# CENTRIPETAL FORCE FROM GRAVITY

Units 14 & 8

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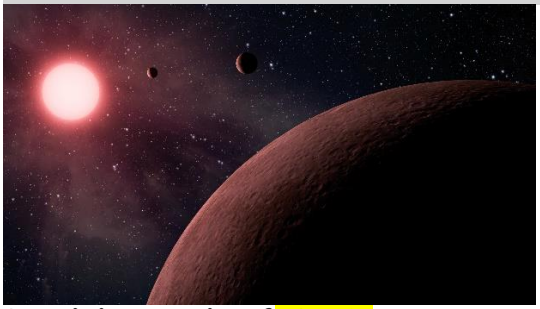
## Earth-Size Planets Among Final Tally of NASA's Kepler Telescope



An artist's conception of KOI-961, a star system detected by Kepler space telescope. It has 3 of smallest planets known to orbit a star other than our sun.

**INTRODUCTION:** Gravity provides the centripetal force to hold exoplanets in orbit of their stars. $G\,m\,M/r^2 = m\,v^2/r$ where $v = r\,\omega = r\,2\pi/T$

Thus: $G\,m\,M/r^2 = m\,4\,\pi^2\,r^2/T^2$

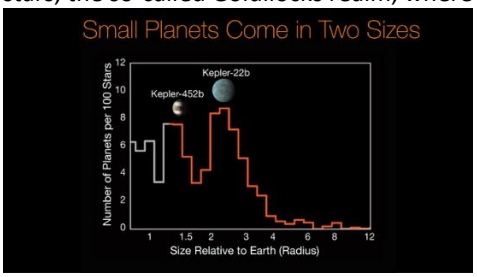
$$M = (4\,\pi^2/G)\,[\,r^3/T^2\,]$$ Kepler's 3rd Law

From NASA for KOI-961: r = 0.006 AU , T = 0.4533 days

AU = astronomical unit = distance from earth to sun = $150 \times 10^9$ m

**QUESTIONS:** (a) Find exoplanet KOI-961's radius of orbit r about it's star in meters?, (b) Find period of KOI-961's in seconds?, (c) Find mass M of exoplanet KOI-961's star it rotates about?

MOUNTAIN VIEW, Calif. — Are we still alone? Setting the stage for the next chapter in the quest to end cosmic **other stars.** The new list is the final and most reliable result of a four-year cosmic census of a tiny region of the Milky Way by NASA's Kepler spacecraft. "The search for planets is the search for life," said Natalie Batalha, a Kepler mission scientist from NASA's Ames Research Center. Among other things, Dr. Batalha said, for the first time**((( there is at least one planet, known as KOI 7711 (for Kepler Object of Interest), that almost matches the Earth, at only 30 percent wider and with an orbit of almost exactly one year.)))** In all, there are 219 new planet candidates in the catalog. Ten of them, moreover, are in the habitable zones of their stars, the so-called Goldilocks realm, where the heat from their stars is neither too cold nor too hot for liquid water.




**QUESTIONS(continued):** (d) NASA States mass of exoplanet KOI-961's Is 0.13 mass of our sun. Find NASA's statement of exoplanet KOI-961's mass in units of kilograms?, (e) How well does your computation of exoplanet KOI=961's mass compare with NASA's stated mass? **HINTS:** sun mass = $2 \times 10^{30}$ kg. G = gravitational const. = $6.67 \times 10^{-11}$ N kg$^2$/m , 3600 s./hr., 24 hr/day

**ANSWERS:** (a) $0.9 \times 10^9$ m., (b) T = $3.917 \times 10^4$ s.,(c) $0.28 \times 10^{30}$ kg. (d) $0.26 \times 10^{30}$ kg. (e) NASA and your computational Mass are quite close. Thanks Kepler(upper Austria)

Researchers have discovered a gap in the distribution of planet sizes, indicating that most planets discovered by Kepler so far fall into two distinct size classes: the rocky Earths and super-Earths (similar to Kepler-452b), and the mini-Neptunes (similar to Kepler-22b). Over the years, Kepler has discovered that **nature likes to make small planets, but it makes them in two ways: rocky, like Earth, and gaseous, like Neptune. (((**In 1984, William Borucki, a NASA physicist and expert on photometry, or measuring light intensity, and a colleague, the late David Koch, had a pretty simple idea: **If a distant star blinked or dimmed periodically, it might mean there was a planet going around it.** All you had to do was watch, very precisely and steadily. At the time, nobody knew if any other stars besides the sun harbored planets. NASA turned down Mr. Borucki and Dr. Koch five times before the experiment was finally approved in 2001. **Kepler was launched into an orbit around the sun on March 6, 2009**, with a simple mission: to stare at some 160,000 stars in a patch of sky in the constellation Cygnus. **If any of those stars dimmed periodically, the size of the dip in light could tell you how big the planet passing in front of it was.** The length of time between blinks would tell you how many days long its year was. At the time Kepler was launched, more than 300 exoplanets, planets outside our solar system, had been found, mostly by examining stars one by one to see if they showed signs of being perturbed — "wobbled" — by the gravitational pull of a planet or planets. In its first few months of observations, Kepler almost immediately doubled the number of known or suspected exoplanets. The tally kept climbing, to 1,200 **by February 2011 and to more than 4,700 a year ago.** About four years ago, Erik Petigura, now at Caltech, extrapolated boldly from the Kepler data and estimated that about a fifth of the sunlike stars in the galaxy had habitable planets. About one in four of the smaller stars, known as red dwarfs, also harbor rocky habitable-zone planets, said Courtney Dressing, an astronomer at Caltech. The data suggested that there **could be billions of Earth-size planets in the Milky Way** basking in lukewarm conditions suitable for liquid water, and so perhaps life as we think we know it. In the meantime the baton is being passed to a new satellite, **TESS, for Transiting Exoplanet Survey Satellite,** led by George Ricker of M.I.T., to be launched next year. It will use the same technique as Kepler to look at broad areas of the sky, searching for planets around the brightest and nearest stars. The **James Webb Space Telescope, which can be used to investigate the atmospheres of some of these planets,** will also be launched next year.