Vol. 27 Issue 4

Autumn 2026

# HORIZON

LA SOCIÉTÉ ROYALE D'ASTRONOMIE DU CANADA
New Brunswick Centre du Nouveau-Brunswick
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

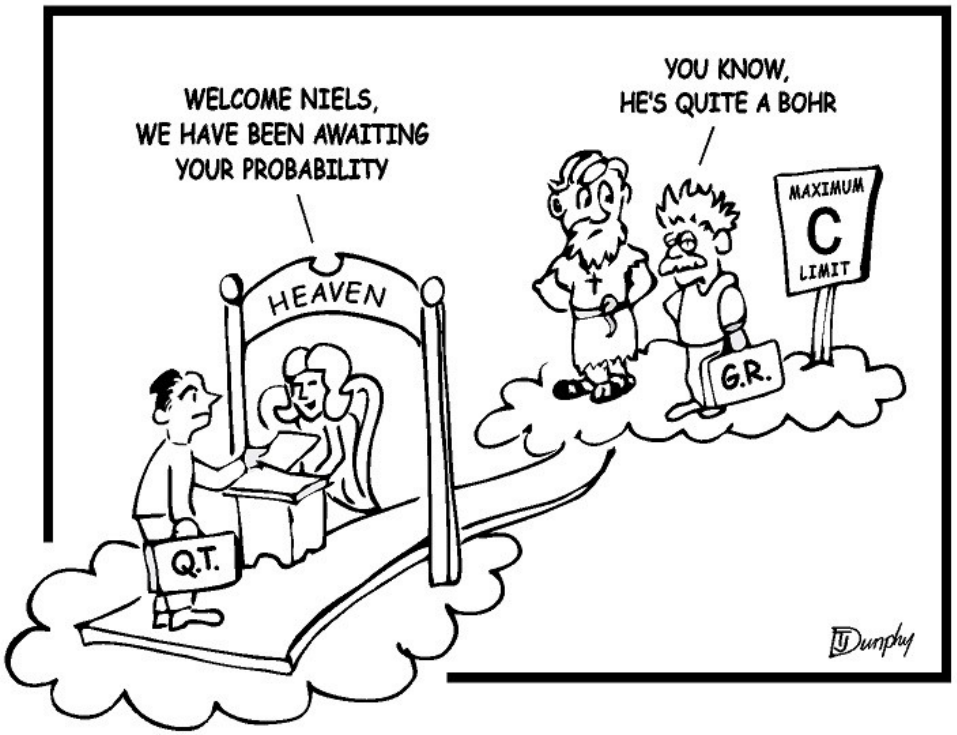
## NGC 6960 – Filamentary Nebula
### Image by François Thériault




This pretty nebula is part of the overall Veil Nebula complex and as such the overall Cygnus Loop. Perhaps more recognisable than its eastern sibling, NGC 6992 / 6995, it is known for its delicate wisps of gas flowing in front of a bright star.

Telescope: WO Zenithstar 80ED / focal length 575 mm
Camera: ASI 183MM Pro
Exposures: Hα = 30 x 300 s / OIII = 30 x 300 s / SII = 30 x 300 s
total = 7.5 hours.

## Ted's Toon




***Toon by Ted Dunphy***

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# Centre News

## Business Meetings

Third Saturday in some months but subject to change.

## Centre Presentation Meetings

Third-week evening of most months

## Star Parties 2027

Kouchibouguac May 28-29
Mount Carleton July 30-31 (tentative)
Fundy September 3-4 (tentative)
Kouchibouguac September 10-11
Mactaquac TBD



***The Kouchie Crew***
***Kouchibouguac Fall Festival***

***Photo submitted by Emma MacPhee***

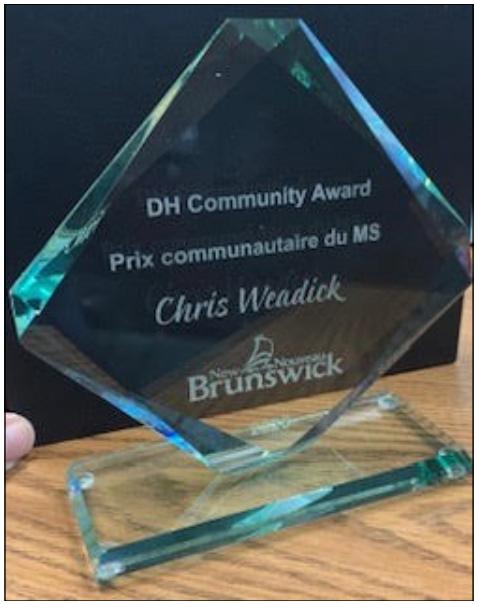
# Congratulations Chris Weadick!

Chris Weadick is passionate about astronomy and enjoys sharing that passion with others. As a amateur astronomer, Chris has been a member of the Royal Astronomical Society of Canada for 21 years and owns 13 telescopes that his wife may or may not know about.

Through volunteering with schools, UNB, and GNB Tourism, Chris is able make learning about planets, stars, and galaxies accessible to the community.

Most recently Chris volunteered at a joint GNB Tourism and Mactaquac Provincial Park event called Camping and Observing Weekend (aka the COW star party) where park goers were able to utilize one of several telescopes to view the wonders of the night sky.

Someone submitted my name for the Community Involvement program at the Department of Health. The summary I provided was that it is on behalf of RASC NB but they only give recognition to people, not programs.



## Halloween Outreach

**by Diana Popa**

Halloween is a great occasion for sidewalk astronomy. I've been meaning to do this for a few years now... call it "trick or peek." Having recently moved onto a busier street, I figured this would be the perfect year to try.

So, on the 31st I dusted off my two Dobs (5" and 8") and set them up outside around 6:30 pm. The Sun was just about to set, the skies were mostly clear, and everything looked promising. I had time to do a quick collimation on the 8", align the Telrad and the finder, and dig out the zoom eyepiece I reserve for outreach. A big white Dob isn't exactly subtle, so I got busy even before it got dark!



***"The Telescope Lady's" Halloween treat***

***Photo by Diana Popa***

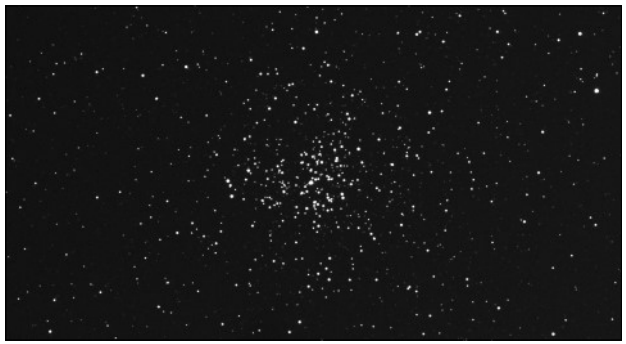
The first visitors were quite young, so I showed how telescopes work by having them look inside the big Dob. They noticed the curved mirror and how it distorted their images—very spoooooky! A very young man who couldn't have been more than two years old amazed us all when he approached the telescope confidently, leaned it forward/down until the eyepiece was as close as he could get it, then closed an eye and tried to look through. All this without instructions, like he had done it all his life!

When the ghosts and ghouls got older, I switched gears. Still not having much to look at, I picked a distant construction crane and had volunteers practise aiming the 8" Dob; first with the Telrad, then with the finder, and finally centering it in the eyepiece and focusing. I am a big believer in hands-on learning and Dobs are quite intuitive, so I had plenty of smiles and wows! Bonus: aiming at a terrestrial object also nicely demonstrated how images are reversed and flipped.

As the twilight sky grew darker a later group of goblins soon spotted the first star. Stellarium showed it to be Vega, which an older kid soon confirmed with their point-and-look app. A little later still, with yet another group, the sky was generous enough to do some proper stargazing. From Altair, we hopped to Sagitta, and then to the Coathanger asterism. A great way to show that "more zoomed in" isn't always better!

I knew Saturn would be rising in the east that evening, but didn't think it would clear the treeline at a reasonable hour, so I didn't mention it to anyone until a sharp-eyed monster asked to look at "that bright star" peeking through a gap. Several phone apps quickly confirmed it was Saturn, but as Ms. Frizzle would say, "The best way to know is to do." With some quick coaching, the original spotter soon had the honour of aiming the telescope and confirming it with his own eyes! (As a side note, I love Saturn for sidewalk astronomy. There's no wondering if people see it or not, because the gasps always give it away!)

The last group left around 7:30 pm, just as I was starting to feel the cold, yet I would have stayed longer if they wanted to. All in all, I had about 10 adults and 15 kids stop by for long enough to chat astronomy or play with the telescopes. I also talked about the RASC to two families whose kids seemed particularly keen. Perhaps we'll have some new members. Either way, I am now known as "the telescope lady" and already planning the next session.



***I had been doing some imaging testing using a 70 mm f/6 refractor. After the star tests thought I would try a DSO pic. M37 was not impressive, looked faint in the eyepiece. I took a 30 s image and look at those stars! I cropped it a bit to get it centered. It reaches to about mag 14.***

***Len Larkin***

# What's Up for Winter

**Curt Nason**

The highlights for the months of December to February are the Geminid meteor shower and lots of action by Jupiter's moons.

The **Sun** reaches the winter solstice at 16:50 on December 21. Solar activity is waning but aurorae can occur during this stage of the sunspot cycle. Earth is at perihelion on January 2.

New **Moon** dates are December 8, January 7 and February 6. The full Long Night's Moon occurs on the evening of December 23; seven and a half hours before perigee, two days after the solstice and a year or two past major lunar standstill. Not only is it close to my idea of a supermoon (full at perigee on the solstice), it is also close to being a superdupermoon (major standstill). A penumbral eclipse occurs on February 20 between 17:52 and 21:13, with maximum coverage of 94% of diameter at the midpoint. The Lunar X will be visible on January 14.

**Mercury** rises 90 minutes before sunrise on December 1 at magnitude -0.6, an easy target. It is at superior conjunction January 1, greatest elongation in the evening sky on February 3, and inferior conjunction on February 18.

**Venus** is at its greatest illuminated extent and within a wide binocular view of Spica as December begins, and it spends the next few months low in the southeastern sky. It reaches greatest western elongation on January 3.

**Mars** begins December in a wide binocular threesome with Regulus and Jupiter. It is at its first stationary point on January 11 and spends the latter half of that month passing through the Leo trio of M95-96-105, coming within a degree of M95 and M96 on January 25-26. Its angular diameter reaches 10" in late December and 13.8" when it is closest and at opposition on February 19. By the end of February Mars is back in the binocular arms of Regulus and about 10˚ from Jupiter's grasp.

**Jupiter** rises around 22:45 on December 1, reaches its first stationary point on December 12, and is at opposition on February 10. With its equator aligned toward us this year we are treated to extra moon events, including mutual events between two moons. Five double shadow transits are visible in December, all after midnight; and three in February, one at 23:22 on January 1.Mutual events occurring around or before midnight in December are Callisto eclipsing Europa at midnight on the evening of the 10th, Ganymede eclipsing Europa at 24:05 on the16th, Europa occulting Ganymede at 23:46 on the 19th, Ganymede occulting Io at 24:07 on the 23rd, and Europa eclipsing Ganymede at 22:46 on the 26th. You will want to be observing Jupiter a half hour before these times to experience the exciting build-up.

**Saturn** transits around 20:00 at the beginning of December and reaches its second stationary point on December 11. It spends the winter within the boundary of Cetus, crossing back into Pisces in late February. As its rings open its moons also become easier to see.

**Uranus** opens the season a week past opposition at magnitude 5.6, about a binocular width below the Pleiades in early evening. It reaches its second stationary point on February 8 and it remains within a binocular view of the Pleiades throughout the season.

**Neptune** starts December about 8˚ west of Saturn and it reaches its second stationary point on December 13. By the end of February it is setting around 20:00.

**Comet** There are currently no bright comets but 2P/Encke, with a 3.3 year period, will make a favourable target in Aquarius in mid-to-late January, brightening to magnitude 6 near the Sun in early February.

**Meteor Showers** The Geminids peak December 14 with the Moon setting by 22:00. The Ursids peak December 22 with a nearly full Moon. The Quadrantids (Boötids) peak January 3 with a waning crescent Moon.

**Zodiacal light** might be seen from a rural sky in the west an hour or two after sunset for two-weeks beginning February 22.

# Extraterrestrial intelligence, the Drake Equation, and the Allen Radio Telescope Array: Are We Alone?

**by David M. Hunter**

Amateur astronomy gives one the chance to look up into the third dimension and wonder what's up and out there? Are we alone in the Universe?

Although most moderns are disconnected from experiencing the cosmos directly, they generally believe extraterrestrial intelligence (ETI) exists. Witness today's popular culture: *Star Trek*, *Star Wars*, endless sci-fi movies, or Steven Spielberg's recent *Disclosure Day* movie. The common assumption is that ETI s are already amongst us or soon to be discovered by mankind. Certainly educated people have been led to believe that the Universe is so big and studded with planets that it is a certainty that ETIs exist, probably nearby. Frequent science reports about the discovery of new exoplanets, or the misleading claim that life has nearly been made in the lab, foster the idea about the inevitability of ETIs. But is this really true when we look at the evidence?

## What Is Life?

Life is stupendously complicated and has properties quite unlike normal matter. It is self-organising, adapts to changing circumstances, maintains homeostasis and order against the natural tendency for increased disorder (entropy). To a very good first approximation the bedrock of life is the cell.

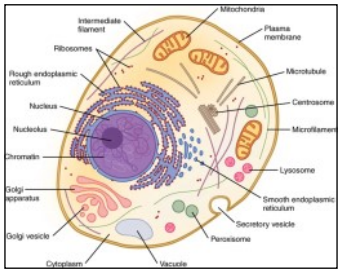



***Fig. 1: Diagram of a typical generalised human cell (Wikimedia Commons User: Iztwoz)***

For some modern viewpoints of life read the books by Ball [Ref. 1], Noble and Nobel [10] and y Arcas [17]. Then, for an important historical book on the subject see famous quantum physicist Erwin Schrödinger on the topic [13]. Schrödinger anticipated the discovery of DNA's (deoxyribonucleic acid) importance and properties, thinking that it would be like a stable crystal that would store important biological information and heredity. Crick and Watson, the discoverers of the DNA structure in 1953 (*https://en.wikipedia.org/wiki/DNA*) eventually led to the 'Central Dogma' which implied that DNA was the master genie computer code controlling and directing life. However, this has more recently been found to be false. Although DNA is definitely an important element in genetic inheritance, the expression of its information is actually controlled by more complex non-coding RNA (ribonucleic acid) mechanisms associated with epigenetics. DNA by itself is dead and helpless. Additionally, the morphogenesis of a fertilised egg into a complex multicellular organism, with different tissue types and organs, is not orchestrated by a master plan in the egg's DNA. See the referenced books for a more detailed explanation.

At the present time we still assume that ETIs will be biological (living) entities. Of course this might be a bad assumption, but to date that is how we frame our search. If ETIs are not biological we assume they first had biological precursors. The first Star Trek movie, *Star Trek: The Motion Picture,* was based on that premise. We believe that living things have special properties which enable them to bootstrap themselves from more simple forms to higher intelligent entities.

Therefore, we consider the appearance of life on the Earth. It must be stated at the outset that life started very early after the Earth's formation. Because of this some speculate that life did not first arise on Earth but was seeded from elsewhere via panspermia. Panspermia is not a crazy idea; Francis Crick, co-discoverer of the DNA structure, thought it possible due to the incredibly complicated nature of life. In other words, how could it have arisen on Earth given the odds against it? But somehow, somewhere in the Universe, perhaps neighbouring Mars, life appeared from non-life via a mysterious process called abiogenesis. See the timing estimates of abiogenesis on Earth in Table 2.

However, the emergence of intelligent technological life, namely us, arose very late, well beyond the midpoint in Earth's habitable lifespan when life could be sustained. Although the Sun is often quoted as having a lifetime of about ten billion years it continually increases in brightness during its lifetime. Because of this, in about one billion years the Earth will become too hot for complex creatures. The Earth is currently about 4.54 billion years old. Humanity appeared about 250,000 years ago!

During the last 75 years our appreciation of how complex life is has dramatically increased. At the time of Darwin the cellular substance called protoplasm, which comprises the bulk of cells, was thought to be a simple substance. This could not be further from the truth.

## The Drake Equation

It is amazing to think that just 100 years ago the scientific consensus was that our Galaxy, the Milky Way, was the entirety of the Universe, and that the Universe was infinitely old and eternal. The idea that the Universe was infinitely old and unchanging (The Steady State Theory (SST) was not overthrown until the 1960s with the discovery of the cosmic microwave background (CMB) radiation. The CMB basically clinched the Big Bang hypothesis.

Francis Drake in the early 60s formulated a simple equation to determine the number of technological civilisations in either a galaxy or the Universe (Eq. 1). He formulated the equation when the SST was still widely accepted. The search for extraterrestrial intelligence (SETI) has to this point yielded nothing, but of course that doesn't mean that ETI doesn't exist. This discrepancy between calculations suggesting a large number of ETIs and our lack of observing any of them is called 'The Fermi Paradox', first enunciated in 1950 by the famous physicist Enrico Fermi during a lunchtime conversation.

*Eq.1*: $$N = R_* f_p n_e f_l f_i f_c * L$$

The terms are identified in the following list:

- $N$: number of technological civilisations
- $R_*$: rate of star formation per year
- $f_p$: fraction of stars with planets
- $n_e$: number of Earth-like planets per system with planets
- $f_l$: fraction of planets with life
- $f_i$: fraction of planets with intelligent life
- $f_c$: fraction of intelligent civilisations that are detectable via their technological ambitions
- L: average longevity of detectable civilisations

In the approximately 65 years since Drake's equation was formulated the estimates of continue to vary wildly. Drake currently thinks that is 10,000 whilst others suggest several million or zero, *i.e.*, we might be the only technological civilisation in the Galaxy. Carl Sagan opined for an optimistically large one million or a pessimistic number of ten. Only one factor has become better established since 1961; $n_e$ is likely to be 1 but there may be some evidence that may be 1 to 2, if a rocky planet in the habitable (liquid water) zone is to be considered Earth-like.

The Drake equation clearly shoves a number of very complex factors under the rug. Typically each variable has been given a fixed estimate ignoring its uncertainty. The authors in the paper titled *Dissolving the Fermi Paradox* call that the "point estimate method." Since there is a great deal of uncertainty in most of the Drake parameters, they statistically model most of them as having log-uniform distributions. A log-uniform distribution is a reciprocal distribution: that is the method they take in their statistical modelling. Shown in Table 1 is their choice of values for the Drake equation variables.

***Table 1. From the paper Sandberg et al [12]***

| | |
|---|---|
| $R_*$ | log-uniform from 1 to 100 |
| $f_p$ | log-uniform from 0.1 to 1 |
| $n_e$ | log-uniform from 0.1 to 1 |
| $f_l$ | log normal rate |
| $f_i$ | log-uniform from 0.001 to 1 |
| $f_i$: | log-uniform from 0.01 to 1 |
| L | log-uniform from 100 to $10x10^9$ |

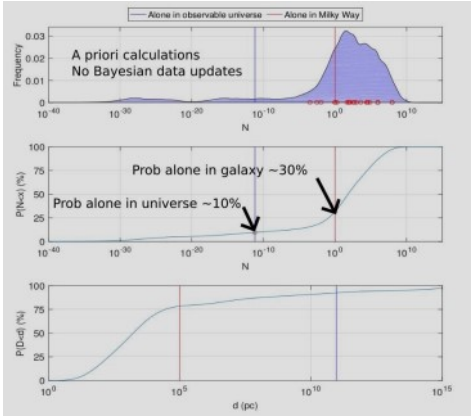



***Fig2:Calculated plots of the Drake Equation adapted from Fig. 1 of the paper by Sandberg et al [12]. The calculations used variables from Table 1 obtained from the same paper. The calculations use no data concerning possible evidence of ETIs in the Galaxy or Universe. The axis is logarithmic. Since the authors are trying to show it is possible we are alone in our Galaxy (or even Universe) the middle plot shows 'aloneness' probabilities versus N, their estimated values of currently existing ETIs. From this analysis they deduce there is a 30% probability that we are alone in the Galaxy (N~1)***

## Bayesian Analysis

There are two main approaches of statistics and probability theory: the frequentist and the Bayesian. Let it be said that I am no expert of probability theory, but I hope what I am saying is basically true! Whilst preparing this article I was overwhelmed with the Bayesian modelling sophistication in some of the research articles, e.g., Kipping [5] . I have been trying to educate myself about Bayesian analysis and I would like to point out that there are excellent articles, open source software, and free books to utilise. Foremost is John K. Kruschke's book [6], freely available to download. The R Language RStudio IDE *https://posit.co/downloads* is also freely available for installation on Linux, Windows and Mac computers.

A common credo amongst certain scientists is that the scientific method should avoid terms such as 'belief' and that the world should be described in totally 'objective' terms, avoiding any influence of human participation or interaction. Of course in the last 100 years quantum physics, with the 'measurement problem', has exposed that idea highly suspect. For instance John Wheeler, the great 20$^{th}$ century physicist, introduced the idea of the quantum participatory Universe, wherein the observer participates in the evolution of events. The frequentist probability view is the long-run frequency of an event over a large (ideally infinite) number of trials. The Bayesian probability view is a degree of belief or certainty about an event, which can be updated when new evidence arises.

In the Bayesian view one starts with a prior distribution about what one already knows and then updates expectations based on new data. It should be obvious that the frequentist approach can not be applied to a large number of 'historical' questions such as evolution and the nature of the Universe. We cannot re-run the clock and test for statistical outcomes.




***Fig. 3: Thomas Bayes was an English statistician, philosopher, and Presbyterian minister. His approach to statistical inference is named after him. His methods were partly motivated by his interest in showing the existence of God.***

***Image is a faithful photographic reproduction of a two-dimensional, public domain work of art. https://commons.wikimedia.org/wiki/File:Thomas_Bayes.gif***

## Bayesian Modelling

Now in the field of SETI there are very, very little data! The *a priori* estimates of the various Drake Equation terms are given in Table 1. We have no data concerning the prevalence of life off of the Earth, but we do know that life started very early after the Earth's formation. We have failed thus far to detect any signals (radio or otherwise) from ETIs or any evidence of galactic colonisation or Dyson sphere artefacts. Nevertheless it can be conjectured, using statistical Bayesian modelling methods (which are beyond the scope of this article) how various models would affect our expectations of discovering ETIs.

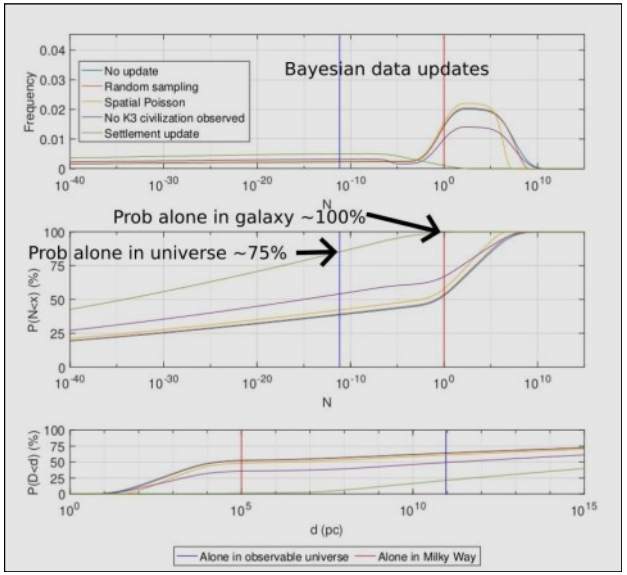



***Fig.4: Bayesian updates as calculated in Sandberg et al [12]. If one takes into account the lack of any evidence for 'expected' ETI engineering in the Galaxy or Universe the prospects for ETIs is substantially diminished.***

Shown in Fig. 4 is a Bayesian update from the same paper referenced in Fig. 2. Some of the modelled terms pertain to lack of evidence of galactic civilisations reaching Earth (settlement) or evidence of advanced civilisations using large amounts of power which are rated in K0, K1, K2, K3 (Kardashev) scales as devised by the Soviet and Russian Nikolai Kardashev in 1964. Also about the same time Freeman Dyson invented the concept of a Dyson Sphere, a spherical or ring structure built around a star to capture a significant

fraction of the star's energy. A key feature of a Dyson sphere is that since the sphere would have to emit all of the acquired energy back to space in the infrared (heat), which would make it an easy signature to detect.

## Evolutionary Timings

In preparation for this article I read, with incomplete comprehension, at least two other recent papers (Kipping [5] and Snyder-Beattie et al [15]). Broadly speaking these papers try to flesh out the timing of the appearance of intelligent life on the Earth. Shown in Table 2 are some of the transitional events and when they occurred. Both papers conclude that it is strange that life appeared early in Earth's history but that it took a very long time for intelligence to appear. With regards to the early appearance of life, some take this as meaning that abiogenesis is a universal, fast, natural occurrence given the conditions on the early Earth. This may or may not be true. It is argued (Carter [3]) that this could be a mistaken conclusion since it involves a possible selection effect. Others argue that this could be because life did not originate on Earth but came by panspermia or even directed panspermia (purposeful, intelligent agency).

The reason intelligent life may have taken so long to appear on Earth is that it took a long time to engineer the planet, via photosynthesis, with an oxygen atmosphere sufficient to support complex life forms. See Fig. 5. The Gaia hypothesis [9], also endorsed by the famous biologist Lynn Margulis, takes this viewpoint.

***Table 2: Data for Evolutionary Transition Timing and Biosphere Start/End Dates***
***Source: Snyder-Beattie et al [15]***

| *Transition* | *Date, Gya* | *Source* | *Method* |
|---|---|---|---|
| Abiogenesis | >4.10±0.01 | Bell *et al.* (2015) | Carbon isotope ratio |
| Abiogenesis | 3.9 | Betts *et al.* (2018) | Molecular clock |
| Abiogenesis | >3.86±0.01 | Mojzsis *et al.* (1996) | Carbon isotope ratio |
| Abiogenesis | >3.77–4.28 | Dodd *et al.* (2017) | Microfossils, isotope ratio |
| Abiogenesis | >3.5 | Awramik (1992) | Microfossils, stromatolites |
| Cyanobacteria | <10 Ma | Lazcano and Miller (1994) | Molecular evolution model |
| Eukaryotes | <1.84 | Betts *et al.* (2018) | Molecular clock |
| Eukaryotes | >1.87–1.68 | Parfrey *et al.* (2011) | Molecular clock |
| Sex | >1.2 | Butterfield (2000) | Fossils of red algae |
| Intelligence | ≈0 | Pääbo (2014) | Oldest artwork |
| *Boundary* | *Timing* | *Source* | *Method* |
| Oceans form | 4.40 Gya | Peck *et al.* (2001) | Oxygen isotope ratio |
| Oceans form | 4.3–4.2 Gya | Cavosie *et al.* (2005) | Oxygen isotope ratio |
| Biosphere ends | 0.8–1.2 Ga | Franck *et al.* (2006) | Climate model |
| Biosphere ends | 0.9–1.5 Ga | Caldeira and Kasting (1992) | Climate model |
| Biosphere ends | ≈1.0 Ga | Kasting (1988) | Climate model |
| Biosphere ends | 1.8–3.3 Ga | Rushby *et al.* (2013) | Climate model |

Biosphere end dates are given for eukaryotic life. Extremophiles may persist beyond the dates given.

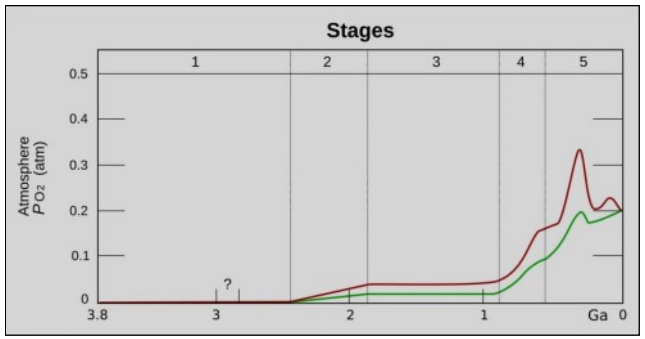



***Fig. 5: History of Earth's atmospheric oxygen levels. https://commons.wikimedia.org/wiki/File:Oxygenation-atm-2.svg***

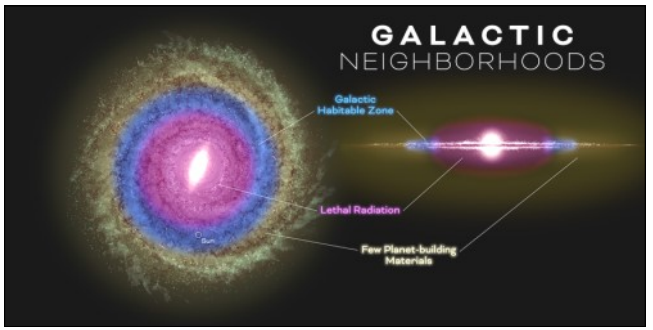



***Fig: 6: The galactic habitable zone. The more we investigate the nature of our planet and the solar system the more unique they appear to be. This is called 'The Rare Earth Hypothesis'. One example is the location of the Sun in our galaxy. https://commons.wikimedia.org/wiki***

**Evidence for Extraterrestrial Intelligence?**
Since the SETI enterprise was initiated about 65 years ago to specifically look for ETI radio signals, nothing has been convincingly picked up. The radio discovery of very accurate periodic radio pulses by Jocelyn Bell Burnell in late 1967 caused a stir and were initially labelled LGMs (Little Green Men). It was eventually realised that the pulses were slowing down and were due to rapidly rotating neutron stars with strong magnetic fields. Sadly, only her supervisor Antony Hewish was awarded the Nobel prize for the discovery. The so called Wow! signal was a strong, narrowband radio signal detected on the 15 August 1977, by Ohio State University's Big Ear radio telescope during a search for extraterrestrial intelligence. It lasted 72 seconds, came from the direction of the constellation Sagittarius, and reached an intensity about 30 times higher than background noise near the 1,420 MHz hydrogen line. The signal did not repeat and is thought by many to have been caused by a natural process.

In October 2017 the first known interstellar object 1I/Oumuamua was observed to enter and leave the solar system. It was estimated to be extremely long and cigar shaped. Its path through the solar system showed non-Newtonian acceleration, which does happen with natural comets as they eject gases due to solar heating. However, Oumuamua showed no comet-like tail. The acceleration has been proposed as due to the emission of molecular hydrogen, but Avi Loeb, head of Harvard Astronomy, proposes that it was an interstellar light sail vehicle [8].

Recently Nicole Mortillaro, the former editor of the Journal of the Royal Astronomical Society of Canada, posted a CBC article
*https://www.cbc.ca/news/science/seti-extraterrestrial-signal-9.7416954*
about the Allen Radio Telescope Array, shown in Fig. 7, dedicated to the task of searching for ETI radio signals. As our technology advances we will be able to more thoroughly search for evidence of ETI. The scientific paper outlines a new sophisticated scanning method for ETI radio signals. It has not found anything yet [14].



***Fig.7: The Allen Radio Telescope Array for SETI. Image from Wiki Media Commons***

**Fine Tuning For Life**
Over the past 70 plus years it has been realised that the laws of physics in our Universe are exquisitely balanced to allow the emergence of life as we know it. Brandon Carter seriously advanced this concept in the 1970s and 1980s when he introduced the anthropic cosmological principle. When you were in school or university you may have wondered things such as: Why is the proton 1,836.15 times more massive than the electron? Why is space three dimensional? It turns out there are a lot of interesting questions like that. Is the Universe just an accidental jumble? There are a number of books and discussions about this topic: Barrow and Tipler [2], Lewis and Barnes [7], and Rees [11]. It is now an accepted scientific fact that the laws of physics and the physical constants are very finely tuned to a very high accuracy to permit the Universe to have life. This is an awkward fact for those with a modern existential philosophical view that the Universe, life, and just about everything are accidental and pointless. Capturing this nihilistic viewpoint. Steven Weinberg wrote in his book, *The First Three Minutes*: "The more the universe seems comprehensible, the more it also seems pointless." But others have a different view [16].

Sir Fred Hoyle, an architect of the SST, had been in the 'pointless' camp until he had an epiphany in 1953 when he was working out the stellar fusion paths that create heavier elements from hydrogen and helium in stellar interiors. He made an exact prediction about the necessary existence of a resonance energy level in carbon-12, which would be crucial for carbon formation to be possible in stars. It is now known as the Hoyle state: an energy resonance of 7.65 MeV in the carbon-12 nucleus. His prediction was stunningly verified when experimentalists probed for the energy level and found the it exactly where Hoyle had predicted.

The details are more subtle than can be told here, it also involves subtle energy levels in the oxygen-16 nucleus. For an in depth discussion of this story refer to the ground

breaking book by Barrow and Tippler [2], pages 250-253. It might be said that the anthropic principle is a tautology, that of course things have to be the way they are or else we wouldn't be here to discuss it. But Hoyle's prediction clearly shows the principle to have powerful scientific and philosophical implications.

There are about 27 constants in the standard model of physics and gravity theory, which our current theories cannot predict. Changing many of these constants, just slightly, makes the Universe hostile to life or just plain unstable, featureless, or very short lived.

## Copernican Principle or the Rare Earth Hypothesis?

The scientific establishment generally prides itself in holding the naturalistic viewpoint that our world can be explained by strictly purposeless, undirected, materialistic processes. It further has held that there is nothing special about Earth or our place in the Universe, a consequence due to the development of the Copernican principle, when Earth was dethroned from the centre of the solar system. Furthermore biology, due largely to the 'Central Dogma' stated by Francis Crick in 1957, in which genetic information is said to flow unidirectionally from DNA to RNA to proteins (the biological soma), posits living things are as von Neuman/ Turing-like state computer machines. But modern biology is moving away from this paradigm, or at least strongly modifying it (see Ball [1], Noble and Nobel [10]). In short, DNA is not the master controller but just part of a much more sophisticated living system.

The point I am trying to make is that living things are not helpless systems depending fatefully on random chances via Darwinian natural selection. Instead, they are purposeful, intelligent, and goal directed. This is the viewpoint being developed by Michael Levin (*https://drmichaellevin.org/)* and others. Many mathematicians, biologists, and physicists have marvelled at the seeming impossibility of life and its still mysterious emergence.

Although its is argued in reference that life is a strongly computational phenomenon, y Arcas [17] recognises that living systems have goals and exhibit teleology, long considered an anathema in the sciences. All of us humans daily deliberate, make plans, and engineer an organised future, impossible through random chance procedures. Isn't it obvious? And why would not the entire cosmos be similarly acting?

## Fred Hoyle's Outrageous Proposition

The viewpoint suggested above was fully stated in 1983 [4].

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## Beautiful Nebulae

### Images by François Thériault



***LDN 817 Little Veil Nebula***

In the south of Cygnus, near Albireo, we can find the SNR G65.3+5.7 supernova remnant complex. It is very faint and very large. Even shooting with a 330 mm scope, I was only able to capture a very small portion of the south-west perimeter of the nebula.

***LBN 251 Longhorn Nebula***

In the middle of Cygnus, this region is a turbulent zone with lots of molecular clouds. The particular feature is classified as LBN 251 (Lynd's Bright Nebula Catalogue). It is called the "Longhorn" due to its resemblance to a longhorn bull head. Some others will call it "The Dolphin." The feature spans a bit larger than the size of the full Moon.



## RASC NB Outreach Events and Handouts

| Year | # of Events | People At Events | Live Feed | Youth | Star Finders English | Star Finders French | Moon Guides English | Moon Guides French | Volunteer Hours |
|---|---|---|---|---|---|---|---|---|---|
| **2017** | 248 | 9951 | 8441 | | 2276 | 162 | 2262 | 131 | 1937 |
| **2018** | 187 | 7289 | 37,922 | >1300 | 1788 | 170 | 1635 | 79 | 1355 |
| **2019** | 240 | 7036 | 46,675 | 2997 | 1320 | 216 | 1520 | 213 | 1950 |
| **2020** | 171 | 1859 | 161,688 | 954 | 817 | 22 | 636 | 125 | 1079 |
| **2021** | 131 | 731 | 60,240 | 565 | 108 | 0 | 46 | 0 | 1160 |
| **2022** | 173 | 12,952 | 63,122 | 10,192 | 586 | 60 | 472 | 106 | 1809 |
| **2023** | 168 | 23,419 | 9787 | 20,612 | 556 | 223 | 452 | 110 | 1789 |
| **2024** | 186 | 12,362 | 12,304 | 6805 | 352 | 92 | 506 | 87 | 2331 |
| **2025** | 167 | 4907 | 61,810 | 2506 | 607 | 167 | 808 | 90 | 2237 |
| **2026** | 143 | 3641 | 1,109,808 | 1563 | 381 | 86 | 439 | 82 | 1869 |

## Types of Outreach Events

| Year | Presenta-tion | Night Observing | Day Ob-serving | Youth Group | School Talks | Exhibi-tion | Observ./ Planet'm |
|---|---|---|---|---|---|---|---|
| **2017** | 61 | 89 | 22 | 19 | 50 | 6 | 1 |
| **2018** | 50 | 80 | 13 | 18 | 20 | 5 | 1 |
| **2019** | 73 | 94 | 10 | 22 | 36 | 5 | 0 |
| **2020** | 86 | 43 | 5 | 8 | 29 | 0 | 0 |
| **2021** | 65 | 48 | 6 | 1 | 11 | 0 | 0 |
| **2022** | 72 | 52 | 6 | 4 | 34 | 4 | 0 |
| **2023** | 60 | 13 | 8 | 14 | 69 | 4 | 0 |
| **2024** | 101 | 23 | 8 | 15 | 33 | 6 | 0 |
| **2025** | 76 | 36 | 7 | 21 | 26 | 1 | 0 |
| **2026** | 92 | 23 | 8 | 1 | 18 | 1 | 0 |

# Astronomy is for the birds... and dung beetles

**Sept. 2026 newspaper column**

**by Curt Nason**

When my grand-turtle James visits in summer I take him outside for a roam in the yard, where he looks sunward for a while before ambling back inside to his home-away-from-home tank through our attached garage. I know he is attracted to the solar warmth rather than studying the Sun like I do, but are any animals aware of the stars in the night sky?

Some birds that migrate during the day use the Sun to navigate seasonally. Using their internal clock for awareness of morning, midday and evening they know that the Sun will pass from their right to their left as they head northward over the day in spring. Some also detect polarized sunlight scattered off the atmosphere, which is strongest at a 90-degree angle from the Sun and allows those birds to know the Sun's location in twilight. Other methods such as memory of the landscape from previous migrations and sensing the Earth's magnetic field are also used.

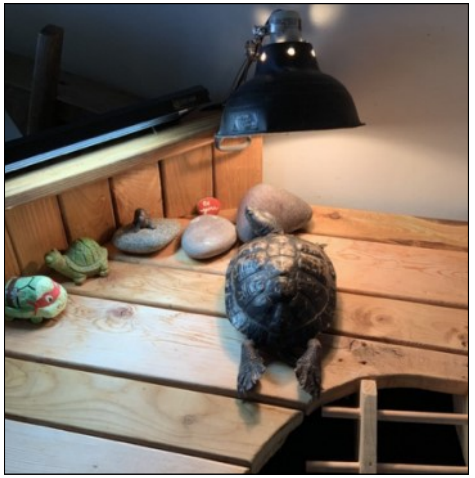
Nocturnal migrators seeking to avoid predators and heat stress have alternative methods for finding their way, and some of them are known to use celestial navigation. They learn that the stars closer to celestial north make smaller circles in the night sky as the Earth rotates. Indigo buntings and bobolinks are two of our summer birds that are avian astronomers. How do we know that?

In the mid-20th century German ornithologists noticed that European warblers caged outdoors faced toward their migration direction on clear nights, but in random directions on overcast nights. The birds exhibited the same tendencies when placed in a planetarium showing a simulation of the night sky. Later, an ornithologist at Cornell University tested indigo buntings. After establishing that they orient toward their favoured direction at spring migration time, he tested them in a planetarium and they faced the northern stars. In further tests he would change the direction of the northern stars to the east or west, sometimes not showing all of the stars to simulate cloudy skies. The birds continued to face the northern stars rather than celestial north, showing that they recognized the star patterns and didn't need to see all of them.

Later, the planetarium projector was programmed to make the star Betelgeuse in Orion the centre of celestial north and the ornithologist exposed young birds to this simulated sky. When placed in the planetarium with the proper sky for their southern trip, they faced away from Betelgeuse rather than from Polaris, the North Star. This indicated that the birds learned the northern star patterns rather than knowing them innately.

A recent issue of Sky & Telescope magazine contained an article by Javier Barbuzano on animals that navigate by the stars. In addition to expanding my knowledge of the above it included tests performed on Dogong moths, which travel a thousand kilometres from southern to northern Australia to escape the summer heat, and South Africa's dung beetle. These nocturnal beetles shape pieces of tasty (to them) dung into a ball and roll it straight home, using the orientation of the Moon as a guide and the Milky Way on moonless nights. Scientists verified the latter by attaching tiny cardboard helmets to a cohort that prevented them from seeing the sky. Contrary to the straight-walking group with transparent helmets, these beetles walked in circles. Tests with the moths proved they also orient to the north-south direction of the Milky Way, which is higher and brighter in the southern hemisphere.

We know that hatchling sea turtles follow the glitter path of the stars and moonlight to reach the ocean. Perhaps James keeps the Sun to his back to head north toward the garage.



***James the Homing Turtle...at home***

***Photo by S Nason***