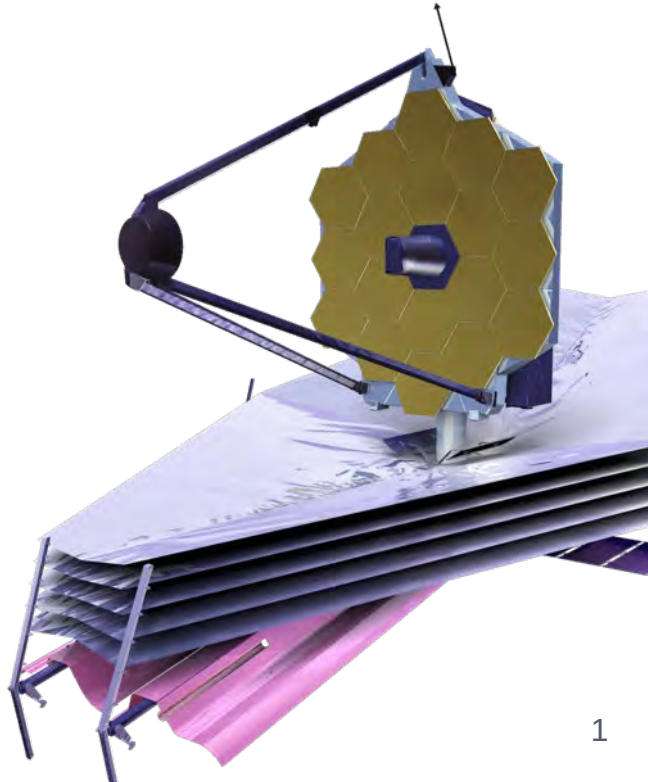
Citizen Science & JWST

Marc Kuchner
NASA Citizen Science Officer
3/1/2023



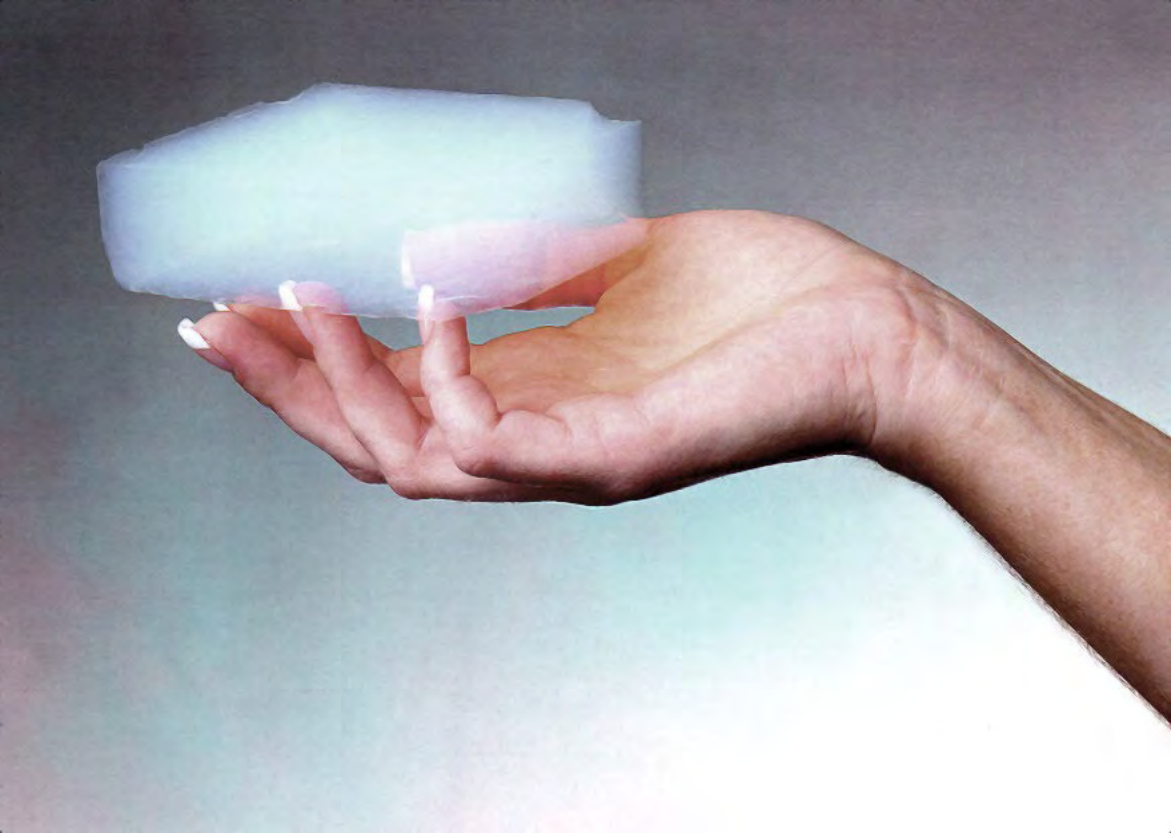
NASA Policy

NASA's citizen science projects are

- science projects that rely on volunteers.
- open collaborations
- held to the same rigorous standards as any NASA science project.

NASA’s Stardust Mission

Comet Wild 2



~28 million micrographs

~1 million grains

< 45 interstellar grains predicted

Andrew
Westphal

Duster
Bruce Hudson

~33,000 volunteer “Dusters”
found 8 interstellar grains.

stardustathome.ssl.berkeley.edu

NASA's citizen science projects have come to **dominate** multiple scientific fields. They have discovered:

- **Most** of the known comets (Battams+, Zhou+, Kracht+, Meyer+, 2004-present)
- **All** of the known samples of interstellar material (Wetphal+, Flynn, Sterken+, Gainsforth+2014 etc.)
- **Most** of the ultracool brown dwarfs (Meisner+ 2020)
- **~1/3** of Kepler's long period (>2 yr) exoplanets (Wang+ 2015, Kostov+ 206)

NASA citizen scientists have discovered:

- The “teepee tent” spectral signature from lightning at 15-30 MHz.
- The star-forming regions called “yellowballs”.
- A rare six-planet transiting system
- The first extreme T subdwarfs
- Zika virus in Peruvian cemetery vases
- The oldest white dwarf debris disk
- The “Dipper” star phenomenon
- The “Peter Pan” disk phenomenon
- Exocomets in Kepler Data
- The Meyer family of comets
- A transiting planet in a quadruple star system
- 400,000 Martian seasonal fans
- 283,000 emperor penguin nests
- 9120 candidate near-Earth asteroids
- 8900 mosquito breeding sites—and got rid of the mosquitos!
- 7 meteorites
- 1 new *kind* of aurora named STEVE

NASA Citizen Science Headlines in 2022

Citizen Scientists Discover Two Gaseous Planets around a Bright Sun-like Star

Ham Radio Operators Tune In to Giant Waves in the Earth’s Ionosphere

Citizen Scientists Help Create 3D Map of Cosmic Neighborhood

Planet Patrollers Turn In 144 Imposter Planets

Juno Spacecraft Returns to “Clyde's Spot” on Jupiter

An Accidental Discovery Hints at a Hidden Population of Cosmic Objects

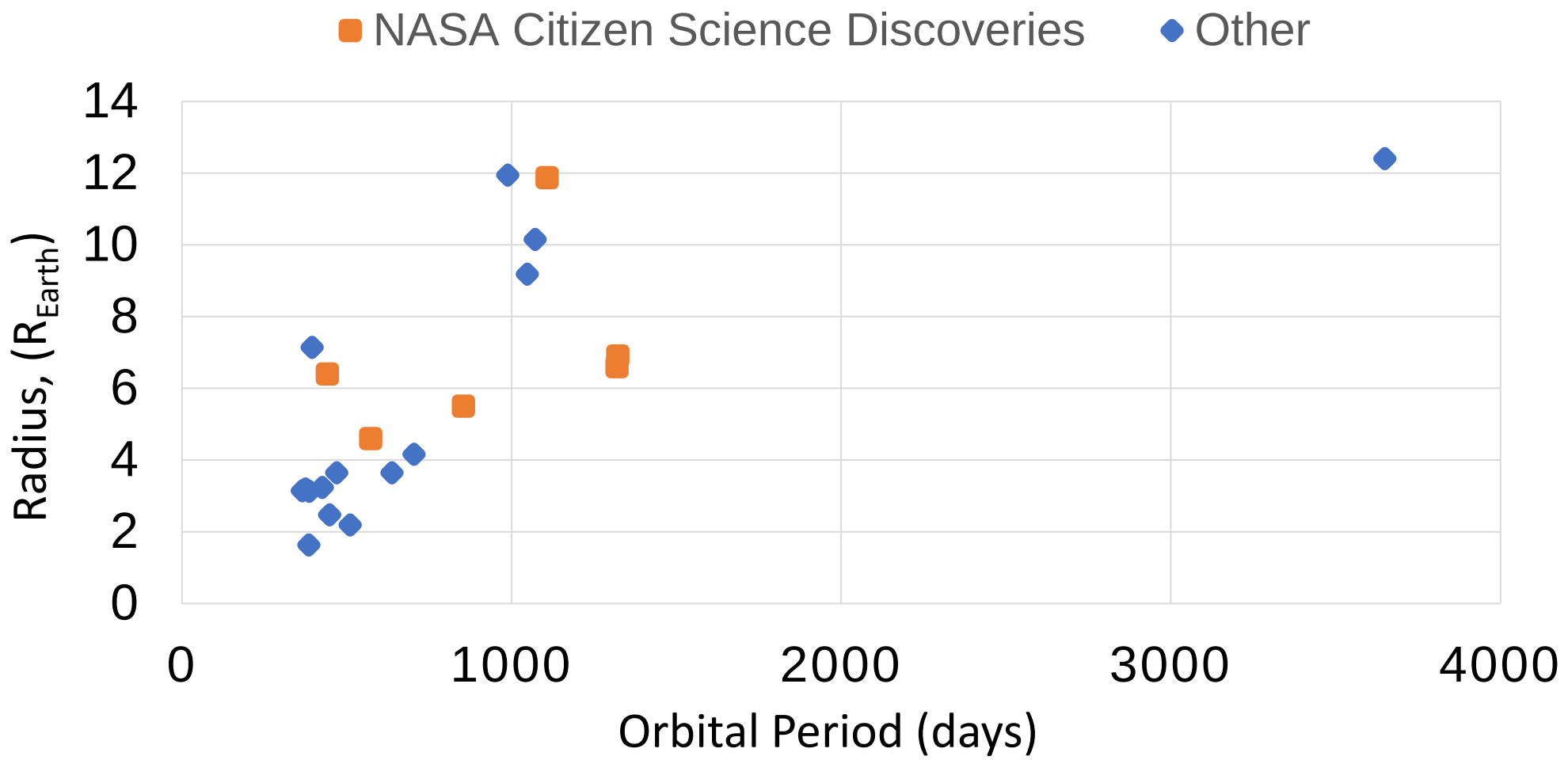
Citizen scientists find young-Jupiter-like object missed by previous exoplanet searches

Puzzling Triple Star System Found by Citizen Scientists Working on Planet Hunters TESS

Citizen Scientists Spot Jupiter-like Planet in NASA TESS Data

EXOPLANETS WITH ≥1 YEAR PERIODS AND KNOWN RADII

1/7/2022



Cit Sci Planets from Wang et al. 2015, Kostov et al. 2016

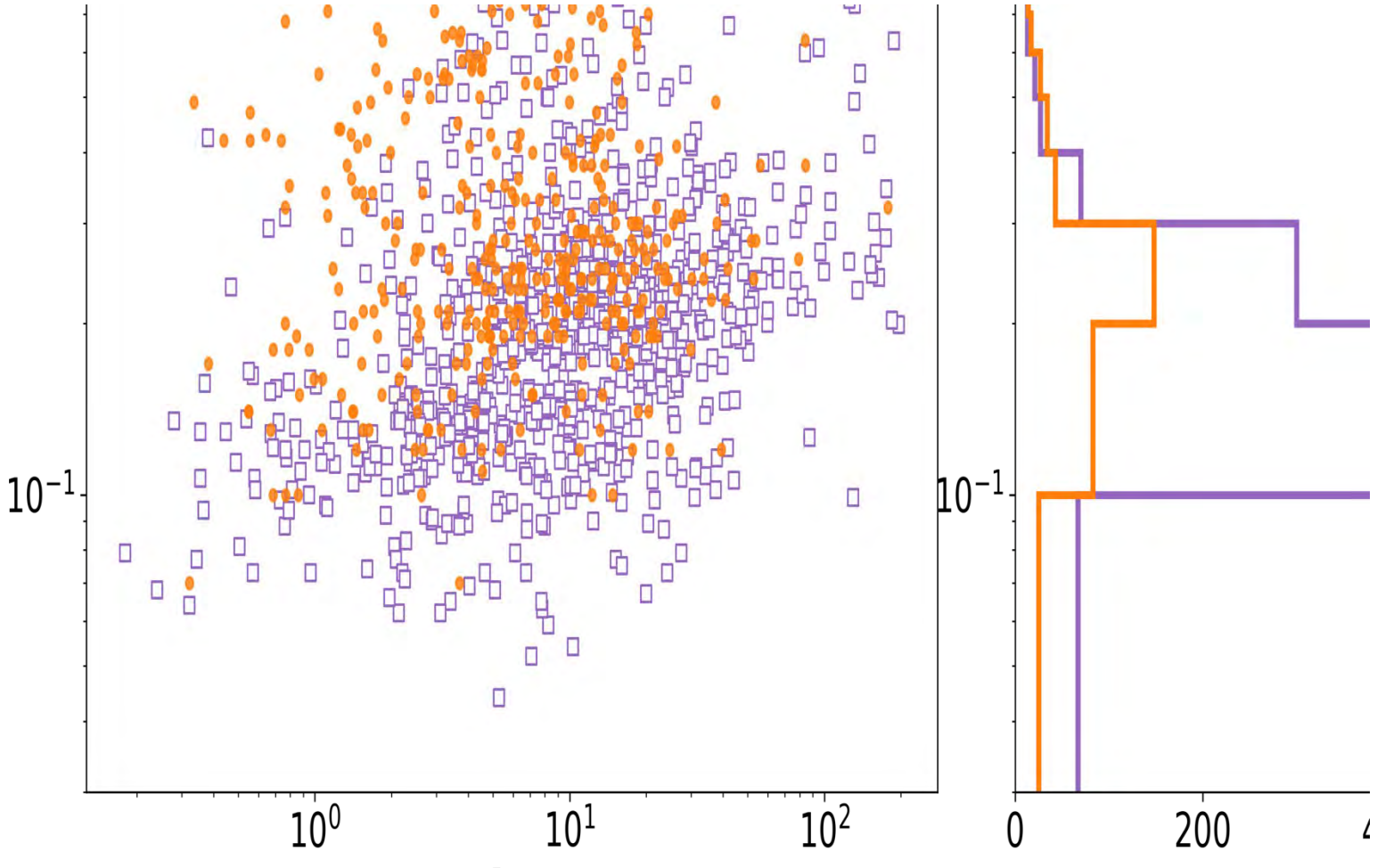
Others from Giles+ 2018, Kipping+ 2016, Beichman+ 2018, Dalba+ 2021, Kipping+ 2014, Schmitt+ 2017. Morton+ 2016, Jenkins+ 2015

Planet Patrol Vetting Results: TESS Triple-9 Catalog

Cacciapuoti et al. 2022

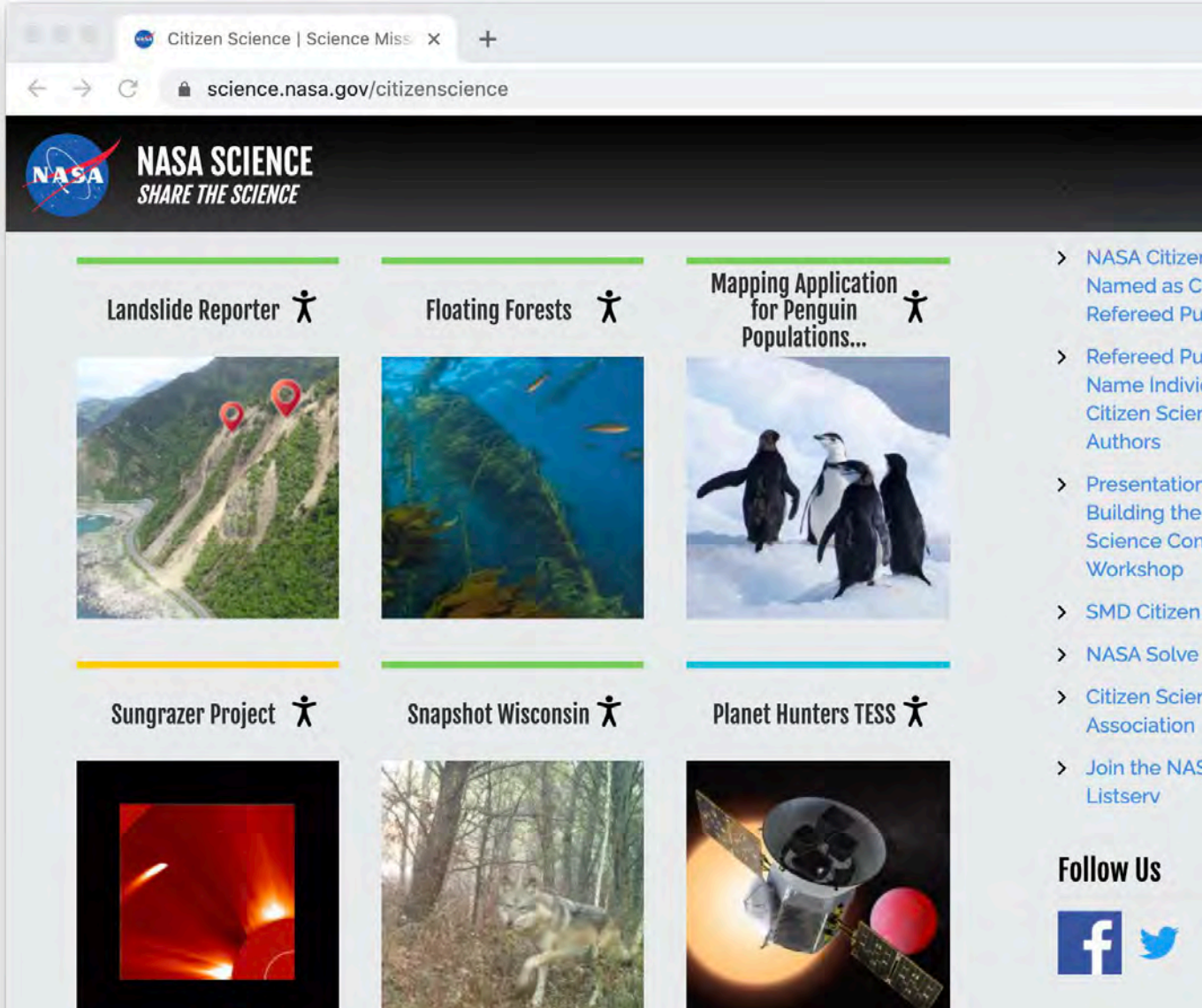
Results:

- 999 candidates vetted. The largest uniformly-vetted sample of TESS planet candidates!
- 146 False Positives and 144 potential False Positives
- Small Planets Are Rarer!



science.nasa.gov/citizenscience

- 32 projects open to the public
- 20 can be done by anyone, anywhere with just a laptop or cell phone



>140,000 NASA citizen scientists have advanced degrees!

~1/6 of the total U.S. science + engineering workforce.

410 NASA citizen scientists have become named co-authors on **refereed** published papers!

science.nasa.gov/citizenscience/publications

At least 12 NASA Cit Sci Science Teams have Regular Meetings/Videocons/Calls Directly with their Volunteers

Real-Time Interactions with scientists change people's lives!

Stardust@Home: videocons on the 3rd Thursday of each month.
Radio Jove: regular phone calls with volunteers.
Planet Patrol, Disk Detective, and **Burst Chasers:** videocons once per week.
Backyard Worlds: three videocons per week.
HAMSci: 3-4 telecons per week
Planet Hunters: monthly Coffee Chats
GAVRT: monthly session with citizen scientists
Fresh Eyes on Ice: monthly meets during the frozen season
Growing Beyond Earth: monthly chats with scientists and virtual office hours.
Dark Energy Explorers: TBD

Citizen Science vs AI

Citizen Scientist: I noticed all these funny blobs, so I wrote a code to start searching for them, and a group of us got together and started running it and Farisa wrote a draft of a paper about it…what do you think?

Machine Learning Code: 76, 23, 89, 22, 01, 54, 28, 28, 90, 07, 52

The oldest disk around a **white** dwarf, an analog for the solar system 8 billion years from now.

Two dust rings.

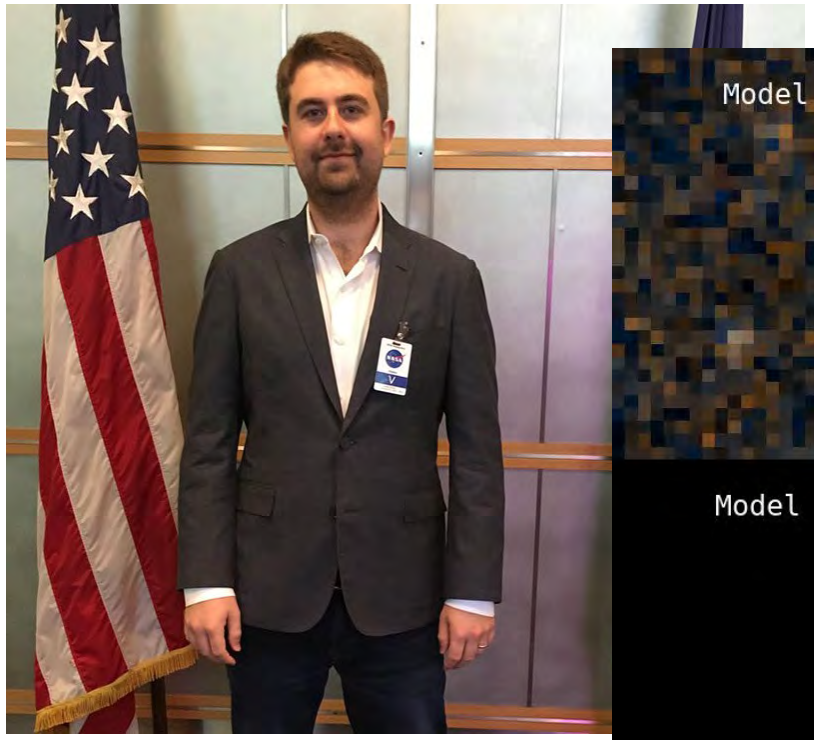
Cold **white** dwarf
LSPM J0207+333

Tidally shredded
comets and asteroids.

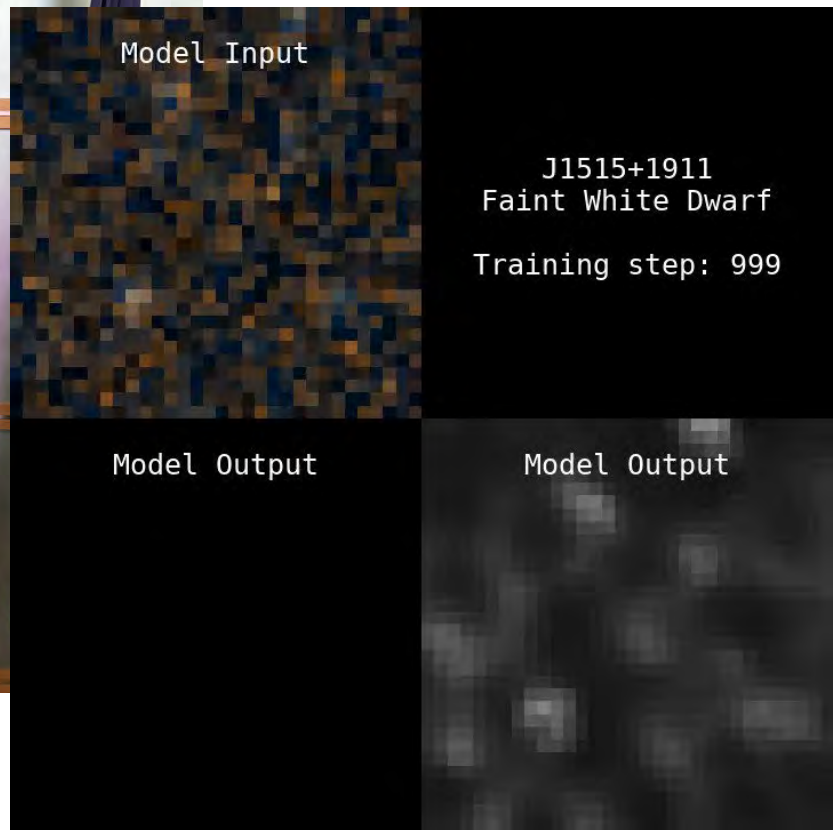
Discovered by
Citizen Scientist
Melina Thévenot

backyardworlds.org

Citizen Scientists Write Their Own AI/ML!



Dan Caselden
Citizen Scientist/
IT Security Engineer



SMDET (Caselden et al. 2020) finds moving objects in WISE image cubes.

Tamara Stajić
Citizen Scientist/
Machine Learning Engineer

How NASA Funds Citizen Science

Dedicated Cit Sci Calls:

Citizen Science for Earth Systems (CSESP)
Citizen Science Seed Funding (CSSFP)
Heliophysics Citizen Science Investigations (HCSI)

Plus **any ROSES element can support cit sci.** These already have:

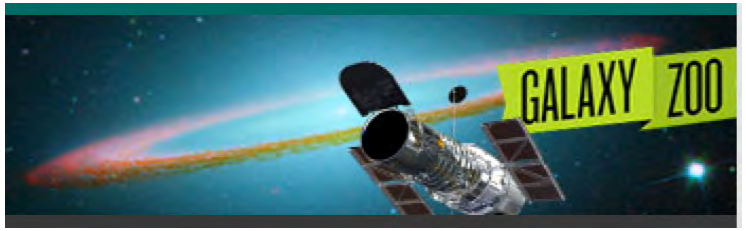
Astrophysics Data Analysis (ADAP)
Ecological Forecasting (EF)
Established Program to Stimulate Competitive Research (EPSCoR)
Exoplanet Research (XRP)
Mars Data Analysis (MDAP)
Remote Sensing of Water Quality (RSWQ)
Solar System Observations (SSO)
Science Activation (SciAct)

Citizen Science in NASA Missions

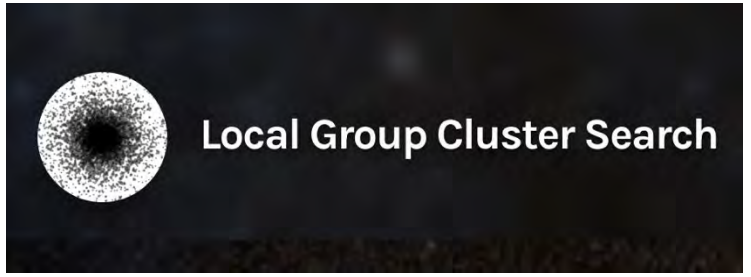
- 1% incentive for Citizen Science in the **2022 Heliophysics Small Explorer (SMEX)** Announcement of Opportunity (AO)
- $2 million incentive for Citizen Science in DRAFT **Astrophysics Probe Explorer (APEX)** Announcement of Opportunity (AO)
- Junocam/Jovian Vortex Hunter
- Electrojet Zeeman Imaging Explorer (EZIE) Magnetometer

Hubble Citizen Science

- Five citizen science projects.
- Predates NASA's citizen science policies.
- Negligible NASA funding. (Funded by ESA, universities, etc.)



Galaxy Zoo Hubble



Local Group Cluster Search

The Andromeda Project

Star Date M83

Hubble Asteroid Hunter

Andromeda Project

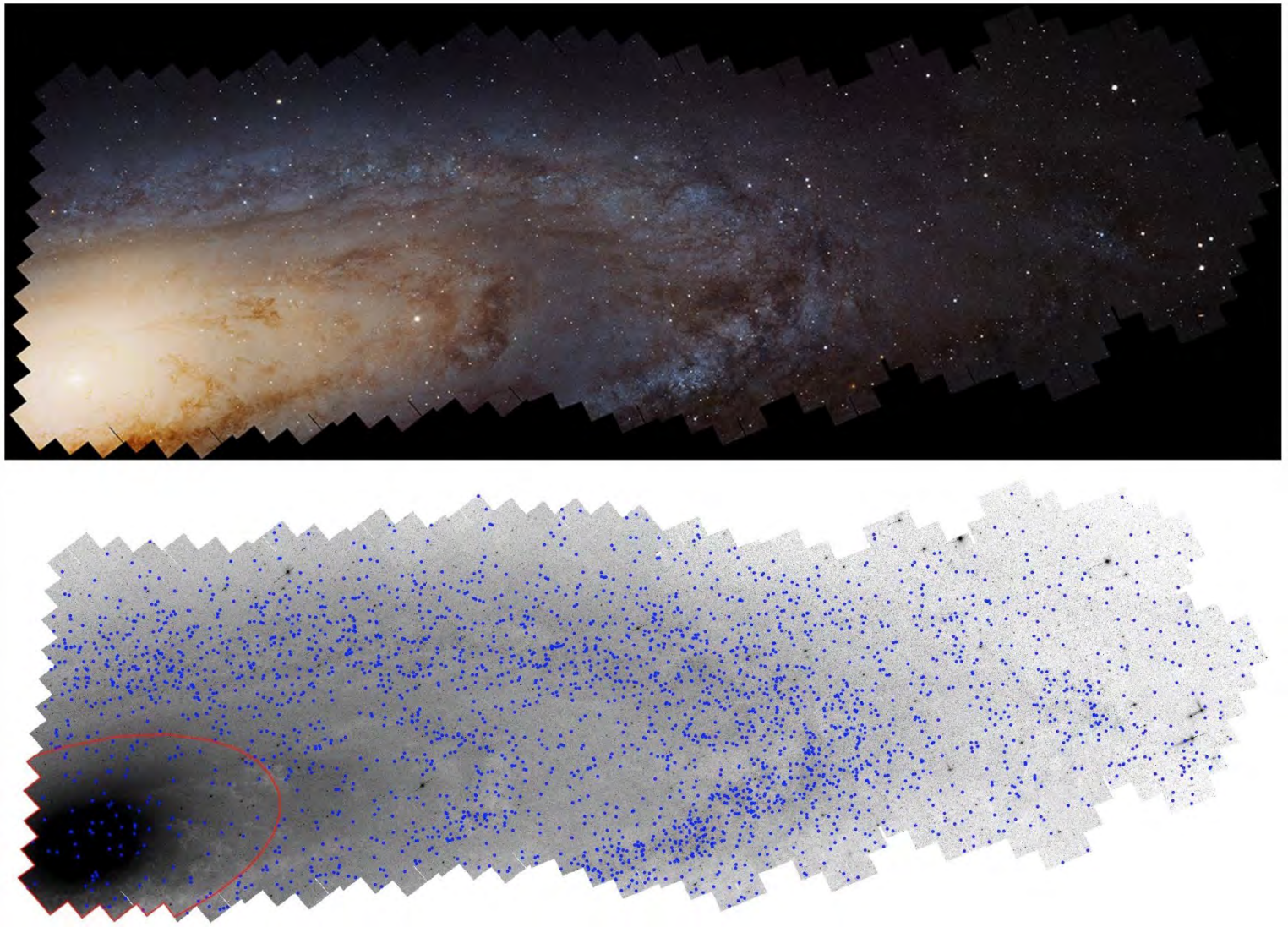
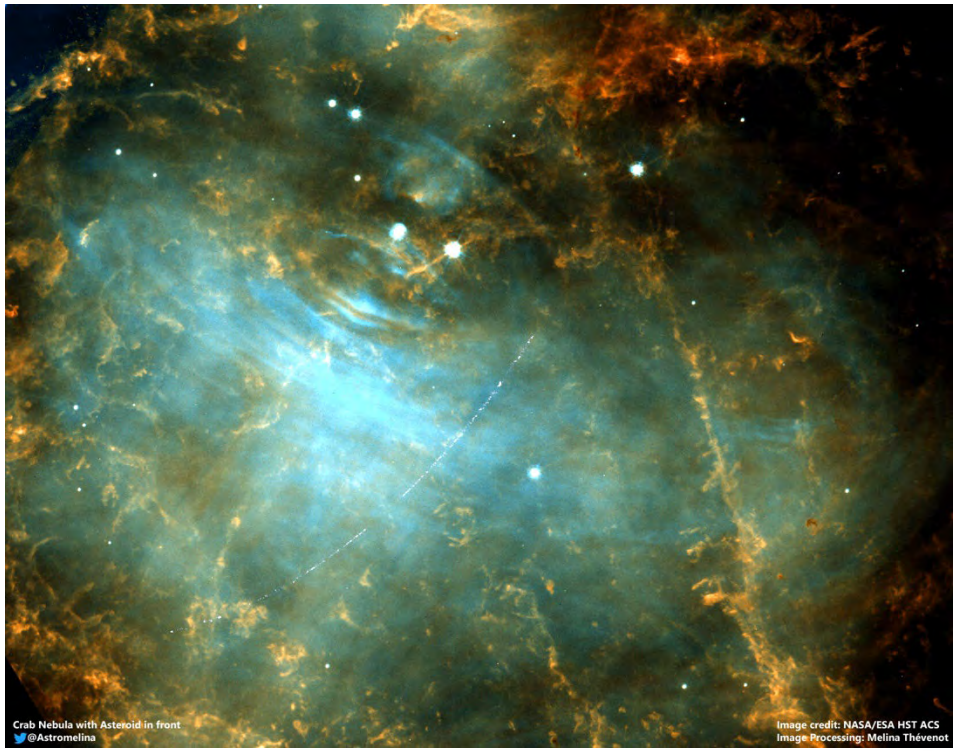


Image Credit: NASA, ESA, J. Dalcanton, B.F. Williams, and L.C. Johnson (University of Washington), the PHAT team, and R. Gendler; Johnson et al. 2015

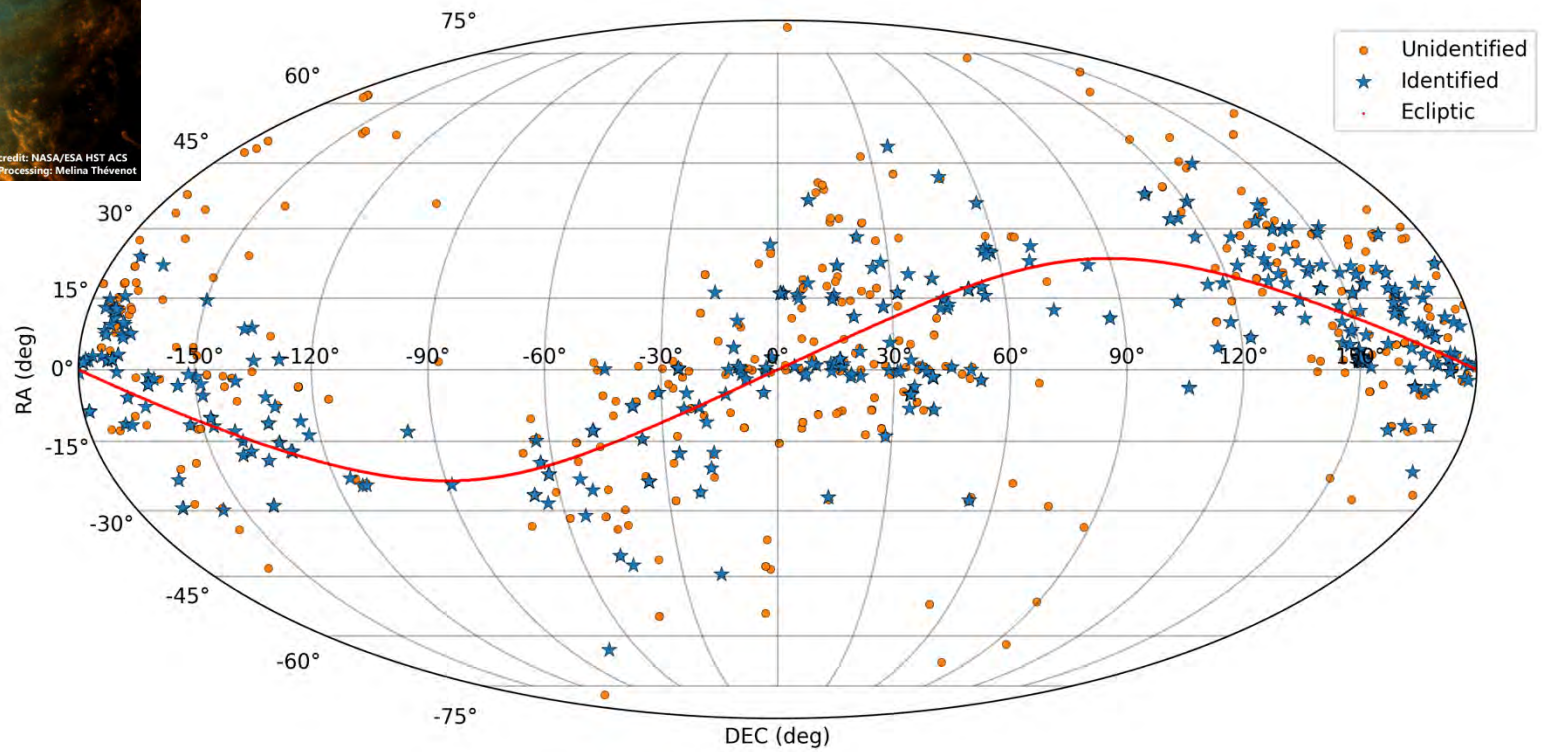
- 2753 Star Clusters!
- Power law mass distribution consistent with Milky Way's (Weisz+2015, Johnson+ 2016,2016)

Hubble Asteroid Hunter



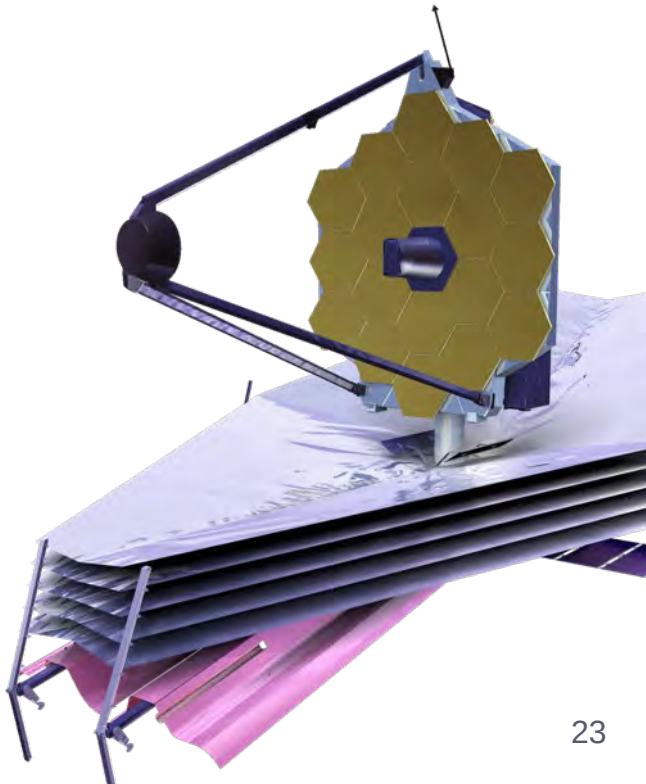
Crab Nebula
w/asteroid trail

1700 small body trails



JWST Citizen Science…so far

- Citizen scientists Austin Rothermich and Dan Caselden, from the Backyard Worlds: Planet 9 project are Co-Investigators on Cycle-1 program.
- Three citizen scientists discovered brown dwarfs that are scheduled to be observed by JWST.
- Citizen science projects Exoplanet Watch and UNITE monitor potential JWST exoplanet targets.
- Judy Schmidt's famous images…
- **No complete projects.**



Exoplanet Watch:
exoplanets.nasa.gov/exoplanet-watch
&
UNITE:
science.unistellaroptics.com

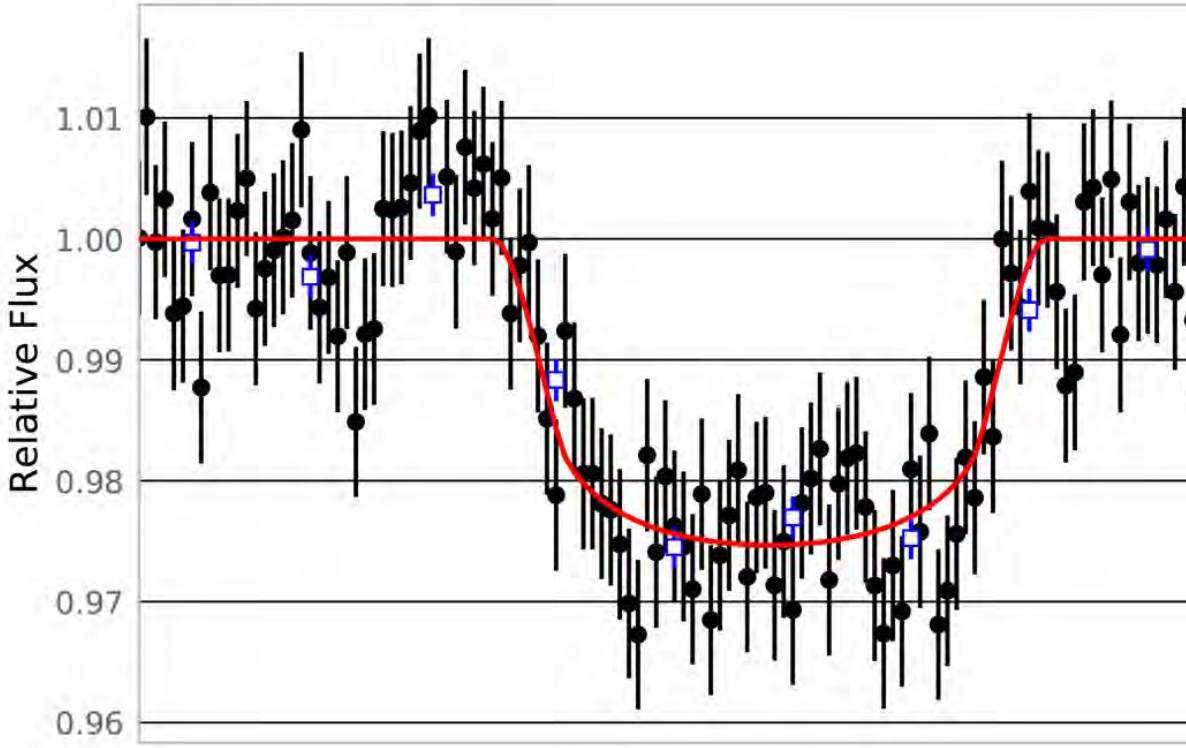
Launched at winter AAS!!

NASA's TESS mission

+

Your Backyard Telescope

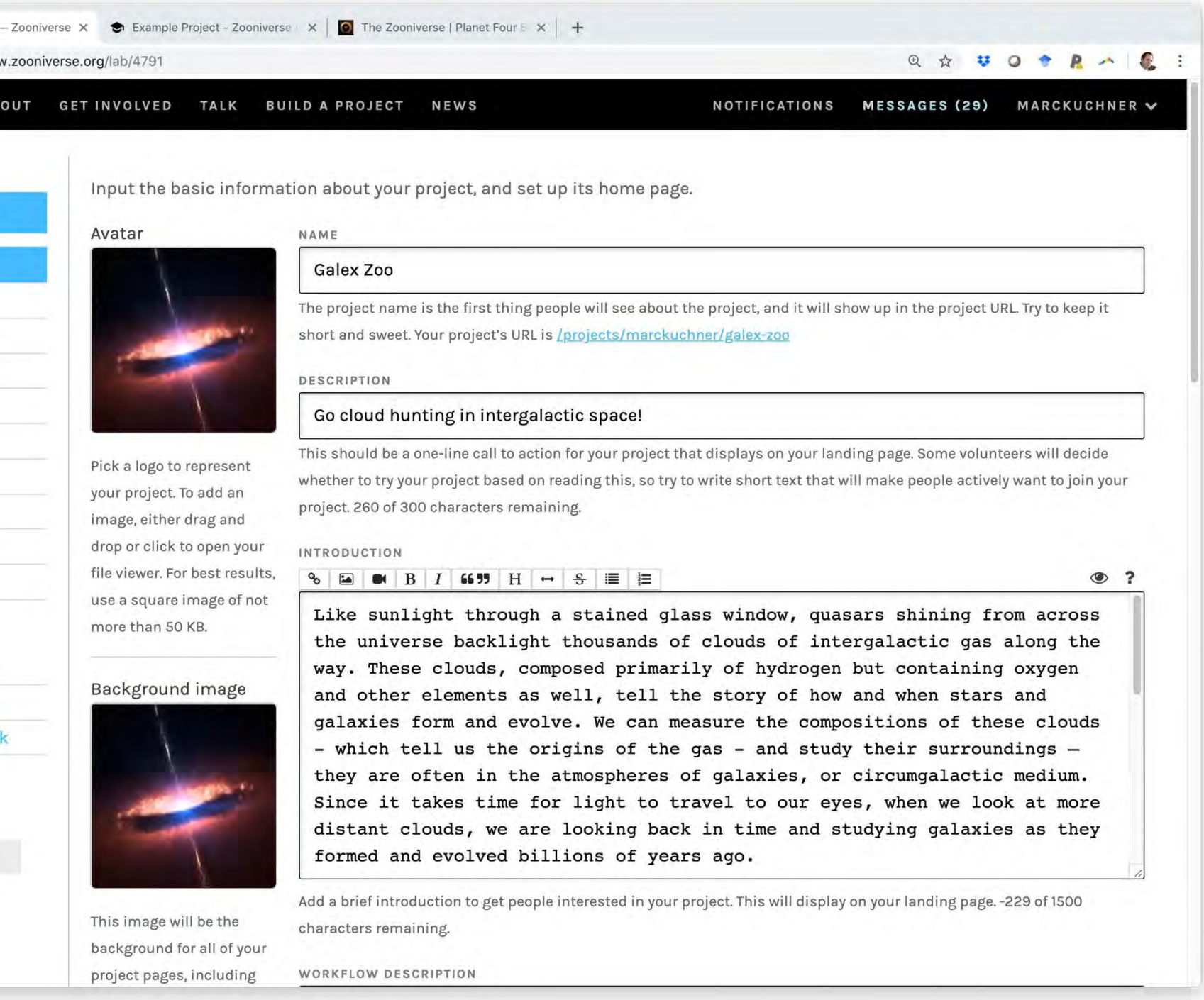
=



2023 is NASA's Year of Open Science, and that includes Citizen Science!

Sharing data, code, and knowledge, enables more inclusive, diverse and equitable participation in science, and leads to more transparent, and reproducible results.

What can we do to encourage more JWST citizen science?



Platforms like Zooniverse make building Cit Sci websites free to JWST community!

Challenges

- Each Cit Sci project requires ~1 year of scientist time before the public can participate.
- Synching up other funding sources to support this development time causes more delays.
- Scientists are nervous to propose citizen science to a science call unless it’s specifically encouraged.

Summary:

Just ONE JWST Citizen Science Project can touch 500,000 people.

Let’s find a way to encourage citizen science in Cycle 3, competing on scientific merits.

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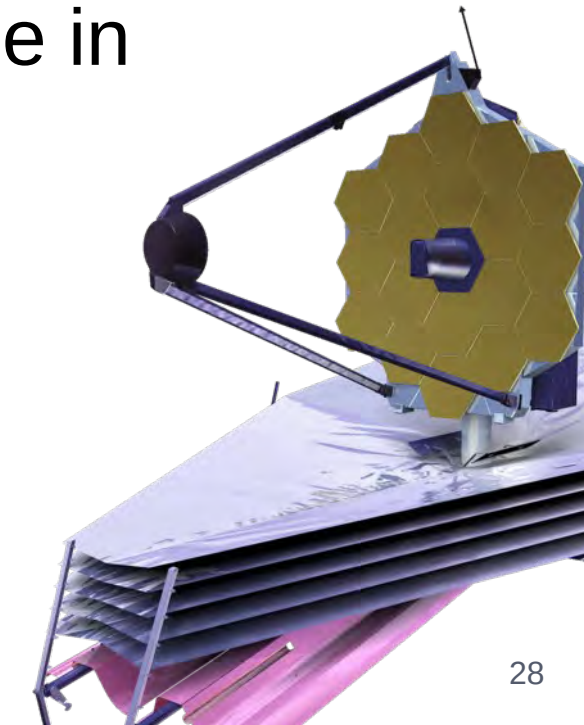

Extra Slides

Where in the Cycle 3 Call could Citizen Science go?

Regular AR Proposals

The general goal of a Regular AR Proposal is to analyze a subset of data from JWST to address a specific scientific issue…. Budget plans should be commensurate with the level of work required to carry out the goals of the proposal. Laboratory astrophysics relevant to JWST observations is an acceptable component of an archival proposal.

Legacy AR Proposals

The main difference between a Regular and a Legacy AR Proposal is that the former aims at performing a specific scientific investigation, while the latter will also create data products and/or tools for the benefit of the community. While Legacy AR Proposals will be judged primarily on the basis of scientific merit, the importance and broad applicability of the products produced by the Legacy Proposal will be key features in judging the overall scientific merit of the proposal.

We encourage the development of open source community software tools for dissemination to the community.

Good, but still forces the public to wait years before their chance to do science!

General Observer (GO) Proposals

A GO Proposal may be submitted for any amount of observing time, counted in hours, including all overheads. GO Proposals are classified as Small (≤ 25 hours), Medium (> 25 and < 75 hours) and Large (≥75 hours)…
There are also opportunities to apply for Joint Observing programs to obtain multi-wavelength data, Survey Proposals to designate a set of scheduling-filling observations JWST can make to improve observing efficiency, and Calibration Proposals to provide calibrations for non-standard instrumentation modes.

In general, proposals are either accepted or rejected in their entirety. Accordingly, proposers are urged to request the actual number of hours required to achieve the proposal science goals. **Laboratory astrophysics** relevant to JWST observations is an acceptable component of a GO proposal. **Ground-based observations** that complement JWST observations may also be included as a component of a GO proposal, but note that these observations must be obtained independently, as STScI does not award time on ground-based facilities

Better! Funding for citizen science arrives when data arrives.

Policy 1 - Limitations on the Use of Funds for the Research of General Observers and Archival Research

Funding allocated to the Space Telescope Science Institute (STScI) by NASA for support of the research of General Observers (GO) and Archival Researchers (AR) is intended to be used for the acquisition, calibration, analysis, and publication of JWST data. Funding for preparatory observations (e.g., ground-based) must be justified within this intention. Funding of observational research by GOs or ARs with other facilities (ground- or space-based) that is considered essential for the preparation for JWST observations must receive specific approval by the STScI's Financial Review Committee.

Evaluating Citizen Science Proposals

A few additional elements beyond scientific merit, budget etc.:

- Utilization of existing platforms and/or existing enthusiast communities

- Use of beta testing: testing the project on a group of volunteers before launch to ensure data quality and positive participant experience.

- Inclusion of a sunset plan to ensure volunteers are informed about the results and invited to remain part of the NASA citizen science community when the project is completed.