The Golden Age of Exoplanets.

AAS Meeting
May 13, 2015

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JPL Distinguished Visiting Scientist
20+ Years of Exoplanets.

Number of Planets = \(180 \times 2^{(\text{Year} - 2005)/3.1}\)

- 1995: 5
- 2000: 48
- 2005: 182
- 2010: 527
- 2014: 1832

Total Number of Planet Discoveries

Year of Discovery
The Exoplanet Gold Rush

Mass (Earth masses)

Period (years)

www.hughosborn.co.uk
The Exoplanet Zoo. (or, Mother Nature is Way More Imaginative Than We Are.)
Hot Jupiters
“Super Earths”
“Tatooine Planets”
Size Relative to Earth (Radius)

Jupiter

Neptune

Earth

2010, 2011

2012

2013

TOTAL = 2,740

Orbital Period in Days
2.0 ± 0.5 planets per M dwarf
Planets, planets everywhere.

• Planetary systems are ubiquitous and diverse.
  – The majority of stars host planets.
  – Vast range of eccentricities, inclinations, masses, atmospheres, stellar types, architectures.

• Neptune and sub-Neptune mass planets are much more common than giant planets.

• Many stars host compact systems of Neptune and sub-Neptune mass planets.

• Free-floating and/or wide-separation gas giants are common.
Kepler’s Search Area
What are Exoplanets Like?
Transiting Planets

Flux

occultation

star alone

star + planet dayside

star + planet nightside

transit

star – planet shadow

Time
Primary Eclipse
Measure size of planet
See star’s radiation transmitted through the planet atmosphere

Secondary Eclipse
See planet thermal radiation disappear and reappear

Learn about atmospheric circulation from thermal phase curves

Figure by S. Seager
Is there life out there?
Earth

Kepler-186 f

Kepler-186f
WHERE THE GRASS IS ALWAYS REDDER ON THE OTHER SIDE
The Future of Exoplanets.
Enduring Quests
Daring Visions
NASA Astrophysics in the Next Three Decades
The exoplanet zoo:

- **Complete** the statistical census of exoplanets

What are exoplanets like?

- **Characterize** giant planet atmospheres
- **Study** the atmospheres of a broad range of exoplanets

The search for life:

- **Measure** the frequency of potentially habitable planets
- **Search** for signs of habitable environments
- **Obtain** resolved maps & spectra of exoEarths

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### Missions

- Kepler
- TESS
- Hubble
- James Webb Space Telescope
- Spitzer
- WFIRST-AFTA
- LUVOIR Surveyor
- ExoEarth Mapper