

The Space Elevator

Based on “safe rotation rates” around the earth:
The speed at which you must travel to avoid either crashing to earth or escaping from it.

where r is the radius of the orbit and m (which cancels) the mass of the orbiting object.

(1) Solve for v .

$$v =$$

1

2

Calculate v for

(2) $r \approx R_{\text{Earth}} \approx 6.4 \times 10^6 \text{ m}$.

$$v =$$

If other orbital radii are expressed as a multiple of the earth radius, kR_{Earth} , the safe orbital speed would be

$$\begin{aligned} v &= \frac{2 \times 10^7}{\sqrt{kR_{\text{Earth}}}} = \frac{2 \times 10^7}{\sqrt{R_{\text{Earth}}}} \cdot \frac{1}{\sqrt{k}} \\ &= \frac{18,000}{\sqrt{k}} \text{ m/s.} \end{aligned}$$

3

4

(3) What is the safe orbital speed at an orbital radius of a trillion earth radii?

(4) What is the circumference of the earth?

(5) How many seconds in a day?

(6) What is the rotational speed of the earth at the equator?

5

6

ADDITIONAL NOTES

Other Solar Systems

An artists conception, based on real observations:



1

Speculation about other solar systems goes back to ancient Greek times.

More “recently” (1584) Giordano Bruno speculated that there were “countless suns and countless earths all rotating around their suns.”

He was accused of heresy.

Serious work on the rest of the Universe began with Edwin Hubble in the 1920s.

2

He found that small nebulae (hazy patches) in the sky were neighboring islands of stars far outside our own galaxy, each containing hundreds of billions of stars.

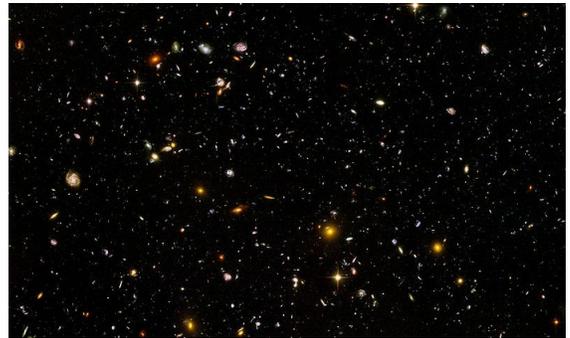
Hubble used a telescope on a mountain top.

(1) Why mountain top? _____

Today we use space telescopes (including one that bears his name).

3

Picture taken by “Hubble:”



4

It seemed highly probable there'd be planets around other stars, given that there is a large number of stars in our galaxy and a large number of galaxies. (Estimates of both are in the 100s of billions.)

But over 70 years went by after Hubble's discovery of other galaxies without convincing proof of _____. Several times discoveries of extrasolar planets were announced, only to prove false.

5

1994, Alexander Wolszczan:

First widely accepted extrasolar planets.

Two or three planet-sized objects orbiting a pulsar, rather than a normal star. (A pulsar is a remnant of a stellar “supernova explosion.”)

6

ADDITIONAL NOTES

1995, Michel Mayor and Didier Queloz:

First discovery of a planet orbiting a star similar to the sun (star 51 Pegasi). About half the mass of Jupiter, with a period of 4.2 Earth days(!).

New class of planets called Hot Jupiters: hot, massive planets orbiting closer to their stars than Mercury.

7



8

Three months later, Geoffrey W. Marcy and Paul Butler and team confirmed the previous discovery, and found two more planets.

By the end of the 20th century, several dozen “worlds” discovered, many after months or years of observation.

The count now is in the thousands.

9

(2) Why the recent flood of discoveries?

- _____
- _____
- _____
- _____

10

Missions

2006: French CoRoT mission. First dedicated “exoplanet” space mission; searches for planets that pass in front of their host stars.

Has contributed dozens of confirmed exoplanets.

11

2009: NASA's first exoplanet mission, Kepler.

Kepler has found that small planets are likely to be the most common in the galaxy, and that our sun is an unusually calm star. Kepler has found exotic, multi-planet solar systems and hot Jupiters of very low density.

12

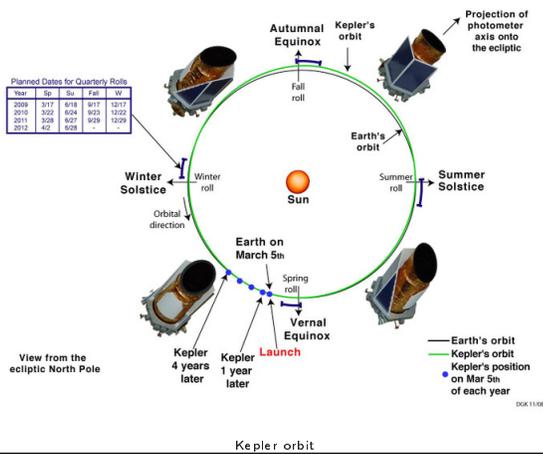
ADDITIONAL NOTES



13



14



15



16

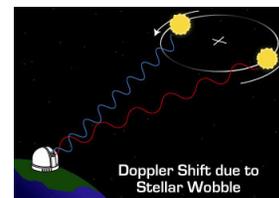
(3) Finding exoplanets is not easy. Why?

- _____
- _____
- _____

17

Methods for finding exoplanets

▷ _____ as star and planet rotate around each other.



18

ADDITIONAL NOTES
