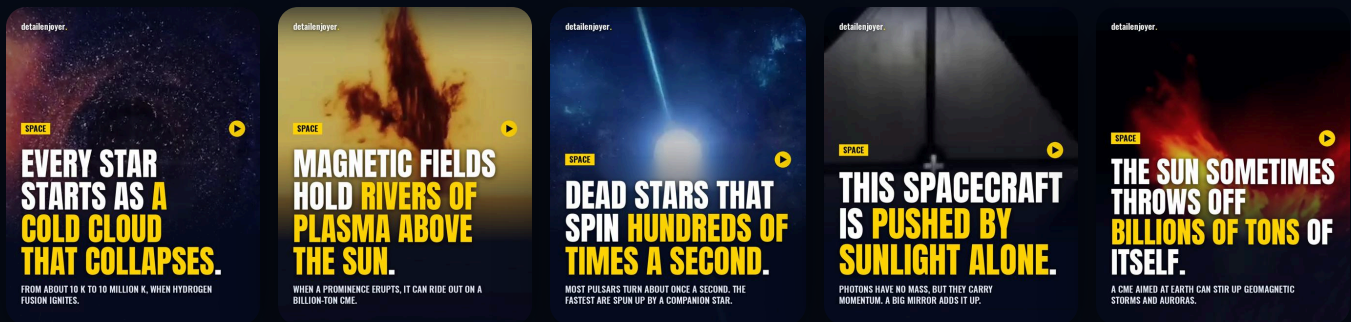




COLLECTION · COL-11

THE SUN AND THE STARS

How stars are born, what the Sun throws into space, what's left when a massive star collapses, how sunlight can push a spacecraft, the plasma clouds the Sun hurls at Earth and the black holes that light up quasars.



INSIDE

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| 02 Solar Prominence | 08 Event Horizon |
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| 04 Solar Sailing | 10 433 Eros |
| 05 Coronal Mass Ejection | 11 Lunar Topography |
| 06 Quasi-Stellar | ✓ Collection Quiz and Answer Key |

DID YOU KNOW?

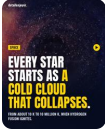
11 case files · 22 quiz questions · by DetailEnjoyer

ABOUT THIS COLLECTION

11 case files from the Space department, in order: a cold cloud collapsing into a star, the magnetic plasma loops and eruptions of the Sun, the spinning neutron stars left behind when massive stars explode, and sails that turn sunlight into thrust. Stars are born in molecular clouds as cold as 10 to 20 K, which must be squeezed by a factor of nearly 10^{20} in density to make a star. **DD-037** When a prominence erupts it becomes the bright core of a coronal mass ejection, which can reach Earth in as little as 15 to 18 hours. **DD-038** Photons have no mass but carry momentum, so a mirror-like sail gets pushed twice: once when light hits it and again when it bounces off. **DD-039**

CONTENTS

- 01



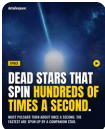
EVERY STAR STARTS AS A COLD CLOUD THAT COLLAPSES.

Stellar Birth
DD-037 · Space / Science · Every star starts as a cold cloud that collapses.
- 02



MAGNETIC FIELDS HOLD RIVERS OF PLASMA ABOVE THE SUN.

Solar Prominence
DD-038 · Space / Science · Magnetic fields hold rivers of plasma above the sun.
- 03



DEAD STARS THAT SPIN HUNDREDS OF TIMES A SECOND.

Neutron Spin
DD-058 · Space / Science · Dead stars that spin hundreds of times a second.
- 04



THIS SPACECRAFT IS PUSHED BY SUNLIGHT ALONE.

Solar Sailing
DD-039 · Space / Tech · This spacecraft is pushed by sunlight alone.
- 05



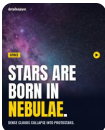
THE SUN SOMETIMES THROWS OFF BILLIONS OF TONS OF ITSELF.

Coronal Mass Ejection
DD-091 · Space / Science · The Sun sometimes throws off billions of tons of itself.
- 06



THE BRIGHTEST OBJECTS ARE FEEDING BLACK HOLES.

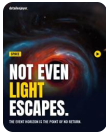
Quasi-Stellar
DD-106 · Space / Science · Some of the brightest objects in the universe are feeding black holes.
- 07



STARS ARE BORN IN NEBULAE.

Nebula
DD-087 · Space · Stars are born when parts of a nebula collapse.

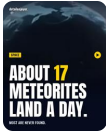
08



Event Horizon

DD-089 · Space / Science · Nothing, not even light, escapes from inside an event horizon.

09



striking!

DD-393 · Space · Researchers estimate about 17 meteorites reach the ground each day.

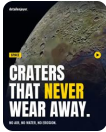
10



433 Eros

DD-380 · Space · Asteroid 433 Eros is about 34 kilometers long.

11



Lunar Topography

DD-385 · Space · With no air or water, the Moon's craters barely erode.



Collection Quiz and Answer Key

22 questions from every case file

Every quick fact has a stable ID (for example DD-037-F01) and comes from a case file with its sources listed. Online edition with videos and slides: <https://detailenjoyer.com/collections/sun-and-stars/>



STELLAR BIRTH

Stars are born in giant molecular clouds: cold (about 10 to 20 K), dusty clouds made mostly of molecular hydrogen, up to about 300 light-years across, and holding enough gas for anywhere from 10 to 10 million suns. Something has to tip a dense region into collapse, such as a supernova shock wave. Gravity then squeezes a core by a factor of nearly 10^{20} in density. The infalling gas heats up into a protostar whose core reaches several million kelvin. A protostar becomes a true star only when its core hits about 10 million K and hydrogen fusion starts. For a sun-like star, the process takes tens of millions of years.

QUICK FACTS

DD-037-F01

Stars are born in molecular clouds as cold as 10 to 20 K, which must be squeezed by a factor of nearly 10^{20} in density to make a star.

DD-037-F02

A protostar becomes a true star only when its core reaches about 10 million K and hydrogen fusion begins.

THE WRITE-UP

Stellar nurseries. Molecular clouds are the coolest and densest parts of the space between stars, at about 10 to 20 K. They're made mostly of molecular hydrogen and range from under a light-year to about 300 light-years across.

Dust keeps it cold. Dust grains of silicates, iron and carbon-rich material block starlight and radiate energy away, keeping the clouds cold enough for gravity to win.

Something tips it over. Clouds are usually too diffuse to contract on their own. A trigger is needed to raise the density somewhere, and a supernova shock compressing nearby gas is one way to start star formation.

A 10^{20} squeeze. To make a star, a cloud core has to shrink until its density rises by a factor of nearly 10^{20} . Gravity does that work against the gas's pressure.

Protostar to star. By the protostar stage the core has reached several million kelvin. Fusion begins at about 10 million K, when protons move fast enough to overcome their electrical repulsion.

It takes time. For a star like the sun, the whole collapse takes roughly 40 to 50 million years. A 15-solar-mass protostar may collapse in only about 100,000 years.

REEL VS. RECORD

- **Units:** 'millions of degrees Kelvin' should be 'millions of kelvins' (or 'million K'). The kelvin isn't written with 'degrees'. [Penn State ASTRO 801; CSIRO]
- **Missing the key step:** collapsing gas reaches several million kelvin as a protostar, but it becomes a star only when the core hits about 10 million K and hydrogen fusion begins. The Reel stops before that point. [NASA Science; Penn State ASTRO 801]
- **Imprecise:** 'density fluctuations' and supernova shocks don't compress the core themselves. Triggers raise the density, and gravity does the collapse. Supernovae are one trigger among several. [CSIRO; NASA Imagine the Universe; OpenStax]
- **Context:** 'dense' molecular clouds are dense only by space standards. A star is about 10^{20} times denser, and the clouds are only about 10 to 20 K. [OpenStax; Chandra]
- **Confirmed:** nurseries are clouds of (mostly molecular) hydrogen, helium and dust spanning light-years, up to about 300 light-years across. [Chandra; NASA Science]

SOURCES

1. Chapter 1: A Star Is Born (NASA Science): <https://science.nasa.gov/exoplanets/resources/life-and-death/chapter-1/>
2. 21.1 Star Formation, Astronomy 2e (OpenStax): <https://openstax.org/books/astronomy-2e/pages/21-1-star-formation>
3. Stellar Evolution: Cycles of Formation and Destruction (NASA Chandra X-ray Center): https://chandra.harvard.edu/edu/formal/stellar_ev/story/index2.html
4. Star Formation (CSIRO Australia Telescope National Facility): <https://www.atnf.csiro.au/resources/education/senior-astrophysics/stellarevolution/formation/>
5. Nuclear Fusion in Protostars (Penn State ASTRO 801): <https://courses.ems.psu.edu/astro801/book/export/html/1758>
6. The Life Cycles of Stars (NASA Imagine the Universe): https://imagine.gsfc.nasa.gov/educators/lifecycles/life_cycles_slides.pdf

Permalink: <https://detailenjoyer.com/case/stellar-birth/> · Last updated Jun 21, 2025



SOLAR PROMINENCE

A solar prominence is a huge loop of relatively cool, dense plasma (electrically charged hydrogen and helium) hanging in the sun's million-degree corona. Twisted magnetic fields rooted in the photosphere hold it up. Prominences form in about a day and can sit quietly for months, looping hundreds of thousands of miles above the surface. When the magnetic structure becomes unstable, the prominence erupts and usually becomes the bright core of a coronal mass ejection (CME). CMEs can carry billions of tons of material at speeds from under 250 km/s to nearly 3,000 km/s, and the fastest Earth-directed ones arrive in 15 to 18 hours.

QUICK FACTS

DD-038-F01

Solar prominences are cool, dense loops of plasma held up in the sun's hot corona by twisted magnetic fields. Stable ones can last for months.

DD-038-F02

When a prominence erupts it becomes the bright core of a coronal mass ejection, which can reach Earth in as little as 15 to 18 hours.

THE WRITE-UP

What a prominence is. A prominence is a large, bright loop of plasma (electrically charged hydrogen and helium) extending from the sun's surface into the corona. Seen against the solar disk instead of the sky, it's called a filament.

Held up by magnetism. Prominences are anchored in the photosphere. Their plasma flows along a tangled, twisted magnetic structure generated by the sun's internal dynamo.

Cool knots in a hot corona. Prominences are cool, dense threads suspended in a corona that is far hotter. Scientists are still debating how so much cool plasma ends up there; the chromosphere is the only plausible source.

Long-lived and enormous. A prominence forms over about a day. Stable ones can last for months and loop hundreds of thousands of miles into space.

From eruption to CME. When the magnetic structure becomes unstable, the prominence bursts outward. Eruptive prominences show up as the brightest part inside a CME, though they usually take up only a small part of its volume.

Space weather. CMEs can carry billions of tons of material at speeds from under 250 km/s to nearly 3,000 km/s. The fastest Earth-directed ones arrive in 15 to 18 hours; slower ones take several days.

REEL VS. RECORD

- **Title:** the Reel's caption title 'Solar Prominent' is a truncation. Every caption is about solar prominences (0.6 s onward), so my title is 'Solar Prominence'. [frames]
- **Overstated:** prominences are described as 'arcs ... that erupt from the sun's surface.' Most don't erupt. They form over about a day and can hang stably in the corona for months; only eruptive prominences break free. [NASA; NASA NTRS]
- **Credit misplaced:** the prominence doesn't release 'billions of tons' on its own. That figure describes a whole CME, and an eruptive prominence is usually a small part of the CME's volume. [NOAA SWPC; Gopalswamy 2014]
- **Confirmed:** 'hundreds of kilometers per second' is typical. CMEs range from under 250 km/s to nearly 3,000 km/s, and the fastest can reach Earth in 15 to 18 hours. [NOAA SWPC; Gopalswamy 2014]
- **Confirmed:** prominences are anchored in the photosphere and extend into the corona along magnetic fields. ('Corona' shouldn't be capitalized.) [NASA]

SOURCES

1. What is a solar prominence? (NASA, 2015): <https://www.nasa.gov/image-article/what-solar-prominence/>
2. Coronal Mass Ejections (NOAA Space Weather Prediction Center): <https://www.swpc.noaa.gov/phenomena/Coronal-mass-ejections>
3. Prominences: The Key to Understanding Solar Activity (NASA Technical Reports Server): <https://ntrs.nasa.gov/api/citations/20110013276/downloads/20110013276.pdf>
4. Gopalswamy, 'Eruptive Prominences and CMEs', in Solar Prominences (Springer, 2014; NASA CDAW preprint): https://cdaw.gsfc.nasa.gov/publications/gopal/gopal2014SolarProminence_chap15.pdf
5. NASA's Heliophysics Fleet Captures May 1, 2013 Prominence Eruption and CME (NASA SVS): <https://svs.gsfc.nasa.gov/10785/>

Permalink: <https://detailenjoyer.com/case/solar-prominence/> · Last updated Sep 7, 2025



DD-058 SPACE / SCIENCE · 3 OF 11

NEUTRON SPIN

Neutron stars are the collapsed cores left after massive stars explode as supernovae, an idea Walter Baade and Fritz Zwicky proposed in 1933. As the core shrinks to about the size of a city, conservation of angular momentum makes it spin much faster, like a skater pulling in her arms. Pulsars are neutron stars whose beams of radiation, from near their magnetic poles, sweep past Earth like a lighthouse. Jocelyn Bell and Antony Hewish detected the first one in 1967. Most pulsars turn only a few times a second at most. The ones that spin hundreds of times a second are millisecond pulsars, old neutron stars 'recycled' by matter and angular momentum from a companion star. The record holder, PSR J1748-2446ad, spins 716 times a second.

QUICK FACTS

DD-058-F01

Most pulsars spin a few times a second or slower; only millisecond pulsars, spun up by companion stars, reach hundreds of spins a second.

DD-058-F02

The fastest known pulsar, PSR J1748-2446ad, spins 716 times a second.

THE WRITE-UP

Born in a collapse. In 1933, Walter Baade and Fritz Zwicky proposed that a massive star collapsing in a supernova could leave behind a tiny, extremely dense neutron star.

Why they spin fast. When a stellar core collapses, it keeps its angular momentum. Shrinking to a fraction of its size makes it rotate far faster, the way a spinning skater speeds up by pulling in her arms.

Cosmic lighthouses. Pulsars emit beams of radiation from near their magnetic poles. As the star turns, the beams sweep past Earth as regular pulses. Jocelyn Bell and Antony Hewish found the first in 1967, and more than 3,000 are now known.

Most are slower. Most pulsars spin only a few times a second or slower; the slowest takes almost 6.7 hours to turn once. Those spinning hundreds of times a second are millisecond pulsars, with periods of 1 to 10 milliseconds.

Spun up by a partner. Millisecond pulsars are 'recycled': matter and angular momentum from a companion star spin up an old neutron star. The fastest known, PSR J1748-2446ad in the globular cluster Terzan 5, spins 716 times a second, beating a 642-Hz record from 1982.

Precise clocks. Their steady pulses make pulsars some of nature's most precise clocks, which astronomers use to test gravity.

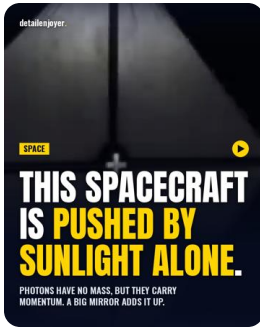
REEL VS. RECORD

- **Confirmed:** neutron stars form when massive stars collapse, and conservation of angular momentum spins them up, as Baade and Zwicky first proposed in 1933. [NASA; Kaspi & Kramer]
- **Overstated:** most pulsars don't spin hundreds of times a second. Typical periods are a few tenths of a second to seconds, and the slowest takes almost 6.7 hours. [NASA; Kaspi & Kramer]
- **Missing the key step:** the pulsars that do spin hundreds of times a second weren't born that fast. They were 'recycled' by a companion star feeding them matter and angular momentum. [Hessels et al. 2006; NASA SVS]
- **Context:** the record is 716 spins a second (PSR J1748-2446ad, Terzan 5, reported in 2006). [Hessels et al. 2006; NRAO]
- **Footage note:** the opening explosion is credited to NASA video; the glowing star with twin beams is an artist's animation, not a telescope image. [frames]

SOURCES

1. Pulsars (NASA Science, Hubble): <https://science.nasa.gov/mission/hubble/science/science-behind-the-discoveries/hubble-pulsars/>
2. Kaspi & Kramer, Radio Pulsars: The Neutron Star Population & Fundamental Physics (arXiv, 2016): <https://arxiv.org/abs/1602.07738>
3. Hessels et al., A Radio Pulsar Spinning at 716 Hz (Science, 2006): <https://doi.org/10.1126/science.1123430>
4. Astronomers Discover Fastest-Spinning Pulsar (NRAO, 2006): <https://www.nrao.edu/pr/2006/mspulsar/>
5. Millisecond Pulsar with Gravitational Waves (NASA Scientific Visualization Studio): <https://svs.gsfc.nasa.gov/10143/>

Permalink: <https://detailenjoyer.com/case/neutron-spin/> · Last updated Jun 15, 2025



DD-039 SPACE / TECH · 4 OF 11

SOLAR SAILING

Light has no mass but does carry momentum. When photons bounce off a mirror-like sail, they push it twice: once when they arrive and again when they reflect. The force (solar radiation pressure) is tiny, so sails have to be huge and spacecraft light. In the vacuum of space, though, the push never stops. Japan's IKAROS first flew a solar sail between planets in 2010. The Planetary Society's LightSail 2 showed a CubeSat could raise its orbit with sunlight, and NASA's ACS3 (launched April 23, 2024) is testing lightweight carbon-fiber booms for an 80 m² sail. By tilting the sail, a craft can speed up, slow down or 'tack' to change its orbit.

QUICK FACTS

DD-039-F01

Photons have no mass but carry momentum, so a mirror-like sail gets pushed twice: once when light hits it and again when it bounces off.

DD-039-F02

LightSail 2's sunlight push was only about 0.058 mm/s², but after a month that adds up to about 550 km/h.

THE WRITE-UP

Massless but pushy. Photons have no mass, but they carry momentum. When they hit a mirror-like sail they push it once on arrival and again as they bounce off.

Light, not wind. The push comes from solar radiation pressure, not the solar wind. The solar wind's charged particles push with less than one percent as much force, roughly a thousandth.

Tiny but relentless. LightSail 2's 32 m² sail gave it an acceleration of about 0.058 mm/s². That's tiny, but over a month it adds up to about 550 km/h (341 mph).

Steering by tilting. By angling the sail, a spacecraft can tack like a sailboat, or turn it against its direction of travel to slow down and lower its orbit. ACS3 tests both raising and lowering its orbit.

Pioneers. JAXA's 14-m IKAROS, launched in 2010, was the state of the art in solar sailing. LightSail 2 later showed that small spacecraft can change their orbits with sunlight.

ACS3. NASA's ACS3 launched on April 23, 2024. Four carbon-fiber composite booms unroll from a CubeSat and stretch a sail about 9 m (30 ft) per side, roughly 80 m² in total.

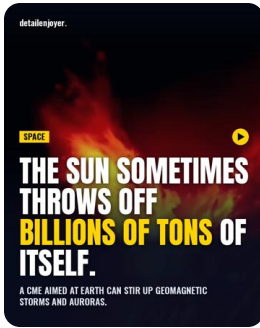
REEL VS. RECORD

- **Confirmed:** 'each photon has no mass' but carries momentum, and reflective sails turn that into thrust. [Planetary Society; Astronomy]
- **Incomplete:** 'gradually accelerating the spacecraft.' Sails can also slow a craft down and lower its orbit by angling the sail against its direction of travel, and ACS3 tests both. [Planetary Society; NASA NTRS]
- **Caveat:** 'without the need for fuel' is true for propulsion (no rocket propellant), but the push weakens with distance from the sun. [NASA ACS3; Astronomy]
- **Clarification:** the push comes from sunlight (radiation pressure), not the solar wind, which pushes with less than one percent as much force. [Planetary Society; NASA NTRS]
- **Footage note:** the animation shows a four-boom diamond sail unfolding from a small satellite over Earth. That's the layout of NASA's ACS3, but the Reel credits only 'galaxies' and doesn't name the mission. [frames; NASA ACS3]

SOURCES

1. What is solar sailing? (The Planetary Society): <https://www.planetary.org/articles/what-is-solar-sailing>
2. Advanced Composite Solar Sail System (ACS3) (NASA): <https://www.nasa.gov/smallspacecraft/what-is-ac3/>
3. ACS3, NASA's Advanced Composite Solar Sail System (The Planetary Society): <https://www.planetary.org/space-missions/acs3>
4. Wilkie et al., Composite Solar Sail (ACS3) Technology overview (NASA Technical Reports Server, 2021): https://ntrs.nasa.gov/api/citations/20205011395/downloads/Wilkie_SciTech_2021_ACS3_overview_20201209_rev_0_for_review.pdf
5. How do photons propel solar sails? (Astronomy, 2020): <https://www.astronomy.com/science/how-do-photons-propel-solar-sails/>

Permalink: <https://detailenjoyer.com/case/solar-sailing/> · Last updated Sep 27, 2025



CORONAL MASS EJECTION

A coronal mass ejection (CME) is a large expulsion of plasma and magnetic field from the Sun's corona. According to NOAA's Space Weather Prediction Center, a CME can eject billions of tons of coronal material carrying an embedded magnetic field. When one reaches Earth it can trigger a geomagnetic storm, which can disrupt radio communication and satellites and push auroras to lower latitudes than usual. Wikipedia gives an average mass of about 1.6×10^{12} kg, noting that estimates are lower limits. The footage shows solar imagery, Earth's magnetic field, city lights from orbit and auroras, with the presenter.

QUICK FACTS

DD-091-F01

CMEs are eruptions of plasma and magnetic field from the corona.

DD-091-F02

A CME can carry billions of tons of material.

THE WRITE-UP

From the corona. CMEs are large expulsions of plasma and magnetic field from the Sun's corona.

Billions of tons. A CME can eject billions of tons of material, per NOAA.

Average mass. Wikipedia gives an average of about 1.6×10^{12} kg, as a lower limit.

Geomagnetic storms. Earth-directed CMEs can cause geomagnetic storms.

Auroras. Those storms can push auroras to lower latitudes.

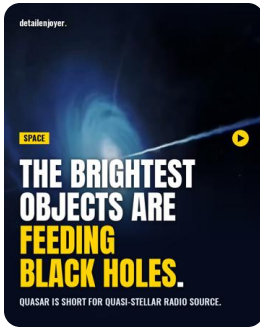
REEL VS. RECORD

- **Note:** 'Several Mount Everests combined': I couldn't find a source for this comparison. The sourced figure is billions of tons, about 1.6×10^{12} kg on average, so I left the mountain comparison out of the write-up.

SOURCES

1. NOAA SWPC: Coronal Mass Ejections: <https://www.swpc.noaa.gov/phenomena/coronal-mass-ejections>
2. Wikipedia: Coronal mass ejection: https://en.wikipedia.org/wiki/Coronal_mass_ejection

Permalink: <https://detailenjoyer.com/case/coronal-mass-ejection/> · Last updated Nov 24, 2023



DD-106 SPACE / SCIENCE · 6 OF 11

QUASI-STELLAR

A quasar is an extremely luminous active galactic nucleus: a supermassive black hole at the center of a galaxy surrounded by a gaseous accretion disk. As gas falls toward the black hole it heats up and releases enormous energy across the electromagnetic spectrum, often outshining the host galaxy. The name comes from 'quasi-stellar radio source', because the first ones found in the 1950s and 60s looked like faint stars. Maarten Schmidt identified the redshift of quasar 3C 273 in 1963, showing quasars are very distant. The footnote shows renderings of galaxies, accretion disks and black holes.

QUICK FACTS

DD-106-F01

Quasars are luminous active galactic nuclei.

DD-106-F02

They're powered by supermassive black holes.

THE WRITE-UP

Active nuclei. Quasars are luminous active galactic nuclei.

Black holes. They're powered by supermassive black holes.

Accretion disks. Infalling gas in an accretion disk releases energy.

The name. 'Quasar' comes from quasi-stellar radio source.

3C 273. Schmidt measured 3C 273's redshift in 1963.

REEL VS. RECORD

- **Note:** None needed.

SOURCES

1. Wikipedia: Quasar: <https://en.wikipedia.org/wiki/Quasar>

Permalink: <https://detailenjoyer.com/case/quasi-stellar/> · Last updated Dec 4, 2023



DD-087 SPACE · 7 OF 11

NEBULA

Nebulae are huge clouds of gas and dust in space. Types include emission nebulae, which glow; reflection nebulae, which scatter starlight; and dark nebulae, which block light behind them. Stars form when dense regions of molecular clouds collapse under gravity into protostars surrounded by disks. Radiation and winds from young, massive stars then shape the surrounding gas and make it glow.

QUICK FACTS

DD-087-F01

Nebulae are clouds of gas and dust.

DD-087-F02

Emission, reflection and dark.

THE WRITE-UP

Clouds. Nebulae are clouds of gas and dust.

Types. Emission, reflection and dark.

Collapse. Dense regions collapse.

Protostar. A protostar forms with a disk.

Glow. Star radiation makes gas glow.

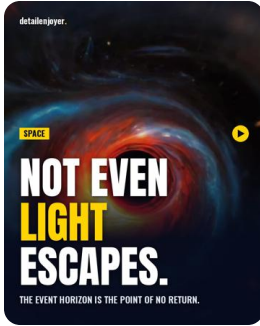
REEL VS. RECORD

- **Note:** None needed.

SOURCES

1. Wikipedia: Nebula: <https://en.wikipedia.org/wiki/Nebula>
2. Wikipedia: Star formation: https://en.wikipedia.org/wiki/Star_formation

Permalink: <https://detailenjoyer.com/case/nebula/> · Last updated Nov 20, 2023



DD-089 SPACE / SCIENCE · 8 OF 11

EVENT HORIZON

A black hole's event horizon is the boundary beyond which nothing, not even light, can escape. Anything that crosses it moves inevitably toward the center, where general relativity predicts a singularity. The horizon results from extreme spacetime curvature caused by mass packed into a small region, and it marks the point of no return.

QUICK FACTS

DD-089-F01

The event horizon is a boundary.

DD-089-F02

Not even light escapes.

THE WRITE-UP

Boundary. The event horizon is a boundary.

Light. Not even light escapes.

Singularity. Relativity predicts a central singularity.

Curvature. Spacetime is extremely curved.

No return. It marks the point of no return.

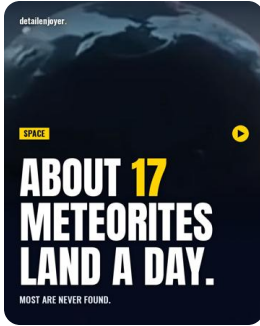
REEL VS. RECORD

- **Note:** The Reel says gravity becomes infinitely strong at the center; that is the prediction of general relativity, which is expected to break down there.

SOURCES

1. Wikipedia: Event horizon: https://en.wikipedia.org/wiki/Event_horizon
2. Wikipedia: Black hole: https://en.wikipedia.org/wiki/Black_hole

Permalink: <https://detailenjoyer.com/case/event-horizon/> · Last updated Nov 22, 2023



DD-393 SPACE · 9 OF 11

STRIKING!

A 2020 study estimated that about 17 meteorites, totaling some 6,100 a year, reach Earth's surface daily, most in oceans or remote areas. Over about 4.5 billion years, impacts number in the billions. Famous craters include Chicxulub in Mexico, linked to the extinction of the non-avian dinosaurs about 66 million years ago, and Meteor Crater (Barringer Crater) in Arizona, about 50,000 years old. The footage shows an animated Earth with impact points.

QUICK FACTS

DD-393-F01

About 17 a day.

DD-393-F02

About 6,000 a year.

THE WRITE-UP

Daily. About 17 a day.

Yearly. About 6,000 a year.

Chicxulub. Linked to the dinosaur extinction.

Arizona. Meteor Crater is about 50,000 years old.

Age. Earth is about 4.5 billion years old.

REEL VS. RECORD

- **Note:** The Reel says meteors; the objects that reach the ground are meteorites.

SOURCES

1. Wikipedia: Meteorite: <https://en.wikipedia.org/wiki/Meteorite>
2. Wikipedia: Chicxulub crater: https://en.wikipedia.org/wiki/Chicxulub_crater
3. Wikipedia: Meteor Crater: https://en.wikipedia.org/wiki/Meteor_Crater

Permalink: <https://detailenjoyer.com/case/striking/> · Last updated Nov 26, 2024



DD-380 SPACE · 10 OF 11

433 EROS

433 Eros is a near-Earth asteroid about 34 by 11 by 11 kilometers, discovered in 1898. NASA's NEAR Shoemaker spacecraft orbited it in 2000 and landed on it on February 12, 2001, the first landing on an asteroid. Manhattan is about 21.6 kilometers (13.4 miles) long, so Eros would overhang it. The footage shows an animated Eros hovering over a landscape for scale.

QUICK FACTS

DD-380-F01

About $34 \times 11 \times 11$ km.

DD-380-F02

1898.

THE WRITE-UP

Size. About $34 \times 11 \times 11$ km.

Discovered. 1898.

Probe. NEAR Shoemaker orbited it.

Landing. Landed Feb 12, 2001.

Manhattan. About 21.6 km long.

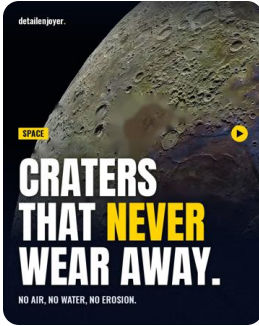
REEL VS. RECORD

- **Note:** None needed.

SOURCES

1. Wikipedia: 433 Eros: https://en.wikipedia.org/wiki/433_Eros
2. Wikipedia: NEAR Shoemaker: https://en.wikipedia.org/wiki/NEAR_Shoemaker

Permalink: <https://detailenjoyer.com/case/433-eros/> · Last updated Nov 20, 2024



DD-385 SPACE · 11 OF 11

LUNAR TOPOGRAPHY

The Moon's craters were made by impacts of asteroids, comets and meteoroids over billions of years. Many large basins date to an early period of heavy bombardment, sometimes called the Late Heavy Bombardment, often placed about 4.1 to 3.8 billion years ago. The South Pole-Aitken Basin, about 2,500 kilometers across, is the largest. Without air or water, there is little erosion to wear them away. The footage shows close-up views of the lunar surface.

QUICK FACTS

DD-385-F01

Asteroids and comets.

DD-385-F02

About 4.1 to 3.8 billion years ago.

THE WRITE-UP

Impacts. Asteroids and comets.

Bombardment. About 4.1 to 3.8 billion years ago.

Largest. South Pole-Aitken Basin.

Size. About 2,500 km.

Erosion. No wind or water.

REEL VS. RECORD

- **Note:** The Reel dates the Late Heavy Bombardment to about 4.5 billion years ago; it is usually placed about 4.1 to 3.8 billion years ago.

SOURCES

1. Wikipedia: Lunar craters: https://en.wikipedia.org/wiki/Lunar_craters

2. Wikipedia: South Pole-Aitken basin: https://en.wikipedia.org/wiki/South_Pole%E2%80%93Aitken_basin

Permalink: <https://detailenjoyer.com/case/lunar-topography/> · Last updated Nov 22, 2024

COLLECTION QUIZ

Test Your Knowledge: 22 questions from The Sun and the Stars. Answers are on the next page.

1. How cold are the molecular clouds where stars are born? (DD-037 · Stellar Birth)

- A. About 10–20 K
- B. About 300 K
- C. About 1,000 K
- D. About 1 million K

2. What is the main ingredient of a molecular cloud? (DD-037 · Stellar Birth)

- A. Helium
- B. Molecular hydrogen
- C. Water vapor
- D. Iron

3. What is a solar prominence called when it's seen against the face of the sun? (DD-038 · Solar Prominence)

- A. A sunspot
- B. A filament
- C. A flare
- D. A corona

4. What holds a prominence up above the sun's surface? (DD-038 · Solar Prominence)

- A. Solar wind
- B. Twisted magnetic fields
- C. Gravity waves
- D. Nuclear fusion

5. Who first proposed neutron stars, in 1933? (DD-058 · Neutron Spin)

- A. Einstein and Bohr
- B. Baade and Zwicky
- C. Bell and Hewish
- D. Hubble and Sagan

6. What makes a collapsing core spin faster? (DD-058 · Neutron Spin)

- A. Magnetism alone
- B. Conservation of angular momentum
- C. Dark matter
- D. Solar wind

7. What pushes a solar sail? (DD-039 · Solar Sailing)

- A. The solar wind
- B. The momentum of sunlight
- C. Magnetic fields
- D. A small rocket

8. Why does a reflective sail get a bigger push than a black one? (DD-039 · Solar Sailing)

- A. It's lighter
- B. Photons push again when they bounce off
- C. It's hotter
- D. It's magnetic

9. Where do CMEs come from? (DD-091 · Coronal Mass Ejection)

- A. The Sun's corona
- B. Earth's core
- C. Jupiter
- D. The Moon

10. How much material can a CME eject? (DD-091 · Coronal Mass Ejection)

- A. Billions of tons
- B. A few kilograms
- C. One ton
- D. Nothing measurable

11. What powers a quasar? (DD-106 · Quasi-Stellar)

- A. A supermassive black hole
- B. A neutron star
- C. A comet
- D. A planet

12. Where are quasars found? (DD-106 · Quasi-Stellar)

- A. At galaxy centers
- B. In our solar system
- C. On the Moon
- D. In nebulae only

13. What is a nebula? (DD-087 · Nebula)

- A. A cloud of gas and dust
- B. A planet
- C. A comet
- D. A black hole

14. Which type glows? (DD-087 · Nebula)

- A. Emission
- B. Dark
- C. Reflection
- D. None

15. What can escape an event horizon? (DD-089 · Event Horizon)

- A. Nothing
- B. Light
- C. Radio waves
- D. Neutrinos

16. What is at the center? (DD-089 · Event Horizon)

- A. A predicted singularity
- B. A star
- C. A planet
- D. Nothing at all

17. About how many reach the ground daily? (DD-393 · striking!)

- A. 17
- B. 1
- C. 1,000
- D. None

18. Which crater is tied to the dinosaurs? (DD-393 · striking!)

- A. Chicxulub
- B. Meteor Crater
- C. Vredefort
- D. Tycho

19. How long is Eros? (DD-380 · 433 Eros)

- A. About 34 km
- B. About 3 km
- C. About 340 km
- D. About 1 km

20. When discovered? (DD-380 · 433 Eros)

- A. 1898
- B. 1998
- C. 1801
- D. 1950

21. What made the craters? (DD-385 · Lunar Topography)

- A. Impacts
- B. Volcanoes only
- C. Rivers
- D. Wind

22. Largest basin? (DD-385 · Lunar Topography)

- A. South Pole-Aitken
- B. Tycho
- C. Copernicus
- D. Mare Tranquillitatis

ANSWER KEY

1. **A. About 10–20 K** Now You Know: They're the coldest, densest parts of interstellar space. *(DD-037)*
2. **B. Molecular hydrogen** Now You Know: That's why they're called molecular clouds, with dust mixed in. *(DD-037)*
3. **B. A filament** Now You Know: It's the same structure. Against the bright disk it looks like a dark thread. *(DD-038)*
4. **B. Twisted magnetic fields** Now You Know: Prominence plasma flows along twisted magnetic structures anchored in the photosphere. *(DD-038)*
5. **B. Baade and Zwicky** Now You Know: They tied them to supernovae. *(DD-058)*
6. **B. Conservation of angular momentum** Now You Know: It's like a skater pulling in her arms. *(DD-058)*
7. **B. The momentum of sunlight** Now You Know: Photons carry momentum. The solar wind's push is less than one percent as strong. *(DD-039)*
8. **B. Photons push again when they bounce off** Now You Know: Light pushes once on arrival and again on reflection. *(DD-039)*
9. **A. The Sun's corona** Now You Know: The Sun's outer atmosphere. *(DD-091)*
10. **A. Billions of tons** Now You Know: Per NOAA's SWPC. *(DD-091)*
11. **A. A supermassive black hole** Now You Know: Via its accretion disk. *(DD-106)*
12. **A. At galaxy centers** Now You Know: Active galactic nuclei. *(DD-106)*
13. **A. A cloud of gas and dust** Now You Know: Interstellar. *(DD-087)*
14. **A. Emission** Now You Know: Ionized gas. *(DD-087)*
15. **A. Nothing** Now You Know: Not even light. *(DD-089)*
16. **A. A predicted singularity** Now You Know: Per relativity. *(DD-089)*
17. **A. 17** Now You Know: 2020 estimate. *(DD-393)*
18. **A. Chicxulub** Now You Know: Mexico. *(DD-393)*
19. **A. About 34 km** Now You Know: Elongated. *(DD-380)*
20. **A. 1898** Now You Know: 19th century. *(DD-380)*
21. **A. Impacts** Now You Know: Collisions. *(DD-385)*
22. **A. South Pole-Aitken** Now You Know: Far side. *(DD-385)*

NOW YOU KNOW!