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1. Strange Star Likely Swarmed by Comets

This illustration shows a star behind a shattered comet. Observations of the star KIC 8462852 by NASA's Kepler and Spitzer space telescopes suggest that its unusual light signals are likely from dusty comet fragments, which blocked the light of the star as they passed in front of it in 2011 and 2013. The comets are thought to be traveling around the star in a very long, eccentric orbit. Credits: NASA/JPL-Caltech

A star called KIC 8462852 has been in the news recently for unexplained and bizarre behavior. NASA's Kepler mission had monitored the star for four years, observing two unusual incidents, in 2011 and 2013, when the star's light dimmed in dramatic, never-before-seen ways. Something had passed in front of the star and blocked its light, but what?

Scientists first reported the findings in September, suggesting a family of comets as the most likely explanation. Other cited causes included fragments of planets and asteroids.

A new study using data from NASA's Spitzer Space Telescope addresses the mystery, finding more evidence for the scenario involving a swarm of comets. The study, led by Massimo Marengo of Iowa State University, Ames, is accepted for publication in the Astrophysical Journal Letters.

One way to learn more about the star is to study it in infrared light. Kepler had observed it in visible light. If a planetary impact, or a collision amongst asteroids, were behind the mystery of KIC 8462852, then there should be an excess of infrared light around the star. Dusty, ground-up bits of rock would be at the right temperature to glow at infrared wavelengths.

At first, researchers tried to look for infrared light using NASA's Wide-Field Infrared Survey Explorer, or WISE, and found none. But those observations were taken in 2010, before the strange events seen by Kepler -- and before any collisions would have kicked up dust.

To search for infrared light that might have been generated after the oddball events, researchers turned to Spitzer, which, like WISE, also detects infrared light. Spitzer just happened to observe KIC 8462852 more recently in 2015.
"Spitzer has observed all of the hundreds of thousands of stars where Kepler hunted for planets, in the hope of finding infrared emission from circumstellar dust," said Michael Werner, the Spitzer project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California, and the lead investigator of that particular Spitzer/Kepler observing program.

But, like WISE, Spitzer did not find any significant excess of infrared light from warm dust. That makes theories of rocky smashups very unlikely, and favors the idea that cold comets are responsible. It's possible that a family of comets is traveling on a very long, eccentric orbit around the star. At the head of the pack would be a very large comet, which would have blocked the star's light in 2011, as noted by Kepler. Later, in 2013, the rest of the comet family, a band of varied fragments lagging behind, would have passed in front of the star and again blocked its light.

By the time Spitzer observed the star in 2015, those comets would be farther away, having continued on their long journey around the star. They would not leave any infrared signatures that could be detected.

According to Marengo, more observations are needed to help settle the case of KIC 8462852.

"This is a very strange star," he said. "It reminds me of when we first discovered pulsars. They were emitting odd signals nobody had ever seen before, and the first one discovered was named LGM-1 after 'Little Green Men.'"

In the end, the LGM-1 signals turned out to be a natural phenomenon.

"We may not know yet what's going on around this star," Marengo observed. "But that's what makes it so interesting."
2. Scientists Get First Glimpse of Black Hole Eating Star, Ejecting High-Speed Flare

An international team of astrophysicists led by a Johns Hopkins University scientist has for the first time witnessed a black hole swallowing a star and ejecting a flare of matter moving at nearly the speed of light.

The finding reported Thursday in the journal Science tracks the star—about the size of our sun—as it shifts from its customary path, slips into the gravitational pull of a supermassive black hole and is sucked in, said Sjoert van Velzen, a Hubble fellow at Johns Hopkins.

"These events are extremely rare," van Velzen said. "It's the first time we see everything from the stellar destruction followed by the launch of a conical outflow, also called a jet, and we watched it unfold over several months."

Black holes are areas of space so dense that irresistible gravitational force stops the escape of matter, gas and even light, rendering them invisible and creating the effect of a void in the fabric of space. Astrophysicists had predicted that when a black hole is force-fed a large amount of gas, in this case a whole star, then a fast-moving jet of plasma—elementary particles in a magnetic field—can escape from near the black hole rim, or "event horizon." This study suggests this prediction was correct, the scientists said.
"Previous efforts to find evidence for these jets, including my own, were late to the game," said van Velzen, who led the analysis and coordinated the efforts of 13 other scientists in the United States, the Netherlands, Great Britain and Australia.

Supermassive black holes, the largest of black holes, are believed to exist at the center of most massive galaxies. This particular one lies at the lighter end of the supermassive black hole spectrum, at only about a million times the mass of our sun, but still packing the force to gobble a star.

The first observation of the star being destroyed was made by a team at the Ohio State University, using an optical telescope in Hawaii. That team announced its discovery on Twitter in early December 2014.

After reading about the event, van Velzen contacted an astrophysics team led by Rob Fender at the University of Oxford in Great Britain. That group used radio telescopes to follow up as fast as possible. They were just in time to catch the action.

By the time it was done, the international team had data from satellites and ground-based telescopes that gathered X-ray, radio and optical signals, providing a stunning "multi-wavelength" portrait of this event.

It helped that the galaxy in question is closer to Earth than those studied previously in hopes of tracking a jet emerging after the destruction of a star. This galaxy is about 300 million light years away, while the others were at least three times farther away. One light year is 5.88 trillion miles.

The first step for the international team was to rule out the possibility that the light was from a pre-existing expansive swirling mass called an "accretion disk" that forms when a black hole is sucking in matter from space. That helped to confirm that the sudden increase of light from the galaxy was due to a newly trapped star.

"The destruction of a star by a black hole is beautifully complicated, and far from understood," van Velzen said. "From our observations, we learn the streams of stellar debris can organize and make a jet rather quickly, which is valuable input for constructing a complete theory of these events."

Van Velzen last year completed his doctoral dissertation at Radboud University in the Netherlands, where he studied jets from supermassive black holes. In the last line of the dissertation, he expressed his hope to discover these events within four years. It turned out to take only a few months after the ceremony for his dissertation defense.

Van Velzen and his team were not the only ones to hunt for radio signals from this particular unlucky star. A group at Harvard observed the same source with radio telescopes in New Mexico and announced its results online. Both teams presented results at a workshop in Jerusalem in early November. It was the first time the two competing teams had met face to face.

"The meeting was an intense, yet very productive exchange of ideas about this source," van Velzen said. "We still get along very well; I actually went for a long hike near the Dead Sea with the leader of the competing group."

Support for this study came from sources including NASA, the Netherlands Foundation for Scientific Research (NOW), the European Research Council, the International Centre for Radio Astronomy Research, the Alfred P. Sloan Foundation and the Australian Research Council.
3. Massive Rocks May Explain Moon's Mysterious Tilt

Gravitational interactions of small bodies with the Earth-Moon system shortly after its formation (artist’s depiction).

Credit: Laetitia Lalila

The mysterious tilt of the moon's orbit is due to gravitational tugs it received from giant, close-passing rocks that eventually slammed into the Earth, new research suggests.

The leading explanation for the moon's origin is that a Mars-size rock called Theia struck the newborn Earth about 4.5 billion years ago, and the moon coalesced from the disk of debris that resulted from this crash.

However, the moon's current orbit is tilted about 5 degrees with respect to Earth. Previous research suggested this inclination should be 10 times smaller — a long-standing mystery known as the lunar inclination problem. Now, new research shows that gravitational jostling of the newborn moon may solve this puzzle. This finding could also help to explain the levels of gold, platinum and other metals seen in Earth's outer layers, the authors of the new research added.

Smack! Collisions in the early solar system

The early solar system was full of giant rocks hurtling around it and later colliding with Earth and the other planets.

For the new research, scientists ran computer models of the newborn solar system, and began their simulations with the moon orbiting around the Earth's orbital plane. (Collisions between the rocks that came to make up the moon should have dissipated their energy and evened out the disk of debris around the Earth, causing the moon to orbit around Earth's orbital plane.) The simulations included rocks with a total mass equal to 0.75 to 1.5 percent of Earth's mass. (For comparison, the moon's mass is about 1.2 percent of Earth's mass.)

Before these giant rocks smacked into Earth, they each typically experienced thousands of close passes with the planet, a portion of which might have brought them close enough to Earth or the moon to strongly perturb the moon's orbit with their gravitational pull. The researchers found that there was a high chance that, a few tens of millions of years after lunar formation, these close passes could have given the moon's orbit the tilt seen today.
"The most surprising thing about these results is the ease with which the moon's orbital trajectory can be tilted, or excited, by gravitational interactions with passing objects," Kaveh Pahlevan, a planetary scientist at the Observatory of the Côte d'Azur in Nice, France, and lead author of the study, told Space.com.

The moon is Earth's nearest neighbor, but its origins date back to a violent birth billions of years ago.

These findings suggest that the giant impact that formed the moon occurred near the end of Earth's formation.

"If the moon-forming event had occurred earlier, when more massive bodies were around, the moon's orbit would have been much more excited and likely destabilized, with the moon colliding with the Earth or escaping to interplanetary space," Pahlevan said. "The relative lateness of the moon-forming event during Earth formation can be understood as a necessity for its survival. Earlier moons were simply lost."

**Precious metals**

These findings also support previous research suggesting that giant rocks delivered a "late veneer" of metals onto Earth, adding about the last 1 percent of the planet's mass. Gold, platinum, iridium and certain other metals are highly siderophile, meaning they have a strong chemical affinity for iron. Because the newborn Earth was largely molten, most of the planet's iron sunk to its core, and this iron should have taken most of Earth's highly siderophile elements with it. The fact that such metals are found in relatively high levels on Earth's surface suggests they were delivered by giant impacts from many massive rocks, after Earth's core finished forming.

"Had such a population of objects not existed, the moon might be orbiting in Earth's orbital plane, with total solar eclipses occurring as a spectacular monthly event," Robin Canup, a planetary scientist at the Southwest Research Institute, wrote in a commentary article about this research, published in the journal Nature. "But our jewelry would be much less impressive — made from tin and copper, rather than from platinum and gold."

The vulnerability of planet-moon systems to gravitational disruption from outside bodies might help to explain some mysterious features of the inner solar system, Pahlevan said. For instance, Venus likely experienced the same kind of giant impacts that created Earth's moon, but it has no moon, and —strangely — spins very little on its axis.

"Could these Venusian features be the outcome of a planet-satellite system that was destabilized by strong collisionless encounters?" Pahlevan said. "That is a topic for future research."

Pahlevan and senior co-author Alessandro Morbidelli, of the Observatory of the Côte d'Azur, detailed their findings in the Nov. 26 issue of the journal Nature.
The Night Sky

Tuesday, December 1

- This evening is dark and moonless until the waning Moon rises around 11 p.m. Once the Moon is up, look for Regulus about 4° left of it (for North America). By dawn on the 2nd the Moon is under Regulus, as shown above.

Wednesday, December 2

- The last-quarter Moon rises in the east around 11 or midnight tonight. You'll find it hanging below Regulus. About 50 minutes later, Jupiter rises below the Moon. By dawn on Thursday the 3rd, the three of them stand high in the south — while Venus blazes in the southeast.

Thursday, December 3

- Jupiter and the Moon shine together after rising after midnight tonight. In early dawn on Friday the 4th, they stand paired less closely (for North America) high in the south, as shown above. By then Mars, Spica, and bright Venus shine to their lower left.

Friday, December 4

- The big Summer Triangle is still laid out the western sky after dark these cold evenings. Its brightest star is Vega, the brightest in the area. Look above Vega for Deneb. Farther to Vega's left or lower left is Altair.

- Before and during dawn on Saturday the 5th, bright Venus in the southeast anchors a diagonal line that stretches past Spica to connect Mars, the waning Moon, and then Jupiter. The thinning crescent Moon in the dawn will pair with Venus on the 7th, before occulting Venus in broad daylight that day for much of North America. (The Moon in these diagrams is drawn three times its actual apparent size.)

Source: Sky and Telescope
ISS Sighting Opportunities (from Denver)

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Sighting information for other cities can be found at [NASA’s Satellite Sighting Information](https://nssdc.gsfc.nasa.gov/planetary/sighting/)

NASA-TV Highlights
(all times Eastern Time Zone)

**Wednesday, December 2**
- 9 a.m. - NASA Social for Orbital ATK CRS-4 mission (NTV-2 (Education))
- 10 a.m. - In-Flight Event with the House Science, Space, and Technology Committee (Starts at 10:15 a.m.) (NTV-1 (Public), NTV-3 (Media))
- 1 p.m. - Coverage of ISS Science, Research and Technology discussion for Orbital ATK CRS-4 mission (all channels)
- 2 p.m. - Coverage of Prelaunch News Conference for Orbital ATK CRS-4 mission (all channels)

**Thursday, December 3**
- 4:30 p.m. - Coverage of the Launch of the Orbital Sciences/ATK Cygnus CRS-4 Mission from the Cape Canaveral Air Force Station, Florida (Launch scheduled at 5:55 p.m. ET; coverage will end shortly after spacecraft separation from the Centaur Upper Stage at appx. 6:16 (all channels)
- 6:30 p.m. - Coverage of the Deployment of the Solar Arrays on the Orbital Sciences/ATK Cygnus CRS-4 Cargo Craft (Solar Array deployment is initiated at appx. 6:50 p.m. ET and is complete by appx. 7:08 p.m. ET) (Starts at 6:45pm) (all channels)
- 8 p.m. - Orbital Sciences/ATK Cygnus CRS-4 Post-Launch News Conference (time subject to change) (all channels)

Watch NASA TV online by going to the [NASA website](https://nasa.gov).
Space Calendar

- Dec 01 - Comet 73P-AT/Schwassmann-Wachmann Perihelion (0.989 AU)
- Dec 01 - Asteroid 5191 (1990 V03) Occults HIP 20948 (6.9 Magnitude Star)
- Dec 01 - Asteroid 2511 Patterson Closest Approach To Earth (1.525 AU)
- Dec 01 - Kuiper Belt Object 2006 QH181 At Opposition (82.599 AU)
- Dec 01 - Benjamin Wilson's 205th Birthday (1811)
- Dec 01/02 - LISA Pathfinder/Spacetech-07 (SMART-2) Vega Launch
- Dec 02 - Comet 246P/NEAT At Opposition (4.180 AU)
- Dec 02 - Asteroid 96192 Calgary Closest Approach To Earth (1.376 AU)
- Dec 02 - Asteroid 10866 Peru Closest Approach To Earth (1.532 AU)
- Dec 02 - Asteroid 397278 Arvidson Closest Approach To Earth (1.844 AU)
- Dec 02 - Asteroid 37452 Spirit Closest Approach To Earth (2.201 AU)
- Dec 02 - 45th Anniversary (1971), Mars 3, Mars Orbit Insertion
- Dec 03 - Cygnus CRS-4 (OA-4)/ SERPENS/ Flock-2e 1-42/ CADRE/ MinXSS/ Nodes 1&2/ STMSat 1 Atlas 5 Launch (International Space Station)
- Dec 03 - Hayabusa 2, Earth Flyby
- Dec 03 - Asteroid 1833 Shmakova Occults HIP 110602 (5.8 Magnitude Star)
- Dec 03 - Apollo Asteroid 2007 VM184 Near-Earth Flyby (0.057 AU)
- Dec 03 - Asteroid 250840 Motorhead Closest Approach To Earth (1.718 AU)
- Dec 03 - Cassini, Orbital Trim Maneuver #467 (OTM-467)
- Dec 04 - Cassini, Distant Flyby of Methone & Pan
- Dec 04 - 50th Anniversary (1965), Gemini 7 Launch (Frank Borman & Jim Lovell)
- Dec 04 - Comet C/2013 US10 (Catalina) At Opposition (4.280 AU)
- Dec 04 - Comet P/2015 W2 (Catalina) At Opposition (1.761 AU)
- Dec 04 - Aten Asteroid 2005 WS3 Near-Earth Flyby (0.065 AU)
- Dec 04 - Asteroid 193 Ambrosia Closest Approach To Earth (0.889 AU)
- Dec 04 - Asteroid 4763 Ride Closest Approach To Earth (1.804 AU)
- Dec 04 - Asteroid 1832 Mrkos Closest Approach To Earth (2.016 AU)
- Dec 04 - Asteroid 12104 Chesley Closest Approach To Earth (2.097 AU)
- Dec 04 - 20th Anniversary (1996), Mars Pathfinder Launch
- Dec 04 - Wilhelm Tempel's 195th Birthday (1821)
- Dec 05 - Aten Asteroid 2010 TK7 (Earth Trojan) Closest Approach To Earth (0.199 AU)
- Dec 05 - Apollo Asteroid 137052 Tjelvar Closest Approach To Earth (0.549 AU)
- Dec 05 - Centaur Object 8405 Asbolus At Opposition (19.452 AU)
- Dec 05 - 15th Anniversary (2001), STS-108 Launch (Space Shuttle Endeavour, International Space Station)

Source: JPL Space Calendar

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Diamond Nanothreads Could Support Space Elevator

Diamonds in the sky might recall a popular Beatles song, but researcher from Penn State University think that’s exactly where these diamonds belong.

They discovered a way to produce ultra-thin diamond nanothreads that could be ideal for lifting a space elevator from Earth to the Moon.

The team, led by chemistry professor John Badding, applied alternating cycles of pressure to isolated, liquid-state benzene molecules and were amazed to find that rings of carbon atoms assembled into neat and orderly chains.

While they were expecting the benzene molecules to react in a disorganized way, they instead created a neat thread 20,000 times smaller than a strand of human hair but perhaps the strongest material ever made.

The Penn State University researchers immediately had a hunch that these diamond nanothreads, which are remarkably light and strong at the same time — could prove to be an ideal material for a space elevator, a long cable anchored on Earth and reaching into space to attach to a satellite in orbit.

Just recently, a team from the Queensland University of Technology in Australia modeled the diamond nanothreads using large-scale molecular dynamics simulations and concluded that the material is far more versatile than previously thought and has great promise for aerospace properties. The simulation was published in early November.

This intriguing research is laying the foundations for what could someday bring the long awaited space elevator, which was first proposed as a concept in 1895.

Source: Space.com
Planets of the Morning

Image Credit & Copyright: Yuri Beletsky (Carnegie Las Campanas Observatory, TWAN)

**Explanation:** Planet Earth's horizon stretches across this recent Solar System group portrait, seen from the southern hemisphere's Las Campanas Observatory. Taken before dawn it traces the ecliptic with a line-up familiar to November's early morning risers. Toward the east are bright planets Venus, Mars, and Jupiter as well as Regulus, alpha star of the constellation Leo. Of course the planets are immersed in the faint glow of zodiacal light, visible from the dark site rising at an angle from the horizon. Sometimes known as the false dawn, it's no accident the zodiacal light and planets both lie along the ecliptic. Formed in the flattened protoplanetary disk, the Solar System's planet's all orbit near the ecliptic plane, while dust near the plane scatters sunlight, the source of the faint zodiacal glow.