

CATAPULTA

WINTER 2019

THE
SPACE
ISSUE

FEATURING AN INTERVIEW WITH ANDY WEIR,
BESTSELLING AUTHOR OF *THE MARTIAN*!

SCIENCE | TECHNOLOGY

SCIENCE IN 2018

18-19

MARS ROVER
16-17

PI DAY - 4



FAST RADIO BURSTS - 5

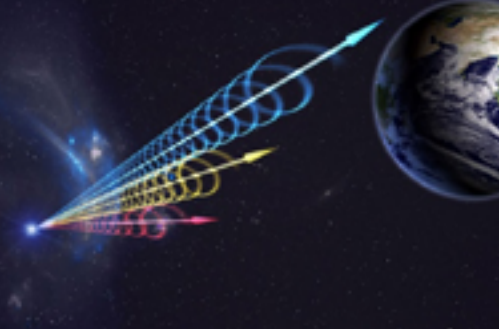
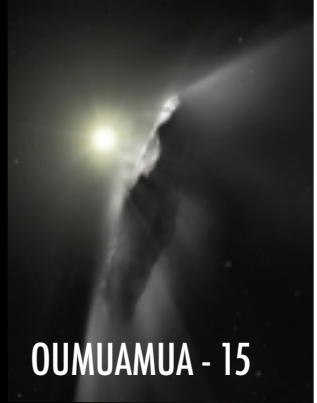


TABLE OF CONTENTS

While he always wanted to be an author, Andy Weir worked as a computer programmer for the majority of his career. On the side, he wrote stories in small installments and posted them on his website. From these stories came *The Egg* and *The Martian*, the former being a short story exploring a unique explanation for the meaning of life, and the latter being a novel following astronaut Mark Watney's struggle to survive on Mars alone. After he put *The Martian* onto the Amazon store to increase accessibility, Weir experienced an extreme growth in popularity. This success resulted in both a book contract and a movie contract. The movie was very popular and received many awards. Since then, Weir has published another book, *Artemis*, with a movie adaptation already in the makings.

WANT YOUR ARTICLE TO BE FEATURED IN THE NEXT ISSUE? EMAIL CATAPULTASCIENCEBLS@GMAIL.COM!

OUMUAMUA - 15



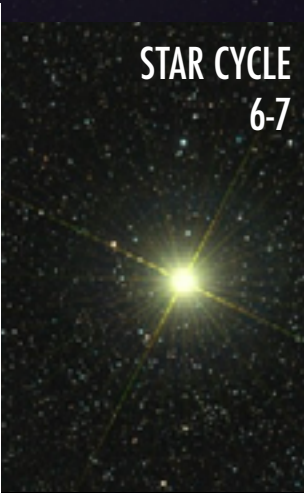
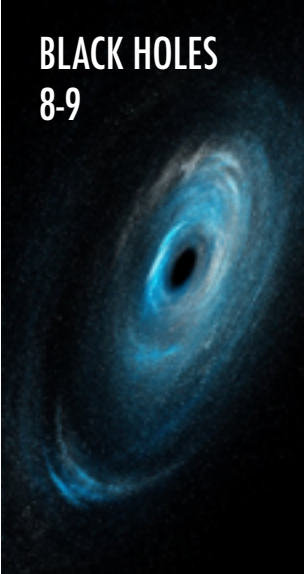
MU69 - 14



TELESCOPES - 13



CHINA ON THE MOON - 12

STAR CYCLE
6-7BLACK HOLES
8-9ANDY WEIR
INTERVIEW
10-11

EDITORS' NOTE

WELCOME TO CATAPULTA'S FIRST EVER THEMED ISSUE: WE'RE CERTAIN YOU'LL FIND OUR SPACE-THEMED MAGAZINE TO BE OUT OF THIS WORLD! GET READY TO BLAST OFF AND EXPLORE EVERYTHING FROM THE FAR SIDE OF THE MOON TO ANDY WEIR'S VISION OF MARS! IF THAT'S NOT REASON ENOUGH TO START READING CATAPULTA, THEN YOU SHOULD KNOW THAT THE FUTURE BELONGS TO THOSE WHO ARE READY FOR IT, AND YOU HAVE EVERYTHING YOU NEED TO START PREPPING FOR THE FUTURE OF SPACE RIGHT HERE IN YOUR HANDS. WHAT ARE YOU WAITING FOR?

"A PHILOSOPHER ONCE ASKED, 'ARE WE HUMAN BECAUSE WE GAZE AT THE STARS OR DO WE GAZE AT THE STARS BECAUSE WE ARE HUMAN?' POINTLESS REALLY. DO THE STARS GAZE BACK? NOW THAT'S A QUESTION."

~STARDUST BY NEIL GAIMAN

THANK YOU TO OUR
PATREON SUPPORTERS!

ALFRED YAN
ELISA VALENTE



WINTER ISSUE STAFF

EDITORS IN CHIEF
ASHLEY CHOU (I)
JERRY HAN (I)

HEAD COPY EDITORS
CHRISTY JESTIN (II)
TIM LIU (II)

ASSISTANT COPY EDITORS
LINA ZHANG (II)
ALEX CHOU (IV)

COPY ASSOCIATES
RACHEL WENG (III)
ALICE ZHANG (III)
CINDY ZHOU (III)
THERESA HUANG (IV)
JACK TRAPANICK (IV)
SHU WEN MEI (IV)
JOANNA LIN (VI)

HEAD CONTENT EDITORS
MAHAD ABDI (I)
AUSTIN WANG (I)

ASSISTANT CONTENT EDITORS
CAROLINE SUNUWAR (II)
JOHN LIN (III)

CONTENT ASSOCIATES
RYAN NIE (I)
DAVID QIAN (II)
ALEX CHEN (III)
SANJANA SINGH (IV)
LORENZO DE SIMONE (V)
MIRA YU (V)
JOANNA LIN (VI)

HEAD LAYOUT EDITOR
NATALIA TAM (III)

ASSISTANT LAYOUT EDITOR
ESTHER SHEN (III)

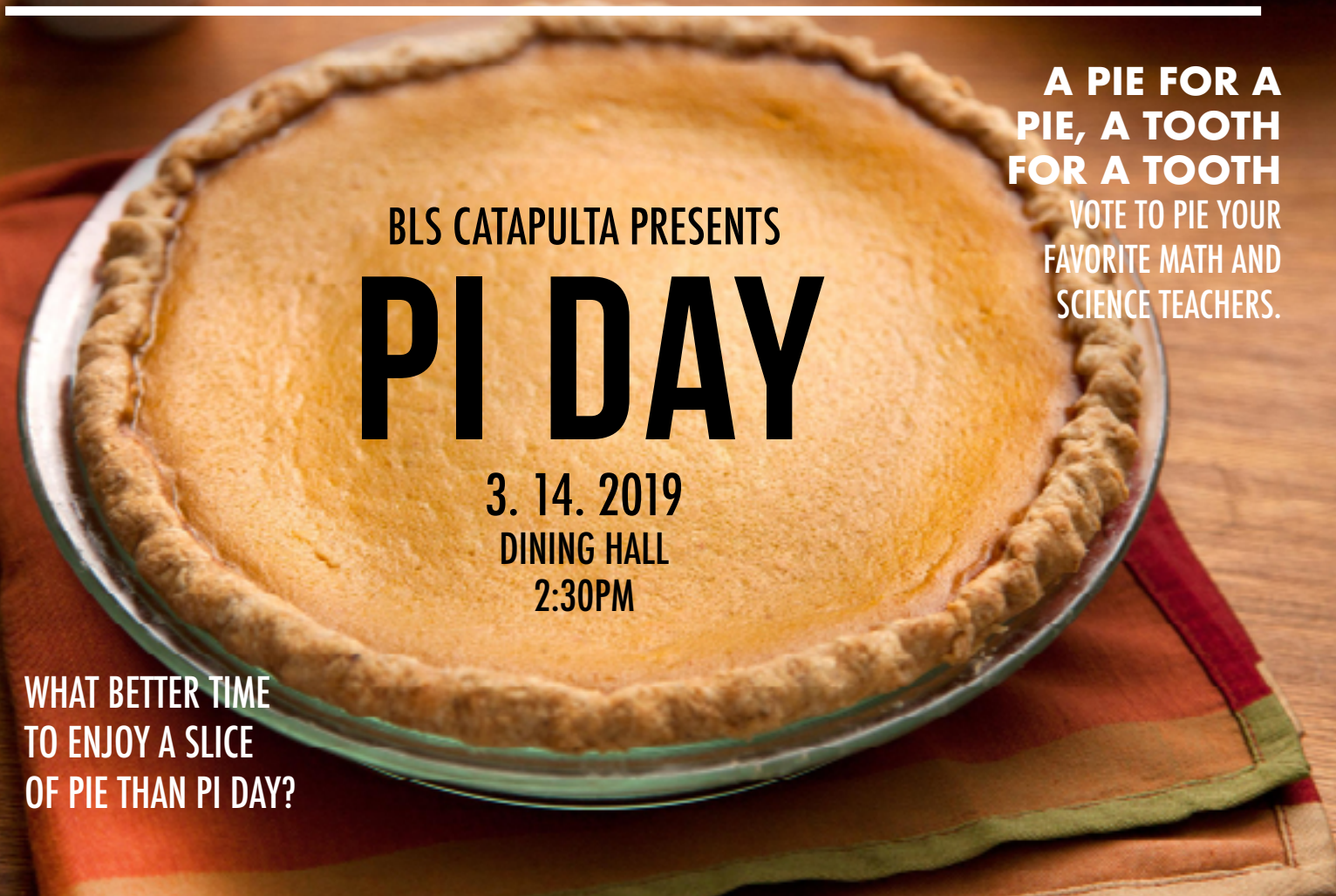
LAYOUT ASSOCIATES
SERENA CAI (II)
SHANNEN ESPINOSA (II)
ALEX CHEN (III)
ERIC CHEUNG (III)
EMILINA TRAN (III)
ALICE WU (III)
SARAH XU (III)

PUZZLE EDITOR
CINDY ZHOU (III)

STAFF WRITERS
JOHN NAGASAWA (I)
LIANE XU (I)

WEBMASTER
KEVIN S. QI (I)

TREASURER
JACK ZHAN (I)



BLS CATAPULTA PRESENTS
PI DAY

3. 14. 2019
DINING HALL
2:30PM

**A PIE FOR A
PIE, A TOOTH
FOR A TOOTH**
VOTE TO PIE YOUR
FAVORITE MATH AND
SCIENCE TEACHERS.

WHAT BETTER TIME
TO ENJOY A SLICE
OF PIE THAN PI DAY?

ABOUT PI DAY

PI DAY IS BLS CATAPULTA'S ANNUAL CELEBRATION OF THE NUMBER 3.14...OR π : EVERY ASPIRING MATHLETE'S BEST FRIEND, NOT ONLY USEFUL FOR CALCULATING THE AREA OF A CIRCLE, BUT ALSO STATISTICS, PHYSICS, ENGINEERING, QUANTUM MECHANICS, AND EVERY OTHER FIELD YOU CAN THINK OF.

HELD IN THE DINING HALL, THIS EVENT IS A CHANCE TO ENJOY A SLICE (OR TWO, OR MORE) OF PIE AS WELL AS BEAR WITNESS TO AN EPIC STEM (SCIENCE, TECH, ENGINEERING, MATH) TEACHER PIEING!

SO HOW CAN YOU PARTICIPATE? FIRSTLY, YOU CAN BUY TICKETS, EACH OF WHICH WILL NET YOU A SLICE OF DELICIOUS PIE. SECONDLY, YOU CAN VOTE FOR YOUR FAVORITE STEM TEACHERS TO GET PIED IN THE FACE (RUNNER-UP WILL PIE THE WINNER)!

WE HOPE TO SEE YOU THERE!

According to an academic study published in Nature this January, a second source of fast radio bursts has been discovered.

These "bursts", also referred to as FRBs, consist of millisecond-long radio pulses that dictate the occurrence of high-energy events taking place outside the Milky Way. Although the sources of FRBs are unknown, scientists speculate that they may be certain astrophysical objects, such as evaporating black holes, or even extraterrestrial life. Many even believe that these bursts are produced by advanced alien civilizations on planets located billions of light years away.

The first FRB, named Lorimer Burst FRB 010724, was discovered by David Lorimer in 2007 after searching through pulsar archives from 2001. In subsequent years, other bursts were occasionally reported, and in 2012 Victoria Kaspi of McGill University approximated that up to 10,000 FRBs could occur daily, with many going unnoticed. Despite this, there are only two known sources from which these waves repeatedly appear: FRB 121102, which has emitted more than 93 bursts, and FRB 180814, which has emitted six bursts that were reported this month.

In mid-2018, FRB 180814 was initially found by Canadian scientists through the use of Canadian Hydrogen Intensity Mapping Ex-

periment (CHIME), a radio telescope aided by two supercomputers located in Okanagan Valley. CHIME, which has detected 13 FRBs in total, remains uniquely stationary in order to map the northern hemisphere on a daily basis. Because of its design, it is likely to discover more repeating FRBs in the future, which plays a crucial role in the gradual understanding of the purpose and origin of these waves. Not only has CHIME detected longer than usual waves from FRB 180814, it has also aided in finding its location, which is currently estimated to be 1.5 billion light years away.

Fortunately, progress in researching FRBs is being made at a steady pace, with the full capacity of CHIME slated to discover many more bursts by the end of this year, which may unravel the secrets behind their existence. As researchers take further steps to develop the proper technologies for understanding such far away phenomena, we are continuing to piece together a better picture of our universe.



**FAST
RADIO
BURSTS**



A STAR IS BORN

Stars! They've been the characters of mythology, guides of navigators, subjects of intrigue for artists and astrologists alike. So what do we know about them now, after launching so many telescopes and probes into space? *The Lion King's* own astute warthog, Pumba, provided a basic idea of what a star is when he said,

**"OH, GEE, I ALWAYS THOUGHT THEY WERE BALLS OF GAS
BURNING BILLIONS OF MILES AWAY."**

The discovery of stars' composition in 1925 was a huge step forward in humans' understanding of what lies beyond our planet. But now, we know much more about the lives of these fiery giants.

NEBULA

Stars form from clouds of hydrogen and helium gas and dust called stellar nebulae. Since it is so cold in space, particles are much more densely packed together than they are on Earth, so that the clouds of gas are much more solid than the air we breathe. Within the nebula, there are some clumps that are denser than others. The gravity of these denser regions pulls on the gas and dust around them, causing the cloud to collapse into itself under its own gravity. As a clump grows in mass, its gravity increases, which increases its center's internal pressure, and so the center begins to heat up. Once this clump separates from the cloud and its gravity is distinguishable from the rest of the nebula, it is called a protostar.

PROTOSTAR

MAIN
SEQUENCE
STAR

The new protostar's angular momentum spins the surrounding gas and dust into a spinning disk which, as the protostar becomes larger and more dense, becomes a planetary system. Infalling matter adds itself to the protostar until its center becomes so dense and hot that thermonuclear fusion takes place. The energy from fusion produces stellar winds, which stop infall from continuing. Thus, the star's mass is fixed and is called a young star. The next few million years can be a time of change for a young star, however. Many stars go through what's called the T-Tauri phase, which is comparable to teenage years in humans. T-Tauri stars are characterized by violent surface activity like flares and eruptions as well as strong stellar winds. Because of the strong stellar winds whirling around its axis of rotation, gas can flow out from the poles of the star, causing it to lose mass until its volatile wind and energy activity settles down. Thus, T-Tauri stars are pre-main sequence stars, shrinking down to mature to a state of stability, at which point it's classified as a main-sequence star.

RED GIANT

After main-sequence stars are formed, they will continue to perform fusion of hydrogen to helium until they run out of hydrogen. When they do, the outer envelope of the star will expand while the inner core collapses in on itself. This stage is called a red giant, the beginning of the end for a star. After the red giant phase, stars' development can go in a few different directions. In the case of stellar fate, size matters!

WHITE DWARF

An average star, like our sun, will begin fusing helium to carbon and oxygen in its core, feeding energy to the expanding outer envelope. Eventually, the helium will run out as well, and the outer layers will be lost. The core left behind becomes a white dwarf, composed of the leftover carbon and oxygen. The gas that made up the outer layers will disperse as another cloud of hydrogen and helium called a planetary nebula.

SUPERNOVA

A massive star, after its red supergiant phase, will commence fusion of helium to heavier and heavier elements in its core until it finally fuses helium to iron. This iron core collapses in on itself until it can no longer be condensed any more and the infalling matter must bounce off of it, radiating an explosion of energy and heavy elements called a supernova. After this, the left-behind core of a massive star about ten times the mass of our sun would form a neutron star, a body so dense, that it causes protons and electrons to combine into neutrons, hence the name. The core of an even bigger star would form a black hole, whose gravity is so great that even light cannot escape from it.

NEUTRON STAR/BLACK HOLE

The gas and dust released from supernovae form stellar nebulae which foster future generations of stars for millions of years. Thanks to the supernovae, the heavy elements which make up life are spread throughout the universe and enable our existence.

The Black Hole

When people think of black holes, they imagine a circular black object in space, sucking in everything that dares come near it. While that may be true in some situations, it does not encompass all that black holes truly are, along with how they interact with us, planets, and the entirety of the universe.

BLACK HOLES

The Origin of Black Holes

It all began in 1784, when philosopher and clergyman John Michell proposed the idea of a “dark star”: a star whose gravitational pull is so strong that even light cannot escape. A little more than a century later, Albert Einstein published his theory of relativity, which determined that classical physics held true to all non-accelerating observers and that the speed of light in a vacuum was the same no matter the speed at which the observer was traveling at. Shortly after, Karl Schwarzschild, a German astronomer, found exact solutions to the Einstein field equations and discovered that matter compressed to a point would be surrounded by a spherical region of space in which nothing could escape. The limit of this region is known as the event horizon and at its edge, the escape velocity equals the speed of light. In the middle of the black hole lies the singularity, where everything is drawn. At the singularity, classical physics are broken and gravity becomes infinitely strong.

The Formation of Black Holes

All black holes come from stars, and in order to understand how they are formed, it is necessary to understand the life-cycle of a star. Stars are formed when large amounts of gas collapse from gravitational attraction; then, when these atoms collide with each other at increasing speeds, it heats up the gas. This heating increases the pressure of the gas until it balances the gravitational attraction. Stars will remain in this state for a long time, but will eventually begin to run out of hydrogen and other nuclear fuels, resulting in a gravitational collapse. This collapse is what many scientists believe caused the formation of many black holes.

Why does this matter and how does it affect us?

In a more frightening situation, when black holes are formed or grow in size by merging with other stars, a burst of light lasting from a few milliseconds to a few minutes known as a gamma-ray burst, is emitted. These bursts are the most energetic form of light and shine trillions of times greater than the Sun. Fortunately, the only observed bursts as of yet have come from outside the Milky Way galaxy, but if one were to point directly at Earth, nothing would be left. Many people wonder about the possibility of a black hole coming near Earth. The closest black hole is debated to be between 3000 and 6000 light years away, but since they can only be detected in certain systems, these black holes could be much closer. If one were to come near Mars, it would cause destructive earthquakes and supervolcanoes on Earth. Or, if it reached Earth's orbit, mass extinction would occur and only a piece of molten rock would be left. Even though this all sounds extremely horrifying, there is no need to worry because a black hole would not be able to come in contact with us for at least another few trillions of years. By that time, the sun will have already exploded and humans will have long since gone extinct or possibly found a new planet to inhabit.

INTERVIEW WITH ANDY WEIR



WHAT INSPIRES YOU?

Mainly my daydreams. I fantasize about having super powers or being on Mars and sometimes that ends up being a book. Also, science. I love to think about all the applications of soon-to-be-invented scientific breakthroughs.



WHAT DO YOU THINK IS THE SIGNIFICANCE OF THE SCIENCE FICTION GENRE IN TODAY'S SOCIETY?

I think it's good for entertainment. And of course it might inspire more people to enter into scientific fields, which is good for everyone.



IS IT A GOOD IDEA TO USE RESOURCES TO MAKE PERMANENT SETTLEMENTS ON MARS OR SHOULD WE BE MORE FOCUSED ON PRESERVING OUR PLANET?

I don't think it has to be one or the other. There are seven billion people here. We can work on more than one thing at a time.



YOU WERE ACTUALLY A SOFTWARE ENGINEER BEFORE YOU MOVED INTO WRITING FULL TIME. WHAT FACTORS INFLUENCED THIS DECISION?

I didn't go full-time in writing until I was 100% sure it would support me financially. Simple as that.



IN RESPONSE TO READER COMPLAINTS ABOUT THE ENDING OF HIS SURVIVAL NOVEL HATCHET, GARY PAULSEN WROTE BRIAN'S WINTER, AN ALTERNATE VERSION WHERE THE PROTAGONIST WAS NEVER RESCUED. HAVE YOU EVER CONSIDERED HOW MARK WATNEY WOULD FARE IF HE HADN'T RECEIVED HELP?

No, I try not to spend too much time "post-gaming" my novels. Once they're done, they're done. I don't speculate on what happens after unless I'm considering a sequel, and I don't speculate on alternate plotlines because I already considered them when I was writing the original book. And what would be the benefit? If I came up with an alternate plot flow that was better than the original, it would just make me feel bad because I should have done that.



WHAT IS THE MESSAGE YOU WANT PEOPLE TO TAKE AWAY AFTER READING ANY OF YOUR WORKS?

No message at all. I just want them to be entertained. When they're done I want them to think "that was cool".



IN A VICE NEWS INTERVIEW, TY FRANCK CLAIMED THAT SCIENCE FICTION ALLOWS HIM TO EXPLORE SOCIO-POLITICAL INTERACTIONS WITHOUT BECOMING OVERLY PERSONAL OR ALIENATING AUDIENCE MEMBERS. ON THE OTHER HAND, YOU STATED IN A SIMILAR INTERVIEW THAT INCLUDING POLITICS MAKES THE PLOT TOO OBVIOUS. DO YOU AGREE WITH FRANCK'S BELIEF? WOULD YOU CONSIDER EXPLORING POLITICS IN THE FUTURE AT ALL?

It definitely enables that avenue, and each writer can do what they like with it. But I choose not to put political or social themes in my stories because that's not what I'm interested in talking about. I write purely to entertain the reader. As a reader, I don't like it when I can tell the author is preaching at me. Even if it's a political or social stance I completely agree with. I don't want that in my entertainment. And I don't want my readers having that feeling of being preached at while they read my stuff. So I don't put it in.



OUR WORLD TENDS TO POLARIZE THE STEM AND ARTS/HUMANITIES FIELDS. WHERE DO YOU BELIEVE YOU FALL IN THIS SPECTRUM? HOW DO YOU BALANCE THE TECHNICAL AND CREATIVE SIDES OF YOURSELF, AND WHAT ADVICE MIGHT YOU OFFER TO SOMEONE WHO FEELS TORN BETWEEN THE TWO?

I think I have a foot in both worlds, but I'm much more interested in science than humanities. A new, well-reasoned, analysis of Beowulf can give people insight into Old English writing styles, but a new piece of technology could end up saving millions of lives from disease or via crop density improvements. Science just does more for humanity than humanities does.



YOU'VE SAID THAT YOU PREFER TO ONLY USE SCIENCE THAT ALREADY EXISTS IN YOUR BOOKS. MANY SCI-FI BOOKS, HOWEVER, INSPIRE NEW INNOVATIONS OR VISIONS FOR THE FUTURE. WHAT DO YOU THINK ARE THE PROS AND CONS OF USING ONLY EXISTING SCIENCE?

Well I don't use strictly existing science. I make use of some near-future stuff or more efficient/effective versions of existing science. But yes, I do like to keep it real as much as possible. The main benefit to this is that you don't have to make up a bunch of rules for invented tech. Example: There are about a million questions I have about transporters in Star Trek. Seems like most of the problems they face could be solved by teleportation and they're just not using it to its full benefit. Rather than leave readers with questions like that, I'd rather just stick with existing tech so all the answers already exist. It becomes a matter of research and math.



FINALLY, WHAT'S ONE THING YOU'D TELL YOUR TEENAGE SELF?

I'd tell him life gets better for him. I suffered from chronic anxiety and depression when I was younger and I was pretty miserable.



CHINA ON THE MOON

There used to be two nations in the space race: the United States and the former Soviet Union. Now, China has joined the game.

The China National Space Administration celebrated the new year with the landing of its Chang'e-4 probe on January 3. Launched almost a month prior on December 8, the 300-pound rover first touched the lunar soil at 10:22 p.m. Beijing time. This success is the first time that humans have landed a probe on the far side of the Moon. Previously, as Mou and Fu of the New York Times explain,

“The difficulty of communicating with earthbound scientists had always made the idea of landing there more complex, if not necessarily prohibitive.”

The Chinese overcame this problem with a relay satellite so that signals from Earth first bounced to the satellite before being sent to the Chang'e-4. Moreover, “this spacecraft included a tactic called autonomous hazard avoidance so that it can decide where to safely land by itself,” adds Jay Melosh of Purdue University. He proposed the idea to the National Aeronautics and Space Administration (NASA) eight years ago, but was told it was not possible.

With the Chang'e-4 having photographed the landscape and analyzed the soil composition, scientists hope that studying this side of the Moon can provide hints about the origins of Earth and other stars. Its landing spot, the South Pole-Aitken basin, is especially important, as it is the oldest

known impact zone, a remnant of a period known as the Late Heavy Bombardment. During this time, space rocks slammed into not only moons but also planets like Earth. Thus, Melosh claims that figuring out the zone's age and composition means uncovering some of Earth's history as well. Furthermore, as the far side of the Moon is quiet with minimal radio signals from Earth, Avi Loeb, a Harvard astronomer, sees a future opportunity to observe even farther into the Universe, possibly even before the creation of the first stars.

With plans to send rovers to Mars and land people on the Moon, China is quickly catching up to NASA and is determined to secure its place as a global and space power. Although the Trump administration is worried about China using space for militaristic purposes, for now, there is no sign of such hostility, only a chance for some major scientific breakthroughs.



HUBBLE SPACE TELESCOPE

The Hubble Space Telescope has been the primary device for observation in space for almost two decades. It captures stunning pictures of the galaxies and the universe around us and is used to create high-resolution images of space with no background light. The iconic spacecraft orbits the planet at a high altitude, which gives it a view of the universe that no ground-based telescopes can achieve. It can look out to a distance of several billion light-years, even into the Hubble Deep Field, one of the farthest regions we have observed. Hubble has outlasted other spacecraft like the Kepler Space Telescope, and is still going strong, sending hundreds of thousands of images back home, and helping shed light on the age of the universe, the identity of quasars, and the existence of dark energy.

The telescope has been orbiting the earth for the past three decades, but it won't last forever. The James Webb Telescope has been touted as the replacement for Hubble, but NASA considers it more of a successor. It will provide information different from that which the Hubble provides. One reason for this is the Webb telescope will be positioned much farther from Earth, some 1.5 million kilometers away, unlike the Hubble Telescope which orbits the Earth at a distance of 570 kilometers. In addition, the Webb telescope will be able to image in infrared light instead of optical and ultraviolet wavelengths, which will help it look back into the Universe's past. This is due to the much larger primary mirror, which is used to gather light in a telescope. The infrared imaging also allows the telescope to look beyond the dust that surrounds newly formed stars.

While the Hubble Space Telescope has provided us with invaluable information on the structure of the universe, the expectations for the Webb Telescope are even higher. Not only will it enable us to map the universe beyond the Hubble, but it will also allow us to glimpse back in time to the beginning of the universe—the closest we will likely come to time travel in our lifetime!



THE DISTANT SNOWMAN

Although the MU69 was initially found in 2014, discoveries have been made which reveal the presence of two asymmetrical lobes in the shape of a snowman.

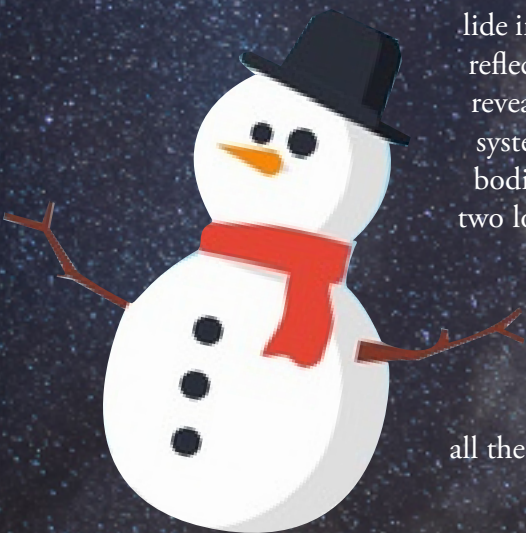
The MU69 comes from an undisturbed part of the solar system known as the cold classical Kuiper belt; objects were probably in a deep freeze since the Solar System formed more than four and a half 4.5 billion years ago. The rock is an example of a contact binary, which is a binary star system containing two objects that are so close that they have merged. The gentle merger of two objects that have two similar sized objects resting on one another after coming together very gently.

Previously in 2018, researchers thought that the object was representative of a bowling pin. However, the most recent images of MU69 show that it is formed of two approximately spherical lumps of rock and ice and pirouettes in space every 15 hours. The two lobe-shaped particles are 12 and nine miles across and are close to a dark brown color similar to that of soil. The reddish color, thought to have been originated from carbon compounds called tholins, are similar to the solar system's other primitive objects, such as the color tones on Pluto and on its biggest moon Charon, whose northern position is permeated with colors of bloodstains.

New images, unfortunately, don't show many surface features due to the poor angle of the sun, which caused the formation of shadows, when the spacecraft flew by. New peaks, troughs, and differences in MU69's surface texture were found are present. Interestingly, not only do the new asymmetrical lobes show a snowman shaped object, but, interestingly enough, the MU69 seems to be wearing a type of necklace.

Researchers could detect the necklace due to the that area where the two lobes collide in color, being chemically disparate relative to the neighboring rock and more reflective than the entirety of MU69. The snowman's lack of craters and shape reveals show the origin of MU69. After a few hundred thousand years of the solar system's inception, many tiny pebbles swirled in tandem. Ultimately, the only bodies orbiting one another were the two separate lobes. Over time, as the two lobes kept ridding themselves of jetsam and flotsam and , they slowly neared each other touched, merging into the snowman shape that has lasted for almost four and a half billion years.

But this isn't the end of the remarkable story of MU69. NASA's New Horizons space probe still requires twenty months for it to retrieve all the data from the flyby, so be on the lookout!



‘OUMUAMUA

On October 19, 2017, a system of powerful survey telescopes, known as the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS), detected a unique celestial object floating in the solar system: ‘Oumuamua.

Though scientifically named as “1I/2017 U1,” the asteroid is commonly known as “‘Oumuamua” which is Hawaiian for “scout.” When the Pan-STARRS 1 telescope first observed this object, what surprised scientist was ‘Oumuamua’s highly elongated structure — at least four hundred meters in length. While first classified as a comet, further observations of its orbit and its appearance indicate that it is an asteroid from interstellar space, the first of its kind to be observed by scientists.

Due to the vastness and diversity of galaxies, it is difficult to find interstellar objects visible to even the most powerful telescope. In fact, the discovery of an object as large as ‘Oumuamua indicates that there might be even more of these interstellar objects in the universe than previously estimated. Specifically, it is estimated that each star in the Milky Way must eject 1015 objects to allow for the possibility of ‘Oumuamua to pass through our Solar System and to be seen by the telescopes.

In regards to the origins of ‘Oumuamua, it appears that it is derived from a two close-orbiting star system, which is when two stars orbit around a particular point. This type of system might generate enough gravity to effectively eject asteroids like the ‘Oumuamua from its own system, sending the object into interstellar space.

While computer models point to the aforementioned theory of binary stars, the appearance of ‘Oumuamua has triggered some speculation of it being an alien object due to its absurd shape and the low likelihood of discovering such an asteroid.

In the long run, while the discovery of the ‘Oumuamua gives us key insight into the nature of interstellar objects, much about the asteroid is still unknown due to its unexpected arrival and rapid departure from the Solar System. To study such objects further, scientists would need to wait for another one to pass by. Currently, scientists are employing the Large Synoptic Survey Telescope (LSST), which has a higher sensitivity for interstellar objects than Pan-STARRS and will be able to more effectively detect objects like ‘Oumuamua. All we can do right now is to wait and see when the next ‘Oumuamua makes its appearance.

MARS 2020 ROVER

Humans have long fantasized about life on Mars—whether it be Martians or even humans in the distant future—and scientists are now one step closer to making that a reality, thanks to engineers at the National Aeronautics and Space Administration (NASA). NASA's new Mars 2020 Rover, which has yet to be named, will be the 8th of its kind to be deployed to the surface of the Red Planet.

The mission, announced in 2012 shortly after the historic landing of NASA's Curiosity rover, shares many similarities with its predecessor. The design of the Mars 2020 Rover is derived from that of Curiosity's, and it will employ a refined version of its landing system. The new rover, however, will be equipped with new scientific instruments, a core drill, and robust wheels, and will be accompanied by a helicopter.

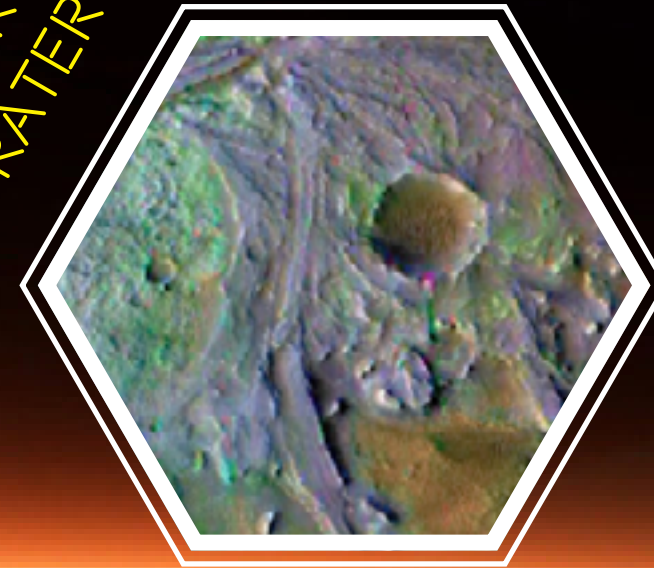
The four pound helicopter will be the first heavier-than-air aircraft to be deployed into the Martian atmosphere, mapping the topography of Mars for future missions. It will explore Mars be-

yond its hills and valleys, and places where land rovers cannot reach. Since Mars is several light minutes away from Earth, scientists will not be able to pilot the aircraft. Instead, the "Helicopter Scout's" flights will be completely autonomous, powered by solar cells. The helicopter will receive and interpret flight commands from the Martian floor, and then execute those commands.

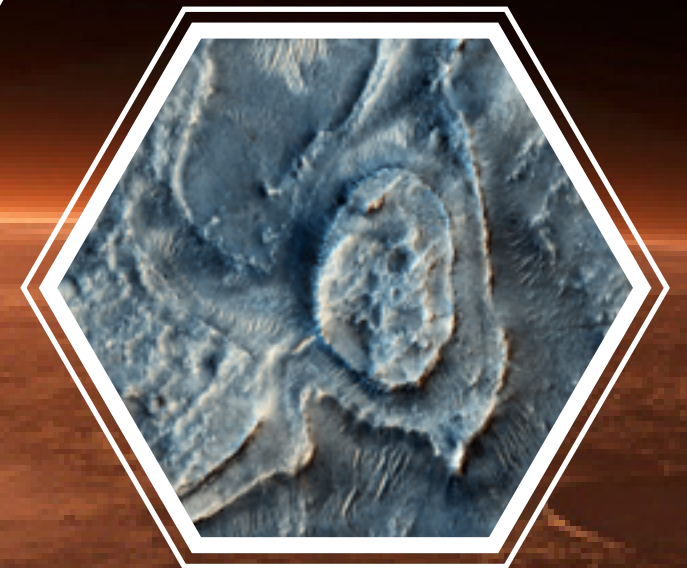
Meanwhile, the Mars 2020 Rover will primarily focus on exploring the red planet for potential signs of life, both in the past and in the present. It will investigate the potential challenges of a manned expedition to Mars, such as testing a method to produce adequate oxygen and inspecting other environmental factors that might hinder future astronauts working on Mars.

As the name suggests, the rover's tentative launch date will be during the summer of 2020, when the position of Mars is most opportune for space travel. It plans to reach Mars's Jezero Crater in February of 2021. The rover's landing site is quite deliberate.

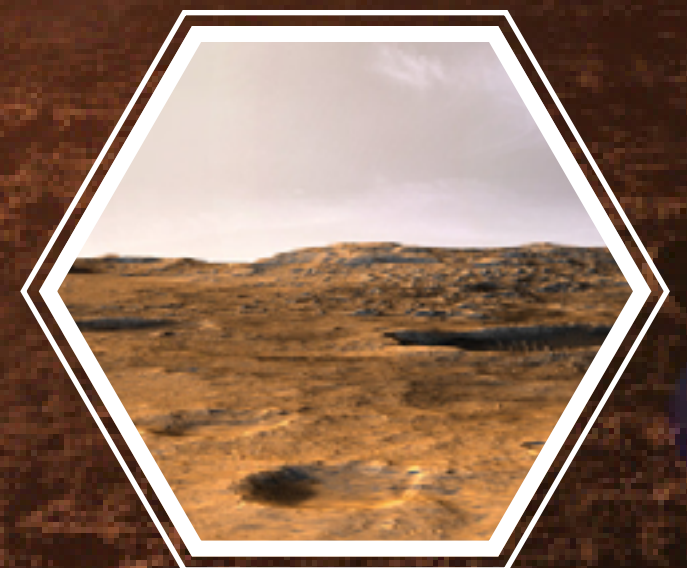
JEZERO
CRATER



NORTHEAST
SYTRIS



COLUMBIAN
HILL



Originally, there were over sixty candidates, but it was eventually winnowed down to three: Columbia Hills, Jezero Crater, and Northeast Syrtis—areas where evidence of potential early life was found in 2017. The geologic diversity near the 28-mile wide Jezero Crater finally gave it the upper hand against other choices. Its 3.6 billion year old landforms feature a large lake-delta system. Neighboring the crater are many different types of rocks, which may preserve great signs of early life on Mars.

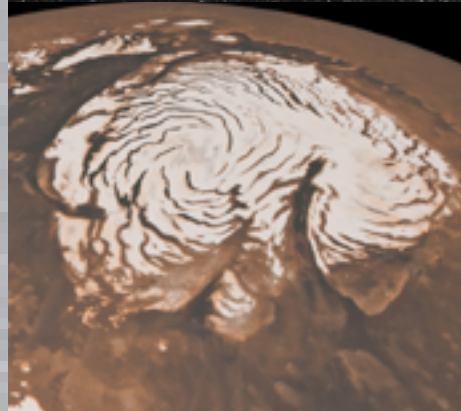
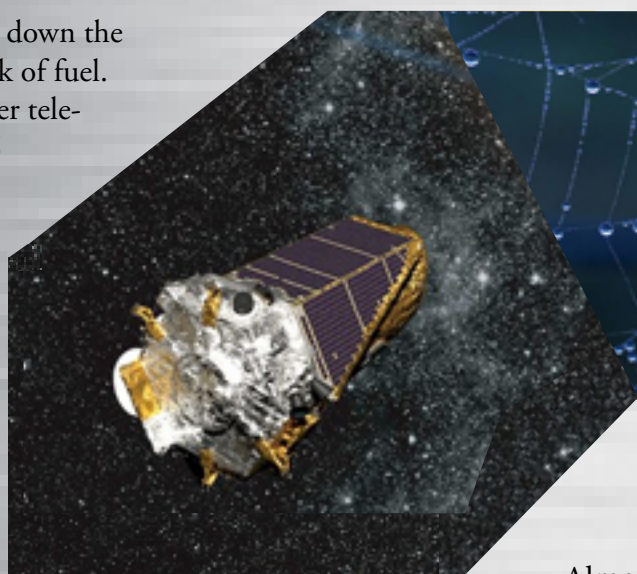
The new rover will gather valuable data for scientists back on Earth, helping them plan future missions and dig into Mars's past. The rover's impact will be crucial to the future of the planet. Human colonization of the Red Planet will probably not happen for a long time, but that possibility has just become a little realer.

2018: YEAR IN REVIEW

SCIENCE'S TOP 8:

On October 30, NASA shut down the Kepler telescope due to a lack of fuel. Launched in 2009, the Kepler telescope has identified 530,506 stars and 2,662 exoplanets. The telescope has also identified 19 planets with possibly favorable conditions to harbor extraterrestrial life in its ten-year tenure.

A Chinese scientist, He Jiankui, sparked controversy when he announced the birth of the first genetically-modified babies. Using CRISPR-Cas9, Jiankui's lab removed the CCR5 gene, which plays a major role in HIV infection, from twin baby girls, allegedly making them immune to AIDS. Further analysis of Jiankui's results indicates that the girls might not be immune to HIV at all because only one of the two copies of CCR5 gene was removed by CRISPR while the other remained viable to produce HIV-susceptible cells.



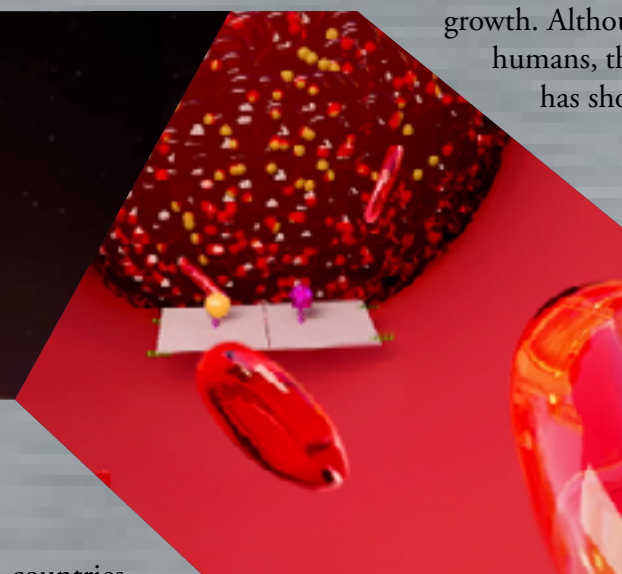
Scientists utilized a unique method to develop biosynthetic spider silk, which matches the strength of its natural counterpart. The strength of the fiber is dependent on the molecular size of its protein; since synthetic spider silk is mass-produced by bacteria using the fiber's DNA, scientists have struggled to develop a protein that is not cut by the bacteria due to its larger size. At Washington University, however, scientists inserted a small sequence into the fiber's DNA, resulting in the fusing of the proteins, producing much stronger silk.

Almost all the water on Mars is contained in its ice caps due to its frigid temperatures. Scientists, however, have long speculated that there might still be the presence of liquid water on Mars. An analysis of radar reflection on Mars has revealed "radar footprints" that are consistent with those of liquid water. The liquid water, however, is not on the Martian surface but is approximately one kilometer underneath, shielded from the frigid atmosphere above. This, along with the brine in the water, are likely to keep the water in liquid form. The observations made by the radar reflection device will likely be confirmed by a probe sent to Mars in the near future. This is the first concrete evidence of liquid water on Mars.

Following the Curiosity rover in 2012, NASA has once again launched a new probe, InSight. The rover completed its three hundred million mile journey over a span of six months in November. Upon its arrival on the Red Planet, InSight captured a recording of Martian winds in what is known as the first sounds from Mars. For the next two years, the rover, equipped with a seismometer, a heat probe, and other scientific instruments, will begin measuring the magnitude of so-called "mars-quakes" in addition to obtaining other information about the Martian atmosphere and terrain.

In February, scientists at the Arizona State University announced the development of a minuscule robot, about a thousand times smaller than a human hair, that has the capability to shrink, inhibit, and kill tumors. The mechanism behind this intriguing innovation comes in two forms. The nanobot is equipped with the aptamers, which are pieces of genetic material to aid the robot in differentiating and targeting tumor cells. After encountering the tumor, the nanobot unfolds and unleashes enzymes known as thrombin to clot the blood vessel where the tumor is located. By inducing this clot, the nanobot effectively cuts off nutrients and oxygen supply to the tumor, which can either kill the tumor or inhibit its growth. Although it has not yet been tested on humans, this new form of cancer treatment has shown potential in tests with mice.

For SpaceX, 2018 has been a productive and fulfilling year. In February, the company launched the Falcon Heavy. This spacecraft was not only produced at a low cost, but it also has a larger carrying capacity than any of its predecessors. In addition, the first-stage boosters on this rocket are partially reusable, which further conserves money and resources. During its test launch, the Falcon Heavy achieved most of its mechanical objectives, including the successful landing of two of its reusable boosters. A third booster, however, fell into the Atlantic Ocean. After the launching of this spacecraft, SpaceX also had numerous successful launches, including the Falcon 9 and GPS satellites later in the year.



In November, delegations from 47 countries voted to dramatically redefine the kilogram, a fundamental unit of mass, from a physical object to the calculations of constants. Previously, the object that defined the kilogram was a cylinder of platinum and iridium, guarded in a vault near Paris. Over its 139-year tenure, the cylinder slowly lost some of its atoms, resulting in an inconsistent definition of the kilogram. After choosing to retire the cylindrical kilogram, scientists voted to use a more abstract concept known as Planck's constants to redefine the kilogram. Since Planck's constants are determined by laboratory measurements, there will still be some variability between the values for this constant; in order to get around this potential issue, there will be a fixed value for the Planck's constant, derived from the most accurate data in the world.



You have heard that the pies Catapulta is selling are out-of-this world, so you are willing to take a trek across space to go get some delicious dessert. Unfortunately, you mixed up the address with 6 other pie shops, and humanity hasn't yet expanded wifi or Google Maps to the entirety of the solar system. You only have enough fuel for one round trip. Based on these clues you gathered from some other space-faring pie enthusiasts, can you figure out where Catapulta's pie shop is located?

1. The 7 shops are the one in the Andromeda Galaxy, the one in the Sombrero Galaxy, the one on Parsec Place, the one with the house #312, the one with the house #313, Slice of Life and Irrelevant Bakery.
2. Of Pie Guys and Stardollars, one is in Pinwheel Galaxy and the other is on Planet Avenue..
3. In Crust We Trust has the house #314.
4. Andromeda Galaxy's house # is 3 greater than Sombrero Galaxy.
5. Of Dough to Go and the shop that has the house #317, one is on Parsec Place and the other is in the Cigar Galaxy.
6. The shop on Nebula Street's house # is 5 less than the house # of the shop in the Cigar Galaxy.
7. The Large Magellanic Cloud's house # is 2 more than In Crust We Trust's.
8. Of Slice of Life and the shop with the house #315, one is on Parsec Place and the other is in the Large Magellanic Cloud.
9. The shop on Supernova Lane is somewhat less than Slice of Life.
10. The Black hole's house # is prime.
11. Pie Guys, the shop on Planet Avenue and the shop with house #312 are different shops.
12. Parsec Place's house # is the average of Protostar Drive's # and Andromeda Galaxy.



PIZZA

	ANDROMEDA	PINWHEEL	MILKY WAY	SOMBRERO	CIGAR	LMC	TADPOLE	PLANET AVENUE	SUPERNOVA LANE	PARSEC PLACE	PROTOSTAR DRIVE	BLACK HOLE CIRCLE	ASTEROID ALLEY	NEBULA STREET	#311	#312	#313	#314	#315	#316	#317	
CATAPULTA																						
SLICE OF LIFE																						
IN CRUST WE TRUST																						
PIE GUYS																						
STARDOLLARS																						
DOUGH TO GO																						
IRRELEVANT BAKERY																						
PLANET AVENUE																						
SUPERNOVA LANE																						
PARSEC PLACE																						
PROTOSTAR DRIVE																						
BLACK HOLE CIRCLE																						
ASTEROID ALLEY																						
NEBULA STREET																						
#311																						
#312																						
#313																						
#314																						
#315																						
#316																						
#317																						

MARK THE GRID WITH
X AND **O**
 TO KEEP TRACK OF
 THE CLUES