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Science AMA Series: We're NASA, MIT and Kepler scientists excited about the launch of our newest planet hunter, TESS. AMA!

NASAGODDARD R/SCIENCE

We're finding planets around other stars! So far we have discovered thousands of these exoplanets with missions like Kepler and K2. Today we're at Kennedy Space Center eagerly awaiting the launch of NASA's newest planet hunter. The Transiting Exoplanet Survey Satellite, or TESS mission, will search nearly the entire sky looking for tiny dips in the light from Earth's closest neighborhood stars that may indicate planets passing in front of the stars.
TESS will make a catalog of thousands of worlds for us to study in more detail with future missions like the James Webb Space Telescope.
TESS will fly in an orbit that completes two circuits around the Earth for every orbit of the Moon. This special orbit will allow TESS's cameras to monitor each patch of sky for nearly a month at a time.
We are:
Natalia Guerrero: I'm a researcher in the TESS Science Office at the MIT Kavli Institute for Astrophysics and Space Research. I measured the TESS camera performance and will lead the team identifying exoplanets and other interesting astrophysical phenomena in the TESS data for further observation by other telescopes.
Elisa V. Quintana: I'm an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Md., where I work on the TESS and WFIRST missions. I study exoplanets in extreme environments and am looking forward to finding new ones with TESS.
Stephen Rinehart: I'm the project scientist for the TESS mission. I help make sure that the mission will be able to do the great science that was proposed, and I'm excited about all the great science that astronomers will be able to do with data from TESS! And, I enjoy giving snarky answers to questions on reddit.
Diana Dragomir: I'm an astronomer at MIT. I study planets around other stars (exoplanets), especially those smaller than Neptune. My research uses data from many telescopes, including the Hubble Space Telescope, Spitzer, the Canadian MOST space telescope and the Las Cumbres Observatory network.
Sam Quinn: I'm an astronomer at the Harvard-Smithsonian Center for Astrophysics. I hunt for exoplanets and use their observed properties to study how they form, evolve, and migrate (yes, migrate!). My role in the TESS Science Office is to help organize follow-up observations of TESS planets with ground-based telescopes to measure their masses and characterize their host stars.
Learn more about TESS at www.nasa.gov/tess
Follow us on @NASA_TESS to stay updated
We are now live!
Thank you all for your questions. We've had a great time answering them, however we're going to log out now.

CORRESPONDENCE:

DATE RECEIVED:
April 17, 2018

DOI:

I always wondered about this but never got the chance to ask someone: How is being an astronomy researcher at NASA's Goddard Space Flight Center different from being one at the usual Astronomy/Physics department at a university?

79c4a06fbba64629867a

Astronomers at NASA Goddard are much like their colleagues at Universities; we do research, write

10.15200/winn.152388.83041

ARCHIVED:
April 16, 2018

CITATION:
NASAGoddard , r/Science , Science AMA Series: We're NASA, MIT and Kepler scientists excited about the launch of our newest planet hunter, TESS. AMA!, *The Winnower* 5:e152388.83041 , 2018 , DOI: 10.15200/winn.152388.83041

grant proposals, and write papers the same way. The biggest difference is that instead of being responsible for teaching, astronomers at Goddard have responsibilities for serving the community, e.g. by helping design and build missions, by supporting community research through guest investigator programs, etc.

-- SR

What kind of techniques do you imagine will become necessary to find rogue planets? Would that even be possible?

imbobbathefett

The main methods we use to find planets (radial velocity, transits, and actual imaging) actually use the light from the host star. Rogue planets do not have a host star, so those methods don't really work. However, we do have a method for that can in principle find rogue planets, and that is microlensing. In this case, we look for light from a background object that is bent and magnified by a massive object (like a planet!). So that is one way that we can do it. There are already microlensing surveys hard at work looking for microlensing signals from rogue planets. D.D.

How far off are we from mining asteroids?

packthatcrack

Somewhere around 330 million kilometers.

In all seriousness, we have a long way to go before we're ready to mine asteroids. We know they're there, and perhaps in a few decades we'll be able to send robots out there, but it's quite an ambitious task!

-- SR

In terms of quality of imaging, what sort of improvements should we expect from this gen (TESS) compared to last? Be as technical as you wish.

And what is expected in future imaging quality 15-20 years down the line? Are we able to focus on objects within/nearby our solar system?

In the future, will our focus be on satellite-based scopes? As opposed to, say, constructing one on the moon... Thanks!

ForVectron

The most important improvements with TESS are really not about imaging at all. The big improvements are in the sensitivity and field-of-view of the cameras -- the field-of-view allows us to survey nearly the whole sky, while the state-of-the-art detectors give us the ability to detect the small changes in a star's brightness caused by a transiting planet. The images that TESS produces will actually have a lot lower resolution than, say, Hubble, but the large-scale survey is something that Hubble couldn't do.

Right now, people are looking at concepts for next generation space telescopes, with launch dates 20+ years in the future; some of those mission concepts will be able to actually directly detect the light from exoplanets (the relatively nearby ones). Mission concepts like those will make spectacular images, and would also have the ability to obtain great images of all sorts of solar system bodies.

We'll continue working with telescopes both on the ground and in space; ground-based are easier to build, but space is a fantastic environment! Certainly, people are thinking about building telescopes on the moon, but that's probably actually *more* challenging than putting telescopes in space (there's lots of dust on the moon, for instance).

-- SR

Okay, my question is, with other star systems, for us to see the light from the star dim when an exoplanet eclipses it's parent, does their system have to be in a certain orientation or.. plane?

How do we determine which star systems are edge on to our perspective?

Or does it work completely different?

FalseIshtar

That's right -- to detect a transit, the planetary orbital plane must be edge on from our point of view!

We don't generally know beforehand which star systems are edge on. That's the reason that missions like TESS (and Kepler and K2 before it) need to look at so many stars. Only a fraction of planets will transit their stars. While this makes our jobs hard, it's also very exciting, because it means that for every planet TESS detects, there are many more that it doesn't! When we calculate the occurrence rate of planets and the total number of planets in the galaxy, we have to correct for the fraction of planets that don't transit.

-SQ

Can TESS find planets in long period orbits that are similar in length to Earth's orbit around the sun?

astroman300

The longest time that TESS will observe any part of the sky is one year, and it will be at the ecliptic poles. This means that it has a chance of finding at most one or two transits of an Earth twin, which is probably not sufficient to confirm it. However, TESS will find rocky planets in the habitable zone of many stars *smaller* than the Sun though!

For the team, are there any patches of the sky you are personally interested in, or are looking forward to having TESS point at?

Senyu

I'm really excited that in the second year of TESS, Kepler's original field-of-view will be visible for 1-2 months. So many of the Kepler planets that orbit bright stars will be visible and we can collect new data on them. I also think it's really cool that TESS will be observing over 85% of the sky, so will likely be observing your favorite constellation. We can make light curves of all of the stars in a given constellation and see how their brightnesses vary over time! EQ

For the team, are there any patches of the sky you are personally interested in, or are looking forward to having TESS point at?

Senyu

There are so many, it's hard to choose. I'll give one answer. Some targets that are near and dear to my heart are stars in open clusters. It turns out that it's pretty hard to measure the ages of normal "field" stars, but stars in any given open cluster all formed at the same time and we can leverage that information to get more precise ages for the stars -- and any planets orbiting them! Studying young planets -- their orbits, their sizes, the architectures of the planetary systems -- can tell us about how they form and migrate after formation. Understanding these physical processes inform our understanding of how likely it is that different types of planets form (e.g., Earth-like planets), and what environmental factors they have experienced throughout their history. TESS will observe many open clusters of different ages and with different environmental conditions, so we can hope to learn more about the evolution of planetary systems.

-SQ

For the team, are there any patches of the sky you are personally interested in, or are looking forward to having TESS point at?

Senyu

I am looking forward to seeing the images (and data!) accumulate over the course of each year at the Continuous Viewing Zone (or CVZ) at the pole of each hemisphere. -NG

1) How sensitive are the CCDs used in TESS?

2) How do the construction/components of these CCDs differ compared to sensors in everyday phones?

3) When looking for dips in the brightness of stars, do you have a frequency you need/want to sample each star to have a high probability of detecting a planet (for example, sampling the star once per day, once per week, etc...)?

4) How much data is collected daily (in terms of gigabytes)? What is TESS's upload/downlink speed?

hoti0101

Hi! 1) The CCD sensitivity depends on the wavelength of the light falling on the detector. This paper by Ricker et al goes into the nitty-gritty of the instrument for this and your other questions: https://www.spiedigitallibrary.org/journals/Journal-of-Astronomical-Telescopes-Instruments-and-Systems/volume-1/issue-01/014003/Transiting-Exoplanet-Survey-Satellite/10.1117/1.JATIS.1.1.014003.full?SSO=1&tab=ArticleLink

2) TESS uses CCDs rather than the CMOS detectors most phone cameras use.The TESS CCDs are deep-depletion CCDs--their pixels can absorb a *lot* of photons before saturating, and when a bright star does saturate a pixel, it "overflows" into adjacent pixels and the detector is still able to measure the star's brightness accurately.

3) The length of each exposure is 2 seconds and TESS stacks up 2-minute postage stamps and 30-minute full-frame images (or FFIs) from these exposures. For the 2-minute images, this gives us a really fine-grained light curve of the stars imaged at that cadence.

4) TESS's data rates in excess of 100 Mbits/s and we expect to accumulate terabytes of data by the end of the mission!

-NG

Hi, NASA! Thanks for doing this AMA!

How will TESS build on Kepler's discoveries? What do you hope will come out of the TESS mission?

AstroManishKr

Hi! Kepler did an amazing job of determining that planets are common (and small planets moreso than large planets!). However, Kepler was a "pencil beam" survey, pointing at one small patch of sky for its entire mission, and as a result, Kepler observed very few bright stars. TESS will build upon this legacy by observing 85% of the sky (and therefore many more bright, nearby stars). This is really important because bright stars are easier to follow up with other telescopes (more photons means higher signal to noise and/or less telescope time). There are many exciting ways in which this will be borne out, but here are two:

1) Radial velocity follow up with ground-based telescopes ("the wobble method") to precisely measure masses of small planets (and thereby understand better their compositions).

2) Observations of exoplanet atmospheres with JSWT (and Hubble, Spitzer, and large ground-based telescopes)

These two things are, in my opinion, two of the most important things that TESS will enable. However, Kepler taught us that TESS will also find lots of wonderful new things that we didn't expect to find!

-SQ

What is the difference between TESS and Kepler?

AstroManishKr

Hi! Kepler was built to answer the question: What is the frequency of Earth-size planets? Before Kepler launched, we didn't know for sure if Earth-sized planets existed. Kepler was a statistical survey that looked at a small patch of sky for 4 years, and taught us that Earths are everywhere. TESS is building on Kepler in the sense that TESS wants to find more small planets but ones that orbit nearby, bright stars. These types of planets that are close to us are much more easy to study, and we can measure their masses from telescopes here on Earth. Kepler planets are thousands of light years away, whereas TESS will find planets hundreds of light years away - still very far but much easier to study. Tess will also observe over 85% of the sky, and the goal is to find which of our nearest stellar neighbors have transiting planets! EQ

You seem to be more on the astronomy side of things but what is the presumeble limiting factor for Tess' lifespan?

Reaction Wheels?

Nuranon

It's hard to say! Everything on the mission is designed to last at least two years (the design life of the mission), but after that, things are no longer "under warranty" (as it were -- there's not really a warranty). So, everything could keep operating for years! And what will fail? There are a lot of possibilities, but we really just can't know which it'll be until it happens...

-- SR

How long do you guys plan to leave the satellite in orbit? How much data do you hope to gather in this time?

11thHero

This orbit is incredibly stable; it's a lunar 2:1 resonance orbit (i.e. TESS does two orbits for each orbit of the moon), which means that the moon helps "shepherd" the spacecraft on its stable orbit. We've modeled the orbit out 100 years, and it appears to be stable that far out. So, while the mission is only planned for 2 years of operation, we could theoretically extend the mission and keep taking data for a long time. At the end of the mission, we'll do a "disposal in place" -- i.e. we'll turn it off and leave it where it is. It's a unique orbit, so it won't interfere with any other spacecraft, so that's a great place to leave it.

Over the 2 year mission, I believe we're expecting to get about 3.5 Tb of data. It's going to keep a lot of people very busy for a long time!

-- SR

Hello, and thanks for taking questions!

I read that Kepler tended to find larger planets close to their stars, since they were easier to detect transiting. Will this bias still be present with TESS?

Also, since such a large amount of data will be gathered, are there any plans to utilize distributed computing to analyze it? Would love to know if I can contribute!

WardAgainstNewbs

All telescopes that look for transiting planets have that bias. It is a bias of the transit method itself, so TESS will have it as well. However, despite this bias, Kepler actually found MORE small planets than large planets, which tells that small planets are much more common than large planets. So we expect TESS to find thousands of small planets as well. We do expect that most of the planets that TESS will find will be fairly close to their stars. D.D.

How can someone like me, an about-to-graduate astrophysics student, currently studying in a university in Canada, be able to get an internship or work with/alongside NASA or in affiliated project, or be involved in any way, since to be frank, the CSA doesn't do much in comparison to NASA?

press-control-w

Happy to hear that you want to study astrophysics! I was a grad student in Canada too :-) One way would be to apply for the IPAC graduate student fellowships: https://www.ipac.caltech.edu/page/graduate-fellowship The IPAC center is a NASA-funded organization in Pasadena. I did one of those and it was a fantastic experience. D.D.

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press-control-w

I'll add -- I've worked with a number of graduate students at Goddard, and almost all of them have actually been non-US citizens! If you're a grad student and you're at a U.S. university, it's really easy -- if you can find a NASA scientist with whom to do a project (which isn't that big of a challenge). If you're at a canadian university, I think it's still possible -- it's really about making contact with a NASA scientist you want to work with.

-- SR

Hey all, I've read in a few places that TESS is expected to discover more than 20,000 exoplanets, about 5 times (!) the number discovered to date. How do you come up with an estimate like that and what is most unique about TESS compared to other exoplanet instruments that will potentially enable those discoveries?

SkywayCheerios

Our planet yield was estimated using a few different simulated data sets of nearby stars and estimated probabilities for different sizes of planets. Check out this paper by Sullivan et al for a *really* in-depth look at how we calculated this: https://arxiv.org/abs/1506.03845 -NG

Hello and thank you so much for hosting this AMA!

I have two questions:

1. Will TESS be doing anything to survey the current weird light fading phenomena occuring close to Tabby's Star (KIC 8462852)?

2. Is TESS planning to be used in coordination with the James Webb Space Telescope? If so, how?

Jetals

Will TESS be doing anything to survey the current weird light fading phenomena occuring close to Tabby's Star (KIC 8462852)?

TESS is an all sky survey, so it will observe the Kepler field during the second year of its mission. I think the Kepler field falls in a region of sky that will be observed for two TESS sectors (~2 months). While it's possible that KIC 8462852 will show us something interesting in its photometric variation during that time, it often does very little. A ground-based campaign led by Professor Boyajian has been doing a very good job monitoring the system already! See the blog posts here.

It's probably more likely that insight will come from TESS observing other stars exhibiting phenomena like that seen around KIC 8462852, which could give us additional clues about the nature of the variability of KIC 8462852. If it's truly a rare system, then the all-sky nature of TESS should help find more of them.

-SQ

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Jetals

An answer to question 2: The center of the TESS continuous viewing zone will overlap with the JWST continuous viewing zone. In this region of the sky as well as in other parts of James Webb's field-of-regard, we will find strong candidate exoplanets for follow-up observation after TESS, especially planets in the size range between Earth and Neptune. -NG

Thanks for doing this AMA!

What are the strangest environments on an exoplanet that you've ever discovered/heard of?

Duvangrgata1

Great question! Well we have found Earth-sized planets that orbit their star every 8 hours! We have found rocky planets that are as big as 2x the Earth, so would have incredible gravity. We know of dozens of planets that orbit 2 stars, so those planets wouldn't have a constant flux from the stars like we do from the Sun, so could life adapt to that environment? Basically Kepler was full of surprises, and probably raised more questions than answers. TESS will likely be the same because it will be observing the whole sky, so it will be fun to see what other oddball systems we will find in the next few years!! EQ

I know that planned TESS mission is shorter than Kepler, but how (technically) you made sure it doesn't fail in similar way as Kepler? Do you have more redundant or more reliable navigation system? How much of the spacecraft mass is fuel (initial, and fuel left after designed orbit insertion)? What do you hope will be actual project life? (i.e. if it is not cancelled after 3 years, or new observatory replaces it).

What kind of downlink capabilities do you have? I heard that you are going to be using high speed downlink only when you are very close to Earth, but do you have other telemetry and command and control all the time available (using slower bands).

baryluk

The TESS orbit is stable for decades and the spacecraft consumes very little fuel per year, so TESS could remain operational for a long time! Our downlink rate is 10Mbit/s. The Ricker et al paper is a good place to start on the in-depth details! Link here: https://www.spiedigitallibrary.org/journals/Journal-of-Astronomical-Telescopes-Instruments-and-Systems/volume-1/issue-01/014003/Transiting-Exoplanet-Survey-Satellite/10.1117/1.JATIS.1.1.014003.full?SSO=1&tab=ArticleLink -NG

I have studied both biology and toxicology, but recently I feel like I have made a wrong choice in the field I specialized in. Is there any work / demand for people with my background in a research lab like NASA or de ESA (since I am dutch and all)?

Omugaru

Hello! If you are at all interested in the search for life in the Universe, then a background in Biology is certainly a great choice. NASA has many "Astrobiologists", and this involves people with diverse backgrounds - from astronomers, chemists, biologists, ... As an astrobiologist, you could study anything from life on Mars to exoplanet atmospheres, and you could work in a lab or you could do field work, ... lots of possibilities. I know people that work for the SETI Institute that spend most of their time studying the hottest deserts, or diving into the deepest oceans on Earth, to study life in extreme environments so we can try to understand how to search for life on other moons and planets that have harsher environments than we do here on Earth. So I would say study what interests you! EQ

How does this particular orbit benefit your mission as opposed to utilizing L2 like the James Webb Space Telescope will?

esullivan02

It is easier to put a satellite in orbit around Earth compared to L2. So whenever we don't need L2, we just use Earth orbit. JWST needs L2 because it needs to be very cold in order to get precise data in the infrared. TESS observes in the optical, and can stay in orbit around Earth (rather than go all the way to L2) because it doesn't need to be quite as cold. D.D.

1. How tiny would a planet/asteroid be where its transit would be rendered undetectable by TESS?
2. Will there be any great published photos of exoplanet transits?

esullivan02

How tiny would a planet/asteroid be where its transit would be rendered undetectable by TESS?

It's a complicated answer, but a great question! Because the transit depth depends on the area ratio between the planet and star $(Rp/R^*)^{2,}$ and the precision of the data depends on the brightness of the star, and the signal-to-noise also depends on the number of transits observed, the smallest size planet we can detect is different for every star. In general, we do better for planets on short orbits around small, bright stars. Taken to the extreme, we have actually detected a disintegrating minor planet around a white dwarf star (https://arxiv.org/abs/1510.06387).

Most planets detected by TESS will be Earth-sized or larger. See these papers for details: https://arxiv.org/pdf/1506.03845.pdf https://arxiv.org/abs/1804.05050

Will there be any great published photos of exoplanet transits?

We won't have images (TESS isn't an imaging mission, but a photometry mission), but I sure do expect a lot of beautiful published transit light curves! You can also expect the artists to get their work in creating artists' impressions to accompany exciting new planet discoveries. :)

-SQ

1. How tiny would a planet/asteroid be where its transit would be rendered undetectable by TESS?
2. Will there be any great published photos of exoplanet transits?

esullivan02

TESS will be able to find planets the size of Earth around the nearest, brightest stars, and could detect passing asteroids in the data. TESS, like Kepler, only collects star light, so we will have lots of signatures we call light curves, which shows how a star's brightness decreases in light when a planet crosses in front of it. It can't actually photograph any planet however, that is for future missions!! -EQ

Will TESS be observing the nearest stars to the sun, say within ~15 light years? Tau Ceti seems like the most 'sun like star' that isn't a binary nearby, and isn't there some possibility of smaller rocky planets around Barnard's Star, since gas giants were ruled out? And of course Alpha & Proxima Centauri, being the closest!

jimiticus

TESS' specialty is observing the nearest stars! The Kepler field was thousands of light years away, but most of TESS stars will be 10 times closer and 30-100 times brighter than Kepler stars. We already know our closest star, Proxima Cen, has a planet. What TESS will be able to do is survey all of our nearest stellar neighbors, within hundreds of light years, and see which have planets. We won't find all of the planets in the neighborhood, however, because TESS only detects planets that transit their star. But TESS will be sensitive to Earth-sized and super-Earth-sized planets orbiting the nearest stars. If those do have planets, then it will be very exciting to follow them up with telescopes from the ground and perhaps James Webb which will be launching in 2020. -EQ

How soon will data be available from TESS? Thank you!

Silencer312

For you, as soon as it's processed! (Ok, for everyone else, too.)

-SQ

How soon will data be available from TESS? Thank you!

Silencer312

The first TESS data release will be six months after the start of sector 1 on the Mikulski Archive for Space Telescopes here: https://archive.stsci.edu/tess/ -NG

How do you go about calibrating your equipments for the vacuum and space radiation and a whole lot of other things which I do not even know about

jai1610

We tested the four TESS cameras at MIT in vacuum chambers cooled to -75C to understand how they will perform in space. The cameras also underwent vibration and thermal cycling tests to simulate the experience of being launched into space. -NG

What type of research will be done from this mission and how would we benefit from it?

AstroManishKr

One (of many!) expected result is: Humanity will learn how common terrestrial planets are in the habitable zone. By terrestrial I mean similar mass and size as the Earth. With this, we will be one big step closer to understanding how likely it is that life has evolved elsewhere in the Galaxy. D.D.

What kind of international cooperation you get from industry, academia, space agencies? How TESS compares to CHEOPS?

baryluk

Regarding CHEOPS: it has a much smaller field of view than TESS, such that it can only observe one star at a time. However, it is larger and will be able to see transits more precisely. So TESS will find thousands of planets, and CHEOPS will be able to observe in more detail the most interesting of the planets that TESS will find. D.D.

When finding planets in the habitable zone, will the discoveries be based more on visual photos gained or more through comparing the characteristics/atmospheres/geology to earth's

gwillly

Hello! With TESS, we don't get visual photos, we get starlight and we measure starlight for a long time for many many stars. It's truly amazing how scientists have been able to find planets just with starlight and clever data analysis techniques. In our quest to find other Earths, we have been taking one step at a time. Kepler found that other Earth-size planets exist in the habitable zone of other stars. Kepler only measured their size and orbits. TESS will use the same technique as Kepler, so will also measure the planet size and orbit, but will confirm planets around the nearest and brightest stars. We can then use all of our telescopes here on Earth to then point to those TESS stars that we know have planets, and measure their masses. With size and mass, you can calculate a planet's density. This allows us to see if we can find another planet that is rocky like Earth. But just because we find a rocky, Earth-sized planet in the habitable zone does't mean the planet is habitable! That is why NASA is building new missions, like James Webb Space Telescope, because we need to learn more about these planets. Webb will be able to probe the atmospheres of these planets and learn about their chemical makeup, and see if they could have atmospheres similar to ours here on Earth. -EQ

What kinds of data about exoplanets will we be able to collect that we haven't been able to collect with past telescopes?

Marches_in_Spaaaace

TESS will find transiting planets, like other surveys have done before it (Kepler, and a few ground-based surveys). But these other surveys either only found planets (of all sizes) around distant faint stars, or around nearby bright stars but only large planets. TESS will find small planets around nearby bright stars. That means that we can then observe those planets with other telescopes in more detail (measure their masses and observe their atmospheres), because they will be much closer to us than most of the small planets found so far. D.D.

During yesterday's interview, I believe I heard the EDGE team briefly mention a Citizens program, that will provide additional data analysis support in the search for transients in 200;000 stars TESS is about to view. Is this a real thing?

Best of luck on today's launch!!

atoneontail

The TESS data will be a rich resource for follow-up of exoplanets as well as many other astrophysical phenomena. The TESS Follow-Up Operations Program (or TFOP) is always looking for interested observers and perhaps a citizen science project in data analysis for TESS in the works! -NG

During yesterday's interview, I believe I heard the EDGE team briefly mention a Citizens program, that will provide additional data analysis support in the search for transients in 200;000 stars TESS is about to view. Is this a real thing?

Best of luck on today's launch!!

atoneontail

There are lots of scientists interested in developing a citizen science program with TESS, many that helped develop those for Kepler/K2, so stay tuned!! TESS is going to collect SO much data, so it's going to be really fun to see what surprises we find with TESS.

Are you preoccupied about damages to the TESS from all the Space Junk orbiting the Earth ?

DogOwner8

Nope.

TESS is in a unique orbit, so there's nothing for it to run into once it's up...

-- SR

What happens when / if you find say exactly what you are after? What happens after that? Send another satellite up to investigate more and possibly get some sort of sample?

mk81ting

Well, the goal of TESS is really to put together a catalog of potential exoplanets that we'll be studying for a long time to come. As we find those objects (the TESS Objects of Interest, or TOIs), people will do follow-up observations from ground-based telescopes, and space-based telescopes like Hubble and JWST. Those will give us more information on these distant worlds, and we'll begin to understand how they compare to the planets in our own solar system.

It would be awesome to some day actually send some sort of probe out to newly discovered exoplanets, but I don't think we're technologically there just yet!

-- SR

Does the TESS have the capability of potentially being serviced by astronauts in the future?

SkulShurtugalTCG

No.

-SR

Is TESS more powerful then Hubble or in the middle of Hubble and the James Webb telescope in terms of power?

thediamondskitty

TESS is different than Hubble and James Webb. The individual cameras/telescopes are much smaller, but they are being used in a wide-field survey -- neither Hubble or Webb are designed for that. So, TESS is, in some sense, less powerful than either Hubble or Webb, but it can do something that neither of them can do!

-- SR

While you are finding planets. Do you guys accept that there isn't a planet like Earth and that we won't ever find alien life?

What percentage of planets do you guys think you have found in the milky way galaxy?

toomanynames1998

I don't accept anything of the sort!

There are 100s of BILLIONS of stars in the Milky Way. We know, based upon data from Kepler and from other studies, that there is approximately 1 planet per star. So, the odds that *none* of these are Earth-like would have to be -- wait for it -- astronomical. I personally think that it's quite likely that there are a number of Earth-like planets out there -- the hard part is identifying them.

As for alien life? I just don't know. Again, just from the sheer numbers, it seems likely that some sort of life is out there -- and again, the hard part is identifying it. And, will alien life be *intelligent* alien life? Perhaps not....

As for percentage -- we've found a few thousand out of a potentially few hundred billion. So, 0.000001% or so. That might be off by a factor of a few.

-- SR