Chasing Exoplanets

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Galerija Kapelica / Kapelica Gallery
Earth without humans II / Zemlja brez ljudi II
Ljubljana, Slovenia
A Search for Earth-size Planets

All the Known Planets In 1994
ALL 786 KNOWN PLANETS

TO SCALE

NOVEL SIZED TO OUR SOLAR SYSTEM

THE REST OF THESE COME IN OTHER SYSTEMS

AND WERE ONLY DISCOVERED RECENTLY

MOST OF THEM ARE MADE OF ROCK

WE KNOW ABSOLUTELY NOTHING OF THEIR EXISTENCE

THIS IS A NEW WAVE FOR MANKIND

THIS IS AN EXCITING TIME.
ALL 786 KNOWN PLANETS TO SCALE (AS OF JUNE 2012)
(SOME PLANET SIZES ESTIMATED BASED ON MPCS)

THIS IS OUR SOLAR SYSTEM.

THE REST OF THESE ORBIT OTHER STARS AND WERE ONLY DISCOVERED RECENTLY.
MOST OF THEM ARE HUGE BECAUSE THOSE ARE THE KIND WE LEARNED TO DETECT FIRST, BUT NOW WE ARE FINDING THAT SMALL ONES ARE ACTUALLY MORE COMMON.
WE KNOW NOTHING ABOUT WHAT’S ON ANY OF THEM.
What fraction of sun-like stars in our galaxy host potentially habitable Earth-size planets?
Exoplanet Discoveries Over Time

Radii estimated for non-transiting exoplanets
Discovery data dithered randomly within discovery year
A Search for Earth-size Planets

Exoplanet Discoveries
Enabling Kepler

- Back illuminated CCDs (20 ppm photometric precision)
- Sophisticated algorithms
- Computational infrastructure
How Hard is it to Find Good Planets?

Jupiter (~1%)

Earth (~0.01%)

Kepler Candidate KOI-351

Kepler Planet — Kepler-20e
First Light Image

Launched March 7 2009
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First Light Image

Launched March 7 2009
Key Science Results

Kepler’s Greatest Hits

- Kepler-10b,c
- Kepler-11b,c,d,e,f,g
- Kepler-16b
- Kepler-47c
- Kepler-22b
- Kepler-62e,f
- KIC-12557548
And Many Others!
Kepler’s First Science Result

HAT-P-7B

Another Star

Kepler Commissioning data (10 days)
W. Borucki et al., 2009
Kepler’s First Science Result

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Stars are large resonant cavities that ring like bells

We’ve measured acoustic modes for >15,000 solar-like stars

Asteroseismology gives unprecedented precision in size, mass of stars

Chaplin et al 2011, Science
A Disintegrating Planet: KIC-12557548
Multiple Transiting Planets
Searching for Habitable Worlds

KEPLER-20e
DECEMBER 2011

KEPLER-22b
DECEMBER 2011

KEPLER-452b
JULY 2015

KEPLER-186f
APRIL 2014

ARTISTIC CONCEPT
A Search for Earth-size Planets

Kepler-452 System

Kepler-186 System

Kepler-452b

Kepler-186f

Mercury

Venus

Earth

Mars

Solar System

ARTISTIC CONCEPT
Kepler's Small Habitable Zone Planets

As of May 10, 2016
A Search for Earth-size Planets

RR Lyr

Kepler

Normalized Flux

Time, Days
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Heartbeat Stars: KOI-54
Heartbeat Stars: Carl

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