

# Kepler Update: 2016



[http://www.nasa.gov/sites/default/files/styles/side\\_image/public/thumbnails/image/286257main\\_07-3348d1-kepler-4x3\\_226-170.jpg?itok=hvzfdmjc](http://www.nasa.gov/sites/default/files/styles/side_image/public/thumbnails/image/286257main_07-3348d1-kepler-4x3_226-170.jpg?itok=hvzfdmjc)

# The Kepler Mission



NASA Discovery Mission # 10: “Are there other planets, orbiting other stars, with characteristics similar to Earth?”

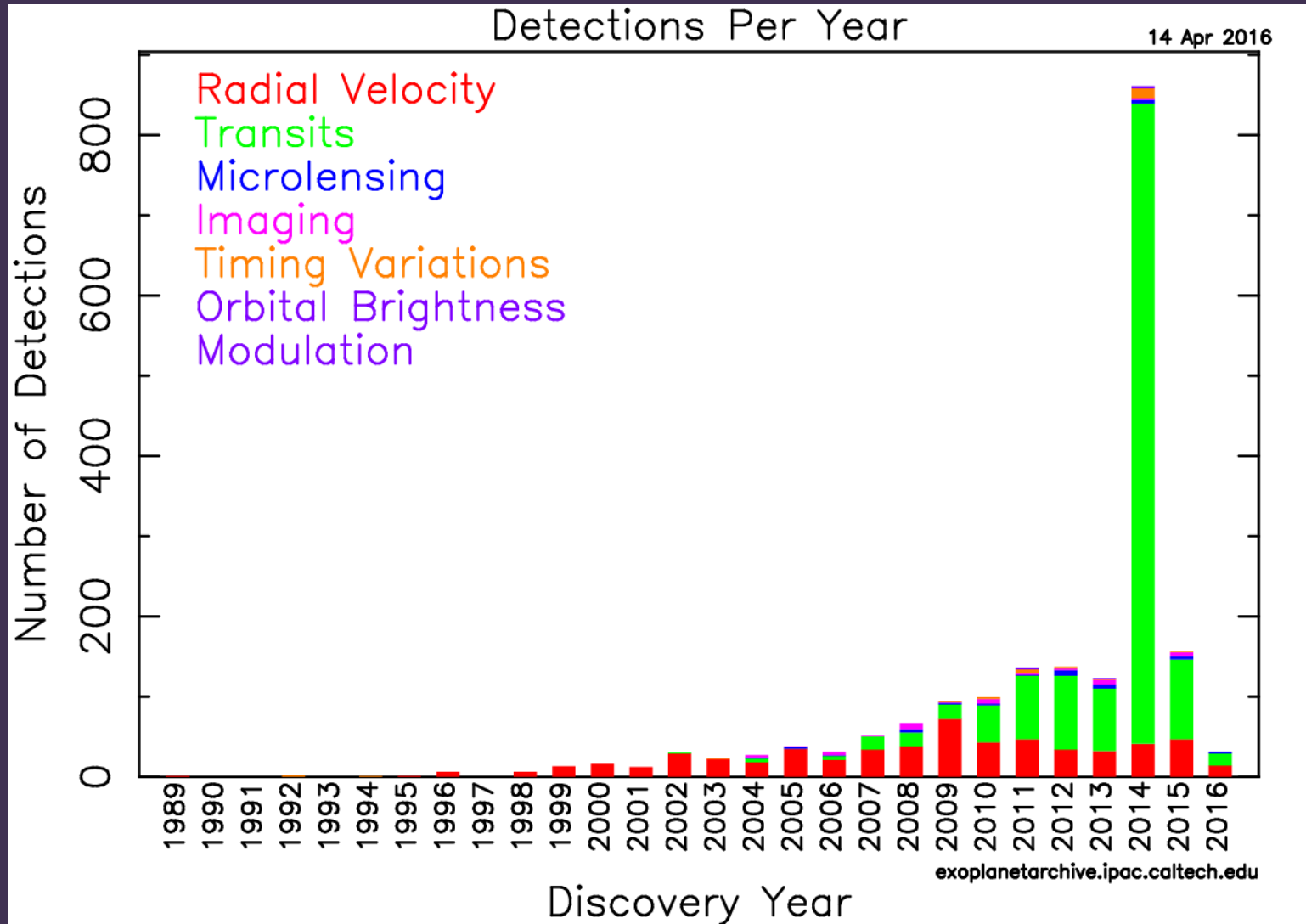
“The Kepler mission will challenge thousands of stars to a staring contest, you know, like the ones you used to have with your siblings when you were younger, and that you have with the cat every once in awhile?”

— Davin Flateau, 365 Days of Astronomy podcast, March 1, 2009

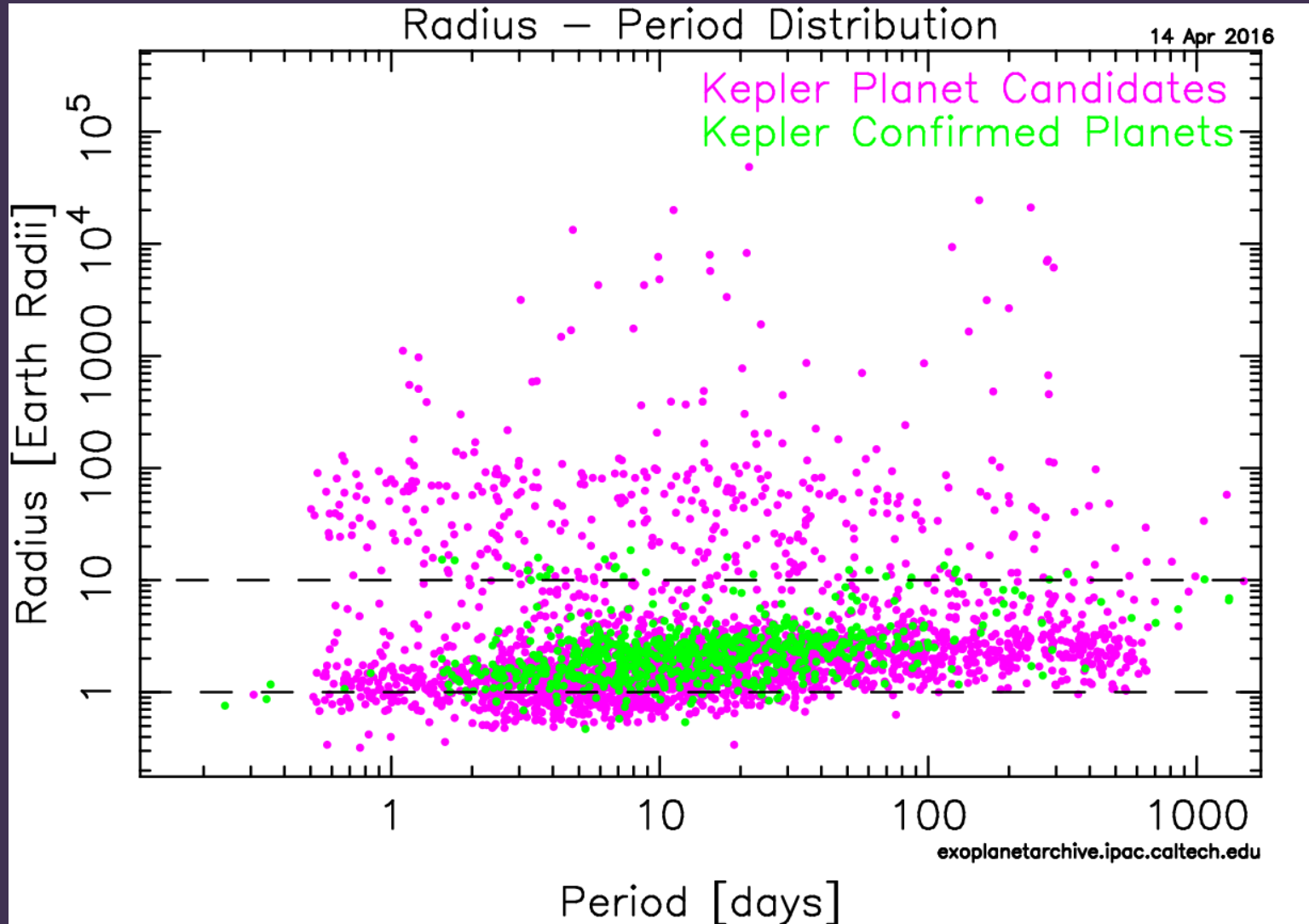
# Kepler Overview

- Mission Characteristics
- Continuously point at a single star field in Cygnus-Lyra region except during Ka-band downlink
- Roll the spacecraft 90 degrees about the line-of-sight every 3 months to maintain the Sun on the solar arrays and the radiator pointed to deep space
- Monitor 150,000 main-sequence stars for planets
- Mission lifetime of 3.5 years extendible to at least 6 years
- Deep Space Network for telemetry
- Routine contact
  - X-band contact twice a week for commanding, health, and status
  - Ka-band contact once a month for science data downlink

# NASA Exoplanet Archive—Detections



# NASA Exoplanet Archive—Distribution



# What I plan to talk about...



Ames Research Center

## Kepler

A Search for Habitable Planets

Home Mission News Science Discoveries Galleries Education **Confirmed Planets: 1041**

Home > News > NASA Kepler News

RSS Send Bookmark

### News

NASA Kepler News

Kepler in the News

Planet-finding News

Manager Updates

Search

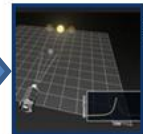
### NASA Kepler News



04-11-2016

#### Kepler goes into Emergency Mode ...and recovers

Kepler went into an Emergency Mode (EM) last Thursday (April 7), the first EM that the Kepler spacecraft has encountered during its seven years in space. On Sunday morning (April 10), the spacecraft reached a stable state and the mission cancelled the spacecraft emergency. The Kepler team is thoroughly assessing all on board systems to ensure the spacecraft is healthy enough to return to science mode and begin the K2 mission's microlensing observing campaign, Campaign 9.



04-07-2016

#### Searching for Far Out and Wandering Worlds

This week, NASA's K2 mission and other ground-based observatories have teamed up to kick-off a global experiment to survey millions of stars toward the center of our Milky Way galaxy in search of exoplanets wandering between the stars.



03-21-2016

#### Caught For The First Time: The Early Flash Of An Exploding Star

The brilliant flash of an exploding star's shockwave—what astronomers call the “shock breakout”—has been captured for the first time in the optical wavelength or visible light by NASA's planet-hunter, the Kepler space telescope.



03-08-2016

#### NASA's K2 mission: The Kepler Space Telescope's Second Chance to Shine

A space telescope with a distinguished history of discovering distant exoplanets – planets orbiting other stars – was about to outdo even itself, racking up hundreds more discoveries and helping to usher in entirely new opportunities in astrophysics research. ...The discoveries roll in....



01-08-2016

#### K2 and Kepler at AAS

A series of tweets gives a small glimpse of a big K2 and Kepler presence at the American Astronomical Society meeting in the first week of January 2016.



11-10-2015

**AAS presents Borucki with Carl Sagan Award**

American Astronomical Society presented the 2014 Carl Sagan Memorial Award to Bill Borucki



11-06-2015

**More on K2SciCon**

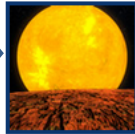
Here are some highlights based on tweets from days 2-4 of the conference.



11-02-2015

**K2SciCon Begins**

K2 astronomers are presenting scientific results at K2SciCon hosted by Las Cumbres Observatory Global Telescope Network in Santa Barbara, Nov 2-5, 2015.



10-23-2015

**Top 20 Intriguing Exoplanets**

Over 60 exoplanet astronomers were asked to give a list of their top 5 interesting planets, which were then crafted into the "[top 20 exoplanets](#)".



10-15-2015

**William Borucki Receives SETI Institutes's 2015 Drake Award**

On October 15, the SETI Institute awarded the 2015 Frank Drake Award for Innovation in SETI and Astrobiology Research to William Borucki, who was the Principal Investigator for NASA's Kepler mission.



09-15-2015

**Kepler: A Giant Leap for Exoplanet Studies**

Article by Kepler scientist Jack Lissauer in the AGU journal EOS Earth & Space Science News.



08-07-2015

**HENAAC Scientist of the Year: Elisa Quintana**

[Elisa V. Quintana](#), Kepler Mission Post-Doctoral Research Scientist, will be awarded HENAAC Scientist of the Year.



07-23-2015

**NASA's Kepler Mission Discovers Bigger, Older Cousin to Earth**

Kepler-452b which has the closest match of planet characteristics to Earth: 60% larger than Earth, orbiting a Sun-like star in a 385 day orbit period, that puts it in the star's habitable zone.



07-01-2015

**Kepler's Borucki Retires after Five Decades at NASA**

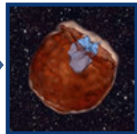
After a career spanning 53 years and championing a mission deemed impossible for decades, William Borucki, the principal investigator of NASA's planet-hunting Kepler mission, will retire from the agency on July 3.



06-17-2015

**Kepler-138b: a Mars-size exoplanet, now with a measured mass**

The Kepler-138 system has two Earth-size planets (Kepler-138c and Kepler-138d) and one Mars-size planet (Kepler-138b). Kepler-138c and Kepler-138d are likely rocky, but Kepler-138d is less dense and cannot be made of the same mix of material as Earth.



05-20-2015

**NASA Spacecraft Capture Rare, Early Moments of Baby Supernovae**

Astronomers are going gaga over newborn Type Ia supernovae measurements taken by NASA's Kepler and Swift spacecraft.



05-14-2015

**Kepler Observes Neptune Dance with Its Moons**

In its new K2 mission, Kepler spacecraft imaged Neptune and two of its moons, Triton and Nereid, 101,580 times, making a 70 day/34 second timelapse movie.



05-14-2015

**Mission Manager Update: K2 in Campaign 5**

...spacecraft operating beautifully; movie of Neptune and its moons; open clusters M44 and M67.



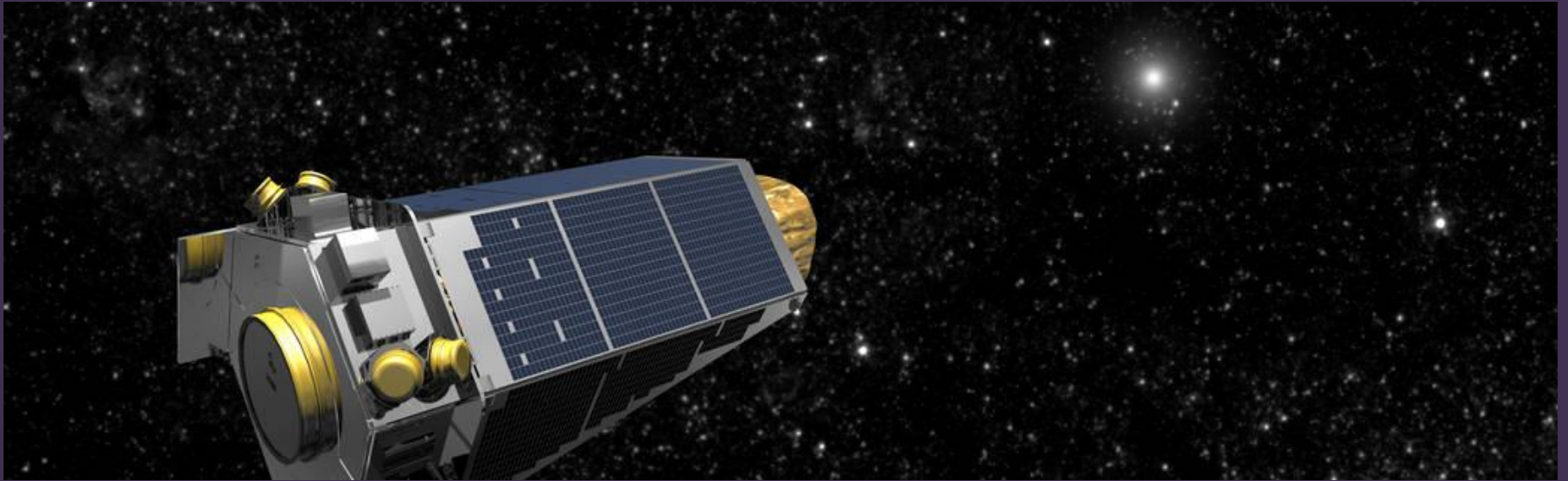
05-12-2015

**Kepler's Six Years In Science (and Counting)**

A graphic tells NASA's Kepler spacecraft's story by the numbers from the moment it began hunting for planets outside our solar system on May 12, 2009.



# Recovering From Emergency Mode



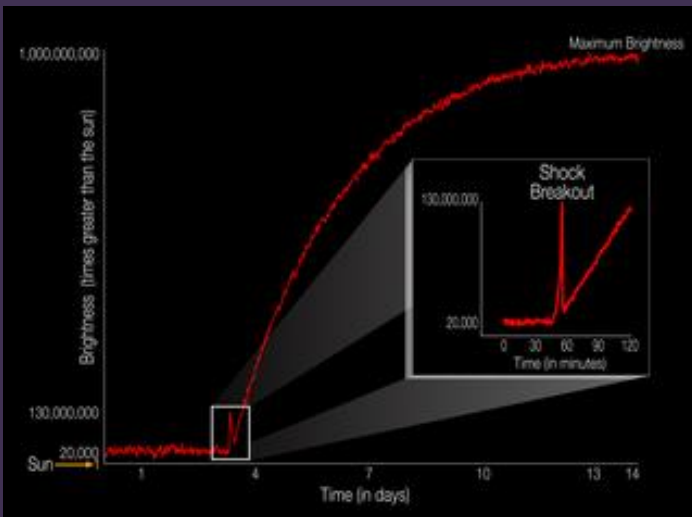
<http://www.nasa.gov/sites/default/files/thumbnails/image/keplerbeautyspot.jpg>

# Microensing Campaign

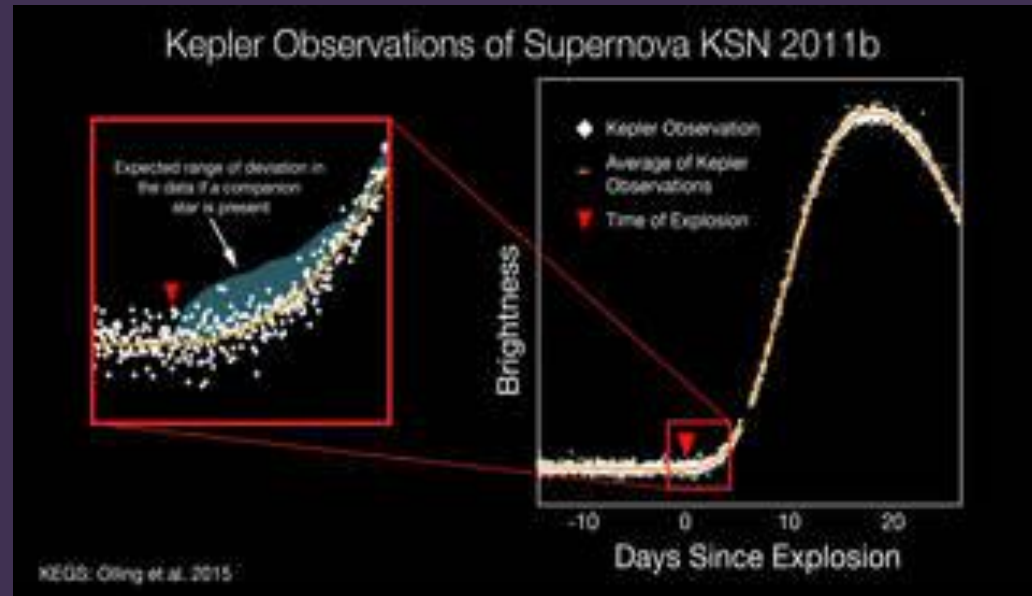
- Joint effort with ground-based telescopes on six continents to survey a wide field near the center of the Milky Way
- General relativistic gravitational bending of light can intensify a background star for a day or two, providing a way of detecting planets farther away from a star or even ones wandering free—see a simulation here:  
<https://youtu.be/hMdVFk389EU>
- Simultaneous observations from the ground and Kepler nearly 100 million miles away can provide location via parallax
- Kepler points opposite the usual direction to observe stars in the night sky for Earth—it would have captured the Earth and Moon passing through its field on April 14

# Kepler Catches Exploding Stars

Type II supernova shock breakout:  
<https://youtu.be/kLlLnQjGfc>



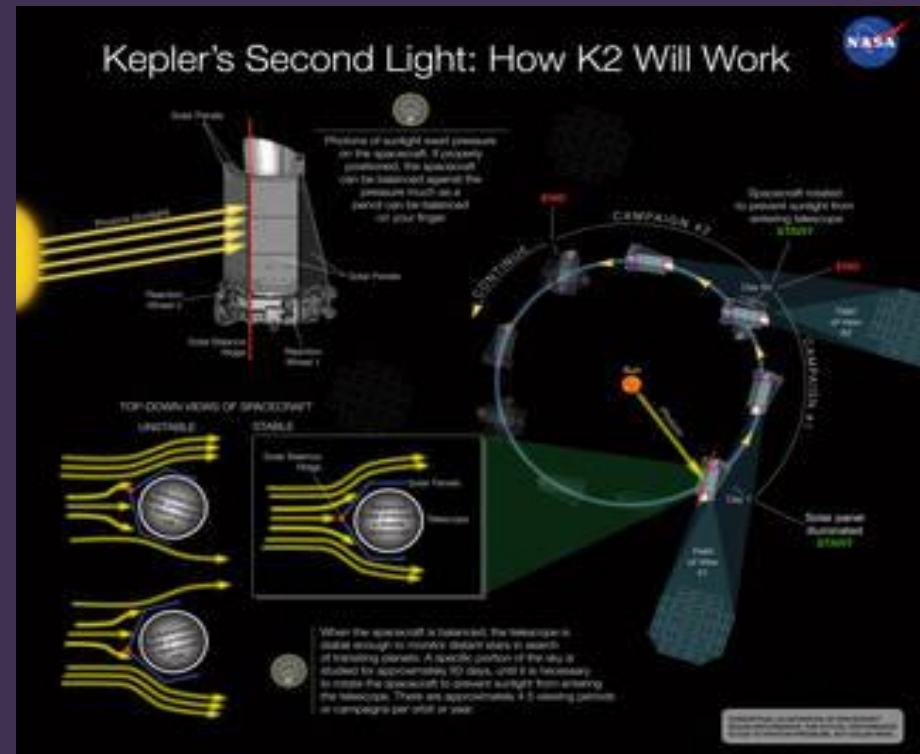
Kepler light curves for type Ia supernovae indicate merger of binary white dwarfs



<http://www.nasa.gov/sites/default/files/thumbnails/image/supernova-may20-2015.jpg>

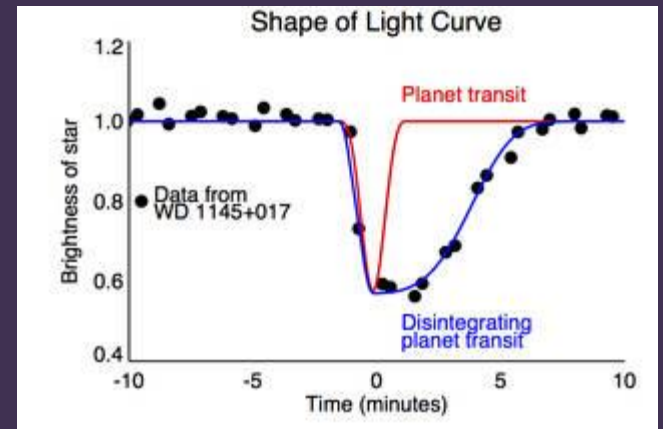
# K2 Mission: Kepler Repurposed

- New targets along the ecliptic in 75-day observing campaigns
- Science community chooses the most compelling science targets
- As of March, nearly 800 scientists have authored more than 100 scientific papers using K2 data
- The science goes beyond searching for transits



<http://www.nasa.gov/content/kepler-multimedia>

# Disintegrating Mini-planet Orbiting a White Dwarf



[http://www.nasa.gov/sites/default/files/styles/side\\_image/public/thumbnails/image/disintegrating\\_asteroid.jpg?itok=2\\_-2QaGw](http://www.nasa.gov/sites/default/files/styles/side_image/public/thumbnails/image/disintegrating_asteroid.jpg?itok=2_-2QaGw)

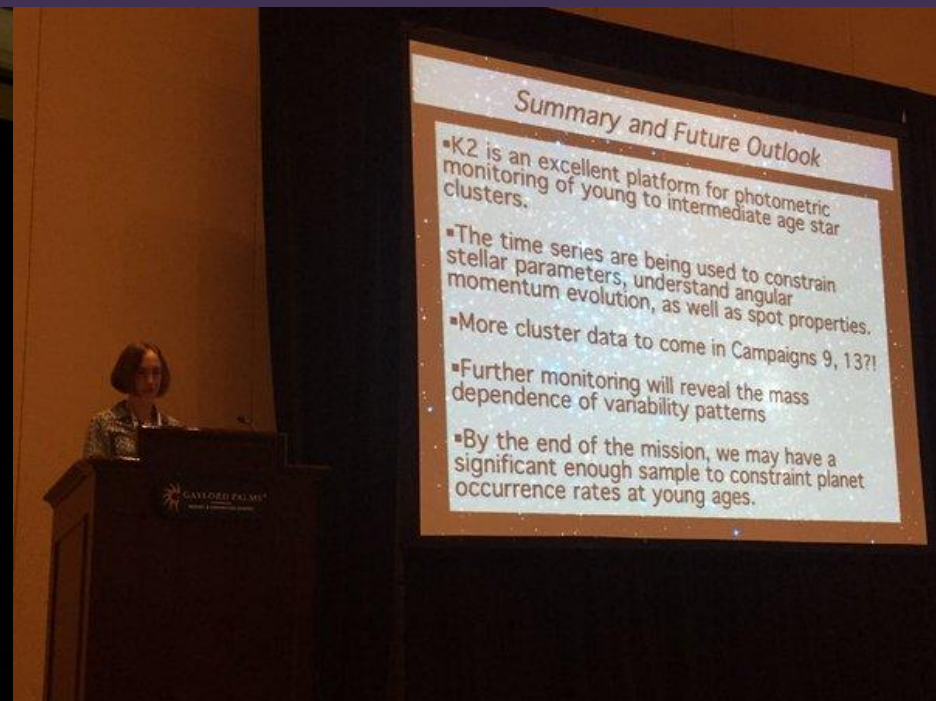
# K2 and American Astronomical Society Conferences

Steve Howell: K2 mission science is diverse. Asteroseismology is brought to new level thanks to more bright stars.

Ann Marie Cody: My favorite area of study, young star clusters. Some only a few million years old. Babies.



<http://kepler.nasa.gov/images/mws/K2keygoals.jpg>



<http://kepler.nasa.gov/images/mws/aas227annmariecody.jpg>

# Kepler Planets in the Top 20

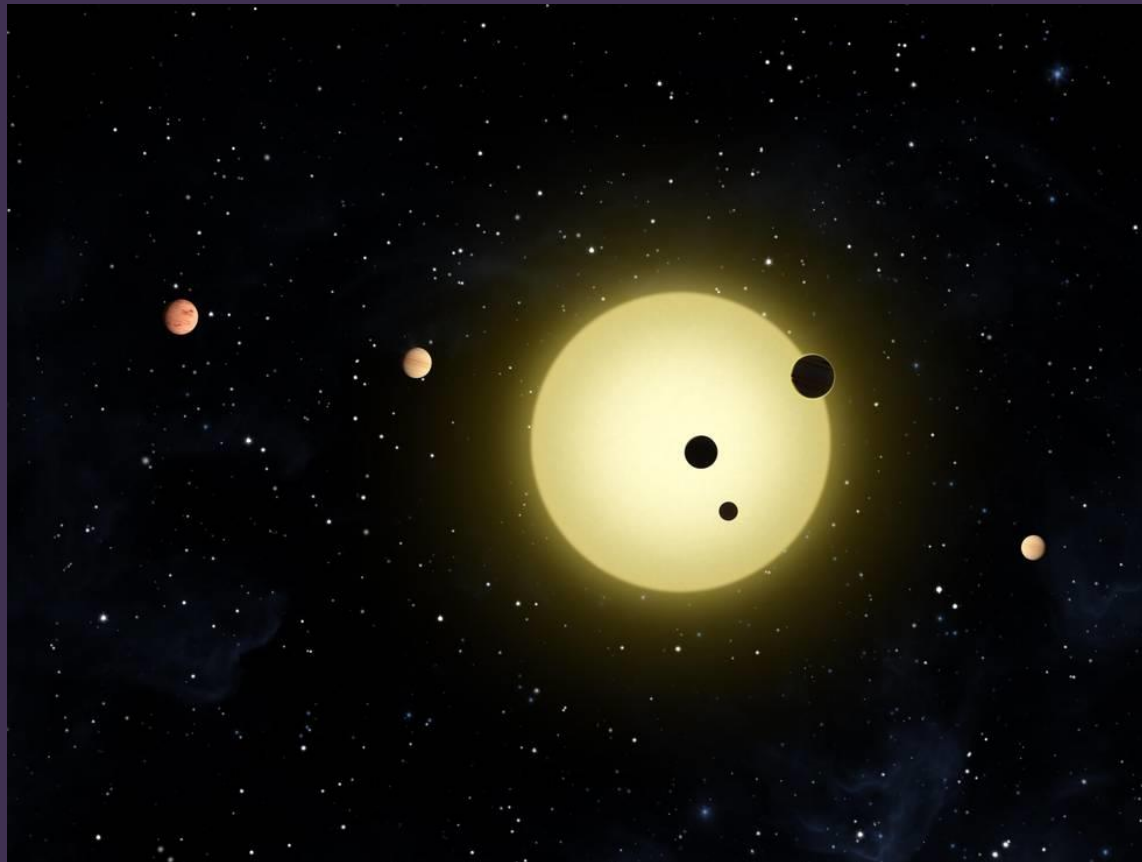
Kepler-186f: first rocky planet found within the habitable zone—also very close in size to Earth



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

Kepler-11 system: first compact solar system discovered by Kepler—at least five planets orbiting at less than the distance of Mercury from the Sun

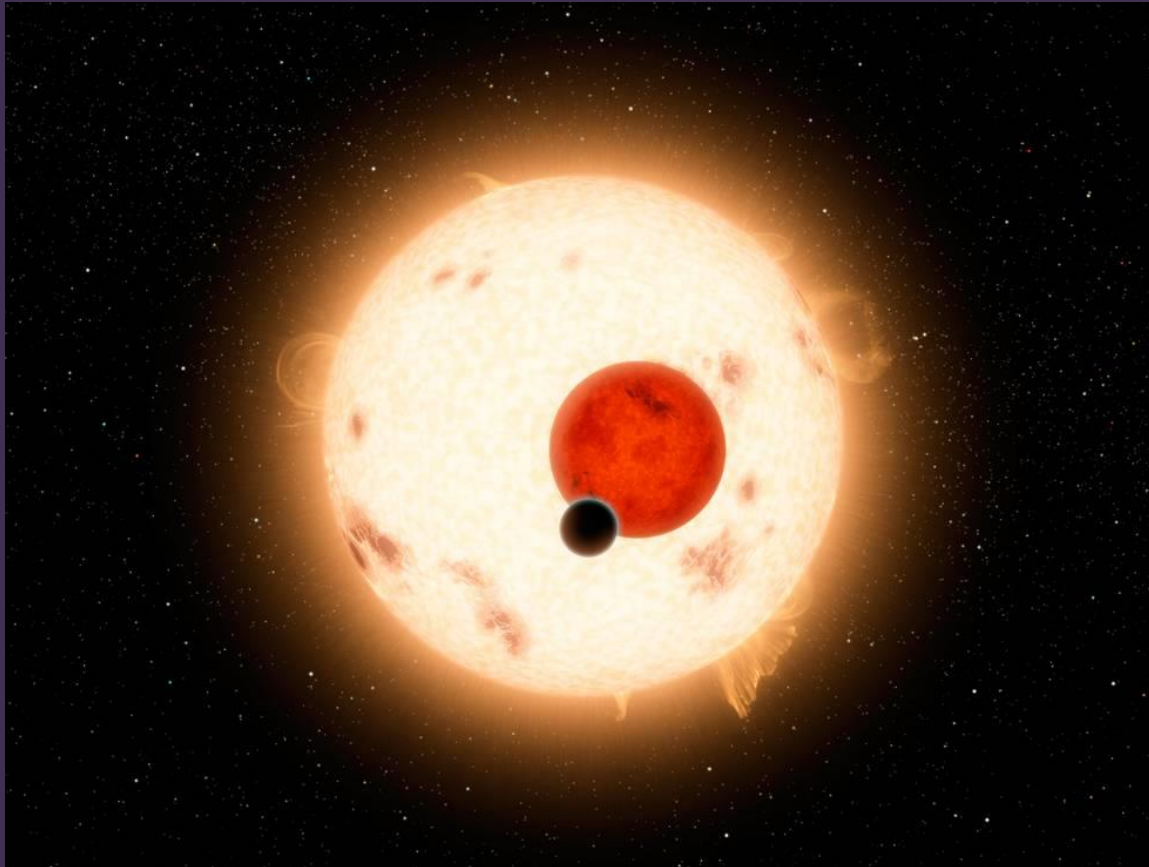


<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>



# Kepler Planets in the Top 20

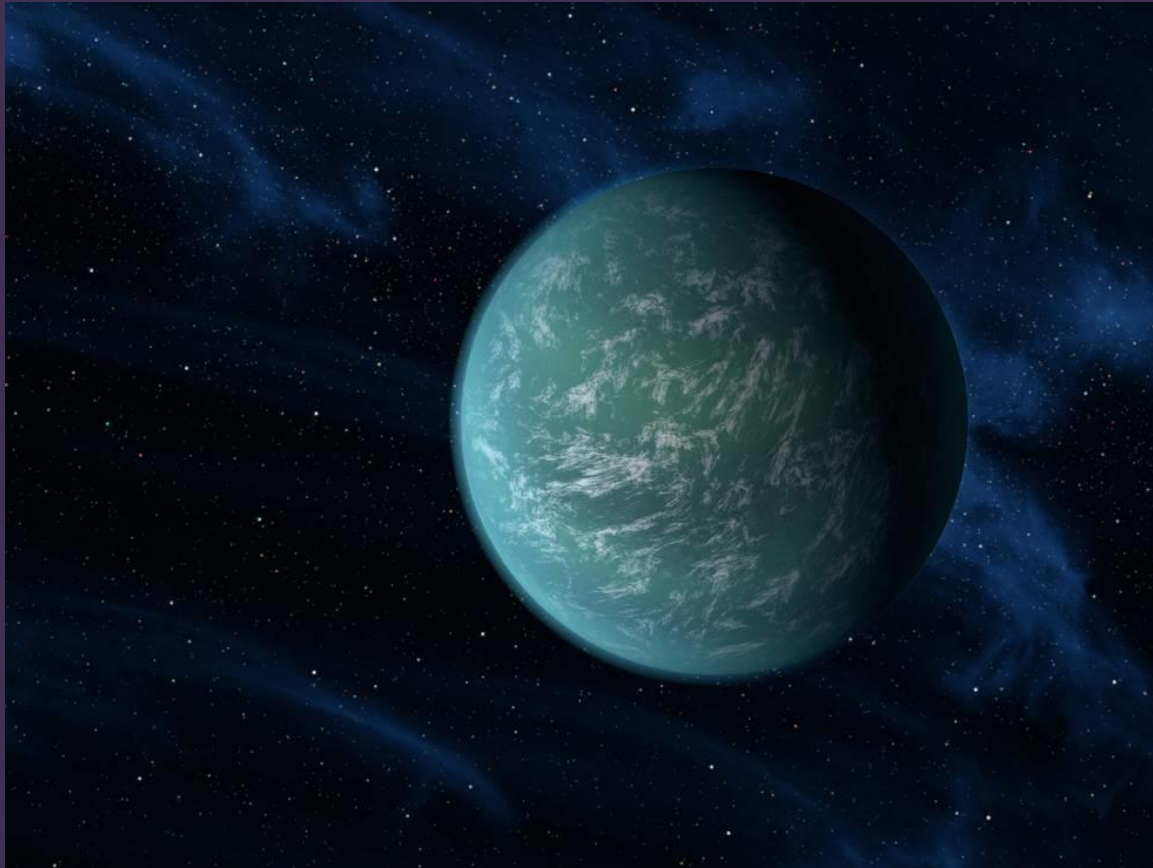
Kepler-18b: first circumbinary planet—“a real-life Tatooine”



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

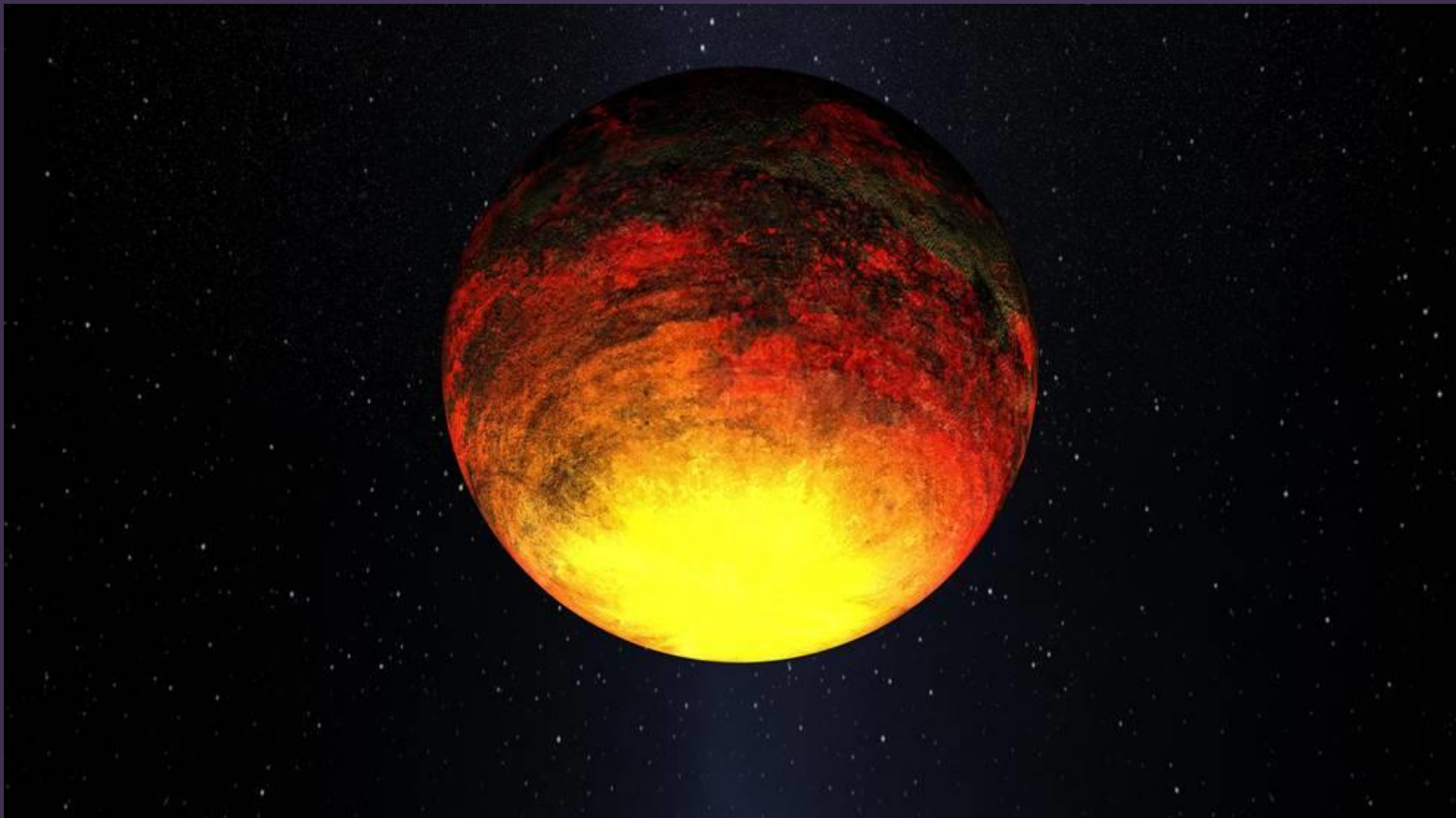
Kepler-22b: first planet confirmed to orbit in the habitable zone—it is 2.4 times the size of Earth



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

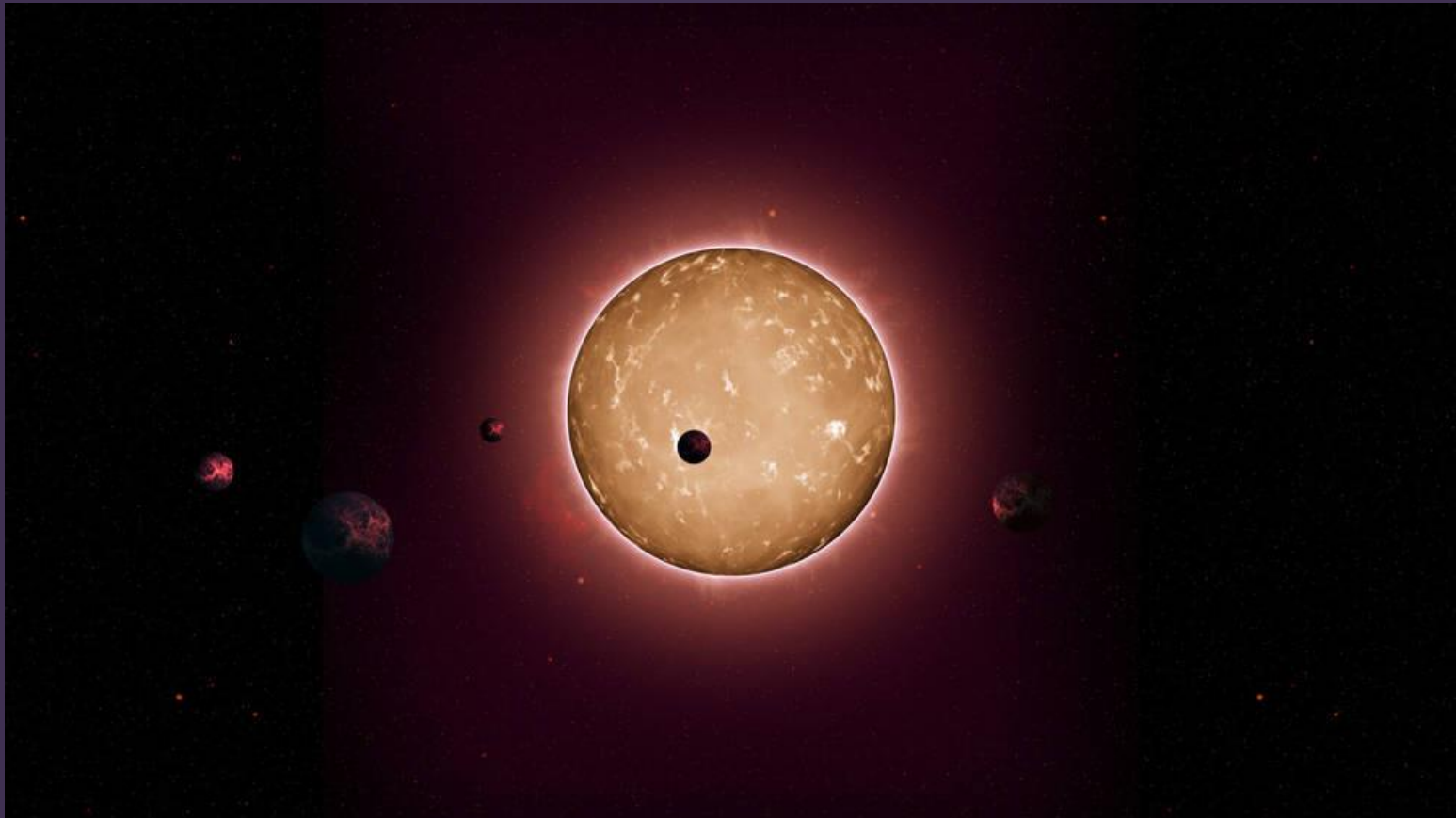
Kepler-10b: first rocky planet discovery—a scorched, Earth-sized world that may have a lava ocean on its surface



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

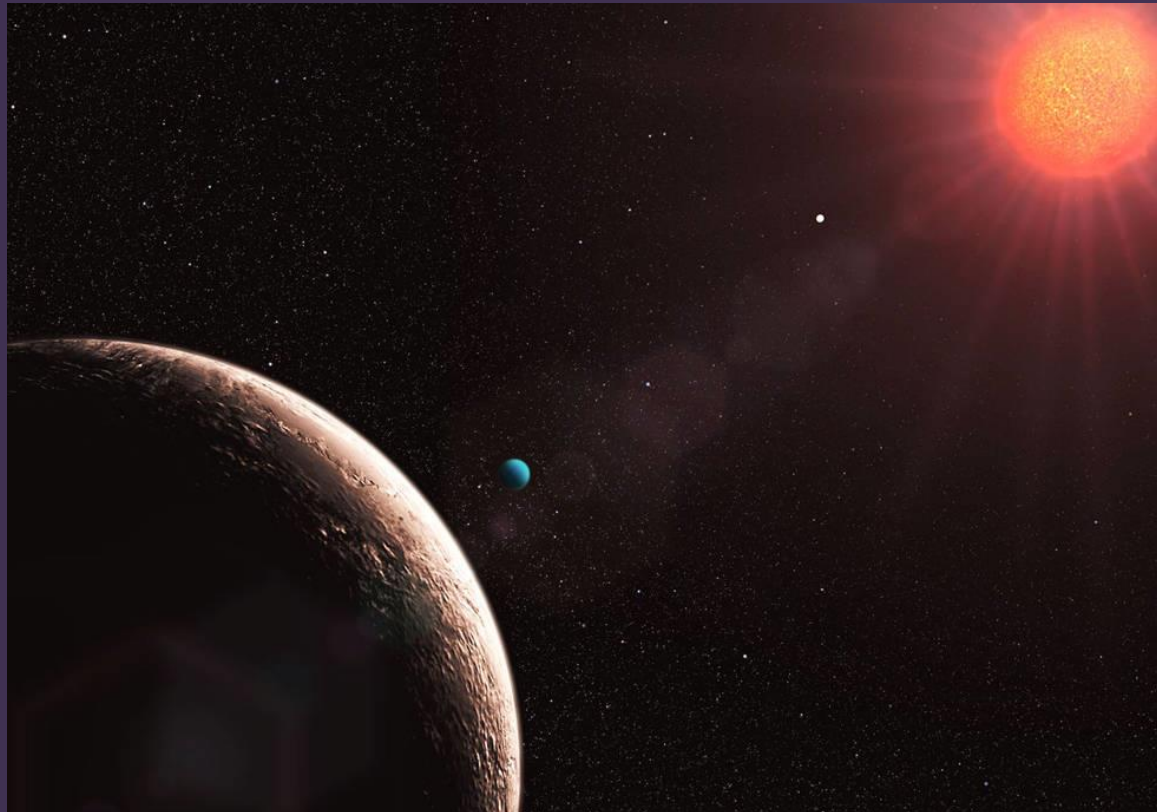
Kepler-444 system: oldest known system, with five planets in orbital resonance—shows systems could form very early in Milky Way's history



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

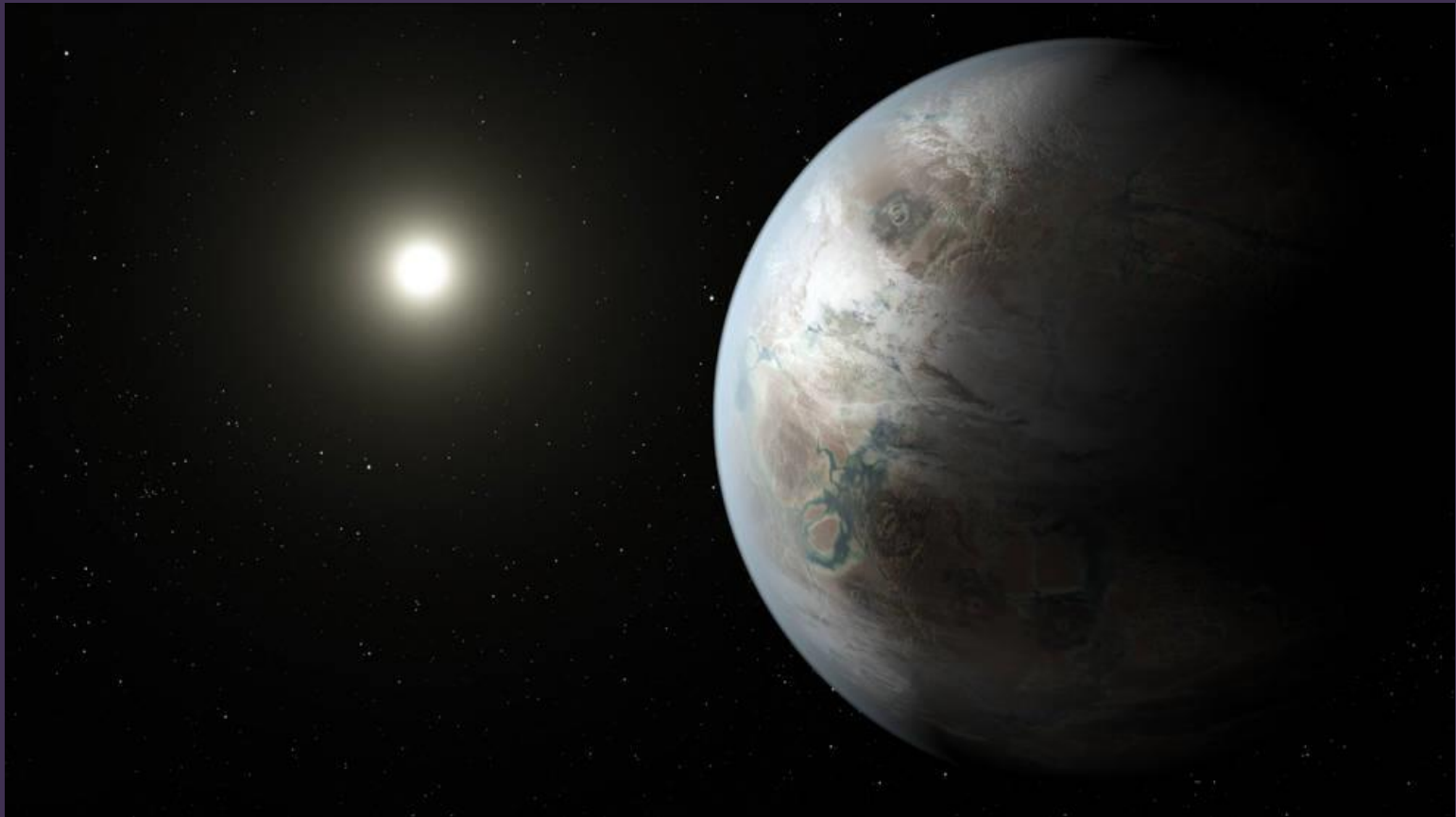
K2-3 system: three super-Earths orbiting a nearby star—their mass and radii are already determined, and atmospheric composition could soon follow



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# Kepler Planets in the Top 20

Kepler-452b: first Earth-sized planet found in the habitable zone of a Sun-like star—radius is 1.6 times Earth's, and distance from the star is 5 percent more



<http://www.nasa.gov/feature/jpl/20-intriguing-exoplanets>

# First Exoplanet Smaller Than Earth to Have Both Size and Radius Measured

