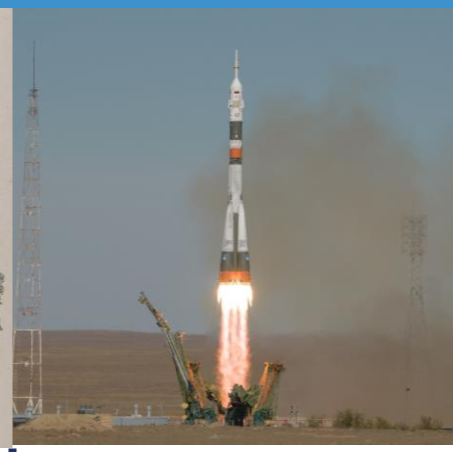
All Of The Above

YOUR MONTHLY DOSE OF SPACE AND TIME



Observe

OUR GALAXY'S SISTER

Nearly overhead by the middle of November at 8pm, find the Andromeda Galaxy, the only galaxy as large as our own visible to the naked eye, though a pair of binoculars will guarantee that you can find it.

Remember

CENTER OF AN EMPIRE

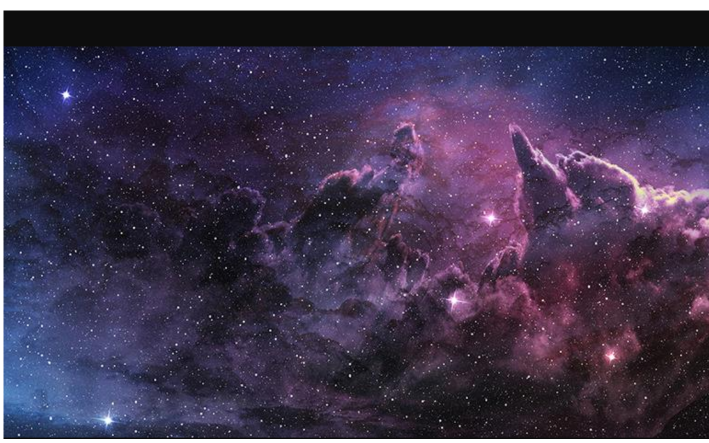
As the Renaissance matured in England, and the British began their expansion of trade across the globe, the need for accurate navigation inspired King Charles II to found the Royal Observatory at Greenwich.

Explore

17 MINUTES OF TERROR

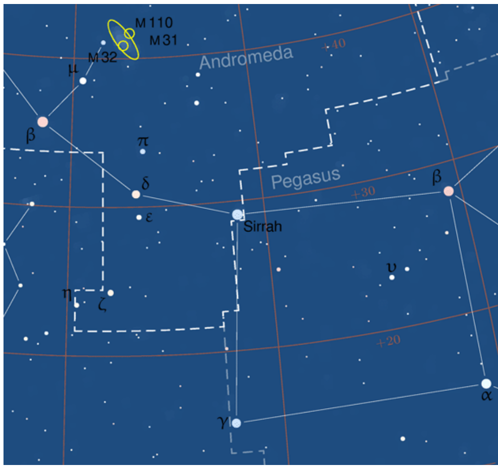
On October 11, 2018, Nick Hague and Alexey Ovchinin lifted off atop a Soyuz rocket. Two minutes into flight, a major failure of the vehicle occurred, sending them into an uncontrolled return to Earth.

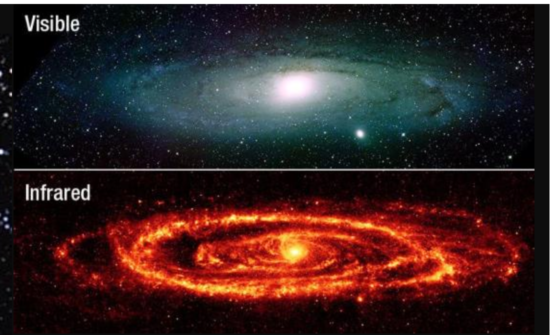
Consider



A HISTORY OF 6 PROTONS

Lets follow the journey of six protons from their moment of creation through to the present day. Where have these 14.5 billion year old fundamental building blocks of the Universe found themselves now?





FROM PEGASUS TO ANDROMEDA

In the mid evening in November, look slightly west of directly overhead to find the great square of Pegasus, which we visited last month. Using the diagram above, trace through the corners of the square to the northwest with a pair of binoculars, and look for a gray hazy patch of light. This is the mighty Andromeda Galaxy, similar in size to our own Milky Way, located 2.5 million light years away from us.

After finding it in binoculars, and noting where in the sky you are looking, try finding it with just your eyes. You will need a dark night, clear sky, no moon, and being away from street lights. If you successfully find it, continue to stare in that direction of sky, looking not directly at the galaxy, but off to one side. Now think of the size of the full Moon in the sky. Andromeda fills a space in the sky that would be filled by a rectangle six moons long and two moons in width. The unaided eye will not see this whole size, but nonetheless what can be seen (with patience) can create a lasting impression as to how incredibly massive a galaxy truly is, recalling that this object is so distant that the light you are seeing left it before Man walked the Earth.

Being similar in age and structure to the Milky Way, Andromeda has been studied in extreme detail. It was the first nebula that was realized to be a galaxy, back in the early 1900s when the Milky Way was thought to be the entire Universe. The history of our estimate of the size of Andromeda compared to the Milky Way illustrates the difficulty we face determining even the simplest facts about galaxies. Size can be measured in at least three ways - total mass, number of stars, or physical space occupied. Over the last 20 years, estimates of all of these sizes for both galaxies have varied dramatically, at times indicating Andromeda to be as much as 3 times more massive than the Milky Way, though with about the same number of stars (several hundred billion), and at other times, such as now, having masses similar to each other, but with Andromeda containing nearly twice as many stars. Most of the variation in estimates relates to the question of “dark matter” - mass that is not normal matter, and therefore not found in stars. Star counts are complicated by the revelation in our own galaxy that brown dwarf stars may outnumber all other star types, but are too dim to see all but the nearest of them.

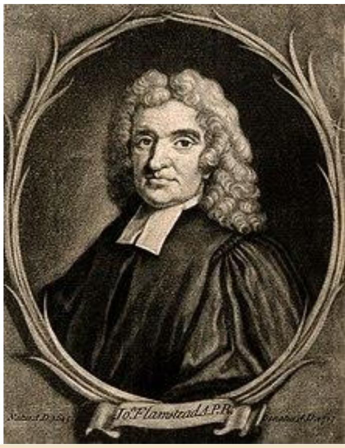
DISCOVERING A GALAXY

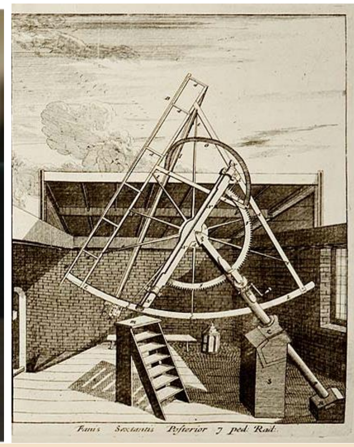
Ancient man identified Andromeda as a persistent glowing cloud in the northern winter sky. After the invention of the telescope, early observers began to realize that the cloud consisted of a bright central region, and a spiral structure of dimmer glow surrounding it.

These observations led, in the 18th century, to the idea that Andromeda, and other, dimmer, spiral gas clouds were star systems in formation. This was backed up by the “nebular theory” of solar system formation, first proposed by Immanuel Kant in 1755, and further elaborated mathematically by Simon Laplace at the end of the century.

As late as 1920, after the Milky Way was recognized as the vast star system containing our own solar system, the nature of the “spiral nebula” was hotly debated - solar systems forming, or collections of distant stars.

In 1925, Sir Edwin Hubble achieved a measurement of distance to a star in Andromeda, obtaining a value of 1.5 million light years, proving conclusively that Andromeda was separate galaxy.






THE ROYAL OBSERVATORY, GREENWICH

Accurate navigation at sea, away from the sight of land, requires knowing both latitude – the north/south position, measured from the equator, and longitude – the east/west position. Latitude is easily measured (in the Northern Hemisphere) by measuring the angle from the horizon to the North Star. Longitude, however, lacks any well-defined reference point. Even early researchers into the problem of measuring longitude understood that the problem could be solved by measuring the height of stars above the eastern or western horizon, and knowing the precise time of the observation. Using a reference book, or almanac, listing the expected height of the star as observed at a particular city at various times throughout the year, it is easy to determine the east-west distance from that city.

As the British began expanding their seafaring trade in the late 1600s, the advisers to King Charles II clearly understood the need to solve the problem of longitude. In 1675 the King commissioned the Royal Observatory at Greenwich to improve star charts, publish more accurate almanacs, and focus research into the accurate measurement of time at sea.

To run the observatory, Charles appointed the first Astronomer Royal, John Flamsteed. Flamsteed soon discovered that funding of the building did not include money to acquire instruments, and he had to provide his own observing equipment. He began systematically charting star, planet, and lunar positions in 1676. Flamsteed was generally an unpleasant person to interact with. When Isaac Newton requested his lunar observations and partially-completed star charts, Flamsteed flat out refused. He particularly disliked Edmond Halley (for whom the comet is named), and routinely attacked Halley in correspondence as well as professional settings. The battle over publication of the star charts ended with Flamsteed collecting and burning 300 of the 400 copies printed before Flamsteed deemed them completed.

Upon Flamsteed's death in 1719, after an incredible 42 years of running the observatory, Halley was appointed the second Astronomer Royal. Today, the 15th Astronomer Royal is Lord Martin John Rees, who has made major contributions to the fields of astrophysics and cosmology.

THE PRIME MERIDIAN

The problem of determining longitude at sea took nearly another 100 years to solve, finally relying on the precise clocks produced by John Harrison starting in 1761. Measurement of longitude would also require an internationally-accepted reference line, the "prime meridian". In 1884, at the height of world dominance of the British Empire, an international treaty established the longitude of the Royal Observatory at Greenwich as the prime meridian, against which all longitudes have subsequently been measured.

Today the Observatory houses a variety of astronomical and timekeeping museum pieces, including Harrison's original clocks, telescopes and other instruments from the 1800s, and, of course, a line marking the prime meridian.



ISS EXPEDITION 57 FAILS TO REACH ORBIT

Liftoff occurred without incident under clear skies at the Baikonur Cosmodrome in southern Kazakhstan. The four "strap on" boosters of the Soyuz vehicle are designed to fire for two minutes and then separate from the craft, leaving the second stage to continue the ascent. However, the crew reported a sudden weightlessness instead of the expected continued acceleration, indicating that the second stage had failed to fire. Although the main escape tower of the Soyuz capsule had been cast off seconds before the failure, the backup escape system, consisting of engines on the capsule itself, fired to rapidly remove the capsule from the damaged second stage.

Moments later the second stage began disintegrating, still filled with thousands of pounds of explosive fuel, while the Soyuz capsule began its "ballistic trajectory" back toward Earth from an altitude of approximately 31 miles. In a ballistic emergency descent, the craft follows an uncontrolled parabolic path through the atmosphere, subjecting the crew to deceleration forces in excess of 7 times the force of gravity. Putting that in perspective, a 150lb person would feel the effect of 1050lbs pressing down on them. This peak force would cause severe permanent harm to most of us, but the trained astronaut can withstand "g forces" as high as 8-10gs and survive.

Hague and Ovchinin reached the ground about 17 minutes after the anomaly, and were found almost immediately by the rescue team. They suffered no apparent health effects, and are back on the roster for a future mission.

The Russian space agency immediately began an investigation into the cause of the failure. Within two weeks of the failure, they reported that one of the strap-on boosters had collided with the second stage nears its fuel tank, caused by a improperly installed sensor on the strap on booster. This discovery continues to point to a quality problem in the assembly of Soyuz spacecraft, coming only a month after a leak on the ISS was traced to a hole accidentally drilled through another Soyuz spacecraft docked to the ISS.

RECOVERY PLAN

. The failure of this Soyuz leaves three crew members on the ISS, with a docked Soyuz spacecraft, the one with the small leak, which has been fixed by the crew using glue and tape. The Russian space agency is requiring success of three robotic missions of the Soyuz before another manned launch. One of these launches has been completed – a weather satellite launch on November 7th , without any issues. If all goes according to plan, the next manned launch to the ISS will occur on December 3rd.

The crew has sufficient supplies to last many months, and resupply plans continue with both Soyuz and SpaceX vehicles. The soonest that the station would need to be abandoned would be in the late spring, should the Soyuz prove unsafe in the robotic mission tests. The ISS itself would then have about a year before its orbit fell dangerously low and loss of the station became a concern.

Meanwhile, both SpaceX and Boeing continue to move toward flight tests of their manned orbital vehicles. SpaceX is planning an uncrewed test flight in January, 2019, followed by a crewed flight in June. Boeing is planning its first uncrewed flight in March, 2019, with a crewed launch planned for August. It is not clear whether either or both of these missions would actually dock with the ISS, but success would line up missions to the ISS using American vehicles later in 2019.

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A TALE OF 6 PROTONS (A TRUE STORY)

Our story begins 13.7 billion years ago with six protons created from the primordial cloud of subatomic stuff in the weirdness that modern cosmology hypothesizes as the “Big Bang”. These six protons, along with their unfathomable number of sibling particles, followed a separation of the original cloud into colossal smaller clouds, which would become the superclusters of galaxies. About 12 billion years ago, this progressive separation of clouds into smaller clouds reached the much smaller scale of individual galactic clouds, and our six protons found themselves within the same galactic cloud.

Now during these billion years, each of them occasionally had the companionship of an electron, who would join them for a time before being stripped away by the collision of a high energy photon. With each return of an electron, the resulting atom would give off a photon of light, and with each loss, a photon would be absorbed. Along with the uncountable multitude of other protons and electrons, the motion of the six added to a vast electromagnetic field which in turn pulled an pushed upon the protons, driving them into still smaller and denser clouds of gas.

Finally, some 10 to 11 billion years ago, the six were in a particularly dense cloud that began to collapse toward its center through the cloud’s own gravitational pull, also generated by each of the protons (and neutrons) from which it was composed. Our six lay near the center of this cloud and were pulled into the incredibly dense core of the collapse, in only a million years since the cloud began its collapse. Now a new experience for each of the six occurred – collisions with other protons began to happen with increasing frequency, and they began to move at higher and higher speeds, crashing harder and harder against each other. Shortly after this, proton collisions became permanent – two protons would collide and stay bonded together, releasing a vast amount of energy. A star had been formed. Our six protons – hydrogen atoms – became three helium atoms.

The pace of our tale then quickened. Less than 50 million years later, this early gargantuan star became low on fuel, began collapsing yet again, and reach temperatures high enough to allow three helium atoms to fuse together to form a single carbon atom, and our six protons became carbon. Within another 10 million years, the star ended its life in a phenomenal supernova, blasting a cloud of atoms into deep interstellar space, while its very center collapsed into a black hole. Our carbon atom was among the survivors that then embarked upon their journey across the galaxy.

Still pulled and pushed by magnetic and electric fields, our carbon atom again found itself in a new collapsing cloud of gas about 5 billion years ago, this time remaining in an orbit outside of the center of the collapse, but attracted by and colliding with a large rock of other heavy atoms, including more carbon, oxygen, nitrogen, iron, nickel, silicon and a host of other materials. This rock collided with other rocks repeatably, slowly growing in size. After about 500 million years since joining the cloud, its center formed an average-sized star, and the carbon atom came to rest near the surface of a very large ball of rock surrounded by a thin layer of gas. During this time, the carbon atom began sharing electrons with other atoms near it, becoming a molecule of various materials, then changing repeatedly.

Another billion years passed before our carbon atom again experienced a great change, bonded to a complex of other carbon, hydrogen and oxygen atoms, and became a protein molecule as part of an early form of life. Upon its death it entered the soil of the planet, and soon was again part of a life form. This cycle repeated for another 3.5 billion years, until finally the carbon atom, in its molecular protein, was absorbed from the soil into an apple tree. Passing through the trunk and branches, it came to rest in the bud of an apple flower, and passed into the apple itself.

I purchased that apple last weekend, and now hold it in my hands. Once eaten, it may become part of me, and it will eventually pass back into the soil. The cycle is likely to repeat thousands more times before our own star consumes the Earth (in another 4.5 billion years), and blasts the carbon atom back into interstellar space.