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Finally, a Nobel for Exoplanets!

by H. Paul Shuch, Executive Director Emeritus

On 6 October 1995, at an astronomy conference in Florence, Italy, SETI League members were elated to learn of the discovery of the first planet orbiting another main-sequence star. 51 Pegasi b was detected by the radial velocity Doppler method by Swiss astronomers Michel Mayor and his graduate student Didier Queloz. Their observations opened up the heavens to a new era of discovery. This announcement was a major boost to SETI research, given that the existence of exoplanets has long been considered essential to the development of life.

In fact, f_p, the fraction of stars with planets, is the second variable in the familiar Drake Equation, and only the second of the seven Drake factors (behind R*, the formation of stars) to be proven to have a non-zero value. To date, several thousand exoplanets have been confirmed by this and other observational methods, confirming the long-held suspicion that planetary formation around certain classes of stars is the rule, rather than the exception.

Last October, fully 24 years after Mayor's and Queloz's landmark discovery, the Nobel committee awarded them its prestigious prize in Physics, "for the discovery of an exoplanet orbiting a solar-type star." I believe the citation should have been for the *first* such discovery, but let's not quibble here. Michel and Didier are well deserving of this long-overdue honor, which has opened up a whole new era of planetary detections, greatly increasing the probability for SETI success.

The two share their Physics Nobel with Canadian theoretical physicist James Peebles. His Nobel Prize citation states simply that Peebles is being recognized "for theoretical discoveries in physical cosmology." As a lifelong professor at Princeton University (where he is now Albert Einstein Professor Emeritus of Science), Peebles provided a theoretical framework for understanding the early Universe, which contributed to the 1964 detection of the cosmic microwave background radiation (CMB) by Bell Labs physicist Arno Penzias and radio astronomer Robert W. Wilson. Those two were awarded the 1987 Nobel Prize in Physics for that discovery.

On a personal note, I had the honor of meeting Michel and Didier at a bioastronomy conference on the Italian island of Capri in 1996. Here is a picture of me singing to Michel and his wife Francois at that meeting. The Song I chose is my own "Pegasus 51", which I wrote the day after Michel announced the detection of the first exoplanet orbiting a main-sequence star.

Guest Editorial

Aether Or

by Dan Duda

from the September, 2019 issue of Penn Central, the monthly newsletter of Central PA Mensa, used by permission

The idea of "nothingness" has intrigued me in recent years. Is there such a thing? What is the mathematical significance of zero? Is it really just a place holder for the "real" numbers? Or is there something else going on beyond our ability to comprehend? Zero and infinity share an interesting feature — they're at opposite ends of a scale, and both ends tend to indicate something beyond our current understanding.

Physics and cosmology are loaded with unsolved mysteries. One that plagued science until the twentieth century was how light from stars, including our Sun, could propagate through the nothingness of empty space. Since light is a wave (in part), what is it waving in that allows us to see celestial objects beyond Earth's atmosphere?

Our colleague Bill Kalin points us to the work of Samuel Tolver Preston — a 19th century engineer and physicist. In 1875 he published *Physics of the Aether*, in which he actually reasoned out a formula that would become famous in the next century: E=MC^2. He claimed that "energy exists only in the form of motion (i.e., kinetic)." He proceeded from that base to reason "...the existence in space of aether particles moving at the speed of light." His reasoning continued to propose "...the existence of a vast store of energy in space of a very intense character." That hypothesis would certainly solve the mystery of the propagation of light through space (which would not be a vacuum).

The next stop on Kalin's fascinating train of discovery is the famous Michelson-Morley experiment (MM). These two were awarded a Nobel Prize in 1907 for a failed experiment. Their intent was to demonstrate that Earth is moving through the aether of space by measuring the difference in the light traveling through two channels - one longitudinal and the other latitudinal (interferometer). They detected no difference, which took us back to the vacuum of empty space.

But Kalen challenges the analysis of Michelson, Morley and the Nobel committee. He asserts that the findings of the experiment were flawed, and that aether did and does exist. it seems that something else was going on that might have yielded the null result. And, surprisingly, that something else might have been relativity. As Einstein proved years later, flow at or near the speed of light causes contraction of a body along its direction of motion. So, the results of the MM experiment can be explained without a need to empty all of space (nice save).

In the words of Albert Einstein, "While I was thinking of this problem in my student years, I came to know the strange result of Michelson's experiment. Soon I came to the conclusion that our idea about the motion of the Earth with respect to the aether is incorrect, if we admit Michelson's null result as a fact. This was the first path which led me to the special theory of relativity."

Looking back, I guess, like our colleague Bill Kalin, we should have known that something was wrong with the conclusions of the MM Experiment. Nature doesn't just abhor a vacuum; it seems it will go to just about any length to prevent it. So, how could we assume that almost all the universe consists of an empty vacuum?

And, back to the words of Einstein "My feeling is religious insofar as I am imbued with the consciousness of the insufficiency of the human mind to understand more deeply the harmony of the Universe which we try to formulate as 'laws of nature'."

Disclaimer: *The opinions expressed in editorials are those of the individual authors, and do not necessarily reflect the position of The SETI League, Inc., its Trustees, officers, Advisory Board, members, donors, or commercial sponsors.* ❖

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Awards_at_setileague_dot_org

Please be sure to indcate the URL of the candidate website you are nominating, and a brief explanation as to why you consider the site worthy of recognition.

Fast Radio Bursts

by Seth Shostak
Senior Astronomer, SETI Institute

From The SETI Institute's *Journey* e-newsletter,
9 September 2019, used by permission

Just when you think you've cataloged all the beasts of the cosmos, a new one howls to us from the celestial savanna. Fast radio bursts are now one of the hottest topics in astronomy. In less time than an eye blink, these mysterious objects can release enough energy to power the world for three centuries. And the race is on to figure out what the heck they are.

Last month, a consortium of five dozen astronomers reported the discovery of eight new bursts that may lead to an answer. The objects were found with the Canadian Hydrogen Intensity Mapping Experiment, or CHIME. This unusual-looking radio telescope, about the size of a football field, consists of four metal mesh cylinders — like skateboard half-pipes — that collect and focus incoming radio waves. CHIME is in a sparsely populated, mountainous region of British Columbia about 30 miles north of the U.S. border.

While CHIME is leading the pack today in discovering radio bursts, the first such burst was found a dozen years ago by a West Virginia University astronomer sitting at his desk in Morgantown. Duncan Lorimer was combing through data obtained from a radio telescope in Parkes, Australia — half a world away — when he noticed a short burp of static, the kind of signal you'd produce by firing up a transmitter and then turning it off a few milliseconds later.

Dozens more FRBs were found thereafter. But all were like the first: "one-offs" that briefly belched radio waves into space and then were gone. That made it impossible to zero in on their location. It's a bit like hearing a momentary squeak from under your car's hood. If you hear it only once, chances are poor that you'll ever pin down its location or its cause.

But in 2012, the Arecibo radio telescope in Puerto Rico detected an FRB that eventually changed this frustrating situation. A few years after its discovery, this object was observed to hiccup again … and again, every few weeks or so. It was like a squeak that repeats, giving you the chance to raise the hood and pinpoint the source. In the case of 121102 (as it's lyrically named), astronomers used large radio telescope arrays — which are good for pinpointing sources on the sky — to learn that this FRB was in a nondescript galaxy 3 billion light-years away.

That phenomenal distance — 5 trillion times farther than Pluto — implies that whatever does the bursting is more energetic than a passel of puppies. Additionally, the fact that all FRBs are of short duration means that whatever's causing them is pretty small. Think of it this way: If a small group of people standing close together all say "boo" at the same time, then it's a pretty short sound. But if you're dealing with a large mob, the sound from the back takes a while to reach you, so the "boo" becomes a long wail.

Because FRBs last only a thousandth of a second or so, any object producing them couldn't be much bigger than 200 miles across — the distance radio waves can cover in that time. This suggests that the source is considerably smaller than an ordinary star: it might be a collapsed stellar corpse — the compact remains of a star that has exhausted its nuclear fuel — or possibly a black hole that's swallowing something or undergoing a collision.

While collisions might explain some of the FRBs, they don't make sense for the repeaters. You can't back up a couple of tangling black holes and have them give a repeat performance. And keep in mind that it's entirely possible that the one-hit wonders are actually repeaters whose encores haven't yet been heard. All FRBs might have the hiccups.

There are literally dozens of celestial objects that might be causing FRBs, ranging from prosaic things like souped-up supernovae — large stars that blow up at the ends of their lives — to weird things like magnetars — collapsed stellar corpses awash in strong magnetic fields. Some of the suggested explanations are truly far out and involve fracturing stellar crusts or exotic cracks in spacetime known as cosmic strings.

There are some who suggest that the FRBs might be alien signals, but that really doesn't make sense. The sources are spread all over intergalactic space, and arranging cooperative alien behavior when even one-way communication takes many billions of years seems unlikely — to put it gently.

Fact is, we simply don't know what causes FRBs. But here's my take: Almost every time astronomers turn up some unexpected new phenomenon in the sky, they're baffled. Quasars and pulsars were deeply puzzling when first discovered. So researchers adopt a Sherlock Holmes approach and collect clues — which is to say, they find as many examples of the new phenomenon as they can. These observations became grist for the theoreticians — wonky types who like nothing better than to solve nature's riddles.

Once there's an abundance of data, the theoreticians can usually cook up the correct explanation pretty quickly. This isn't always the case, of course. We still don't know what dark matter and dark energy are, despite decades of observation.

But I'm betting the odds. The new, repeating FRBs uncovered by CHIME are likely game-changers because they're ripe to be pinpointed and studied in detail. The drama of the FRBs is about to enter its second act, and I dare say that two years from now FRBs will be just another critter in the cosmic zoo.

Exotic and novel, yes, but at least we'll understand what they are.

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Event Horizon

SearchLites readers are apprised of the following conferences and meetings at which SETI-related information will be presented. League members are invited to check our World Wide Web site (www.setileague.org) under *Event Horizon*, or email to us at info@setileague.org, to obtain further details. Members are also encouraged to send in information about upcoming events of which we may be unaware.

February 14 – 16, 2020: *Boskone 2020*, Boston, MA.
February 21 – 23, 2020: *Farpoint Convention*, Hunt Valley, MD.
February 23 – 27, 2020: *SPACOMM 2020*, Lisbon, Portugal.
April 26, 2020, 1300 EDT: Twenty-Sixth SETI League Annual Membership Meeting, Little Ferry, NJ.
May 22 - 26, 2020: *Balticon 54* Baltimore Science Fiction society Annual Convention, Baltimore, MD.
June 9 - 11, 2020: *Global Space Exploration Conference*, St. Petersburg, Russia.
July 9 -12, 2020: *Readercon 31*, Quincy, MA.
July 10 -12, 2020: *Shore Leave 22*, Towson, MD.
July 29 - August 2, 2020: *78th World Science Fiction Convention*, Wellington, New Zealand.
August 15 - 23, 2020: *43rd COSPAR Scientific Assembly*, Sydney Australia.
August 29 - September 5, 2020: *International Union of Radio Science* General Assembly and Scientific Symposium, Rome, Italy.
October 12 - 16, 2020: *71st International Astronautical Congress*, Dubai, United Arab Emirates.
October 15 - 18, 2020: *Microwave Update*, Sterling, VA.
October 16 - 18, 2020: *Capclave*, Rockville, MD.
November 20 - 22, 2020: *Philcon 2020*, Cherry Hill, NJ.
August 25 - 29, 2021: *79th World Science Fiction Convention*, Washington, DC.
September 27 - 1 October 2021: *72nd International Astronautical Congress*, Paris, France. ❖

Hello Out There!

by Dan Duda

from the November, 2019 issue of Penn Central, the monthly newsletter of Central PA Mensa, used by permission

Who hasn't looked up at the night sky and wondered 'are we the only ones?' It's possible that even cavemen were awed by the possibilities.

"Hey Og, get out here!" The noise echoed through the cave. Og cleared his eyes and slowly staggered to the cave opening. "Wasup Backtoot?" (Yes, cave parents had a sense of humor). "I think there's someone over that mountain over there Og. And I think they're watching us." Og was incredulous. How could they watch us from so far away? How could they talk with each other at that distance? He saw no smoke signals; he heard no tom tom beats. (*OK, I'm guilty of historical misappropriation here. But stay with me – there's a point.*)

Neither Og nor Backtoot could imagine the existence of binoculars or radio telescopes. So, Og said, "Backtoot, if they're there watching us, we'd know it. We would have seen or heard something to alert us." I'm a big fan of SETI, and I really enjoyed our colleague Paul Shuch's SETI presentation at the Winter Solstice Regional Gathering a few years back. SETI's big question is "is there intelligent life beyond Earth?" And that's a legitimate question. But then others, like Enrico Fermi go beyond and ask, 'if there are so many intelligent civilizations out there, why haven't we heard from any of them?' And that question is only partly legitimate. Given the enormous time spans involved (and the potential for huge technological advances), isn't it more likely that we wouldn't have the tools to perceive communications from a more advanced civilization?

Consider the fact that the time interval between cave dwellers and modern society is less than 100,000 years. And look at the enormous advances in technology that have occurred over that span. Now consider a million; or a billion years for technology to evolve. What audacity for us to think that we'd be able to pick-up and understand messages from other civilizations.

Just like Og and Backtoot couldn't imagine cell phones; radio telescopes; LIGO gravity wave detectors; etc. isn't it likely that we can't even imagine the communications technology of civilizations who might be eons in advance of ours?

There's another useful comparison to help us contemplate our situation in time and space. Does an ant have any idea of our existence? Sure, it might have some comprehension of the sole of a shoe descending; or the intense beam of light from a young boy with a magnifying glass. But we can assume that real awareness of what we are and how we communicate is just not there.

The universe might very well be teeming with intelligent civilizations, many so far ahead of us in technology that we would have no idea how to look for signs of their existence. In addition to expecting that these civilizations would greet us by signaling prime numbers in sequence and that they would be receivable by our current state of technology, we need to ask ourselves:

- Do we really have the technology to intercept an advanced alien message?
- Would we understand it if we did?
- Would an alien civilization be interested enough in us to send it?
- Would the ant interpret the significance of the shadow of our foot shading his path?
- Would Og catch the significance of a glint of light reflecting off the glass of binoculars?

I know the people involved in SETI science are very intelligent, so there's no doubt they've considered this dilemma. But all I read seems to suggest that radio telescopes are all we need to intercept alien signals – if they exist. Hmmmm. In fairness, perhaps this is due to the fact that radio telescopes are the best tool we have at this time.

I do believe this search is essential for many reasons. In the immortal words of Carl Sagan, "In the deepest sense the search for extraterrestrial intelligence is a search for ourselves."

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