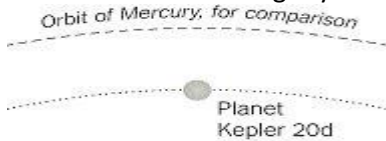


CENTRIPETAL FORCE & GRAVITATION Units 14 & 8

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& NYTimes Dec 20,2011 by Dennis Overbye. Please e-mail Dr Cise on how you used this application. Thanks!

Two Earth-Size Planets Are Discovered

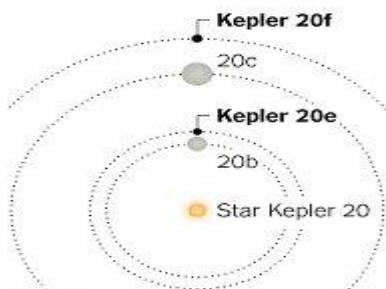
In what amounts to a kind of holiday gift to the cosmos, astronomers from [NASA's Kepler spacecraft](#) announced Tuesday that they had discovered a pair of planets the size of [Earth](#) orbiting a distant star. The new planets, one about as big as Earth and the other slightly smaller than Venus, are the smallest yet found beyond the solar system.



Two Small Planets

Astronomers have discovered a pair of Earth-size planets orbiting the star Kepler 20. The planets, named Kepler 20e and 20f, join three other larger planets in close orbit around the distant star.

Note: Planet sizes are enlarged.



Sources: Nature; NASA THE NEW YORK TIMES

INTRODUCTION: Gravity provides the centripetal force(force toward center of circle) which keeps the planets in orbit about their home star. Newton's fourth law of gravity($F = GmM/R^2$) tells us where the centripetal force comes from. In the case of these stars. Any centripetal force must = mV^2/R . Thus, $GmM/R^2 = mV^2/R$ where $V = 2\pi f$, $f = 1/T$. This produces Kepler's third law: $GM/4\pi^2 = R^3/T^2$ where M = mass of home star, G = gravitational constant, R = distance planet is from home star, T = period of plane about the home star.

QUESTION: Knowing R_{20e} and R_{20f} as shown below find T_{20e} / T_{20f} ?

ANSWER: $T_{20e}/T_{20f} = 0.354$

Astronomers said the discovery showed that Kepler could indeed find planets as small as our own and was an encouraging sign that planet hunters would someday succeed in the goal of finding Earth-like abodes in the heavens. Since the first Jupiter-size exoplanets, as they are known, were discovered nearly 15 years ago, astronomers have been chipping away at the sky, finding smaller and smaller planets.

Kepler 20e, the closer and hotter planet, is also the smaller — about 6,900 miles across, or slightly smaller than Venus — and it resides about **5 million miles from its star = R_{20e}** . The more distant planet, **Kepler 20f**, also broiling at around 800 degrees, **is 10 million miles out from its star = R_{20f}** . It is 8,200 miles in diameter, about the size of Earth. The two planets are presumed to be rocky orbs that formed in the outskirts of their planetary system and then migrated inward.

Their star, which is slightly smaller and cooler than the Sun, is about 950 light years away from us. Kepler had previously found three larger Neptune-like planets around it, so the new observations bring the total to five so far. Kepler detects planets by watching for blinks when they move in front of their stars. **Since it was launched in 2009, it has found 2,326 potential planets, 207 that would be Earth-size, if confirmed** as the two reported Tuesday have been. **Confirmation of a planet, however, requires additional observations, usually of its star's wobbles as it gets tugged by the planet going around.** The gravitational pull of planets as small as the Earth on their parent star is too small to measure with the current spectrographs. And so the astronomers resorted to a statistical method called Blender, developed by Dr. Fressin and Guillermo Torres of the Harvard-Smithsonian Center, in which millions of computer simulations of background stars try to mimic the Kepler signal. They concluded that Kepler 20e was 3,400 times more likely to be a planet than background noise, while the odds in favor Kepler 20f being real were 1,370 to 1.