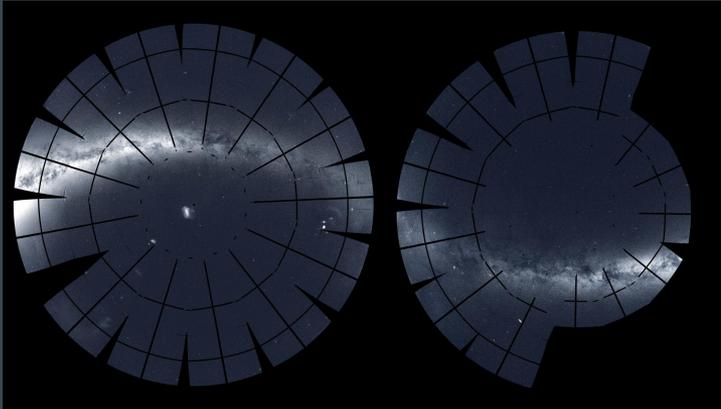


NASA TESS Communications

A how-to guide for getting NASA coverage for your result



Meet the team

Amber Straughn, Associate Director for Communications, Goddard Astrophysics

Barb Mattson, Communications Scientist & Goddard AstroComms team lead

Claire Andreoli, Communications Manager for Astrophysics (that's me!)

Frank Reddy, Senior Science Writer

Jeanette Kazmierczak, Science Writer

Sara Mitchell, @NASAUniverse lead

Kelly Ramos, @NASAUniverse

Scott Wiessinger, video producer

Sophia Roberts, video producer

Adriana Manrique, animator

Elizabeth Apala, outreach lead

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Jeanette Kazmierczak
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ASD Social Media Lead

Kelly Ramos
ASD Social Media Specialist

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ASD Video Producer

Elizabeth Apala
ASD Outreach Lead

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APOLLO 50
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It starts in a new discovery ...

The Astrophysical Journal Letters, 848L25 (2017), 2017 October 20
(See the end matter for the full list of authors.)

OPEN ACCESS

Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A

LIGO Scientific Collaboration and Virgo Collaboration, Fermi Gamma-ray Burst Monitor, and INTEGRAL

Received 2017 October 6; revised 2017 October 30; accepted 2017 October 6; published 2017 October 16

Abstract

On 2017 August 17, the gravitational-wave event GW170817 was observed by the Advanced LIGO and Virgo detectors, and the gamma-ray burst GRB 170817A was observed independently by the Fermi Gamma-ray Burst Monitor, and the *Astro-Compass* Shield for the Spectroscopy and Analysis of Gamma-ray Emission (SAGE). The probability of the near-simultaneous arrival and optical observations of GRB 170817A and GW170817 occurring by chance is 3.0×10^{-7} . We therefore confirm binary neutron star mergers as a progenitor of short GRBs. The association of GW170817 and GRB 170817A provides new insight into fundamental physics and the origin of short GRBs. We use the observed time delay of $1.1 \pm 1.4 \pm 0.016$ s between GRB 170817A and GW170817 to (a) constrain the difference between the speed of gravity and the speed of light to be between -3×10^{-16} and 7×10^{-16} times the speed of light, (b) place an upper bound on the violation of Lorentz invariance (LIV) present as a new test of the equivalence principle by comparing the Shapiro delay between gravitational and electromagnetic radiation. We also use the speed of light and the Lorentz factor of the ejecta emitting the gamma-rays. GRB 170817A is the closest short GRB with a known distance, but is between 2 and 6 orders of magnitude less energetic than other bursts with measured redshift. A new generation of gamma-ray detectors and submillimeter sources in existing detectors, will be essential to detect similar short bursts at greater distances. Finally, we predict a joint detection rate for the Fermi Gamma-ray Burst Monitor and the Advanced LIGO and Virgo detectors of $1.1\text{--}1.4$ per year during the 2018–2019 observing run and $0.3\text{--}1.2$ per year of design sensitivity.

Key words: binaries: close – gamma-ray burst: general – gravitational waves

1. Introduction and Background

GW170817 and GRB 170817A mark the discovery of a binary neutron star (BNS) merger detected both as a gravitational wave (GW; LIGO Scientific Collaboration & Virgo Collaboration 2017a) and a short-duration gamma-ray burst (SGRB; Goldstein et al. 2017). SGRBs are thought to be powered by radiation from the coalescence of BNS and neutron star (NS)–black hole (BH) binary systems but have a poorly understood origin (e.g., Li & Paczyński 2017). GRB 170817A is the first BNS merger event detected by both means of the most likely source of simultaneously detectable GW and electromagnetic (EM) radiation from the same source. This is important as joint detections enable a unique test of general relativity and constrain the equation of state of neutron star matter (Abbott et al. 2017). BNS mergers are predicted to yield significant contributions to the EM spectrum (Mergler & Berger 2012; Frasin et al. 2017), including SGRBs (Illiano et al. 1984; Paczyński 1986; Berger et al. 1990; Paczyński 1991; Narayan et al. 1993), which produce prompt emission in gamma-rays and afterglow emission.

A major astrophysical implication of a joint detection of an SGRB and of a GW from a BNS merger is the confirmation that these bursts are indeed the progenitors of at least some SGRBs. GRBs are classified as short or long depending on the duration of their prompt gamma-ray emission. This cut is based on spectral differences in gamma-rays and the bimodality of the observed

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LETTER

The X-ray counterpart to the gravitational-wave event GW170817

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A long-standing paradigm in astrophysics is that collisions—or mergers—of two neutron stars form highly relativistic and collimated outflows (jets) that power γ -ray bursts of short (less than two seconds) duration¹. The observational support for this model, however, is only indirect². A harbinger outstanding prediction is that gravitational-wave events from such mergers should be associated with γ -ray bursts, and that a majority of these bursts should be seen off-axis, that is, they should point away from Earth³. Here we report the discovery observations of the X-ray counterpart associated with the gravitational-wave event GW170817. Although the electromagnetic counterpart at optical and infrared frequencies is dominated by the radioactive glow (known as a kilonova⁴) from freshly synthesized r-process neutron capture (r-process) material in the merger ejecta⁵, observations at X-ray and late, radio frequencies are consistent with a short γ -ray burst viewed off-axis⁶. Our detection of X-ray emission at a location coincident with the kilonova transient predicts the missing observational link between short γ -ray bursts and gravitational waves from neutron star mergers, and gives independent confirmation of the collimated nature of the γ -ray burst emission.

On 17 August 2017 at 12:41:04 universal time (UTC; hereafter T₀), the Advanced Laser Interferometer Gravitational-Wave Observatory (LIGO) detected a gravitational-wave transient from the merger of two neutron stars at a distance⁷ of 40 ± 8 Mpc. Approximately two seconds later, a weak γ -ray burst (GRB) of short duration (< 2 s) was observed by the Fermi Gamma-ray Space Telescope⁸ and INTEGRAL⁹. The low luminosity of this γ -ray transient was unusual compared to the population of short GRBs at cosmological distances¹⁰, and its physical connection with the gravitational-wave event remained unclear. A vigorous observational campaign targeted the localization region of the gravitational-wave transient, and rapidly identified a source of bright optical, infrared and diffracted emission in the early-type galaxy NGC 4993¹¹. This source was designated SSS17a by the Swift team¹², but here we use the official IAU designation, AT 2017gk. AT 2017gk was initially not visible in radio and X-ray wavelengths. However, on 22 August 2017, we observed the field with the Chandra X-ray Observatory and detected X-ray emission at the position of AT 2017gk (Fig. 1). The observed X-ray (see Methods) implies an isotropic luminosity of 9×10^{46} erg s⁻¹ if located in NGC 4993 at a distance of about 40 Mpc. Further Chandra observations, performed between 1 and 2 September 2017, confirmed the presence

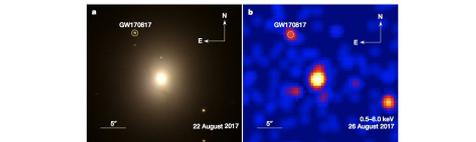


Figure 1. Optical/infrared and X-ray images of the counterpart of GW17017. (a) Optical/infrared image showing a light and red transient in the early-type galaxy NGC 4993, at a projected physical offset of about 2 kpc from its nucleus. A similar small offset is observed

in less than a quarter of short GRBs¹³. Dust lanes are visible in the inner regions, suggestive of a past merger activity (see Methods). (b) Chandra observations revealed a faint X-ray source at the position of the optical/infrared transient. X-ray emission from the galaxy nucleus is also visible.

1. Introduction

The detection of gravitational waves (GWs) by the Laser Interferometer Gravitational-wave Observatory (LIGO) is one of the most exciting advances in physics in decades. Abbott et al. (2016a) reported the first LIGO detection of GWs, resulting from the merger of two black holes (BHs). The observed waveforms showed a near-perfect match to predictions from general relativity for the inspiral and merger of two BHs, ushering in the era of GW astronomy. Extensive follow-up observations based on this GW event found no robust electromagnetic (EM) counterparts (e.g., Abbott et al. 2016; Coughan et al. 2016; Evans et al. 2016; Soares-Santos et al. 2016), consistent with theoretical predictions for stellar-mass BH mergers.

The next frontier is multi-messenger astronomy, where GW sources are associated with EM emitters, connecting GW astronomy to our richer understanding of astrophysics. Core-collapse supernovae, mergers of two neutron stars (NSs), and mergers of NS–BH binaries are among the EM sources likely to have detectable GW signals. In particular, NS–NS mergers have been predicted to be the progenitors of short γ -ray bursts (e.g., Troja & Paczyński 1996; Narayan et al. 1992), and may produce kilonovae (Li & Paczyński 1998) that are responsible for the majority of r-process nucleosynthesis in the Universe (Gälik et al. 1989). On 2017 August 17 at 12:41:04 UTC, LIGO-Virgo detected event GW170817—the observed first gravitational-wave signal of an NS–NS inspiral, and early analysis indicated a

luminosity distance of $D_L = 40 \pm 8$ Mpc (LIGO Scientific Collaboration & Virgo Collaboration 2017a, 2017b; Abbott et al. 2017). This discovery is the first in a new class of GW events stemming from NS binary coalescences, which are predicted to produce EM emission. Approximately 2 s after the GW trigger, the Gamma-ray Burst Monitor (GBM) instrument on board the Fermi Gamma-ray Space Telescope was also triggered by the short-duration GRB 170817A (Coughan et al. 2017; Goldstein et al. 2017a, 2017b; von Kienlin et al. 2017). Thanks to light localization by LIGO-Virgo, follow-up ground-based optical imaging soon discovered the associated optical transient Swgpe Supernova Survey 17a (SSS17a; Coughan et al. 2017a, 2017b), near the galaxy NGC 4993 at $z = 0.0098$ ($D_L = 42.5 \pm 0.3$ Mpc; da Costa et al. 2017).

This discovery initiated rapid follow-up surveillance by X-ray telescopes. The first X-ray observations of the field yielded upper limits from the Monitor of All-sky X-ray Images (MAXI) on board the International Space Station (Sugita et al. 2017) and the X-ray Telescope (XRT) on Swift Observatory (Evans et al. 2017a). In particular, Swift observations began 0.6 days post-trigger, followed by a cadence of one-to-several observations daily. No X-ray emission was detected at the location of SSS17a up to a limiting luminosity of 4.2×10^{46} erg s⁻¹ at 9.2×10^4 erg s⁻¹ (Evans et al. 2017c). Stacked Swift-XRT observations spanning 16 days event GW170817—the observed first possible weak source reported in Evans et al. (2017b) that, with refined astrophysical corrections and

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https://doi.org/10.3847/2041-8213/aa7046

OPEN ACCESS

A Deep Chandra X-Ray Study of Neutron Star Coalescence GW170817

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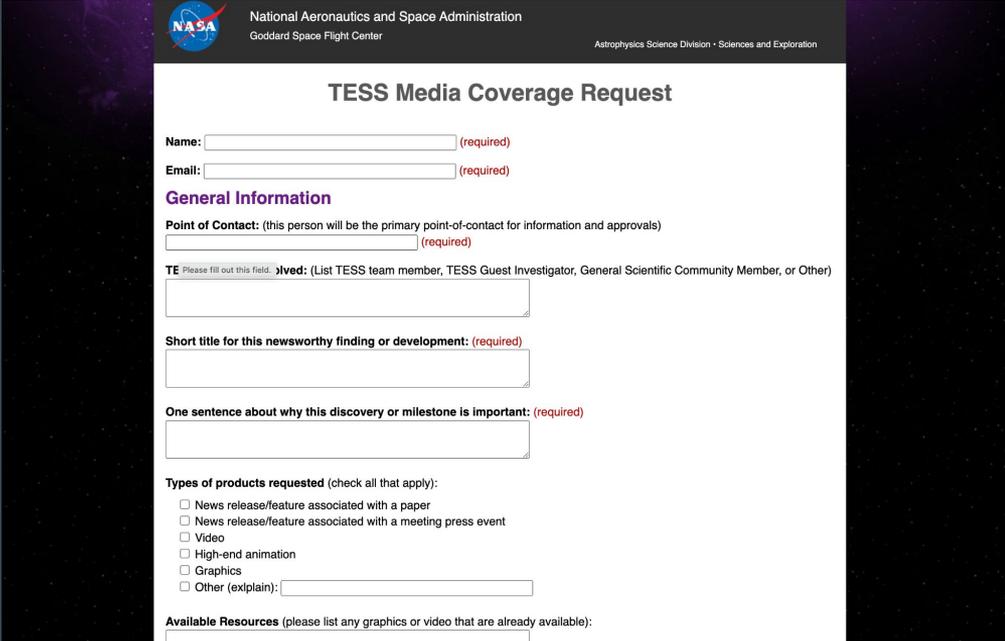
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Abstract

We report Chandra observations of GW170817, the first neutron star–neutron star merger discovered by the joint LIGO-Virgo Collaboration, and the first direct detection of gravitational radiation associated with an electromagnetic counterpart. Fermi short γ -ray burst GRB 170817A, first event triggered on 2017 August 17 and subsequent observations identified an optical counterpart, SSS17a, coincident with NGC 4993 ($\sim 10^\circ$ separation). Early Chandra ($\Delta t = 2$ days) and Swift ($\Delta t = 1.3$ days) observations yielded non-detections at the optical position, but ~ 9 days post-trigger Chandra monitoring revealed an X-ray point source coincident with SSS17a. We present two deep Chandra observations totaling > 65 ks, collected on 2017 September 01–02 ($\Delta t = 15\text{--}16$ days). We detect X-ray emission from SSS17a with $L_{0.3\text{--}10\text{keV}} = 2.4 \times 10^{46}$ erg s⁻¹ and a power law spectrum of $\Gamma = 2.4 \pm 0.8$. We find that the X-ray light curve from a binary NS coalescence associated with this source is consistent with the afterglow from an off-axis short γ -ray burst, with a jet angle $\geq 23^\circ$ from the line of sight. This event marks both the first electromagnetic counterpart to a LIGO-Virgo gravitational-wave source and the first identification of an off-axis short GRB. We also confirm extended X-ray emission from NGC 4993 ($L_{0.3\text{--}10\text{keV}} \sim 9 \times 10^{45}$ erg s⁻¹) consistent with its IS90 galaxy classification, and report two new Chandra point sources in this field, CXOU J170819.8–730411.6 (gravitational waves – stars: neutron – X-rays: binaries)

Tell your comms team

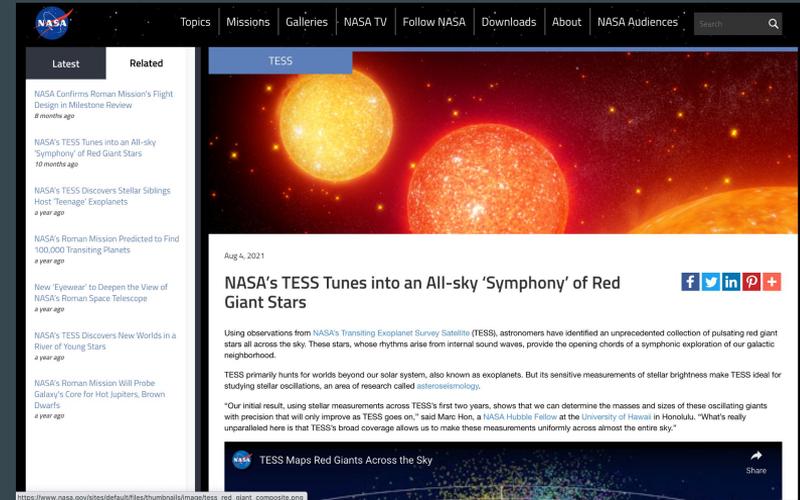
- ✘ Our team asks for media requests from folks *when they submit the paper to the journal*
- ✘ TESS media request form link: https://asd.gsfc.nasa.gov/media_req_tess/
- ✘ Please talk to us BEFORE you post a paper on arXiv!



The image shows a screenshot of the "TESS Media Coverage Request" form. At the top, it features the NASA logo and the text "National Aeronautics and Space Administration" and "Goddard Space Flight Center". On the right, it says "Astrophysics Science Division • Sciences and Exploration". The form title is "TESS Media Coverage Request". Below the title, there are two input fields: "Name: [input] (required)" and "Email: [input] (required)". A section titled "General Information" follows. It includes a "Point of Contact" field with a note "(this person will be the primary point-of-contact for information and approvals)" and "(required)". Below that is a "TE" field with a note "(Please fill out this field. Required: (List TESS team member, TESS Guest Investigator, General Scientific Community Member, or Other))". There are three more input fields: "Short title for this newsworthy finding or development: (required)", "One sentence about why this discovery or milestone is important: (required)", and "Types of products requested (check all that apply):". The "Types of products requested" section has four checkboxes: "News release/feature associated with a paper", "News release/feature associated with a meeting press event", "Video", and "High-end animation". There is also a checkbox for "Graphics" and an "Other (explain):" field with an input box. At the bottom, there is an "Available Resources" section with a note "(please list any graphics or video that are already available):" and an input field.

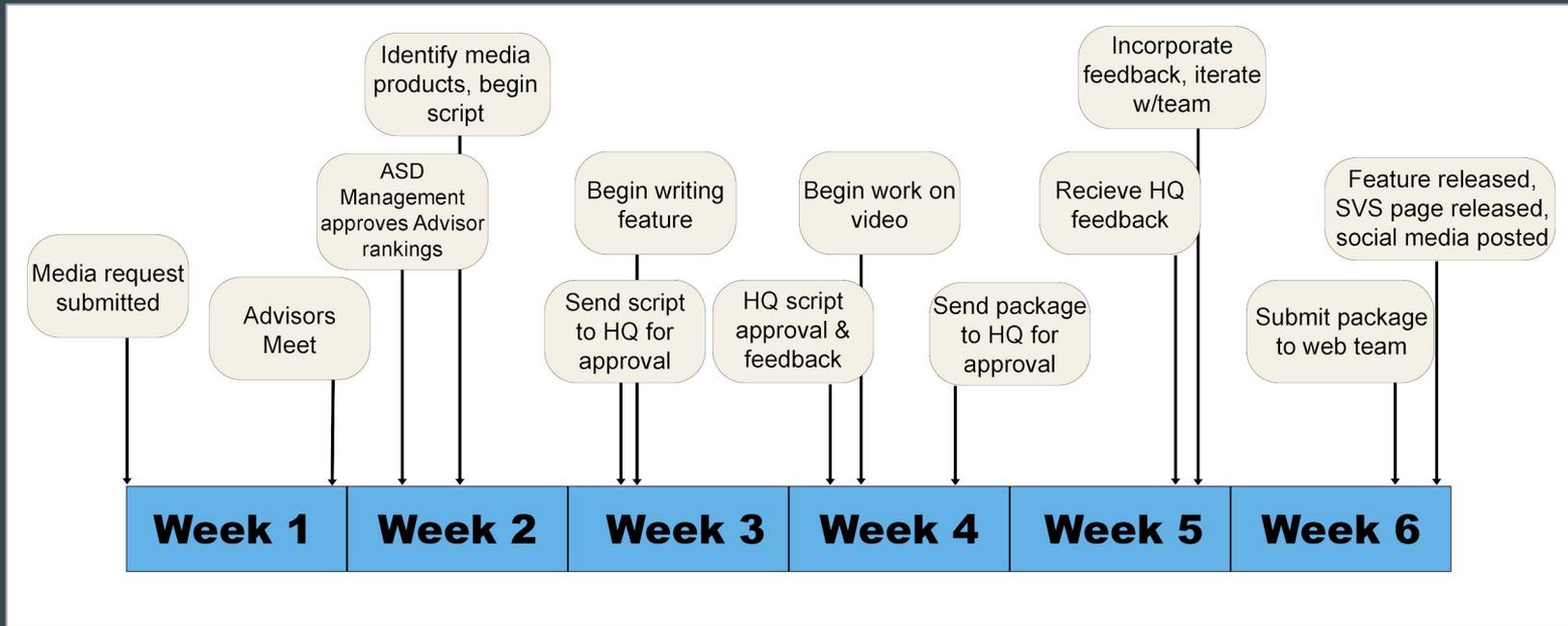
Media request is accepted, now what?

- ✘ We'll work up a news feature (typically) or press release (for Very High Profile results)
- ✘ We'll also work on multimedia products - videos and/or still images to explain the finding
- ✘ Lead time: 4-10+ weeks
- ✘ 6 weeks minimum for graphic or video support



What does the schedule look like?

Minimum timeline - assuming everything is in place, and everyone responds in a timely fashion



Example: TESS Detects its First Earth-Size Planet in HZ

The screenshot shows the NASA website interface. At the top, there is a navigation bar with links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences, along with a search bar. Below the navigation bar, there are two tabs: 'Latest' and 'Related'. The 'Latest' tab is active, showing a list of recent news items. The main content area features a large image of a star with three planets orbiting it, labeled TOI 700 b, TOI 700 c, and TOI 700 d, with a green shaded region representing the Habitable Zone. Below the image is the article title 'NASA Planet Hunter Finds its 1st Earth-size Habitable-zone World' and a date of 'Jan 6, 2020'. The article text describes the discovery of TOI 700 d, an Earth-sized planet in the habitable zone of its star, discovered by NASA's Transiting Exoplanet Survey Satellite (TESS). It also mentions that TOI 700 d is one of only a few Earth-size planets discovered in a star's habitable zone so far. The article includes a quote from Paul Hertz, NASA's astrophysics division director, and a 'Share' button at the bottom.

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Jan 6, 2020

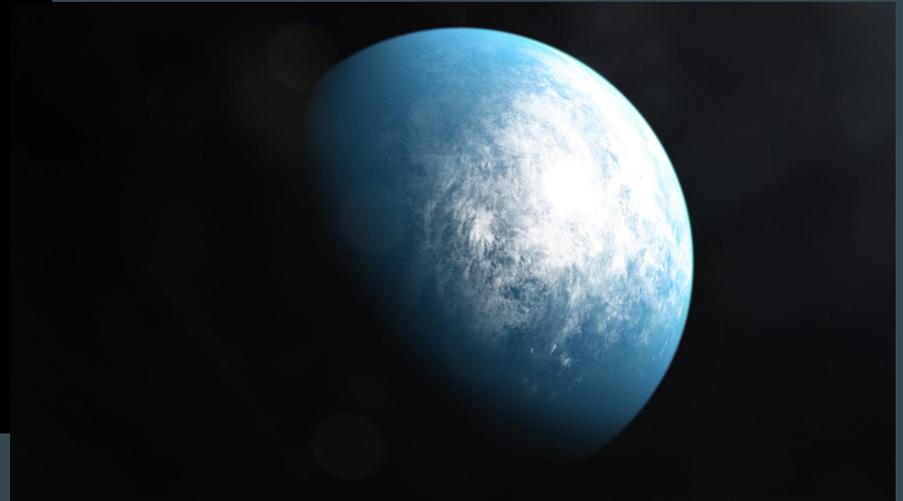
NASA Planet Hunter Finds its 1st Earth-size Habitable-zone World

NASA's Transiting Exoplanet Survey Satellite (TESS) has discovered its first Earth-size planet in its star's habitable zone, the range of distances where conditions may be just right to allow the presence of liquid water on the surface. Scientists confirmed the find, called TOI 700 d, using NASA's Spitzer Space Telescope and have modeled the planet's potential environments to help inform future observations.

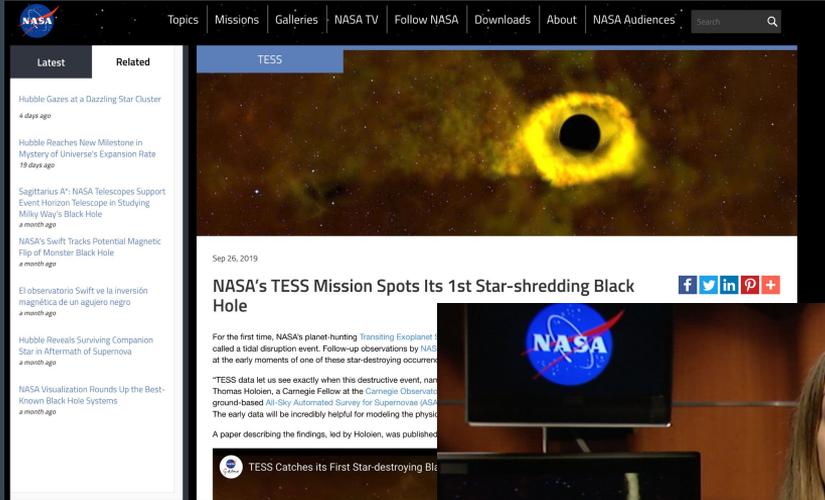
TOI 700 d is one of only a few Earth-size planets discovered in a star's habitable zone so far. Others include several planets in the TRAPPIST-1 system and other worlds discovered by NASA's Kepler Space Telescope.

"TESS was designed and launched specifically to find Earth-sized planets orbiting nearby stars," said Paul Hertz, astrophysics division director at NASA Headquarters in Washington. "Planets around nearby stars are easiest to follow-up with larger telescopes in space and on Earth. Discovering TOI 700 d is a key science finding for TESS. Confirming the planet's size and habitable zone status with Spitzer is another win for Spitzer as it approaches the end of science operations this January."

TESS Mission's First Earth-size World in Star's Habitable-zone
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Example: TESS Mission Spots Black Hole Destroying Star



The screenshot shows the NASA website's navigation bar with links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences. The main content area is titled 'TESS' and features a large image of a black hole with a glowing yellow ring. Below the image is the headline 'NASA's TESS Mission Spots Its 1st Star-shredding Black Hole' dated Sep 26, 2019. A sidebar on the left lists other space-related news items.

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TESS

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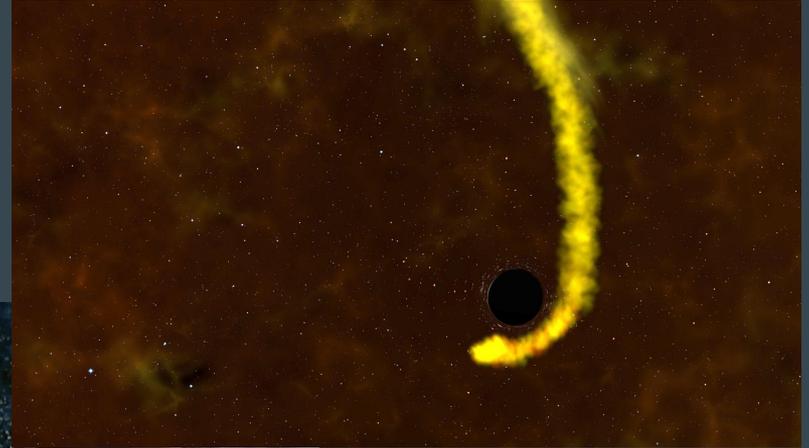
NASA's TESS Mission Spots Its 1st Star-shredding Black Hole

For the first time, NASA's planet-hunting Transiting Exoplanet Survey Satellite (TESS) has captured the early moments of one of these star-destroying occurrences.

TESS data let us see exactly when this destructive event, named *TESS 1519-5037*, occurred. The early data will be incredibly helpful for modeling the physics of these events.

A paper describing the findings, led by Holman, was published in *Nature* on September 26, 2019.

TESS Catches its First Star-destroying Black Hole



We also promote partner releases

Interesting result but no time to coordinate NASA coverage? We sometimes promote institutional releases from nasa.gov/tess

The screenshot displays the NASA Transiting Exoplanet Survey Satellite (TESS) website. The top navigation bar includes links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences, along with a search bar. The main content area is titled "Transiting Exoplanet Survey Satellite (TESS)" and features a sidebar on the left with social media links and related topics. The main content is organized into several sections:

- Exoplanets**: A section titled "Citizen Scientists Spot Jupiter-like Planet" with a sub-header "Exoplanets".
- 'ABCs of Exoplanets'**: A section with a large graphic of the letters "ABCs" and the word "EXOPLANETS". It includes a description: "Every new planet found orbiting a distant star opens a world of possibilities. Exoplanets capture our imaginations. TESS will scour the skies to discover more distant worlds than ever before. Come along on the journey with 'ABCs of Exoplanets.'" and links to "Interactive Book" and "Posters".
- Exoplanets**: A section titled "DLR: NASA's TESS Finds a Planet with an Eight-hour..." with a sub-header "Exoplanets".
- Exoplanet Exploration**: A section with the text: "Step outside on a clear night, and you can be sure of something our ancestors could only imagine: Every star you see likely plays host to at least one planet. NASA's Exoplanet Exploration Program is responsible for implementing plans for the discovery and understanding of planets around nearby stars."
- Stars**: A section titled "TESS Tunes into an All-sky 'Symphony' of Red Giant..." with a sub-header "Stars".
- Stars**: A section titled "U-Warwick: Teardrop star reveals hidden supernova..." with a sub-header "Stars".
- Related Links**: A section with links to "TESS Launch Team | Prelaunch Briefings, Events", "Launch Campaign Photos", "TESS project website at NASA Goddard", "TESS Guest Investigator Program Office website", and "TESS Science writers guide HD multimedia on TESS".

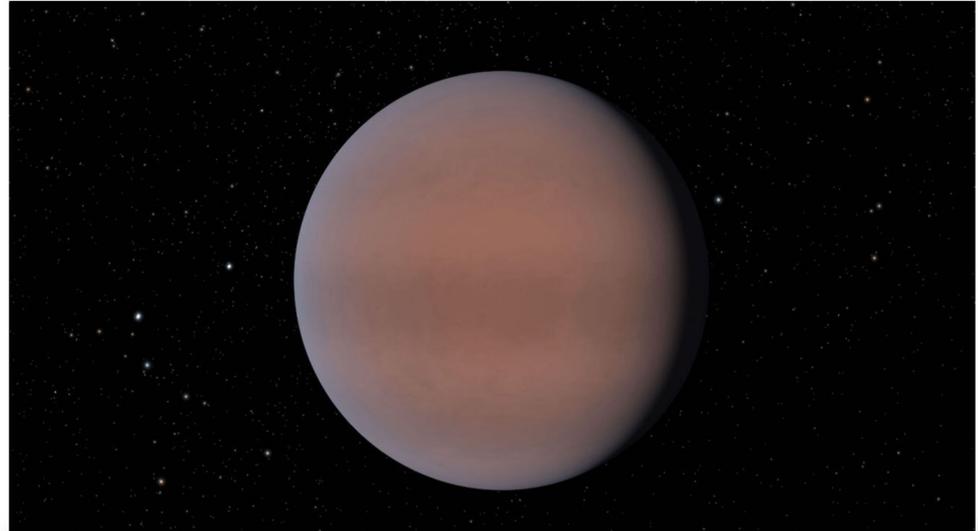
NASA Exoplanets: Discovery Alerts

The screenshot shows the NASA Exoplanet Exploration Program website. At the top, there is a navigation bar with the NASA logo and links for Topics, Missions, Galleries, NASA TV, Follow NASA, Downloads, About, and NASA Audiences. A search bar is also present. Below the navigation bar is a large banner for the TESS Exoplanet Mission, featuring a star and a planet. Underneath the banner, there are tabs for Overview, Images, Videos, and Media Resources. On the left side, there is a sidebar with a 'Follow' section containing social media icons for Facebook and Twitter, and a 'Related Topics' section listing 'Kepler and K2' and 'All Topics A-Z'. The main content area features a large image of a planet with a blue and orange atmosphere. To the right of this image, there are two smaller images: one of a planet with a white atmosphere and one of a planet with a red atmosphere. Below these images, there are several text boxes. One box is titled 'Discovery Alert: Water Vapor Detected on a 'Super Neptune'' and is attributed to 'Hubble'. Another box is titled 'Keck: NASA's Planets on' and is attributed to 'Exoplanets'. Below these boxes, there is a section titled 'About 1' with a sub-heading 'NASA's Transiting Exoplanet Survey Satellite (TESS) is an all-sky survey satellite that will discover exoplanets around our star, the Sun. TESS launched on September 27, 2018, aboard a SpaceX Falcon 9 rocket.' and a 'Read more' link. At the bottom of the page, there is a section titled 'Citizen Scientists Spot Jupiter-like Planet' with a sub-heading 'Exoplanets'.

NEWS | January 13, 2022

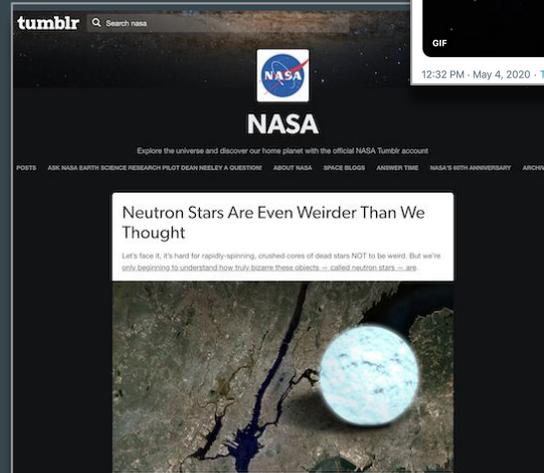
Discovery Alert: Water Vapor Detected on a 'Super Neptune'

By Pat Brennan, NASA's Exoplanet Exploration Program



Social Media Coverage

- ✗ Twitter and Facebook:
@NASAUniverse
 - ✗ Highlight news features
 - ✗ Serialized content
 - ✗ Evergreen content
- ✗ Tumblr post on the NASA HQ account
- ✗ Instagram posts on the NASA HQ account
- ✗ We work with partners like @NASAExoplanets to cross-promote and coordinate content



Tips for working with your local comms team

We expect:

- ✘ Tell us early about upcoming results and papers
- ✘ Give timely feedback on draft visuals and text
- ✘ Communicate with your fellow authors
- ✘ Keep us apprised of the publication status and timelines

Tips for working with the NASA TESS comms team

We offer:

- ✘ Write a feature or release; shepherding through institution processes
- ✘ Create visuals to accompany the release
- ✘ Provide every opportunity to ensure science is correct and fairly represented
- ✘ Support the feature with social media

Questions?

