NASA’s Exoplanet Detection: the Missions and Women Involved

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Additional Resources
http://nasawavelength.org/list/2062

Women in STEM¹
- Girls STEAM Ahead with NASA (NASA’s Universe of Learning)
- Chandra Women in STEM (posters)
- Women@NASA
- Women’s History Month (Library of Congress)

Explore Exoplanets:
- NASA Exoplanet Exploration
- NASA’s Eyes on Exoplanets
- Exoplanet Travel Bureau (Posters)
- 5 Ways to Find a Planet
- TRAPPIST-1 System
- Kepler Orrery IV²

Activities and Guides:
- TRAPPIST-1 System Scale Model
- TESS 3D and Paper Models
- DIY Planet Search (Observing with NASA-MicroObservatory)
- NSN’s Universe Discovery Guides³
- Star Witness News Story: 20 Years of Exoplanets
- Space Place: All About Exoplanets

Featured Resource:
- Exoplanet Explorers (Citizen Science project)⁴
“We are advertising for a staff scientist in the Kepler Science Office. Would you be interested?”
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Would you be interested?”

…

“Hey mum! I’m being head-hunted by NASA!”
The NASA Kepler Mission
The NASA Kepler Mission

- Launched in 2009
- 1-m optical telescope
- Monitored 200,000 stars for 4 years
- Using the transit method of planet discovery
- Designed to measure $\eta_{Earth}$
The final Kepler planet candidate catalog

NASA Exoplanet Archive

Planetary Radius [Earth radii] vs. Orbital Period [days]

Thompson et al., submitted
The final Kepler planet candidate catalog

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The final Kepler planet candidate catalog

Survey sensitivity dominates here
Exoplanets, including rocky planets, are incredibly common in our Galaxy.
To overcome the survey sensitivity issues, we just needed more time – three years, to be precise
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The K2 mission was born!
The K2 mission is performing an ecliptic plane survey – planets, but also astrophysics ranging from solar system science to supernovae...

K2 is in its fourth year and is expected to exhaust its thruster fuel supply in the next few months
K2 data are coming in faster than astronomers can handle

We created Exoplanet Explorers to enable the enthusiastic citizen science community to help us find the best exoplanet signals.
K2-138, the first multi-planet system found entirely by citizen scientists

And 94 more planet candidates identified in the last MONTH!
Humble Beginnings

My first role model
My First NASA Job

1995-1997

My first real role model
My First Space Mission
Kepler Mission (2009-2013)

What fraction of stars in our galaxy harbor Earth-sized planets?
Kepler taught us that planets are everywhere!

- Earth-size
- Super-Earth size
  1.25 - 2.0 Earth-size
- Neptune-size
  2.0 - 6.0 Earth-size
- Giant-planet size
  6.0 - 22 Earth-size
TESS Mission (2018+)

Search for small planets around nearby, bright stars that are amenable to follow-up.
TESS will find thousands of planets close to Earth

Kepler Search Space:
- 3000 light-years
- 0.25% of the sky

TESS Search Space:
- 300 light-years
- >85% of sky
Most nearby stars are M dwarfs

Stars within 80 light years of Sun

Legend:

- B
- A
- F
- G
- K
- M (hot)
- M (cold)

Distance: 25.00 pc
Star Systems: 2167
Objects: 3069

image credit: A. Riedel, RECONS
James Webb Space Telescope (2019+)

Where do we point Webb?

TESS is our finder scope!
Webb will characterize hundreds of planet atmospheres

Early release science includes a large transiting exoplanet program
Wide-Field imager:

1) Microlensing search for planets on wide orbits

2) >100,000 transiting planets

WFIRST will directly image planets
The Future is Bright!
Exoplanet Missions
Managing Behind the Scenes

Maura Fujieh, PMP
Kepler/K2 Project Manager
How did I get here ...
NASA’s Kepler/K2 Missions

- Kepler telescope launched in 2009 to search for exoplanets in a single field of view

- Spacecraft re-purposed as K2 in 2014 to continue observations along the ecliptic plane
Giving a face to science results

Earth-sized exoplanet spotted in star’s habitable zone

New-found world orbits a cool, dim star, and might even contain water.

Alexandra Wittke
17 April 2014

Astronomers have found the first Earth-sized exoplanet within a star’s habitable zone. The planet is the closest thing yet to the coveted ‘Goldilocks’ orb that scientists have long sought — a world roughly the size of Earth orbiting a star at a distance that is just right for liquid water to exist.

Citizen scientists comb through data from distant stars, discover five planets

By Katie Langin | Jan. 12, 2018, 5:15 PM
Many Hands Touch the Data

Key
- JPL
- ARC
- BATC
- LASP
- STScI
- NExScI

Deep Space Network
JPL

Mission Operations Center
LASP

Flight Planning Center
Ball Aerospace

Data Management Center
(Product Archive)
STScI

Science Operations Center
ARC

Project Management
ARC

Science Office
ARC

Exoplanet Archive
(Product Archive)
NExScI

Guest Observer Office
ARC
Meanwhile - Behind the Scene

- Finance (Budgets & Resources)
- Educators
- Safety & Mission Assurance
- Graphics & Outreach
- Media & Public Affairs
- Legal (e.g., software release)
- Audit & Quality
- Procurement
- Records & Documents
- Logistics, Property, Shipping
- IT & Computer Systems
- High End Computing
- Project Manager
From My Perspective

• The Project Manager is responsible for getting the mission over the finish line.
  – Every PM has a different leadership style. Know yourself. Know your team.
  – Interactions across areas of expertise are tricky. Is that balance appropriate or has it become exaggerated?
  – The needs of a project change over its lifecycle. Does the mission have what it needs, both now and moving forward.
Future missions await ...
Exoplanet Characterization
Use spectroscopic methods to study exoplanet atmospheres

Spitzer Space Telescope

NASA/JPL-Caltech/R. Hurt (IPAC)

Hubble Space Telescope

NASA

James Webb Space Telescope

Northrop Grumman
Seven webinars to be held in 2018, with these goals:

- **Increase knowledge of NASA Astrophysics-related concepts**
- **Improve familiarity of NASA Astrophysics resources and ways to use them**
- **Utilize real NASA data**
- **Interact with NASA Subject Matter Experts**

To participate, join NASA’s Universe of Learning Community of Practice (CoP) through ASTC: [http://community.astc.org/home](http://community.astc.org/home).

Webinars will be archived for later viewing, including this introductory video: [https://vimeo.com/252961419](https://vimeo.com/252961419)

As a follow-on to this webinar series, there will be an opportunity to apply for **$2,500** mini-fund resources to be competitively awarded to selected institutions, in order to implement or facilitate programming, produce exhibits, etc., using Universe of Learning resources.
To ensure we meet the needs of the education community (you!), NASA’s UoL is committed to performing regular evaluations, to determine the effectiveness of Professional Learning opportunities like the Science Briefings.

If you prefer not to participate in the evaluation process, you can opt out by contacting Kay Ferrari <kay.a.ferrari@jpl.nasa.gov>.

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