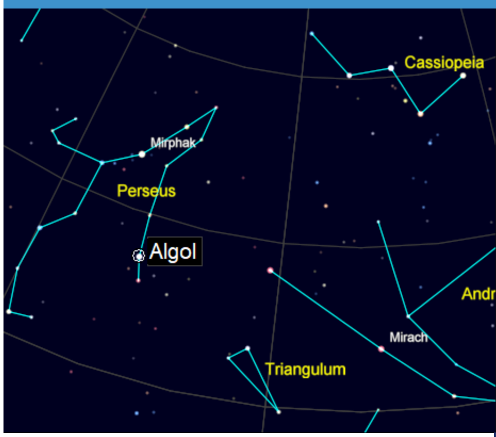
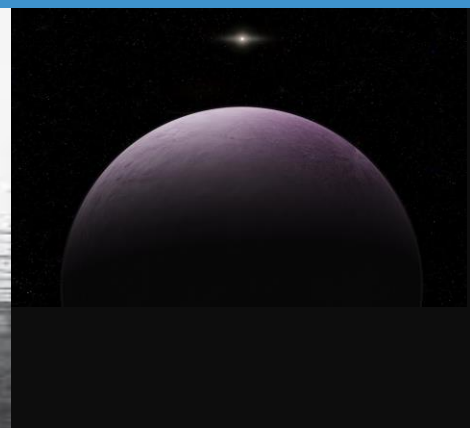
All Of The Above

YOUR MONTHLY DOSE OF SPACE AND TIME





Observe

THE DEMON STAR

This month, take the opportunity to observe and track the most easily viewed and noticed variable star of the Northern Hemisphere: Algol, in the constellation Perseus. Find Cassiopeia and use the map above to guide you to Algol.

Remember

LITTLE GREEN MEN 1

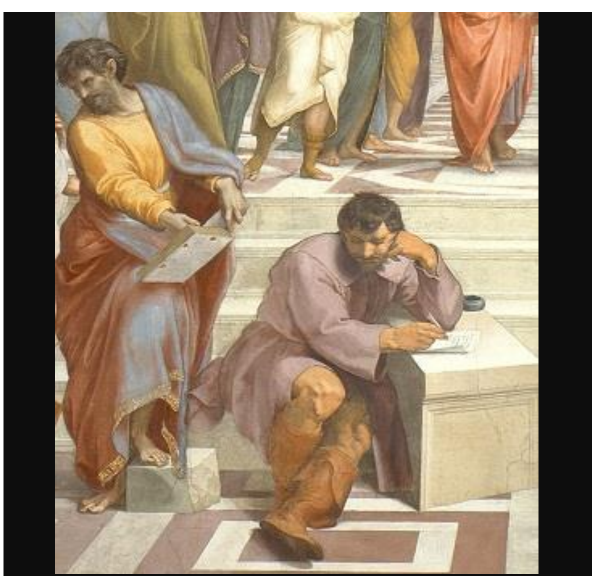
In January, 1968 one of the earliest large radio telescopes detected a signal repeating every 1.3 seconds coming from a location within the Milky Way galaxy, as if a beacon from another advanced civilization was reaching out to contact us.

Explore

FAROUT

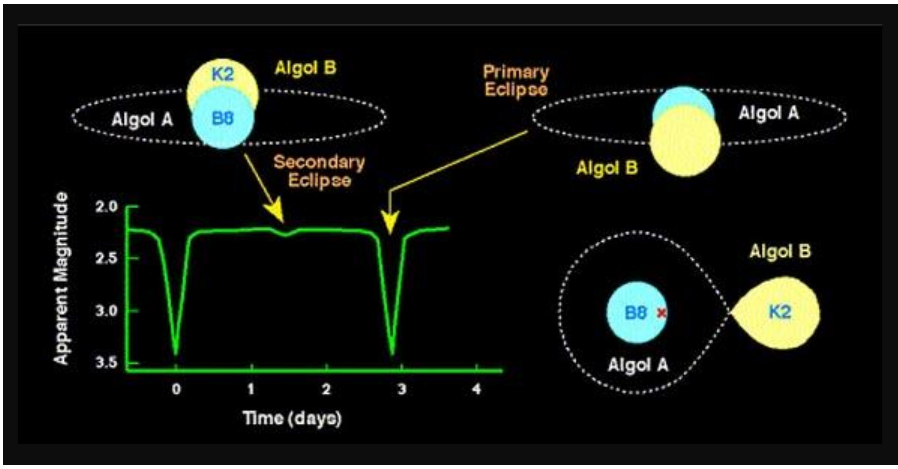
The search for the (modern) Planet X has revealed the most distant object in the Solar System ever observed.

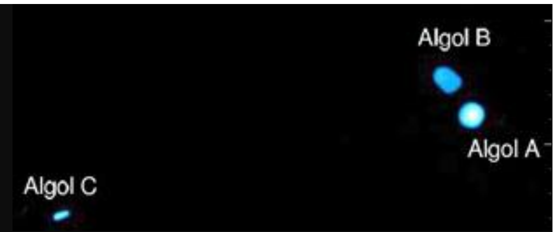
Consider

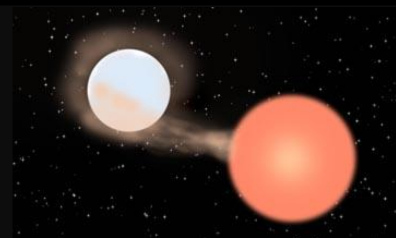


THE PROBLEM OF MOTION

From the days of ancient Greece, at the very beginning of Man's investigation into what the Universe really is, what it is actually made of, and by what (non-mystical) principles it operates, a fundamental debate started which has never been fully resolved. Is the world constantly changing, or does nothing ever change? Before dismissing the question as ridiculous and accepting that change is constant, let's have a closer look at the actual question being asked.







ALGOL - AN ECLIPSING BINARY STAR

In mid-January, about 7pm, the constellation of Perseus lies directly overhead in Connecticut skies. The second brightest star in Perseus has gone by a variety of names in different cultures. Algol is Arabic for “Head of the Ogre”, in Hebrew Rosh ha Satan, “Head of Satan”, in Latin Caput Larvae, “Spectre’s Head”, and was associated in Greek mythology with Medusa, the Gorgon with snakes for hair that turned men who viewed her to stone.

Algol is a variable star - its brightness, normally of magnitude 2.1 (a bright, easily visible star) drops to 3.4 (about 1/3 the brightness, still visible, though not quite so easily) once every 2 days 20 hours, 48 minutes and 57 seconds. The star dims and recovers quite rapidly - from bright to dim and back again in only 6 hours. The precise regularity brought the early realization by John Goodricke in 1783 that Algol’s dimming is caused by a dimmer object orbiting the star, eclipsing it as seen from Earth.

This explanation was confirmed in 1889 using a spectroscope to produce the spectrum of Algol. The spectrum showed absorption lines from two stars, separated in wavelength, and oscillating periodically about their expected positions in perfect time with the dimming and recovery of the star’s brightness. Additional oddities in the spectral analysis led to the discovery several decades later of a third star in the Algol system.

The bright primary star and its eclipsing companion are separated by 1/6th the distance between the Sun and Mercury. The third star - not participating in the eclipses - orbits at a distance about twice that of Mars from the Sun. The primary has a mass of 3 Suns, and the secondary 0.7 Suns. Oddly, the smaller secondary is an aging red giant, while the primary is a stable star - typically more massive stars age more rapidly. Although the component stars are too near each other to be viewed separately in optical telescopes, observations using the CHARA astronomical interferometer have resulted in separate images of the components. These show evidence of gas flowing from the red giant secondary to the primary, explaining that the originally larger star has shed most of its mass to the originally smaller star.

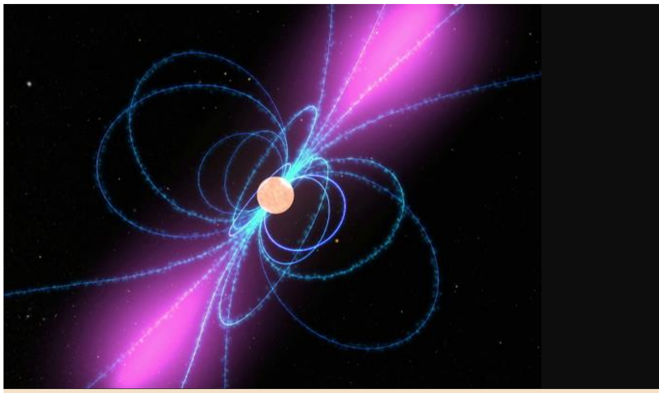
Algol is located 93 light years from Earth, but approached the Sun within 9.8 light years about 7.3 million years ago.

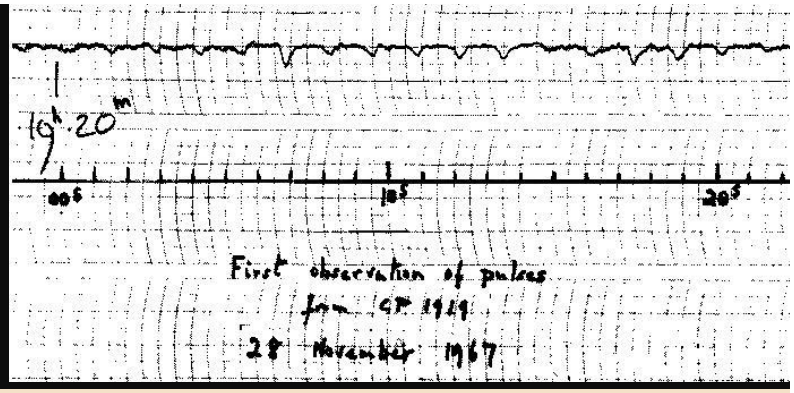
OBSERVING ALGOL

Below I’ve listed the five most convenient eclipse times for Algol over the next month. To track the dimming of the star, first find it about 3 hours before the time listed, noting its brightness relative to other nearby stars. Then check every 30 minutes or so and you should begin seeing changes within the first hour. (For the event on the 17th, you will most likely only see the brightening half of the cycle).

To locate Algol, look to the north to find the W of Cassiopeia. Follow the left edge of the central peak to the southwest to reach the triangle of stars marking the head of Perseus. Then along the right (east) edge of the constellation, Algol is the fourth star, as shown on the map at the start of this month’s newsletter.

Best Algol Eclipse Times
01/12 at 1:21am
01/14 at 10:10pm
01/17 at 6:59pm
02/03 at 11:55pm
02/06 at 8:45pm





THE DISCOVERY OF PULSARS

By the mid-1960s, the field of radio astronomy – observing the Universe in radio waves instead of visible light – was in its infancy. Of particular interest were radio emissions from stars, which proved difficult to identify against other larger area sources. To investigate a new technique for finding radio stars, based on the idea that star sources would "twinkle" due to interference from the solar wind, while larger sources would not (similar to separating planets, which do not twinkle, from twinkling stars in visible light due to Earth's atmosphere), a very large radio antenna, covering 4.5 acres, was constructed in Cambridge, England in 1967. The work was (as is typical) mostly done by graduate students, including Jocelyn Bell.

Jocelyn's was the main operator of the facility. The antenna tilted north to south, and otherwise scanned the sky east to west using the Earth's rotation to bring objects overhead. An "observation" consisted of a pen marking signal strength on a continually moving strip of paper (computers were rather primitive in 1967), and in these early days of operating the antenna, Jocelyn personally examined thousands of feet of the output. After many months of learning what manmade signals and other interference looked like on the charts, she was able to recognize the twinkling point sources that the team was looking to find.

In late summer, she became aware that occasionally a pattern of very rapid signal changes occurred in a tight group – she described it as "scruff" on the recording. This didn't match any known natural or manmade source, but passed rapidly enough to seem like a point source object. To get a better image of the scruff required running a "fast scan" – basically, running the paper under the pen much faster – but this could only be done for short periods of time, as each attempt generated huge lengths of paper. After several failed attempts Jocelyn captured the signal on a fast scan, and then the real fun began.

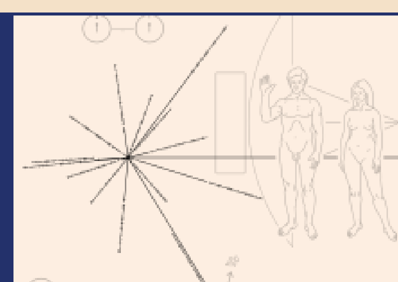
The signal showed a very regular pattern – pulses every 1.3 seconds, strongly suggesting a manmade signal; however, additional observations showed that the object tracked with the stars, and observations made at other radio facilities eliminated any local source or instrument issue. A measure of an effect (a bit complicated to explain) called dispersion resulted in a determination that the source was not in the solar system, but was within the Milky Way galaxy – so a manmade signal was definitely ruled out. But there was no known astronomical object that could produce so regular and rapidly changing signal. And so…

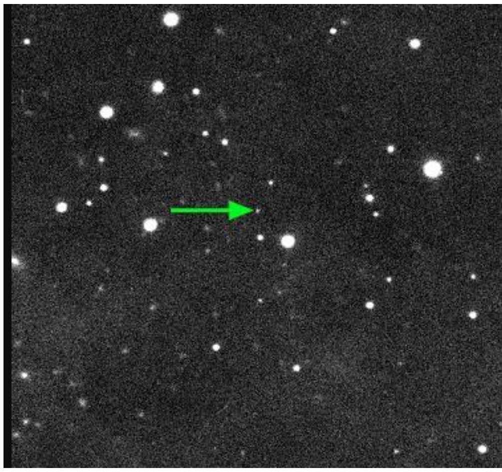
Before presenting their results, the senior researchers at Cambridge met to discuss precisely how to proceed to notify the world that they may have discovered an alien civilization in the process of trying to make contact with us by sending out a radio beacon. They even labelled the object Little Green Men 1 (LGM1). Thankfully, this was over the Christmas holiday, and during the delay Jocelyn found evidence of three additional points in the sky showing the same signal pattern.

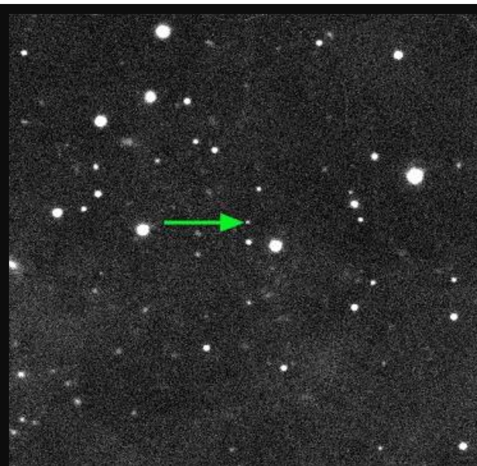
These additional discoveries removed the possibility of aliens – it was far too unlikely to have 4 civilizations all trying to contact Earth using the same technique. More astrophysicists became involved, and began theorizing the true nature of the objects discovered – remains of supernovae, spinning at very high speeds and emitting radiation at their magnetic poles like lighthouses, sweeping their beams across Earth with every rotation. Sufficiently fascinating and bizarre, just not as incredible as little green men.

USING PULSARS TO CONTACT ALIENS

Oddly enough, the fact that pulsars are so unusual in their pulsed signals led to their use by NASA on plaques attached to the two Pioneer spacecraft that will eventually leave the solar system and travel through interstellar space. The plaque contains a map of the locations and periods of 14 pulsars relative to Earth. Any civilization receiving these plaques will have discovered pulsars and could use the map to pinpoint Earth in space and time.







MOST DISTANT DWARF PLANET DISCOVERED

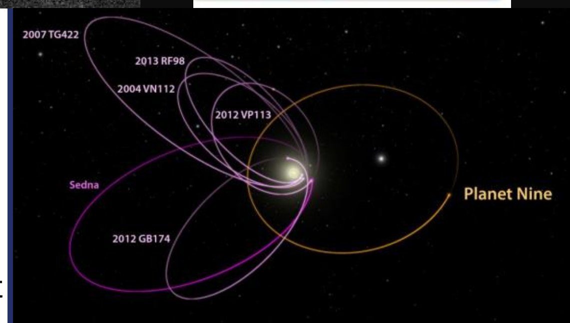
The quest for “Planet 9” (or maybe Planet X if you are a Pluto fan) continues to heat up. Evidence that there may be a planet somewhat larger than Earth orbiting the Sun at an extreme distance well beyond Pluto has been mounting over recent years from patterns seen in the orbits of several long-period comets.

Such an object should be visible in the largest telescopes, but would easily be missed as it would be confused with the billions of stars also visible in these instruments. A planet at such a distance would appear to move only extremely slowly against the background of fixed stars. Surveys (mostly computerized) are underway now to conduct this search, and have already yielded two extremely distant dwarf planets.

Back in October, the dwarf planet 2015 TG387, nicknamed “The Goblin” was announced, based on data from 2015 and additional observations this year. This object is 200 miles in diameter, orbiting in a highly elliptical orbit from 6-189 billion miles (Pluto is 4.5 billion miles) from the Sun, completing an orbit once every 34080 years.

The discovery of 2018 VG18, nicknamed “Farout” was announced in mid-December. This is a more recent discovery, with the first image obtained on November 10th, with the 8 meter diameter Subaru telescope in Hawaii and follow up observations made with the 6.5 meter Magellan telescope in Chile to begin to determine the object’s distance and orbit. With the distance determined, the relative brightness of the object, which shines by the light from the Sun which it reflects, gives a rough measure of the object’s size. This dwarf planet is about 300 miles in diameter, and is currently 110 billion miles from the Sun. It will take many more months if not years of observing to precisely determine its orbit. Spectroscopic analysis indicates the planet has a pinkish hue on its surface, which matches the spectrum of other icy dwarf planets observed in the Kuiper belt.

As the search for Planet 9 continues we can expect several more announcements of new dwarf planets in the Kuiper belt, and possibly larger objects at greater distances.



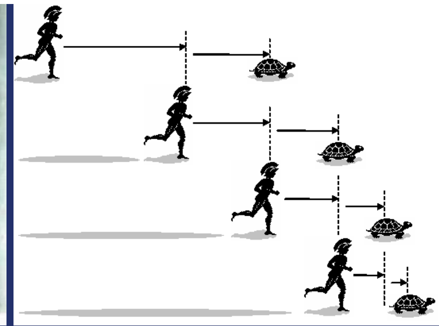
EVIDENCE FOR PLANET 9

In 2016 two astronomers, Mike Brown and Konstantin Batygin published a paper predicting the existence of an unseen planet about 10 times the mass of Earth, orbiting the Sun in the Kuiper belt. They examined the orbital dynamics of six recently-discovered Kuiper belt objects (seen in the diagram above) and noted the odd clustering of the perihelions (closest approaches to the Sun) of their orbits.

This alignment of orbits strongly suggests that these objects have been gravitationally affected by a much larger object orbiting in a more circular orbit, which these authors dubbed Planet 9.

With each newly discovered object sharing these alignments, the mathematical modeling will improve upon the predicted orbit and current location of Planet 9, and will hopefully narrow the regions of sky in which the searchers should concentrate their time.

A discovery of an additional significant planet will bring with it the opportunity to revise our understanding of solar system formation, as well as a potential new target for direct exploration.



MOTION, TIME, AND THE PLENUM

Three ancient Greek philosophers, Heraclitus, Parmenides, and Zeno of Elea, all living in the early 6th century BC, established basic competing themes of philosophy that continue to this day. We have no writings from any of them beyond fragments reported by other, much later, philosophers. Nonetheless, we can reconstruct their arguments with only minor ambiguity.

Heraclitus is most famous for his saying “no man ever steps in the same river twice”, which symbolizes his view of the Universe as in a state of constant change. He sees nothing as remaining constant, and everything continually “becoming” something else. Clearly for Heraclitus, there is no issue with motion; however, this concept of unending change leads to the conclusion that even the fundamental principles of the Universe are subject to change, and from this we need to conclude that science is impossible, and knowledge meaningless.

Parmenides took the opposing viewpoint – nothing ever changes, existence is what it forever has been and forever will be. In this view motion is an illusion, and in reality impossible. An object that is to move must move into a space where there is nothing, for no two things can occupy the same space. But, says Parmenides, “nothing” cannot exist, so there can be no space that contains nothing. All space must be occupied, therefore, by something, and hence no object can move. You might need to read that a couple of times to get the idea.

Parmenides inspired the later Zeno of Elea, who presented six paradoxes, all leading to the conclusion that motion is impossible. Here is one. Achilles, famous for his speed, has a race against a tortoise. Wanting to be fair, he gives the tortoise a head start. But, in the time it takes Achilles to reach where the tortoise starts the race, the tortoise has moved to a new location. And, by the time Achilles reaches this second location, the tortoise again moves. Each time Achilles reaches where the tortoise last was, the tortoise has moved forward. Therefore, Achilles can never catch up to the tortoise, despite what our common sense knows to be true.

To resolve Parmenides’ problem of motion requires that we make a distinction between “nothing” (which I will call Void) and empty space. Though Parmenides is correct that a Void cannot exist, empty space, which I will call a vacuum, can and does exist. Bringing this to a concrete example, consider two spheres not in contact with one another. By “not in contact” is meant there exists a distance between them. A distance is a difference in position. To have a difference in position there must be “space” between them. This space may be occupied, with matter, or not occupied, as is the case in a vacuum. In either case, the space itself is a non-void, and existent. And so, we can have motion. Resolving Zeno’s paradox is a bit trickier to do correctly, though the common explanation is to invoke the mathematical concept of a limit, which was developed 2000 years after Zeno. But limits involve the use of infinity, and you know what I think about infinity…

Another approach to solving both Parmenides problem of motion and Zeno’s paradoxes is to revisit the nature of time. We consider time to flow in a continuous stream, which means between any two instants in time there exists another instant in time – that there is no shortest interval of time. But suppose this is not the case. As I’ve said in an earlier newsletter, humans cannot distinguish events that occur within 2 thousandths of a second, and the shortest measurable duration is somewhere around 0.0000000000000001 seconds (I’ll avoid the lengthy discussion I found on that topic), though notably those measurements rely upon quantum mechanics… and you know what I think about…

So what if time isn’t continuous? If time occurs in discrete steps, we may also conclude that space is not infinitely divisible, but consists of discrete cells which objects occupy. At each time “step” matter would spontaneously move from cell to (adjacent) cell. Parmenides could have his universe filled with existing things and still allow motion, and Achilles would eventually get close enough to the tortoise to suddenly jump ahead of him without needing to “reach” his position. Ok. That’s enough for this month…