Science AMA Series: We are Disk Detective, a NASA citizen science project devoted to finding new planetary systems with YOUR help. AUA!

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[1]Affiliation not available

April 17, 2023

Abstract

Disk Detective is a collaboration between NASA Goddard Space Flight Center and the Zooniverse Project, searching for previously undiscovered circumstellar disks and planetary systems with your help! We use citizen science to help visually inspect data from NASA's Wide-field Infrared Survey Explorer (WISE), as well as other full-sky surveys. With over 30,000 scientists (and counting) helping to classify thousands of targets, we've discovered over 50 new disk candidates, indicators of 50 new potential planetary systems to investigate, with more to come. In addition to the citizen science analysis on our Web site, we have an extensive follow-up observation program with collaborators around the world, including observing runs and data analysis that our citizen scientists take part in! We have several members of the team here to answer your questions: Marc Kuchner: research astrophysicist at NASA Goddard Space Flight Center, Disk Detective science team leader Alissa Bans: research post-doc at Adler Planetarium John Debes: ESA/AURA astronomer at Space Telescope Science Institute Steven Silverberg: graduate student at University of Oklahoma and NASA Goddard Space Flight Center John Wisniewski: assistant professor of astronomy at University of Oklahoma Hugo Durantini Luca: Disk Detective "super-user" We'll be back at 1 pm ET (10 am PT, 5 pm UTC), Ask us anything! And if you want to get involved, join us at http://www.diskdetective.org/. EDIT: Proof! EDIT #2: Hi, all! Steven here, with the rest of the team live via Internet, ready to answer your questions. Let's get started! EDIT #3 (3:30PM EDT): We went a bit over our time here; looks like we need to sign off. We'll be answering any other questions that may come up over the next couple of days. In the meantime, come classify subjects on the Web site! While you're there, be sure to check out Talk, our built-in social media site for the project. And, if you happen to have made 300 classifications, email us at diskdetectives@gmail.com to join our Advanced User Group. Thanks for all the great questions!

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DISK_DETECTIVE R/SCIENCE

ABSTRACT

Disk Detective is a collaboration between NASA Goddard Space Flight Center and the Zooniverse Project, searching for previously undiscovered circumstellar disks and planetary systems with your help! We use citizen science to help visually inspect data from NASA's Wide-field Infrared Survey Explorer (WISE), as well as other full-sky surveys. With over 30,000 scientists (and counting) helping to classify thousands of targets, we've discovered over 50 new disk candidates, indicators of 50 new potential planetary systems to investigate, with more to come.

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We have several members of the team here to answer your questions:

Marc Kuchner: research astrophysicist at NASA Goddard Space Flight Center, Disk Detective science team leader

Alissa Bans: research post-doc at Adler Planetarium

John Debes: ESA/AURA astronomer at Space Telescope Science Institute

Steven Silverberg: graduate student at University of Oklahoma and NASA Goddard Space Flight Center

John Wisniewski: assistant professor of astronomy at University of Oklahoma

Hugo Durantini Luca: Disk Detective "super-user"

We'll be back at 1 pm ET (10 am PT, 5 pm UTC), Ask us anything! And if you want to get involved, join us at http://www.diskdetective.org/.

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WRITE A REVIEW

CORRESPONDENCE:

DATE RECEIVED:
September 26, 2015

DOI:
10.15200/winn.144318.82839

ARCHIVED:
September 25, 2015

CITATION:

I've tried citizen science projects before, and I've wished I had a better understanding of what I'm looking at.

Do you think that citizen scientists benefit from having access to immediately relevant educational material, such as images found by the project?

Do you think projects should offer users the chance to test their judgement of images against the way an experienced eye has judged the same image?

How time consuming is it to handle this user interactive work?

Joy2b

Disk_Detective , r/Science , Science AMA Series: We are Disk Detective, a NASA citizen science project devoted to finding new planetary systems with YOUR help. AUA!, *The Winnower* 2:e144318.82839 , 2015 , DOI: 10.15200/winn.144318.82839

Hugo: I understand your point, /u/Joy2b. I have some experience with citizen science projects before Disk Detective and that was a problem in some cases. But Disk Detective gave me access to a lot of information and training that could be almost impossible for me to get otherwise, considering my home country (Argentina). At Disk Detective we do it in several stages: users teach other users, and the science team trains a group of more advanced users so we are able to help with more difficult tasks.

What is the actual data you get and interpret, if it's photos can you verify the validity of these photos besides NASA providing you with just photos?

sowreckd2

John D: Disk Detectives look at images from multiple all-sky surveys, some of which were conducted by NASA (like the WISE mission). These images are the best we can do with current technology, but they have their limitations, which is where you come in.

Sometimes there are isolated artifacts in the data. We also measure the brightness of our targets in each of these images, which helps us to understand what type of star we're looking at and what kind of dusty system it might have.

What's the plan for following up on all those candidates?

Zeitgeistalt

Alissa: After we identify a chunk of subjects that are "none of the above/ good candidates" from http://www.diskdetective.org/, we start digging into the subjects in detail. First, with the help of our "super users", we vet the objects by looking them up in astronomical databases. We check for things like whether or not the object is a variable star or whether or not the object has already been identified as a circumstellar disk by other work. Once a subject passes this vetting, it goes to our small telescope follow-up program. We've followed-up about 300 Disk Detective sources with the Tillinghast 1.5 meter telescope at Whipple Observatory, using the FAST spectrograph to take medium resolution spectra of our targets, helping us identify what type of host star we are looking at. We've also observed a few hundred sources with the ROBO AO imager on the 60 inch telescope at Mount Palomar on take detailed images that help us search for hidden background object that might not have been resolved in the WISE images on the website. After objects pass the small-telescope vetting, we apply for time to observe them with big telescopes like Keck and SOFIA.

What makes non-professionals who are *relatively* untrained observers (i.e. citizen scientists) a better choice for this project than a computer program to look for these circumstellar disks and planetary systems?

Jobediah

Marc: Several teams of trained astronomers have been working on this problem with computers, and the computer algorithms have been unreliable. So the standard in the professional literature has become that each disk candidates needs to be examined by eye. Plus, citizen scientists are creative and they come up with new ideas!

What was your most recent discovery?

taybucs95

Alissa: We are currently finishing up a paper detailing the discovery of about 50 objects, most of which are nearby, debris disk candidates. We have also discovering a bunch of new Be stars and shell stars, which are very different from debris disks--they likely have fast rotating disks made from ejected stellar material. And we have hundreds of other interesting candidates in our follow-up pipeline!

What kind of acknowledgement is there in place to individuals "lucking in" to discover a successful candidate?

mfarah
Alissa: In our first paper covering 50 something new Disk Detective Objects of Interest, we are formally acknowledging all the users who help classify those objects on the website. Some users who have helped us with advanced vetting, including helping us look through and classify the follow-up images we took with ROBO-AO, will actually share authorship with us on corresponding research papers!

What kinds of difficulties are there in the inspection process that make a human eye better at this revision process than a computer algorithm?

mfarah
John W.: It is challenging to parameterize all of the types of "contaminants" that affect the data for use in computer algorithms; thus, it is generally more robust to use human visual inspection. For example, blending of sources by background/foreground sources, including diffuse extended sources (e.g. galaxies) are challenging to parameterize via algorithms.

Earlier this year, a study by Roger Griffith et al. used WISE data to search for the infrared fingerprints of artificial structures surrounding nearby galaxies and found no "Type III" civilizations but found a number of objects worth a second look.

What do you think of the use of WISE data to search for alien life; is it a valuable endeavor? And what do you think, in general, of unorthodox uses of the data collected by your missions, is it something you anticipated, or does it surprise you?

astrofreak92
Marc: We think this is very cool! In fact, we're planning to add a search for Type III civilizations to Disk Detective when we've finished combing through the data that are presently online.

What is the closest a Stellar Black Hole could be to earth without us knowing? I know it is very difficult to detect black holes. The closest ones detected are parts of binary star systems and are > 1600 ly away. A black hole that isn't part of a binary star system would be very hard to detect. Is it possible you might detect a black hole? Also, same questions for brown dwarfs.

RamBamBooey
John D.: An interesting question, with a complicated answer! In some theories of quantum gravity, tiny black holes are appearing and disappearing all around us and inside us, but they vanish in less than a Planck time. But the black holes we astronomers speak of most often are much more massive and easier to spot, because we see objects orbiting them and falling into them. Here's an interesting paper that tries to answer your question: http://adsabs.harvard.edu/abs/2003ApJ...596..437C

Does machine vision / image processing still play a significant role in the project, or has it largely been placed in the hands of the collective group? Are you concerned that an important discovery may go unnoticed because of this, or have you determined the group as a whole to be more effective and accurate than machines?

invisiblewardog
John D.: The images on the site have already gone through multiple stages of image processing, and the science team is constantly assessing whether more processing will help. But mostly it works the other way. For a large number of subjects, we worry that interesting and unique stars might go

unnoticed by a computer program. Human beings work well at making serendipitous connections. Also, if we have many people looking at one subject, we can protect against any one person making a mistake.

So, I have a question: What must you study to become an exoplanetologist? Also, how much does one exoplanetologist make a year? I am in high school and I am considering going down this route.

astrofox001
John W.: Studying how exoplanetary systems form helps us to understand how our Solar System might have formed. Tackling this type of "big picture" question is what motivates most of us to enter the sub-field. In terms of career options, one can participate in exoplanet research as a citizen scientist (e.g. on Disk Detective), as well as on a professional level as an undergraduate student, graduate student, postdoctoral researcher, and senior astronomer. The salaries start off modest at the undergraduate level (similar to any other hourly job college students have), and rise as you progress. Permanent positions have pay grades similar to engineers.

Maybe the principle of Zooniverse is to apply to fewer candidate the below but I am still wondering;

Do you think one day we will have the equivalent of Zooniverse but instead of picture we will have spectra that would help determine what elements we could find in this area/system/etc. We can relay on computer that will do the job automatically or the data to be stored would be too big at that time to be stored massively like the pictures on Zooniverse are?

Interstellaire
John D.: If you're asking about whether they will ever have a Zooniverse project that studies spectra, it's certainly possible; often research with spectral information can take a fair bit of training, so we're still investigating how to effectively implement this on DiskDetective.org. Currently on our site, you can look at a very simple spectrum of each subject (also called a Spectral Energy Distribution). Check out this recent Disk Detective blog post for more info.

Right now we're working on combining all of the information we have on our Disk Detective subjects, including follow-up spectra, into a single database. It is conceivable that we will have a second phase to Disk Detective where our users make use of that database. Please stay tuned!

How is Neil DeGrasse Tyson viewed by those in your field? Has there been any significant uptick in interest or funding since Cosmos aired?

TheJeezus
Steven: StarTalk Radio (Neil's show) actually helped us promote this AMA (thanks to Hugo)!

Dr. Tyson was my undergraduate commencement speaker; hearing him speak in person was rather remarkable even as someone familiar with the field. He's done some rather amazing things for popularization of science, though his main focus recently has been more on that than on producing new research.

Disk Detective launched around the same time that Cosmos premiered, so we don't actually know if there was an uptick in interest on our end due to the show, and there hasn't been any change in our funding clearly caused by the show. Still, I expect to see an effect from Cosmos in the number of people going into STEM fields over the next twenty years.

Do circumstellar disks exist in binary/multiple star systems? Does the number of stars change how the planets form?

SqoishMaloish
Alissa: What a great question, one of my favorite topics! People have found many exoplanets around and within binary systems. In fact, you may be familiar with PH1b, a circumbinary planet nested in a quadruple star system found by volunteers on our sister zooniverse site, Planet Hunters! Circumbinary is when the planet and/or disk itself orbits around both stars, whereas a circumprimary system is where the planet and/or disk orbits around just one of the stars. There are known examples of each! There's evidence from infrared images that there's a circumbinary disk around 99 Herculis, and GG Tau has evidence of a circumbinary disk that is undergoing planet formation! The famous disk around Fomalhaut (possibly home to one of the first ever directly imaged exoplanets), is actually an example of a circumprimary disk (the star Fomalhaut has TWO stellar companions). The number of stars certainly can change how planets form, though it's a complicated process. Sometimes stellar companions can "warp" a circumstellar disk, maybe even leading to exoplanets on inclined orbits. Stay tuned: we may find some circumbinary disks (or circumprimary disks) in Disk Detective!

For the type of imaging data that you use, what are the most pressing limitations on it? Image resolution? Spectral resolution? Algorithms for identifying possible candidates?

Of these limitations, which ones are you the most optimistic about improving upon (either by yourselves or by others in the data pipeline) in the near future?

omgdonerkebab
Steven: For the classification data that we're using, the biggest limitations are image resolution and contrast. The longest-wavelength WISE image band (centered at 22 microns) has a resolution of about 12 arcseconds--plenty of space for other stars or background contaminants to produce false positives. This is one of the reasons why we need to use data at multiple wavelengths, as well as visually inspect all the data--as well as why algorithms aren't the best for catching false positives. In addition, we conduct follow-up observations at higher resolution, to catch things that our initial data might have missed. In a perfect world, we'd have a full-sky survey at higher resolution, but that's not in the cards at this time.

I'm most optimistic about using what our volunteers have learned from how to classify data to improve our algorithms for weeding out bad subjects faster, so we can have our Detectives spend more time on good data.

How many new disk candidates to you expect to detect (above and beyond the 50 you've already found) by the time the project is over? How many people have to look at the same system and identify it as a candidate before you trust that classification?

LivinEasy
Steven: Of the ~270,000 subjects on the Disk Detective site, we expect to find about 12,000 that get classified as "None of the Above/Good Candidate." Of those, we expect about 2,600 of them to make it through our literature-vetting process, which then get submitted for more follow-up observations (with instruments like FAST and ROBO-AO). We expect that about half of those will make it through examination with these telescopes, leaving us with an expected ~1,300 new disk candidates.

Howdy! This is my first time asking something on one of these science AMAs.

Anyway, how serious is the kessler syndrome proposed by the NASA scientist Donald J. Kessler in 1978. And how long will it take to get a manned mission to one of these habitable planets up and running realistically?

NapalmForBreakfast

Marc: NASA takes space debris very seriously, but that's not really our department, Though the Kessler syndrome is somewhat relevant to Disk Detective--it forecasts to a time when the Earth becomes host to its own debris disk! A manned mission to any nearby star (with habitable planet or not) is not presently realistic.

Space-time has never failed to impress me in any way....My question is how does a citizen science project help an individual....do you provide any rewards for individuals or monetary goodies for enthusiasts....your Work is very Appealing.

etimejumper

Hugo: Thank you! Indeed, it helps individuals to get access to information and learning possibilities that we can't have otherwise. Speaking of rewards, I and the other citizen scientists are volunteers, so monetary rewards are not the most important to us and could even represent a conflict for what a volunteer program is. But we get other rewards, like appearing in upcoming papers that Disk Detective is working to publish and opportunities like traveling to astronomical complexes and actually observing in a professional observatory--like when I traveled to CASLEO and participated in an observation run. As an aspiring astronomer it's hard to think of better rewards!