Simply In Awe!

It’s both beautiful and yet beyond comprehension.

When we have a clear night there are two occasions for me to gaze upwards and become lost in thought. One is in the evening when the dogs are outside just before going to bed. The other is in the morning because we are usually awake well before sunrise.

We are very lucky in that there is no light pollution locally.

So, in the evening, while I look at the broad expanse of stars, my eyes are drawn to the Big Dipper and to Orion.

In the morning, when we look to the East there is Venus sparkling bright in the night-sky over the hills.

I still vividly remember all those years ago when I was sailing in the Western Mediterranean coming on deck in the middle of the night to find the stars down to the horizon all 360 degrees about me. I am sure it will be one of the last memories of mine just before I die! I hope so!

But I speak of the solar system. Here’s an article that was recently published by EarthSky that goes way beyond the solar system. It is a wonderful essay and almost mystical.

What is a galaxy?

Posted by Andy Briggs in ASTRONOMY ESSENTIALS, September 25, 2020

We live in a galaxy called the Milky Way. But there is so much more to know about these grand and glorious star islands in space! Click in here, and prepare to have your mind expanded.
This is a giant galaxy cluster known as Abell 2744, aka Pandora’s Cluster, located in the direction of the constellation Sculptor. The cluster is about 4 million light-years across and has the mass of 4 trillion suns. It appears to be the result of a simultaneous pile-up of at least 4 separate, smaller galaxy clusters that took place over a span of 350 million years. Read more about this image at HubbleSite. Image via NASA/ESA/J. Lotz/M. Mountain/A. Koekemoer/the Hubble Frontier Fields Team.

A galaxy is a vast island of stars in an ocean of space. Galaxies are typically separated from one another by huge distances measured in millions of light-years. Galaxies are sometimes said to be the building blocks of our universe. Their distribution isn’t random, as one might suppose: galaxies are strung out along unimaginably long filaments across the universe, a cosmic web of star cities.

A galaxy can contain hundreds of billions of stars and be many thousands of light-years across. Our own galaxy, the Milky Way, is around 100,000 light-years in diameter. That’s about 587,900 trillion miles, nearly a million trillion kilometers.

Galaxies are of widely varying sizes, too.

There are an estimated two trillion galaxies in the universe.
Illustration showing snapshots from a simulation by astrophysicist Volker Springel of the Max Planck Institute in Germany. It represents the growth of cosmic structure (galaxies and voids) when the universe was 0.9 billion, 3.2 billion and 13.7 billion years old (now). Image via Volker Springel / MPE/ Kavli Foundation.

Galaxies group together in clusters. Our own galaxy is part of what is called the Local Group, for example: a cluster comprising 55 galaxies that we know of so far.

In turn, galaxy clusters themselves group into superclusters. Our Local Group is part of the Virgo Supercluster.

The “glue” that binds stars into galaxies, galaxies into clusters, clusters into superclusters and superclusters into filaments is – of course – gravity, the universe’s construction worker, which sculpts all the structures we see in the cosmos.

Distances from the Local Group for selected groups and clusters within the Local Supercluster, which is called the Virgo Supercluster.

There are several basic types of galaxy, each containing sub-types. Galaxies were first systematically classified, based on their visual appearance, by the famous astronomer Edwin P. Hubble in the late 1920s and 30s, during years of painstaking observations. Hubble’s Classification of Galaxies, as it is known, is still very much in use today, although, since Hubble’s time, like any good classification system it has been updated and amended in the light of new observations.

Before Hubble’s study of galaxies, it was believed that our galaxy was the only one in the universe. Astronomers thought that the smudges of light they saw in their telescopes were in fact nebulae within our own galaxy and not, as Hubble
discovered, galaxies in their own right. It was Hubble who demonstrated, by measuring their velocities, that they lie at great distances from us, millions of light-years beyond the Milky Way, distances so huge that they appear tiny in all but the largest telescopes. Moreover, he demonstrated that, wherever he looked, galaxies are receding from us in all directions, and the further away they are, the faster they are receding. Hubble had discovered that the universe is expanding.

A diagrammatic representation of Edwin Hubble's “tuning fork diagram.” In the late 1920s and 30s, Hubble conducted the laborious observations needed to begin to classify galaxies. His original classification scheme was published in 1936 in a book called “The Realm of the Nebulae.” His original scheme is – like all scientific work – continually being modified. But his idea of a “tuning fork diagram” has continued to be useful. Image via Las Cumbres Observatory.

The most common type of galaxy is the one most people are familiar with: the spiral galaxy. The Milky Way is of this family. Spiral galaxies have majestic, sweeping arms, thousands of light years long, made up of millions upon millions of stars. Our solar system is situated about 2/3 of the way out from the galactic center towards the periphery of the galaxy, embedded in one of these spiral arms.

Spiral galaxies are also characterised by having a bright center, made up of a dense concentration of stars, so tightly packed that from a distance the galaxy’s center looks like a solid ball. This ball of stars is known as the galactic bulge. At the center of the Milky Way – within the galactic bulge – the density of stars has been calculated at 1 million per 34 cubic light-years, for example.

Meanwhile, in the vicinity of our sun, the stellar density has been estimated as 0.004 stars per cubic light-year. Big difference!
The Milky Way is, in fact, in one of Hubble’s spiral galaxy sub-types: it’s a **barred spiral**, which means it has a bar of stars protruding out from either side of the center. The ends of the bar form the anchors of the spiral arms, the place from where they sweep out in their graceful and enormous arcs. This is a fairly recent discovery: how the bar forms in a galaxy is not yet understood.

Also established recently is the fact that the disk of the Milky Way is not, as most diagrams depict, flat: it is **warped**, like a long-playing vinyl record left too long in the sun. Exactly why is not known, but it is thought to be the result of a gravitational encounter with another galaxy early in the Milky Way’s history.

**Elliptical galaxies** are the universe’s largest galaxies. They are huge and **football**-shaped.

They come to be because – although most galaxies are flying apart from each other – those astronomically close to each other will be mutually gravitationally attracted. Caught in an inexorable gravitational dance, eventually they merge, passing through each other over millions of years, eventually forming a single, **amorphous** elliptical galaxy. Such mergers may result in the birth of new generations of stars as gravity’s shock-wave compresses huge clouds of interstellar gas and dust.

The Milky Way is caught in such a gravitational embrace with M31, aka the **Andromeda galaxy**, which is 2 1/2 million light-years distant. Both galaxies are moving toward each other because of gravitational attraction: they will **merge** in about 6 billion years from now. However, both galaxies are surrounded by huge **halos** of gas which may extend for millions of light-years, and it was **recently discovered** that the halos of the Milky Way and M31 have started to touch.
The two galaxies have had their first kiss.

Galaxy mergers are not uncommon: the universe is filled with examples of galaxies in various stages of merging together, their structures disrupted and distorted by gravity, forming bizarre and beautiful shapes.

Galaxies may take billions of years to fully merge into a single galaxy. As astronomers look outward in space, they can see only “snapshots” of this long merger process. Located 300 million light-years away in the constellation Coma Berenices, these 2 colliding galaxies have been nicknamed The Mice because of the long tails of stars and gas emanating from each galaxy. Otherwise known as NGC 4676, the pair will eventually merge into a single giant galaxy. Image via [Wikimedia Commons](https://commons.wikimedia.org/).

At the lower end of the galactic size scale, there are the so-called dwarf galaxies, consisting of a few hundred to up to several billion stars. Their origin is not clear. Usually they have no clearly defined structure. Astronomers believe they were born in the same way as larger galaxies like the Milky Way, but for whatever reason they stopped growing. Ensnared by the gravity of a larger galaxy, they orbit its periphery. The Milky Way has around 20 dwarf galaxies orbiting it that we know of, although some models predict there should be many more.

The two most famous dwarf galaxies for us earthlings are, of course, the Small and Large Magellanic Clouds, visible to the unaided eye in Earth’s Southern Hemisphere sky.

Eventually, these and other dwarf galaxies will be ripped apart by the titanic maw of the Milky Way’s gravity, leaving behind a barely noticeable stream of stars across the sky, slowly dissipating over eons.
Lynton Brown captured this beautiful image of the Milky Way over Taylor’s Lake near Horsham, Australia, on April 22, 2019. The 2 objects on the right are the Magellanic Clouds. Thank you, Lynton!

It is believed that all galaxies rotate: the Milky Way takes 226 million years to spin around once, for example. Since its birth, therefore, the Earth has travelled 20 times around the galaxy.

At the center of most galaxies lurks a supermassive black hole, of millions or even billions of solar masses. The record holder, TON 618, has a mass 66 billion times that of our sun.

The origin and evolution of supermassive black holes are not well understood. A few years ago, astronomers uncovered a surprising fact: in spiral galaxies, the mass of the supermassive black hole has a direct linear relationship with the mass of the galactic bulge. The more mass the black hole has, the more stars there are in the bulge. No one knows exactly what the significance of this relationship is, but its existence seems to indicate that the growth of a galaxy's stellar population and that of its supermassive black hole are inextricably linked.
This discovery comes at a time when astronomers are beginning to realize that a supermassive black hole may control the fate of its host galaxy: the copious amounts of electromagnetic radiation emitted from the maelstrom of material orbiting the central black hole, known as the **accretion disk**, may push away and dissipate the clouds of interstellar hydrogen from which new stars form. This acts as a throttle on the galaxy’s ability to give birth to new stars. Ultimately, the emergence of life itself may be tied to the activity of supermassive black holes. This is an area of much ongoing research.

While astronomers still know very little about exactly **how galaxies formed** in the first place – we see them in their nascent forms existing only a few hundred million years after the Big Bang – the study of galaxies is an endless voyage of discovery.

Less than a hundred years after it was realized that other galaxies beside our own exist, we have learned so much about these grand, majestic star cities. And there is still much to learn.

**Bottom line:** What is a galaxy? Learn about these starry islands in space.

There are an estimated **two trillion** galaxies out there. It is beyond comprehension. Well it is to this mind sitting in front of his Mac in a rural part of Oregon. **Two trillion!** I can’t even get my mind around the fact that our local galaxy, our Milky Way, is 100,000 light years across. Although some would say that it is even larger; about 150,000 light years across. And what is a light year?

Here’s **NASA to answer** that:

A light-year is a unit of distance. It is the distance that light can travel in one year. Light moves at a velocity of about 300,000 kilometers (km) each second. So in one year, it can travel about 10 trillion km. More precisely, one light-year is equal to 9,500,000,000,000 kilometers.

**Why would you want such a big unit of distance?** Well, on Earth, a kilometer may be just fine. It is a few hundred kilometers from New York City to Washington, DC; it is a few thousand kilometers from California to Maine. In the **universe**, the kilometer is just too small to be useful. For example, the distance to the next nearest big galaxy, the Andromeda Galaxy, is 21 quintillion km. That’s 21,000,000,000,000,000,000 km. This is a number so large that it becomes hard to write and hard to interpret. So astronomers use other units of distance.

In our **solar system**, we tend to describe distances in terms of the **Astronomical Unit** (AU). The AU is defined as the average distance between the Earth and the Sun. It is approximately 150 million km (93 million miles). Mercury can be said to be about 1/3 of an AU from the Sun and Pluto averages about 40 AU from the Sun. The AU, however, is not big enough of a unit when we start talking about distances to objects outside our solar system.

For distances to other parts of the Milky Way Galaxy (or even further), astronomers use units of the light-year or the **parsec**. The light-year we have already defined. The parsec is equal to 3.3 light-years. Using the light-year, we can say that:

- The Crab supernova remnant is about 4,000 light-years away.
- The Milky Way Galaxy is about 150,000 light-years across.
- The Andromeda Galaxy is 2.3 million light-years away.

So here we are. In a remote part of our galaxy, the Milky Way, far, far from everywhere, on a pale blue dot. As Carl Sagan put it in his talk from *The Age of Exploration* given in 1994:

> On it, everyone you ever heard of... The aggregate of all our joys and sufferings, thousands of confident religions, ideologies and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilizations, every king and peasant, every young couple in love, every hopeful child, every mother and father, every inventor and explorer, every teacher of morals, every corrupt politician, every superstar, every supreme leader, every saint and sinner in the history of our species, lived there on a mote of dust, suspended in a sunbeam. ...
> Think of the rivers of blood spilled by all those generals and emperors so that in glory and triumph they could become the momentary masters of a fraction of a dot.
Carl Sagan, Cornell lecture in 1994

It all seems impossible for us mortals to understand.

But it won’t stop me from peering up into the night sky and wondering about the universe with total awe.

And thank goodness for dogs!

And What About Mathematics?

Yet another revelation!

Fairly soon after publishing my post about music and the dog world I came across another article on dogs, and other animals, having a sense of numbers.

Now this post which was originally published by The Conversation is intricate in it’s deliberations but it is still clear. Try the article yourself.

ooOoOoo
Animals that can do math understand more language than we think

May 28, 2020

By Erik Nelson, Phd Student, Philosophy, Dalhousie University

It is often thought that humans are different from other animals in some fundamental way that makes us unique, or even more advanced than other species. These claims of human superiority are sometimes used to justify the ways we treat other animals, in the home, the lab or the factory farm.

So, what is it that makes us so different from other animals? Many philosophers, both past and present, have pointed to our linguistic abilities. These philosophers argue that language not only allows us to communicate with each other, but also makes our mental lives more sophisticated than those that lack language. Some philosophers have gone so far as to argue that creatures that lack a language are not capable of being rational, making inferences, grasping concepts or even having beliefs or thoughts.

An illustration of a sulky chimpanzee from Charles Darwin’s 1872 book, ‘The Expression of the Emotions in Man and Animals.’ (Wellcome Collection)

Even if we are willing to accept these claims, what should we think of animals who are capable of speech? Many types of birds, most famously parrots, are able to make noises that at least sound linguistic, and gorillas and chimpanzees have been taught to communicate using sign language. Do these vocalizations or communications indicate that, like humans, these animals are also capable of sophisticated mental processes?

The philosophy of animal language

Philosophers have generally answered this question by denying that talking parrots and signing gorillas are demonstrating anything more than clever mimicry. Robert Brandom, a philosopher at the University of Pittsburgh, has argued that if a parrot says “red” when shown red objects and “blue” when presented with blue ones, it has not actually demonstrated that...
it understands the meaning of those words. According to Brandom — and many other philosophers — understanding the meaning of a word requires understanding both the meaning of many other words and the connections that exist between those words.

Imagine that you bring your toddler niece to a petting zoo for the first time, and ask her if she is able to point to the rabbits. If she successfully does, this might seem like a good indication that she understands what a rabbit is. However, you now ask her to point to the animals. If she points to some rocks on the ground instead of pointing to the rabbits or the goats, does she actually understand what the word “rabbit” means? Understanding “rabbit” involves understanding “animal,” as well as the connection between these two things.

So if a parrot is able to tell us the colour of different objects, that does not necessarily show that the parrot understands the meanings of those words. To do that, a parrot would need to demonstrate that it also understands that red and blue fall underneath the category of colour, or that if something is red all over, it cannot, at the same time, be blue all over.

What sort of behaviour would demonstrate that a parrot or a chimpanzee did understand the words it was using? As a philosopher who focuses on the study of animal cognition, I examine both empirical and theoretical work to answer these types of questions.

In recent research, I argue that testing an animal’s arithmetical capabilities can provide insight into just how much they are capable of understanding. In order to see why, we need to take a brief detour through the philosophy of mathematics.

**Counting animals**

In the late 1800s, the German mathematician and philosopher Gottlob Frege tried to demonstrate that arithmetic is an objective science. Many philosophers and mathematicians at the time thought that arithmetic was merely an artifact of human psychology. Frege worried that such an understanding would make arithmetic entirely subjective, placing it on no firmer ground than the latest fashion trends.

In *The Foundations of Arithmetic*, Frege begins by logically analyzing what sorts of things numbers are. He thinks that the key to this investigation is figuring out what it takes to answer the question “how many?”

If I hand you a deck of cards and ask, “How many?” without specifying what I want counted, it would be difficult to even figure out what sort of answer I am looking for. Am I asking you how many decks of cards, how many cards all together, how many suits or any of the other number of ways of dividing up the deck? If I ask, “How many suits?” and you respond “four,” you are demonstrating not just that you can count, but that you understand what suits are.

Frege thought that the application of number labels depends on being able to grasp the connection between what is being counted and how many of them there are. Replying “four” to the question “How many?” might seem like a disconnected act, like parrots merely calling red objects “red.” However, it is more like your niece pointing to the rabbits while also understanding that rabbits are animals. So, if animals are able to reliably respond correctly to the question “How many?” this demonstrates that they understand the connection between the numerical amount and the objects they are being asked about.

**Animal mathematical literacy**

One example of non-human animals demonstrating a wide range of arithmetical capabilities is the work that Irene Pepperberg did with African grey parrots, most famously her subjects Alex and Griffin.

In order to test Alex’s arithmetic capabilities, Pepperberg would show him a set of objects on a tray, and would ask, “How many?” for each of the objects. For example, she would show him a tray with differently shaped objects on it and ask, “How many four-corner?” (Alex’s word for squares.) Alex was able to reliably provide the answer for amounts up to six.

Alex was also able to provide the name for the object if asked to look for a number of those objects. For example, if a tray had different quantities of coloured objects on it including five red objects, and Alex was asked, “What colour is five?” Alex was able to correctly respond by saying “red.”

Pepperberg’s investigations into the ability to learn and understand basic arithmetic provide examples that show that Alex
was able to do more than simply mimic human sounds. Providing the right word when asked, “How many?” required him to understand the connections between the numerical amount and the objects being asked about.

**Animal mathematical skills**

While Pepperberg’s results are impressive, they are far from unique. Numerical abilities have been identified in many different species, most prominently chimpanzees. Some of these capabilities demonstrate that the animals understand the underlying connections between different words and labels. They are therefore doing something more than just mimicking the sounds and actions of the humans around them.

Animals that can do basic arithmetic show us that some really are capable of understanding the terms they use and the connections between them. However, it is still an open question whether their understanding of these connections is a result of learning linguistic expressions, or if their linguistic expressions simply help demonstrate underlying capabilities.

Either way, claims that humans are uniquely able to understand the meanings of words are a bit worse for wear.

ooOoo

There’s little that I can add to the excellent summary in that penultimate paragraph;

Animals that can do basic arithmetic show us that some really are capable of understanding the terms they use and the connections between them. However, it is still an open question whether their understanding of these connections is a result of learning linguistic expressions, or if their linguistic expressions simply help demonstrate underlying capabilities.

but one thing is becoming clearer and clearer: dogs and other animals are a whole lot smarter than many (most?) of us think. Primarily on the back of research into the nature of our creatures and especially those creatures that are very close to us.

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**Out Of The Mouths Of Young People!**

A young man aged eight asks a very deep question.

Now the answer, that I am about to republish, is written to Tristan, aged 8. But frankly I have no doubt that the answer will be keenly read by persons of all ages. Certainly, this 75-year-old found the answer of great interest.

But to the question:

How can a Big Bang have been the start of the universe, since intense explosions destroy everything? – Tristan S., age 8, Newark, Delaware
How could an explosive Big Bang be the birth of our universe?

April 30, 2020
By Michael Lam, Assistant Professor of Physics and Astronomy, Rochester Institute of Technology

Pretend you’re a perfectly flat chess piece in a game of chess on a perfectly flat and humongous chessboard. One day you look around and ask: How did I get here? How did the chessboard get here? How did it all start? You pull out your telescope and begin to explore your universe, the chessboard....

What do you find? Your universe, the chessboard, is getting bigger. And over more time, even bigger! The board is expanding in all directions that you can see. There’s nothing that seems to be causing this expansion as far as you can tell – it just seems to be the nature of the chessboard.

But wait a minute. If it’s getting bigger, and has been getting bigger and bigger, then that means in the past, it must have been smaller and smaller and smaller. At some time, long, long ago, at the very beginning, it must have been so small that it was infinitely small.

Let’s work forward from what happened then. At the beginning of your universe, the chessboard was infinitely tiny and then expanded, growing bigger and bigger until the day that you decided to make some observations about the nature of your chess universe. All the stuff in the universe – the little particles that make up you and everything else – started very close together and then spread farther apart as time went on.

Our universe works exactly the same way. When astronomers like me make observations of distant galaxies, we see that they are all moving apart. It seems our universe started very small and has been expanding ever since. In fact, scientists now know that not only is the universe expanding, but the speed at which it’s expanding is increasing. This mysterious effect is caused by something physicists call dark energy, though we know very little else about it.

A visualization of tiny energy fluctuations in the early universe. ESA, Planck Collaboration, CC BY

Astronomers also observe something called the Cosmic Microwave Background Radiation. It’s a very low level of energy that exists all throughout space. We know from those measurements that our universe is 13.8 billion years old – way, way older than people, and about three times older than the Earth.

If astronomers look back all the way to the event that started our universe, we call that the Big Bang.
Many people hear the name “Big Bang” and think about a giant explosion of stuff, like a bomb going off. But the Big Bang wasn’t an explosion that destroyed things. It was the beginning of our universe, the start of both space and time. Rather than an explosion, it was a very rapid expansion, the event that started the universe growing bigger and bigger.

This expansion is different than an explosion, which can be caused by things like chemical reactions or large impacts. Explosions result in energy going from one place to another, and usually a lot of it. Instead, during the Big Bang, energy moved along with space as it expanded, moving around wildly but becoming more spread out over time since space was growing over time.

Back in the chessboard universe, the “Big Bang” would be like the beginning of everything. It’s the start of the board getting bigger.

It’s important to realize that “before” the Big Bang, there was no space and there was no time. Coming back to the chessboard analogy, you can count the amount of time on the game clock after the start but there is no game time before the start – the clock wasn’t running. And, before the game had started, the chessboard universe hadn’t existed and there was no chessboard space either. You have to be careful when you say “before” in this context because time didn’t even exist until the Big Bang.

You also have wrap your mind around the idea that the universe isn’t expanding “into” anything, since as far as we know the Big Bang was the start of both space and time. Confusing, I know!

Astronomers aren’t sure what caused the Big Bang. We just look at observations and see that’s how the universe did start. We know it was extremely small and got bigger, and we know that kicked off 13.8 billion years ago.

What started our own game of chess? That’s one of the deepest questions anyone can ask.

Before the Big Bang then there was “no space and there was no time.” Michael Lam says that is confusing. I think that’s a gigantic understatement.

There’s Dark Energy!

I wonder if we humans will ever come to the point where it is all understood!
More On The Magnificent Hubble!

The BBC have published an excellent article.

There was such a good response to the article on the Hubble that I published on April 27th that it was an easy decision to republish the article that was presented on the BBC website on the 24th, and this time the photographs can be downloaded.

Hubble telescope delivers stunning 30th birthday picture

By Jonathan Amos, Science correspondent, 24 April 2020
It's 30 years ago to the day that the Hubble telescope was launched – and to celebrate its birthday, the veteran observatory has produced another astonishing image of the cosmos.

This one is of a star-forming region close to our Milky Way Galaxy, about 163,000 light-years from Earth.

The larger object is the nebula NGC 2014; its companion is called NGC 2020.

But astronomers have nicknamed the scene the “Cosmic Reef” because it resembles an undersea world.

[There is an audio by Antonella Nota that is a little under 10 minutes long. I cannot embed it into this post for some unclear reason. Go here if you want to listen to it! It's well worth listening to.]

Antonella Nota: “It’s called the people’s telescope because it brought the Universe to the people”

Famously blighted by blurred vision at the outset of its mission in 1990, Hubble was eventually repaired and upgraded.

The remarkable pictures it has taken of planets, stars, and galaxies have transformed our view of the cosmos.

Indeed, there are those who think Hubble is the most important scientific tool ever built.

It's still far from retirement.

The US space agency (Nasa), which runs the observatory in partnership with the European Space Agency (Esa), says operations will be funded for as long as they remain productive.

Last year, its data resulted in almost 1,000 scientific papers being published – so it continues to stand at the forefront of discovery.
For its 25th birthday, Hubble imaged a giant cluster of stars called Westerlund 2

Engineers obviously keep a watching brief on the health of Hubble’s various systems. Pleasingly, all four instruments onboard – the two imagers and two spectrographs – work at full tilt.

In the past, the telescope’s Achilles heel has been the six gyroscopes that help turn and point the facility, maintaining a rock-steady gaze at targets on the sky.

These devices have periodically failed down the years, and during their final servicing mission in 2009 space shuttle astronauts were tasked with replacing all six.

Three have subsequently shut down again, but Nasa project scientist Dr Jennifer Wiseman says this is not yet an issue for serious concern.

“Nominally, we need three gyroscopes, but we can operate on just one due to the ingenuity of the engineers,” she asserted.

There’s a quiet confidence that Hubble can keep working well into the 2020s. Its supposed “successor” – the James Webb Space Telescope (JWST) – is due for launch next year, but the presence in orbit of this more modern observatory will in truth merely just extend capability; it won’t make Hubble redundant.

That’s because the new facility has been designed to see the cosmos at longer wavelengths of light than Hubble. The duo will be complementary and will on occasion actually pursue targets together to get a fuller perspective.

This is an exciting prospect for astronomers everywhere – but especially for those in Europe where Hubble has been such a rewarding endeavour, says Esa project scientist Dr Antonella Nota.

“From the memorandum of understanding there was a guarantee that European astronomers would get 15% of observing time for the duration of the mission. If I look back at how much time European astronomers got – on average it’s 22%. And it is a peer-reviewed process so we never needed to put a finger on the scales. European astronomers are creative; they’re
What has Hubble contributed to science?

It’s a bit of a cliche, but Hubble has truly been a “discovery machine”.

Before the telescope launched in 1990, astronomers didn’t know whether the Universe was 10 billion years old or 20 billion years old.

Hubble’s survey of pulsating stars narrowed the uncertainty, and we now know the age extremely well, at 13.8 billion.

The observatory played a central role in revealing the accelerating expansion of the cosmos – a Nobel Prize-winning breakthrough – and it provided the definitive evidence for the existence of super-massive black holes at the centre of galaxies.
It’s amazing to think that when Hubble launched, scientists had yet to detect the first exoplanet, the name given to a planet orbiting a star other than our Sun. Today, Hubble is pioneering the study of these far-off worlds, examining their atmospheres to try to gauge their nature.

And although the sparkling eight-metre-class ground-based telescopes can now match – and even exceed – Hubble’s skill in certain fields of study, the space telescope remains peerless in going super-deep.

Its so-called Deep Field observations in which it stared at a small patch of sky for days on end to identify the existence of very distant, extremely faint galaxies is one of the towering achievements in astronomy.

These studies have shown us what the Universe was like just a few hundred million years after the Big Bang. Only JWST, with its finely-tuned infrared detectors, will go deeper still.
Kathryn Sullivan was one of the astronauts onboard Space Shuttle Discovery when it released Hubble into its 612km-high orbit on 25 April, 1990 – a day she recounts in a recent book, Handprints On Hubble.

“Hubble’s scientific impact has just been immense. But what I had not really appreciated until I started writing my book was the extent to which Hubble – because of its gorgeous images and their mind-bending implications – has really permeated popular culture,” she told BBC News.

“I see Hubble on the side of U-Haul (rental) trailers, on tattoos, on lunchboxes, on shirts, in advertisements, almost ubiquitously.

“And I think part of that is down to Hubble coming into service just as the internet was becoming the thing we now know it to be.

“That’s put the pictures right in front of people.”
JWST will study the Universe at longer wavelengths of light

ooOOoo

This is the most amazing invention and regular missions to service the telescope including regular updates to the technology have kept it current.

It has produced the most distant and beautiful photographs. It has also refined our knowledge of when the universe came into existence – 13.8 billion years ago.

Staggering!

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Loading...
Two days of nostalgia follow! *You have been warned!*

As many of you already know, my father died fairly suddenly on December 20th, 1956. I had turned 12 some six weeks previously.

After about a year my mother remarried. His name was Richard Mills. Richard came to live at the house in Toley Avenue and had the unenviable task of taking on a new ‘son’ and ‘daughter’. *My sister, Elizabeth, some four years younger than I.*

Richard was a technical author in the newly-arrived electronics industry and one day he asked me if I would like to build a short-wave receiver. He coached me in the strange art of soldering wires and radio valves and other components and in the end I had a working receiver. That led, in turn, to me studying for an amateur radio licence. More of that tomorrow.

But the point of the introduction is to relay that **The Morse Code** is 175 years old on the 24th May.

Read more:

ooOoOo

**Simply elegant, Morse code marks 175 years and counting**

The elegantly simple code works whether flashing a spotlight or blinking your eyes—or even tapping on a smartphone touchscreen

There’s still plenty of reason to know how to use this Morse telegraph key. (Jason Salmon/Shutterstock.com)

By **Eddie King**
Ph.D. Student in Electrical Engineering, University of South Carolina

May 21st, 2019

The first message sent by Morse code’s dots and dashes across a long distance traveled from Washington, D.C., to Baltimore on Friday, May 24, 1844 – 175 years ago. It signaled the first time in human history that complex thoughts could be communicated at long distances almost instantaneously. **Until then**, people had to have face-to-face conversations; send
coded messages through drums, smoke signals and semaphore systems; or read printed words.

Thanks to Samuel F.B. Morse, communication changed rapidly, and has been changing ever faster since. He invented the electric telegraph in 1832. It took six more years for him to standardize a code for communicating over telegraph wires. In 1843, Congress gave him US$30,000 to string wires between the nation’s capital and nearby Baltimore. When the line was completed, he conducted a public demonstration of long-distance communication.

Morse wasn’t the only one working to develop a means of communicating over the telegraph, but his is the one that has survived. The wires, magnets and keys used in the initial demonstration have given way to smartphones’ on-screen keyboards, but Morse code has remained fundamentally the same, and is still – perhaps surprisingly – relevant in the 21st century. Although I have learned, and relearned, it many times as a Boy Scout, an amateur radio operator and a pilot, I continue to admire it and strive to master it.

![Samuel F.B. Morse's own handwritten record of the first Morse code message ever sent, on May 24, 1844. Library of Congress](image)

**Easy sending**

Morse’s key insight in constructing the code was considering how frequently each letter is used in English. The most commonly used letters have shorter symbols: “E,” which appears most often, is signified by a single “dot.” By contrast, “Z,” the least used letter in English, was signified by the much longer and more complex “dot-dot-dot (pause) dot.”

In 1865, the International Telecommunications Union changed the code to account for different character frequencies in other languages. There have been other tweaks since, but “E” is still “dot,” though “Z” is now “dash-dash-dot-dot.”

The reference to letter frequency makes for extremely efficient communications: Simple words with common letters can be transmitted very quickly. Longer words can still be sent, but they take more time.

**Going wireless**

The communications system that Morse code was designed for – analogue connections over metal wires that carried a lot of interference and needed a clear on-off type signal to be heard – has evolved significantly.

The first big change came just a few decades after Morse’s demonstration. In the late 19th century, Guglielmo Marconi invented radio-telegraph equipment, which could send Morse code over radio waves, rather than wires.

The shipping industry loved this new way to communicate with ships at sea, either from ship to ship or to shore-based stations. By 1910, U.S. law required many passenger ships in U.S. waters to carry wireless sets for sending and receiving messages.

After the Titanic sank in 1912, an international agreement required some ships to assign a person to listen for radio distress signals at all times. That same agreement designated “SOS” – “dot-dot-dot dash-dash-dash dot-dot-dot” – as the international distress signal, not as an abbreviation for anything but because it was a simple pattern that was easy to remember and transmit. The Coast Guard discontinued monitoring in 1995. The requirement that ships monitor for distress signals was removed in 1999, though the U.S. Navy still teaches at least some sailors to read, send and receive Morse code.
Aviators also use Morse code to identify automated navigational aids. These are radio beacons that help pilots follow routes, traveling from one transmitter to the next on aeronautical charts. They transmit their identifiers—such as “BAL” for Baltimore—in Morse code. Pilots often learn to recognize familiar-sounding patterns of beacons in areas they fly frequently.

There is a thriving community of amateur radio operators who treasure Morse code, too. Among amateur radio operators, Morse code is a cherished tradition tracing back to the earliest days of radio. Some of them may have begun in the Boy Scouts, which has made learning Morse variably optional or required over the years. The Federal Communications Commission used to require all licensed amateur radio operators to demonstrate proficiency in Morse code, but that ended in 2007. The FCC does still issue commercial licenses that require Morse proficiency, but no jobs require it anymore.

**Blinking Morse**

Because its signals are so simple—on or off, long or short—Morse code can also be used by flashing lights. Many navies around the world use blinker lights to communicate from ship to ship when they don’t want to use radios or when radio equipment breaks down. The U.S. Navy is actually testing a system that would let a user type words and convert it to blinker light. A receiver would read the flashes and convert it back to text.

Skills learned in the military helped an injured man communicate with his wife across a rocky beach using only his flashlight in 2017.

**Other Morse messages**

Perhaps the most notable modern use of Morse code was by Navy pilot Jeremiah Denton, while he was a prisoner of war in
Vietnam. In 1966, about one year into a nearly eight-year imprisonment, Denton was forced by his North Vietnamese captors to participate in a video interview about his treatment. While the camera focused on his face, he blinked the Morse code symbols for “torture,” confirming for the first time U.S. fears about the treatment of service members held captive in North Vietnam.

Navy pilot Jeremiah Denton, a prisoner of war, blinks Morse code spelling out ‘torture' during a forced interview with his captors.

Blinking Morse code is slow, but has also helped people with medical conditions that prevent them from speaking or communicating in other ways. A number of devices – including iPhones and Android smartphones – can be set up to accept Morse code input from people with limited motor skills.

There are still many ways people can learn Morse code, and practice using it, even online. In emergency situations, it can be the only mode of communications that will get through. Beyond that, there is an art to Morse code, a rhythmic, musical fluidity to the sound. Sending and receiving it can have a soothing or meditative feeling, too, as the person focuses on the flow of individual characters, words and sentences. Overall, sometimes the simplest tool is all that’s needed to accomplish the task.

I do hope you read this article in full because it contains much interesting information. Many people will not have a clue about The Morse Code and, as you can see above, it is still relevant.

Finally, I can still remember the The Morse Code after all these years!

It Stretches The Mind Beyond Imagination!

The most incredible story of all!

I first read the story early yesterday morning in The Guardian Newspaper.

But then I saw another version of the same story on the BBC News site, from which I republish it in its entirety.

First ever black hole image released

By Pallab Ghosh
Science correspondent, BBC News
Astronomers have taken the first ever image of a black hole, which is located in a distant galaxy.

It measures 40 billion km across – three million times the size of the Earth – and has been described by scientists as “a monster”.

The black hole is 500 million trillion km away and was photographed by a network of eight telescopes across the world.

Details have been published today in Astrophysical Journal Letters.

Prof Heino Falcke, of Radboud University in the Netherlands, who proposed the experiment, told BBC News that the black hole was found in a galaxy called M87.

“What we see is larger than the size of our entire Solar System,” he said.

“It has a mass 6.5 billion times that of the Sun. And it is one of the heaviest black holes that we think exists. It is an absolute monster, the heavyweight champion of black holes in the Universe.”

The image shows an intensely bright “ring of fire”, as Prof Falcke describes it, surrounding a perfectly circular dark hole. The bright halo is caused by superheated gas falling into the hole. The light is brighter than all the billions of other stars in the galaxy combined – which is why it can be seen at such distance from Earth.

The edge of the dark circle at the centre is the point at which the gas enters the black hole, which is an object that has such a large gravitational pull, not even light can escape.

Taking the temperature of black holes

Hawking: Black holes store information

Dozen black holes at galactic centre
I have suspected that the M87 galaxy has a supermassive black hole at its heart from false colour images such as this one. The dark centre is not a black hole but indicates that stars are densely packed and fast moving.

The image matches what theoretical physicists and indeed, Hollywood directors, imagined black holes would look like, according to Dr Ziri Younsi, of University College London – who is part of the collaboration.

“Although they are relatively simple objects, black holes raise some of the most complex questions about the nature of space and time, and ultimately of our existence,” he said.

“It is remarkable that the image we observe is so similar to that which we obtain from our theoretical calculations. So far, it looks like Einstein is correct once again.”

But having the first image will enable researchers to learn more about these mysterious objects. They will be keen to look out for ways in which the black hole departs from what’s expected in physics. No-one really knows how the bright ring around the hole is created. Even more intriguing is the question of what happens when an object falls into a black hole.

What is a black hole?

- A black hole is a region of space from which nothing, not even light, can escape
- Despite the name, they are not empty but instead consist of a huge amount of matter packed densely into a small area, giving it an immense gravitational pull
- There is a region of space beyond the black hole called the event horizon. This is a “point of no return”, beyond which it is impossible to escape the gravitational effects of the black hole

Prof Falcke had the idea for the project when he was a PhD student in 1993. At the time, no-one thought it was possible. But he was the first to realise that a certain type of radio emission would be generated close to and all around the black hole, which would be powerful enough to be detected by telescopes on Earth.

He also recalled reading a scientific paper from 1973 that suggested that because of their enormous gravity, black holes appear 2.5 times larger than they actually are.

These two previously unknown factors suddenly made the seemingly impossible, possible. After arguing his case for 20 years, Prof Falcke persuaded the European Research Council to fund the project. The National Science Foundation and agencies in East Asia then joined in to bankroll the project to the tune of more than £40m.
The eventual EHT array will have 12 widely spaced participating radio facilities.

It is an investment that has been vindicated with the publication of the image. Prof Falcke told me that he felt that “it’s mission accomplished”.

He said: “It has been a long journey, but this is what I wanted to see with my own eyes. I wanted to know is this real?”

No single telescope is powerful enough to image the black hole. So, in the biggest experiment of its kind, Prof Sheperd Doeleman of the Harvard-Smithsonian Centre for Astrophysics, led a project to set up a network of eight linked telescopes. Together, they form the Event Horizon Telescope and can be thought of as a planet-sized array of dishes.

KATIE BOUMAN Information gathered is too much to be sent across the internet. Instead the data was stored on hundreds of hard drives which were flown to a central processing centre.
Each is located high up at a variety of exotic sites, including on volcanoes in Hawaii and Mexico, mountains in Arizona and the Spanish Sierra Nevada, in the Atacama Desert of Chile, and in Antarctica.

A team of 200 scientists pointed the networked telescopes towards M87 and scanned its heart over a period of 10 days.

The information they gathered was too much to be sent across the internet. Instead, the data was stored on hundreds of hard drives that were flown to a central processing centres in Boston, US, and Bonn, Germany, to assemble the information. Prof Doeleman described the achievement as “an extraordinary scientific feat”.

“We have achieved something presumed to be impossible just a generation ago,” he said.

“Breakthroughs in technology, connections between the world’s best radio observatories, and innovative algorithms all came together to open an entirely new window on black holes.”

The team is also imaging the supermassive black hole at the centre of our own galaxy, the Milky Way.

Odd though it may sound, that is harder than getting an image from a distant galaxy 55 million light-years away. This is because, for some unknown reason, the “ring of fire” around the black hole at the heart of the Milky Way is smaller and dimmer.

Follow Pallab on Twitter

ooOoOoo

One of the most remarkable things about this story is that it continues to validate the theories of Albert Einstein (1879-1955). That is doubly impressive.

The film, How to see a Black Hole: The Universe’s Greatest Mystery, is a most interesting account of the skills that were utilised by the team, and the luck of that same group in pulling it all together.

This is clearly the start of a new journey in astronomy.

I will leave you by repeating the image of the black hole.
The first ever picture of a black hole: It’s surrounded by a halo of bright gas.

Just A Number, Or Is It!

I can do no better than republish in full the following:

(Simply because I scarcely understand it)

ooOoOo

Why the number 137 is one of the greatest mysteries in physics

Famous physicists like Richard Feynman think 137 holds the answers to the Universe.

By PAUL RATNER, 31st October, 2018.

- The fine structure constant has mystified scientists since the 1800s.
The number $\frac{1}{137}$ might hold the clues to the Grand Unified Theory.

Relativity, electromagnetism and quantum mechanics are unified by the number.

Does the Universe around us have a fundamental structure that can be glimpsed through special numbers?

The brilliant physicist Richard Feynman (1918-1988) famously thought so, saying there is a number that all theoretical physicists of worth should “worry about”. He called it “one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man”.

That magic number, called the fine structure constant, is a fundamental constant, with a value which nearly equals $\frac{1}{137}$. Or $\frac{1}{137.03599913}$, to be precise. It is denoted by the Greek letter alpha – $\alpha$.

What’s special about alpha is that it’s regarded as the best example of a pure number, one that doesn’t need units. It actually combines three of nature’s fundamental constants – the speed of light, the electric charge carried by one electron, and the Planck’s constant, as explains physicist and astrobiologist Paul Davies to Cosmos magazine. Appearing at the intersection of such key areas of physics as relativity, electromagnetism and quantum mechanics is what gives $\frac{1}{137}$ its allure.

Physicist Laurence Eaves, a professor at the University of Nottingham, thinks the number 137 would be the one you’d signal to the aliens to indicate that we have some measure of mastery over our planet and understand quantum mechanics. The aliens would know the number as well, especially if they developed advanced sciences.

The number preoccupied other great physicists as well, including the Nobel Prize winning Wolfgang Pauli (1900-1958) who was obsessed with it his whole life.

“When I die my first question to the Devil will be: What is the meaning of the fine structure constant?” Pauli joked.

Pauli also referred to the fine structure constant during his Nobel lecture on December 13th, 1946 in Stockholm, saying a theory was necessary that would determine the constant’s value and “thus explain the atomistic structure of electricity, which is such an essential quality of all atomic sources of electric fields actually occurring in nature.”

One use of this curious number is to measure the interaction of charged particles like electrons with electromagnetic fields. Alpha determines how fast an excited atom can emit a photon. It also affects the details of the light emitted by atoms. Scientists have been able to observe a pattern of shifts of light coming from atoms called “fine structure” (giving the constant its name). This “fine structure” has been seen in sunlight and the light coming from other stars.

The constant figures in other situations, making physicists wonder why. Why does nature insist on this number? It has appeared in various calculations in physics since the 1880s, spurring numerous attempts to come up with a Grand Unified Theory that would incorporate the constant since. So far no single explanation took hold. Recent research also introduced the possibility that the constant has actually increased over the last six billion years, even though slightly.

If you’d like to know the math behind fine structure constant more specifically, the way you arrive at alpha is by putting the 3 constants $h, c, \text{ and } e$ together in the equation —

$$\alpha_{SI} = \frac{1}{4\pi\epsilon_0} \frac{e^2}{\hbar c} \approx \frac{1}{137}$$

$$\alpha_{CGS} = \frac{e^2}{\hbar c} \approx \frac{1}{137}$$

As the units $c, e, \text{ and } h$ cancel each other out, the “pure” number of $137.03599913$ is left behind. For historical reasons, says Professor Davies, the inverse of the equation is used $2\pi e^2/hc = 1/137.03599913$. If you’re wondering what is the precise
Now, as I said in my introduction, I don’t understand this. But it doesn’t stop me from marvelling at the figure.
When you think of fractals, you might think of Grateful Dead posters and T-shirts, all pulsating with rainbow colors and swirling similarity. Fractals, first named by mathematician Benoit Mandelbrot in 1975, are special mathematical sets of numbers that display similarity through the full range of scale — i.e., they look the same no matter how big or how small they are. Another characteristic of fractals is that they exhibit great complexity driven by simplicity — some of the most complicated and beautiful fractals can be created with an equation populated with just a handful of terms. (More on that later.)

One of the things that attracted me to fractals is their ubiquity in nature. The laws that govern the creation of fractals seem to be found throughout the natural world. Pineapples grow according to fractal laws and ice crystals form in fractal shapes, the same ones that show up in river deltas and the veins of your body. It's often been said that Mother Nature is a hell of a
good designer, and fractals can be thought of as the design principles she follows when putting things together. Fractals are hyper-efficient and allow plants to maximize their exposure to sunlight and cardiovascular systems to most efficiently transport oxygen to all parts of the body. Fractals are beautiful wherever they pop up, so there’s plenty of examples to share.

Here are 14 amazing fractals found in nature:

![Fractal Image](https://via.placeholder.com/150)

To view the other 13 fractals then go across to here.

Aren’t they beautiful! Or, to pick up on a sentence in the article: “It’s often been said that Mother Nature is a hell of a good designer,”

Not only a good designer but the provider of life as we know it!

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**What A Great Man He Was!**

I am, of course, referring to the recent death of Stephen Hawking.
There’s no way that I can add anything to the widespread reporting of the very sad death of the theoretical physicist, cosmologist and author Professor Stephen Hawking.

Except, possibly, this interesting quirk of fate.

For this great man died yesterday: March 14th.

The very same day that another very famous man, the German-born Albert Einstein, was born. As in March 14th. Albeit, Stephen Hawking’s death being 139 years after the birth of the 1921 winner of the Nobel Prize in Physics.

Did you also know that Professor Hawking was a great dog lover!

I was very pleased that The Conversation blog site released a wonderful tribute to Stephen Hawking. The item opens, thus:

ooOOoo

Acclaimed British theoretical physicist, cosmologist and author Stephen Hawking has died aged 76. Hawking is best known for his work on black holes, which revolutionised our understanding of the universe.

Hawking passed away today peacefully at his home in Cambridge, his family confirmed in a statement:

We are deeply saddened that our beloved father passed away today. He was a great scientist and an extraordinary man whose work and legacy will live on for many years.

His courage and persistence with his brilliance and humour inspired people across the world. He once said, “It would not be much of a universe if it wasn’t home to the people you love.” We will miss him forever.

Read more: A timeline of Stephen Hawking’s remarkable life

Hawking was born on January 8, 1942, in Oxford, England. In 1963 he was diagnosed with ALS, a form of Motor Neurone Disease, and later confined to a wheelchair and forced to communicate via a computerised voice. But he continued his theoretical work and was outspoken on many things over much of his life.

Tributes have been pouring in on social media for the scientist, who made complex science accessible to everyone in his 1988 bestselling book A Brief History of Time.

ooOoO

Do read the rest of that article. I will take the tribute from Alice Gorman that closes The Conversation article to close today’s post.

ooOoO

Alice Gorman, Senior Lecturer in archaeology and space studies, Flinders University

There are few scientists who reach as far into popular culture as Stephen Hawking did. His research tackled the biggest of big questions – the nature of time, space and the universe we live in.

Sometimes it feels like science is losing ground in the modern world, but people still look to the stars for answers about who we are and how we come to be here.

Hawking’s bestselling A Brief History of Time made cosmology accessible to people and brought black holes out of the
shadows and into the public imagination.

Personally I'll miss his appearances on The Big Bang Theory, where he could out-nerd the nerds, and also provide some often necessary common sense. It was always great to see a world-class scientist just having fun.

ooOooo

What a very great man he was!

The Aesthetic Beauty Of Mathematics!

Sorry! Did you say the beauty of mathematics?

Those of you that read this blog fairly regularly know that from time to time I drift away from all things dog and potter in the garden of simply fascinating ideas.

Such is the case today.

It is an article on mathematics that was sent to me by Jim Goodbrod. He had read it in The New York Times in April.

Read it and see if you, too, find it as fascinating as I did!

ooOooo

The World’s Most Beautiful Mathematical Equation

Richard A. Friedman APRIL 15, 2017
I was doing KenKen, a math puzzle, on a plane recently when a fellow passenger asked why I bothered. I said I did it for the beauty.

O.K., I’ll admit it’s a silly game: You have to make the numbers within the grid obey certain mathematical constraints, and when they do, all the pieces fit nicely together and you get this rush of harmony and order.

Still, it makes me wonder what it is about mathematical thinking that is so elegant and aesthetically appealing. Is it the internal logic? The unique mix of simplicity and explanatory power? Or perhaps just its pure intellectual beauty?

I’ve loved math since I was a kid because it felt like a big game and because it seemed like the laziest thing you could do mentally. After all, how many facts do you need to remember to do math?

Later in college, I got excited by physics, which I guess you could say is just a grand exercise in applying math to understand the universe. My roommate, a brainy math major, used to bait me, saying that I never really understood the math I was using. I would counter that he never understood what on Earth the math he studied was good for.

We were both right, but he’d be happy to know that I’ve come around to his side: Math is beautiful on a purely abstract level, quite apart from its ability to explain the world.

We all know that art, music and nature are beautiful. They command the senses and incite emotion. Their impact is swift and visceral. How can a mathematical idea inspire the same feelings?

Well, for one thing, there is something very appealing about the notion of universal truth — especially at a time when people entertain the absurd idea of alternative facts. The Pythagorean theorem still holds, and pi is a transcendental
number that will describe all perfect circles for all time.

But our brains also appear to respond to mathematical beauty as they do to other beautiful experiences.

In a 2014 study, Semir Zeki, a neuroscientist at University College London, and other researchers used fM.R.I. scanners to observe the brains of 15 mathematicians while they were thinking about various equations. The subjects were shown 60 mathematical formulas two weeks before they were scanned and during and after the scan. They were also asked to rate their level of understanding of each equation and their subjective emotional response to it, from ugly to beautiful.

The researchers found a strong correlation between finding an equation beautiful and activation of the medial orbitofrontal cortex, a region of the prefrontal cortex just behind the eyes. This is the same area that has been shown to light up when people find music or art beautiful, so it seems to be a common neural signature of aesthetic experience.

Geeks, take heart: While you can’t see or hear mathematical ideas, they too are capable of arousing a sense of beauty.

No doubt you’d like to know which equation won the beauty contest. It was the so-called Euler’s identity, which is a deceptively spare but profound equation that links five fundamental mathematical constants: a mix of real and imaginary numbers that combine to make zero. And the ugliest? Ramanujan’s infinite series for the reciprocal of pi — a clunky equation, even to this non-mathematician.

While mathematicians were more likely to find formulas beautiful if they understood them well, the correlation was not perfect, so the researchers were able to show that the observed brain activation was a result of the experience of beauty apart from meaning. This makes sense, in that there were equations that subjects understood completely yet found ugly.

Now, the medial orbitofrontal cortex is also active when we find something pleasurable or rewarding, which isn’t surprising either, since you’d expect beautiful experiences to be both.

My love of math originated in the physical world. My father, an insatiably curious guy and electrical engineer, used to build things with me — crystal radios, electric generators, all kinds of exciting contraptions.

One summer evening I found him tinkering with a mysterious metal box in the garage. It was a prototype of a ruby laser. When he flicked the switch, a brilliant thin red light shot out of the laser and up into the night sky.

“How far does it go?” I asked. “To infinity,” he said and added, smiling, “or further.”

I was awe-struck. I still am.

Richard A. Friedman is a professor of clinical psychiatry and the director of the psychopharmacology clinic at the Weill Cornell Medical College, and a contributing opinion writer.

ooOoOoo

While my understanding of mathematics is average, to say the best, I did identify with the idea spelt out a few paragraphs above. This one:

...... so the researchers were able to show that the observed brain activation was a result of the experience of beauty apart from meaning.

Because it took me back to looking up at the night sky out at sea well away from land.

Did I understand the meaning of what I was looking up at? Of course not! Did I experience beauty? Beyond what I could put into words!
On a clear night you can see some 4,000 stars in our universe. (Photo taken of a night sky over England – National Trust)

Paul Handover  May 5, 2017

Dr. Jim Goodbrod / KenKen / Medial orbitofrontal cortex / National Trust / New York Times / night skies / Richard Friedman / Semir Zeki / University College London / Weill Cornell Medical College

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For the love of the dog! Wonderful passion about all matters canine!

Freedom to Survive Nakibul Hoq, blogging from Bangladesh in the city of Dhaka.

Lime Bird Writers Limebird was created in 2011, designed with writers in mind

Naked Capitalism How Yves Smith finds the time to produce the huge volume of articles and website links every day is beyond me.

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