allow for a certain amount of mixing of the two types of oceans. This could make the "habitable zone" even larger.

An unknown factor is the role of an atmosphere, which has not yet been detected. Another factor is that Proxima Centauri is a "flare star". Such stars send up random outbursts of electromagnetic and magnetic energy. These could be lethal to any life form on PC-b.

So, we wait for the results of new studies of our closest extrasolar planet. [Live Science, Sept. 12, 2018].

THE INVOLVEMENT OF DARK MATTER IN THE EARLY UNIVERSE

There are astronomers around the world, for example at the University of Michigan and University of Vienna, who are proposing that dark matter was dominant in the early years of the universe, and it was instrumental in forming unique stars, called dark stars.

Right after the big bang, there were no stars or galaxies; only energy, and energetic particles like quarks, electrons, protons and neutrons and… dark matter. Everything was much more compact. It has been proposed that dark matter functions in the form of weakly interacting massive particles – WIMPS for short. It took about 200 million years after the big bang for the WIMPS to be clustered enough to form huge bodies that also attracted ordinary baryonic matter (like hydrogen nuclei).

The high-speed WIMPS collided with each other to give off an annihilation energy that gave the "dark" stars their light. This is a different kind of energy profile than what we get from hydrogen to helium fusion energy. Nevertheless, plenty of hydrogen was in the dark stars, and as the WIMPS become depleted, normal hydrogen fusion kicked in. Eventually, these very large stars collapsed into black holes. This fits in with results of current scans of the earliest universe which show numerous giant black holes.

The current universe is now too far expanded and the density of dark matter is too low to allow for continual condensation of WIMPS to make dark stars. However, some scientists think that near the centers of galaxies there may be enough dark matter to create a sustainable population of dark stars. NASA's Fermi Gamma-ray Telescope (launched in 2008) has been looking for high energy sources near our galaxy's center. [Astronomy, Oct. 2018].

BIG ORGANIC MOLECULES IN THE SUBSURFACE OCEAN OF ENCELADUS

Cassini, NASA's probe of Saturn discovered geysers of icy particles spewing up from the saturnian moon Enceladus. The plumes appear to be an aqueous mix of ice, ions and molecules that originate from below the surface of the moon. Two types of on-board analytical instruments indicate that the geysers may contain organic molecules consisting of carbon and hydrogen, plus a high proportion of hetero atoms (not carbon) such as oxygen and nitrogen.

The on-board mass spectrometer and cosmic dust analyzer could analyze organic molecules and fragments with molecular mass up to thousands of atomic mass units. These fragments include actual simple molecules like methane and formaldehyde, but also numerous organic groups such as ethoxy, carbonyl and aromatic rings. Groups containing nitrogen and oxygen were commonly detected.

The source of such a predominance of organics could be comets, which are known to be rich in carbon-containing molecules. But the distribution of molecular types seems to be different in Enceladus as compared to comets. It may be that organic molecules are undergoing change in their structure caused by hydrothermal processes in the interior ocean.

Cassini actually flew through the plumes to collect samples. [Sky & Tel. October, 2018].

BIRTHDAYS IN OCTOBER

Ejner Hertzsprung (Danish), b. Oct. 8, 1873, d. Oct. 21, 1967. Worked out relationship of star luminosity with size and temperature. With Henry Russell, created the Hertzprung-Russell diagram.

Henry Norris Russell (Amer.), b. Oct. 25, 1877, d. Feb. 18, 1957. Worked out relationship of star luminosity, size, and temperature. With Hertzsprung, created the Hertzsprung-Russell diagram.

Subrahmanyan Chandrasekhar (Ind.), b. Oct. 19, 1910, d. Aug. 21, 1995. Astrophysicist. Worked out dynamics around black holes. Nobel Prize 1983.

Karl Guth Jansky (Amer.), b. Oct. 22, 1905, d. Feb. 14, 1950. A pioneer in radio astronomy. Detected radio waves originating from the center of the Milky Way galaxy.

Karl Schwarzschild (Ger.), b. Oct. 9, 1873, d. May 11, 1916. Mathematician-astronomer. Developed theories about existence of black holes and dynamics around black holes.

MOON PHASES IN OCTOBER: Last Qtr.: Tues. the 2nd; **New:** Mon. the 8th; **First Qtr.:** Tues. the 16th; **Full:** Wed. the 24th; **Last Qtr.:** Wed. the 31st.

THE PLANETS IN OCTOBER: By the end of the first week of the month, **Venus** will drop below the western horizon. It swings around the Sun and emerges early in November in the eastern morning sky, right before sunrise. So, early risers will get to see it as the "morning star" starting early in November. **Jupiter** (mag. -1.8) is continuing its westward movement and is getting low enough to give us only a narrow window for observing it. **Saturn** remains a pretty sight at magnitude 0.5 but, it too, is slipping toward the west. It is located between Scorpius and Sagittarius. A small telescope gives us a very nice view of the tilted rings and some of the planet's moons. **Mars** is still quite prominent high up in the south. The red planet is still quite bright at magnitude -1.3 at the beginning of the month, but it weakens to -0.6 by month end. As usual, **Mercury** is hard to spot. However, if you can find Jupiter in the west, Mercury will be just below it on the 27th.

METEOR SHOWERS IN OCTOBER: October is usually the month in which we look for the **Orionids**. They are supposed to be seen any time during the month, with peak appearances on the 21st. But, a secondary meteor shower is to be put on by the **Draconids** around October 8/9. A dark night provided by a New Moon will help us find them.

Constellation nicknames: Place a letter in the blank which matches the constellation with its nickname. For example, Orion would match with "The Hunter" (Answers page 1)

1. Aquila _____	**A The Scorpion**
2. Auriga _____	**B The Harp**
3. Capricornus _____	**C The Swan**
4. Cetus _____	**D The Archer**
5. Cygnus _____	**E The Charioteer**
6. Draco _____	**F The Eagle**
7. Gemini _____	**G The Sea Goat**
8. Lyra _____	**H The Twins**
9. Pegasus _____	**I The Fox**
10. Sagittarius _____	**J The Whale**
11.Scorpius _____	**K The Winged Horse**
12.Vulpecula _____	**L The Dragon**

The Forsyth Astronomical Society meets on the second Wednesday of the month at 7:30 p.m. at Kaleideum North (formerly SciWorks). For information about ongoing activities, check the FAS website: http://www.fas37.org. The public is invited to Stone Mountain State Park on Saturday the 13th. Check the website for details.

The front desk at Kaleideum often has FAS information (336-767-6730, ext. 1000)

Have a great month. Bob Patsiga, editor