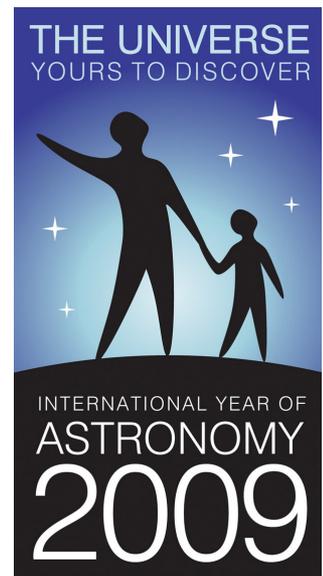




The *Kepler Mission* and the Year of Astronomy

Pamela Harman, SETI Institute

Edna DeVore, Co-I; Alan Gould, Co-I; David Koch, Dept PI.





Kepler Mission and IYA

- Kepler in Historical Perspective
- Kepler's Laws and IYA
- *Kepler Mission and IYA*



Historical Perspective

Early Astronomers

- Unpredictable events
- Chinese records dated 1300 BC
- Babylonians predictable events 700 BC

Greeks

- 600 BC, predictable events
- Greek words meaning "law and order"
"kosmos nomos" ~ astronomy

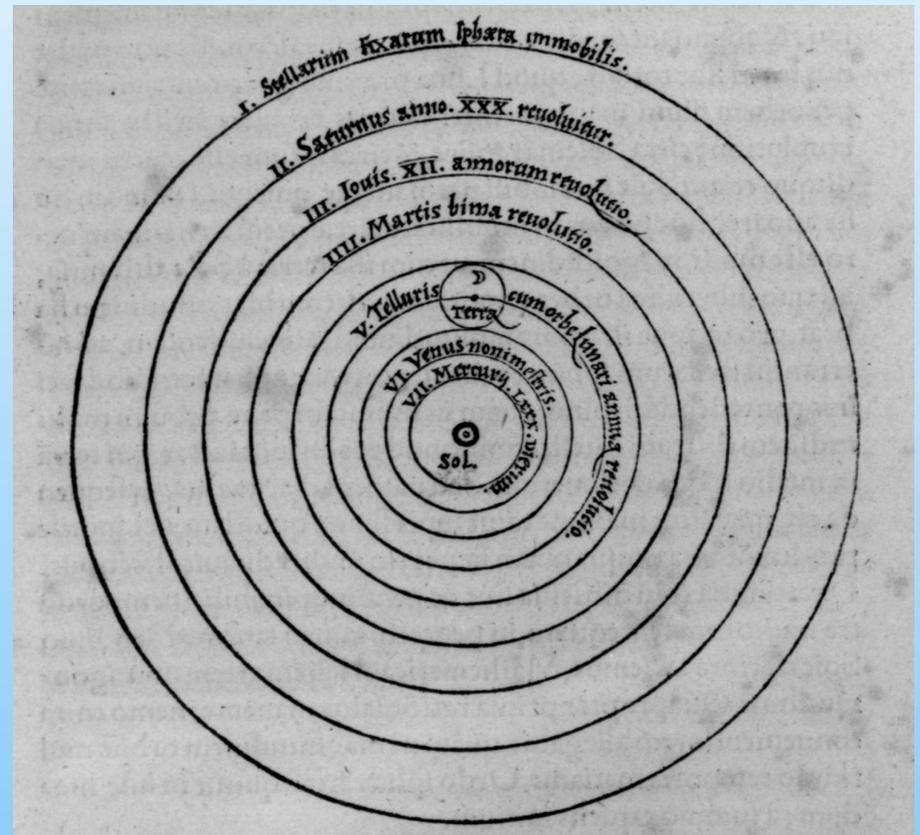
Ptolemy

- 150 AD concentric system



Historical Perspective

- Modern Astronomy
 - Copernicus, 1543





Brahe and Kepler

Kepler

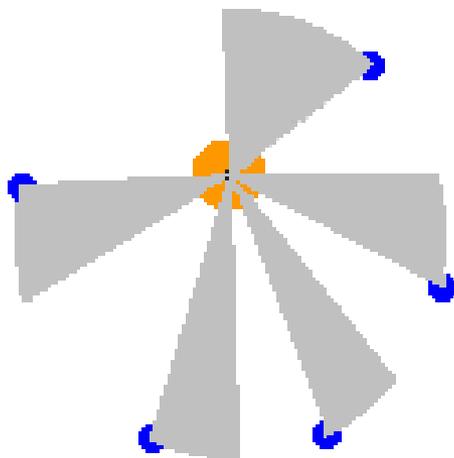




Kepler's Laws 1609

Astronomia Nova

1. Planets move in orbits that are ellipses
2. The line joining a planet with the Sun sweeps equal areas in equal times.



The areas of all
triangles are the
same size
-Kepler's law of
Equal Areas -



Kepler's 3rd Law 1619 *Harmonices Mundi*

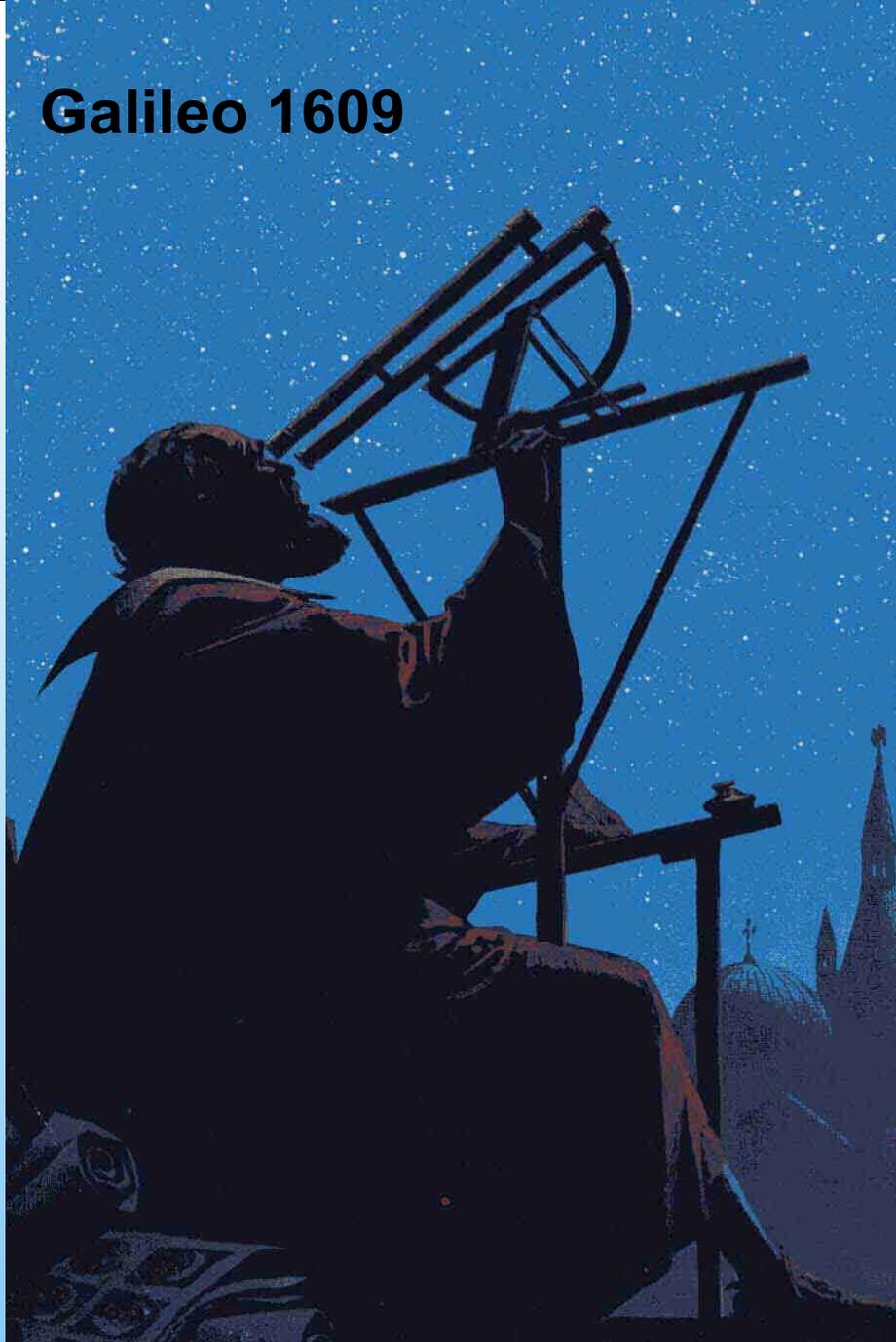
- 3. The square of the period of the orbit of a planet is proportional to the cube of its mean distance from the Sun.**

$$P^2 \sim a^3$$



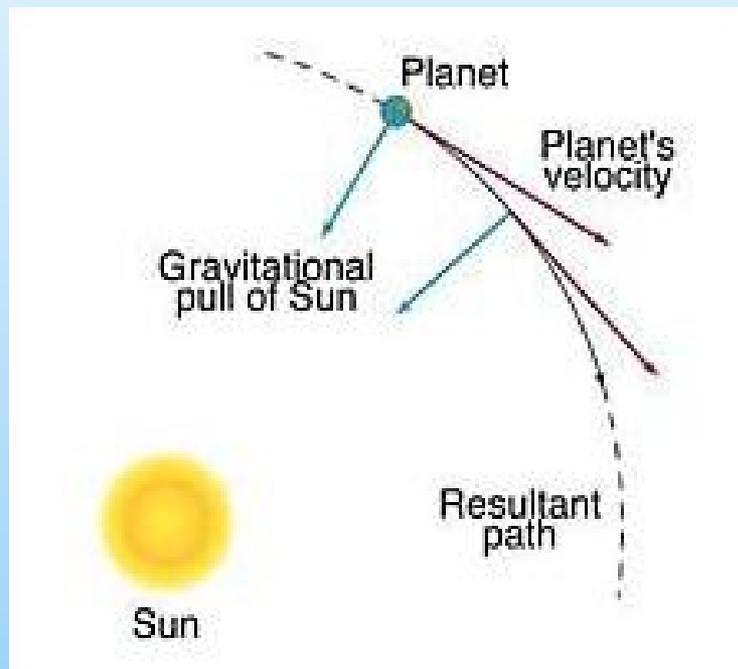
Galileo 1609

Kepler





Newton's law of gravity and planetary motion



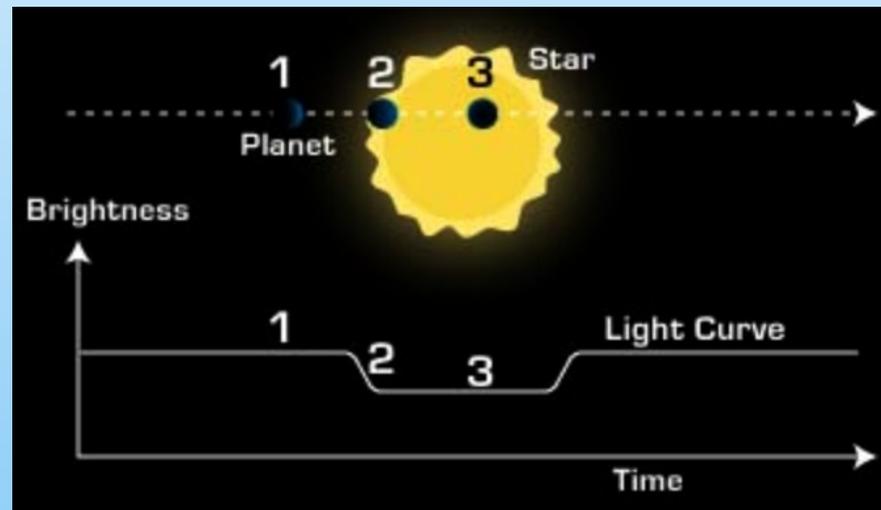
Luca Bombelli



Kepler Mission

Transit Method of Detection

launched March 6, 2009





Kepler Mission

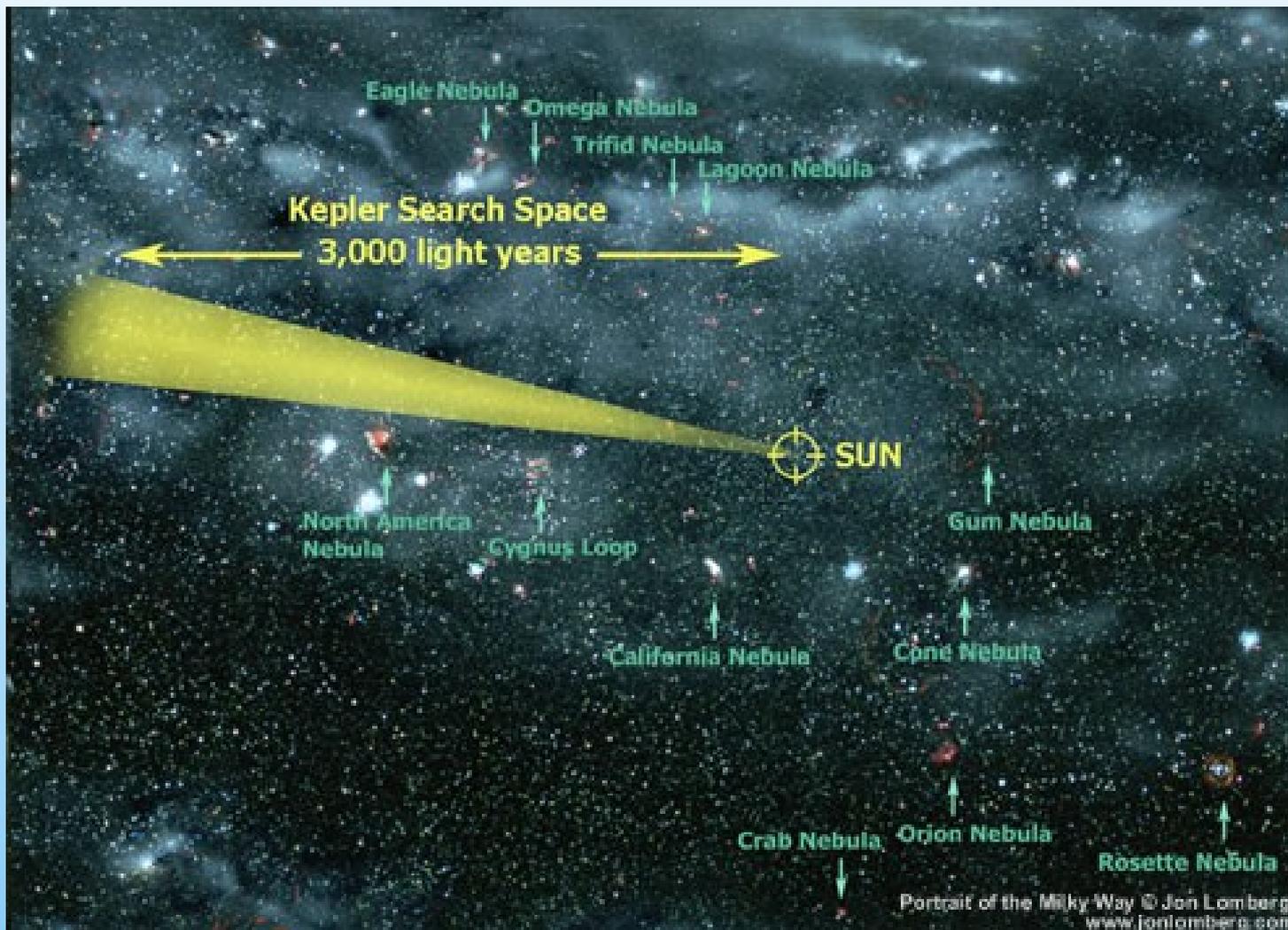
- Find the frequency of terrestrial planets in the Galaxy
- Characterize the properties of inner planetary systems.
- Determine the properties of stars (single & multiple) hosting planets.
- Discover terrestrial planets in habitable zones (or show that they are rare).
- Detect true Earth analogs
- A NULL result would also be very significant (frequency of stars with terrestrial planets is less than 5%)

Kepler is uniquely qualified to detect Earth-sized *extrasolar planets* “before this decade is out”!



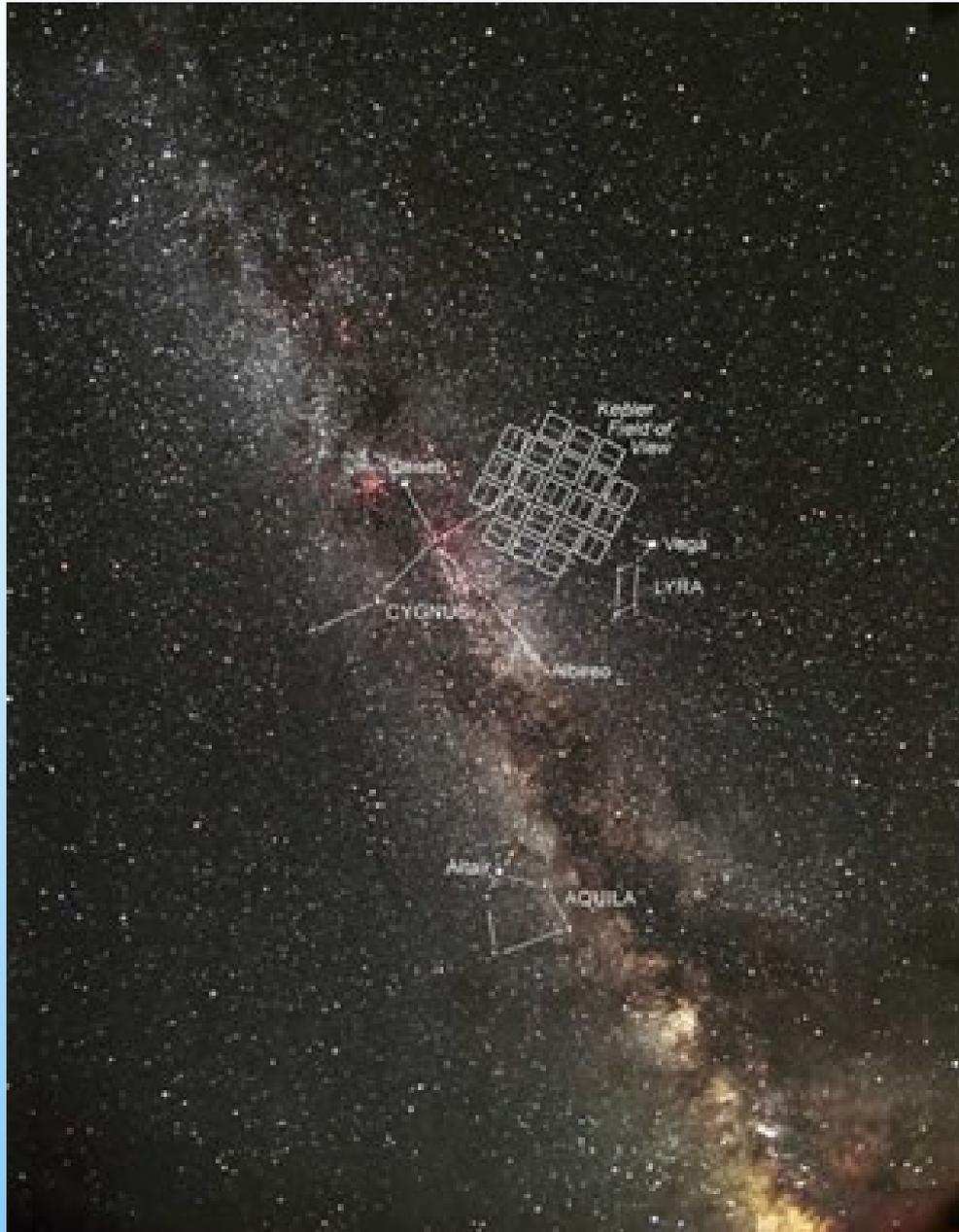


Target Region





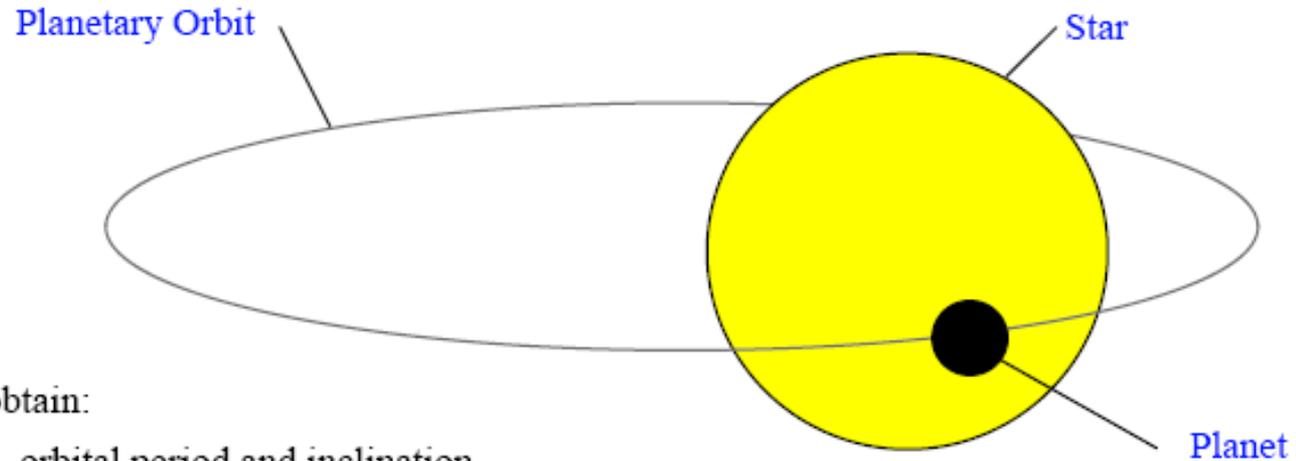
Kepler



Carter Roberts



Information from Transits



From transit data obtain:

Duration, depth, orbital period and inclination.

Derive planet sizes and orbital radii (when combine with stellar information)

From ensemble of planetary systems:

Estimates frequency of planet formation for inner planets.

Distribution of planetary sizes, orbital sizes, co-planarity, effects of Jovian planets.

With a measurement of reflected light you can also get an idea of the planet's atmosphere (reflectivity, albedo). With a measurement of the "wobble" you get the planet's mass, and combined with the size you get the density (composition).



Kepler Mission and IYA

- Launched March 6, 2009
 - Data downloads every 30 days
- Name in Space
- Star Wheel
- FOV Litho
- Lesson plans illustrate Kepler's Laws
- LEGO orrery
- Mission Poster



Kepler

Name in Space

Kepler



CERTIFICATE OF PARTICIPATION

This is to certify that the name

Johannes Kepler

has been included on the list of names launched in 2009 with the Kepler spacecraft into orbit around the Sun. The Kepler Mission is NASA's first mission capable of finding Earth-size planets orbiting other stars in our galaxy.

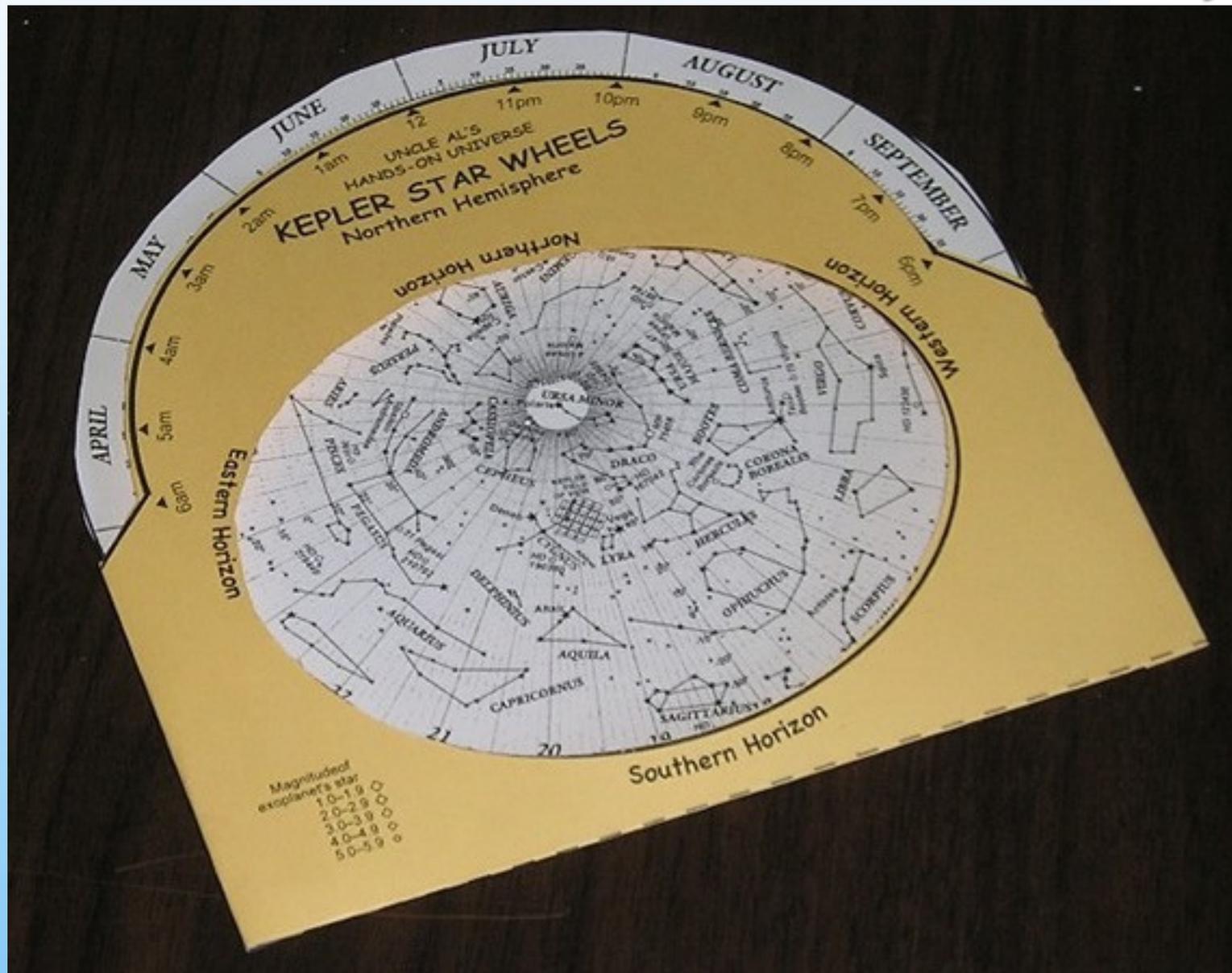


The Name in Space Activity is part of the International Year of Astronomy 2009, which is also the 400th anniversary of Kepler's publication of his first two laws of planetary motion.

No. 14940



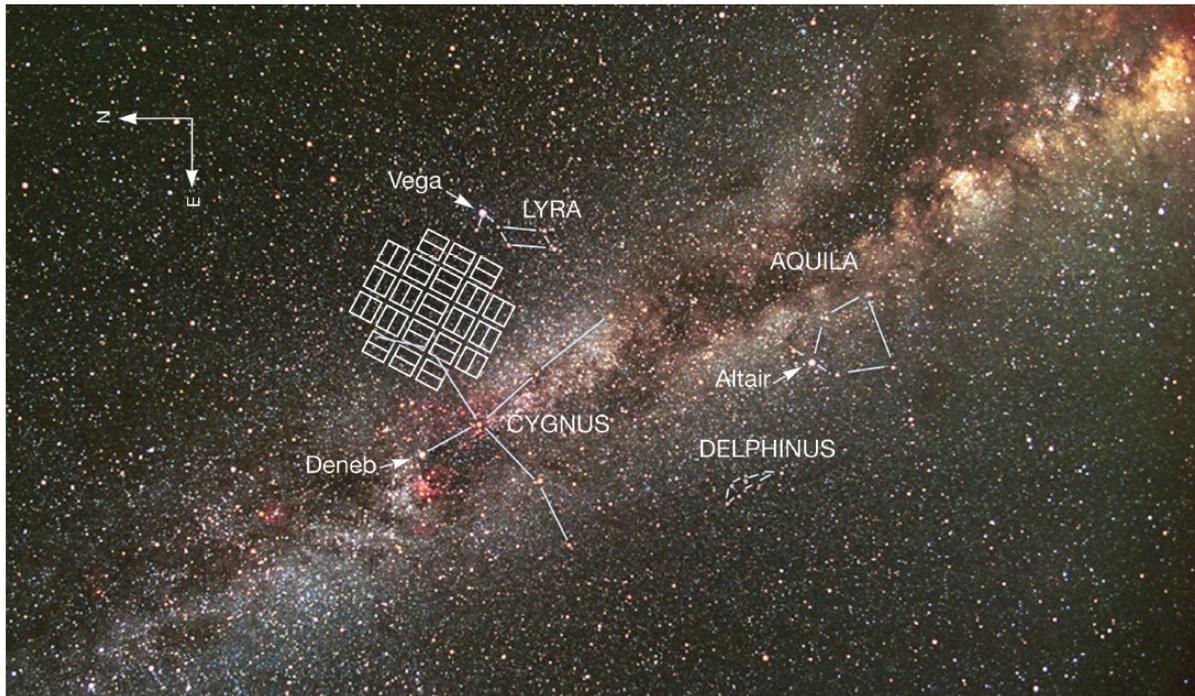
Kepler





Field of View Litho

National Aeronautics and Space Administration

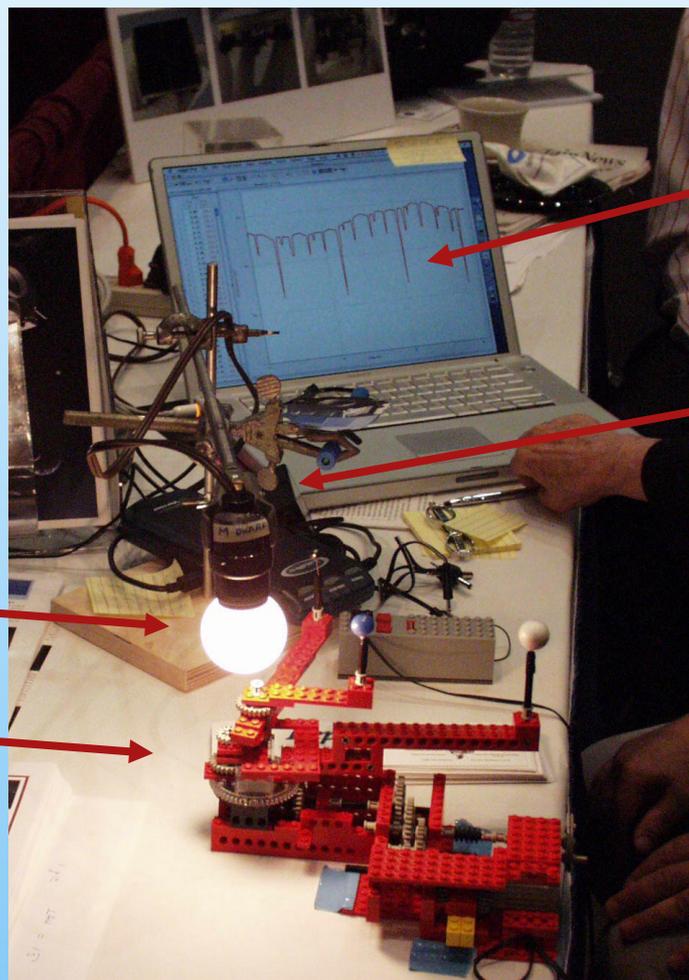


The Kepler Mission Star Field

www.nasa.gov



LEGO Transit Model



Data display--laptop

Detector--
inside a Kepler
spacecraft model
in latest edition

Star

Orrery--planets



Kepler Website

<http://kepler.nasa.gov>



Kepler Mission: *A search for habitable planets.*

- Kepler Home
- Overview
- News & Schedule
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- Johannes Kepler >
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- In the News >
- Search This Site

[Mission Manager's Updates](#) -|- [NASA Portal for Kepler](#) Quick Links

SUCCESSFUL LAUNCH: 2009 March 6 at 10:49 pm EST.

Ejection of the Dust Cover: 2009 April 8

FIRST LIGHT!!



NASA
National Aeronautics
and Space Administration

*Kepler
First Light Image*
April 08, 2009

The image shows a grid of 12 small, square, light-brown panels, each containing a different field of view from the Kepler telescope. The panels are arranged in a 3x4 grid. The top-left panel is the largest and shows a field of stars. The other panels are smaller and show different fields of view.

NASA Kepler twitter

Current count of exoplanets:
[PlanetQuest](#) or [Extrasolar Planets Encyclopedia](#)



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Kepler Home > Educators Quick Links

For Educators

[Kepler in a Nutshell](#)—what the *Kepler* mission is about, in simple terms.

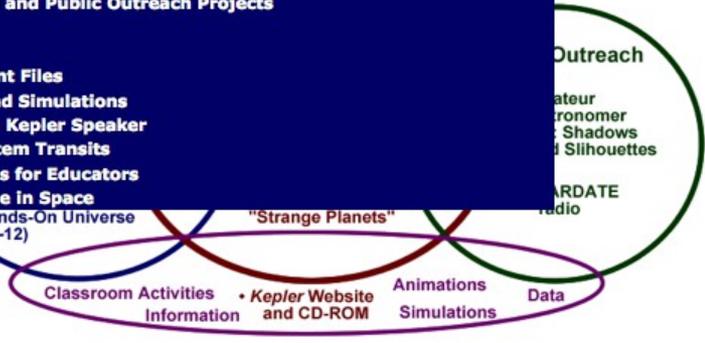
The diagram below shows the main *Kepler* mission Education and Public Outreach (EPO) projects.

It is an interactive diagram:



Download
 Kepler Star Wheel - a planisphere that you can use to find the location of the Kepler target field of view as well as naked eye stars known to have exoplanets visible from the northern hemisphere.

- EDUCATION/OUTREACH**
- Kepler in Brief
- Education and Public Outreach Projects
- Activities
- Handouts
- Powerpoint Files
- Models and Simulations
- Request a Kepler Speaker
- Solar System Transits
- Web Links for Educators
- Your Name in Space
 - Hands-On Universe (9-12)



Check for [Teacher Workshops](#) in your area or online.



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Kepler Home > Educators > Activities Quick Links

Classroom Activities on Planet Finding

[K-3](#) | [4-adult](#) | [6-adult](#) | [9-adult](#) | [college](#)

The activities on this page support International Year of Astronomy (2009). They are also instrumental in teaching the following National Science Education Standards (USA):

- The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. [5-8]
- Most objects in the solar systems are in regular and predictable motion. those motions explain such phenomena as the day, the year, phases of the moon, and eclipses. [5-8]
- Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system.... [5-8]

All the activities below are © by the Regents of the University of California and may be duplicated for non-profit education purposes. Some (as noted) were created in development of the Great Explorations in Math and Science (GEMS) Space Science Sequences and the Full Option Science System (FOSS) Planetary Science course.

Grades K-3

[K-3](#) | [4-adult](#) | [6-adult](#) | [9-adult](#) | [college](#)

[Kepler Coloring Sheet](#) - Grades K-3 (84 kb PDF).



Kepler EPO Projects



Formal

- New GEMS strand:
Space Science
"Finding New Worlds"
- FOSS Teacher workshops
- Space Place activities
- Hands On Universe
*Planet-finding for
high school*

Informal

- Multi-media planetarium
program (large dome)
- Interactive planetarium
program (small dome)
- Kepler CD-ROM
- Exhibit
Orrery Transit Model

Public Outreach

- Amateur
Astronomers
*-kit
-ephemerides
-TransitSearch*
- Broadcast
television
program
- STARDATE
radio
programs

Lessons, simulations — **Website** — Information, data



EPO Plan for all ages



- Space Place: website for young children
- Full Option Science (FOSS): grades K-2, 3-6
- Great Explorations in Math and Science (GEMS): grades 3-5 and 6-8
- Hands On Universe (HOU): high school
- Traveling Exhibit: general public
- Planetarium program: general public
- Radio, Broadcast TV: general public
- Amateur Astronomers: all ages



Kepler Mission: *A search for habitable planets.*



Questions/Comments?



Kepler
A Search for Terrestrial Planets

<http://kepler.nasa.gov>

Contact Us