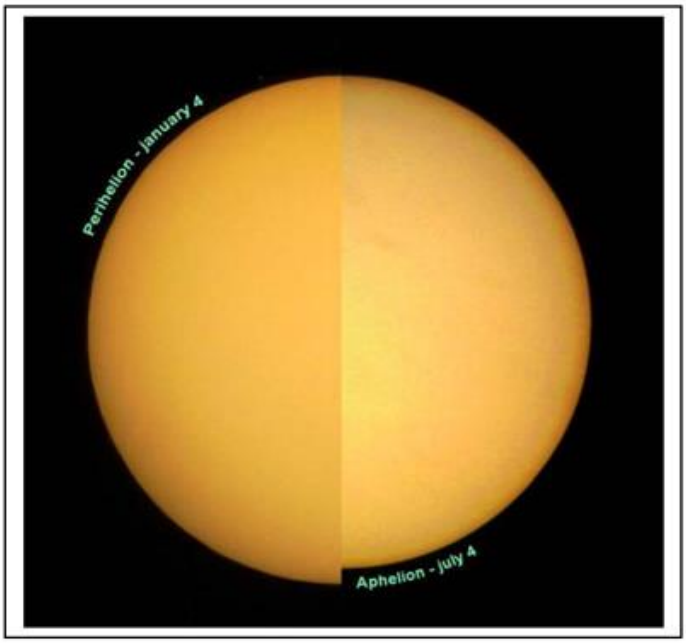
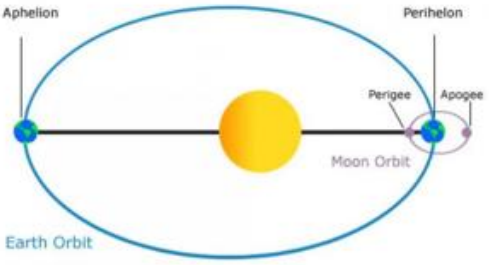
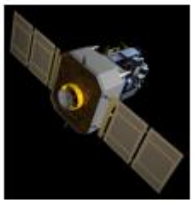
Changes in the Sun's Diameter





1. What is the average diameter of the Sun?

2. What percentage did it change compared to its average diameter?



"peri" = near

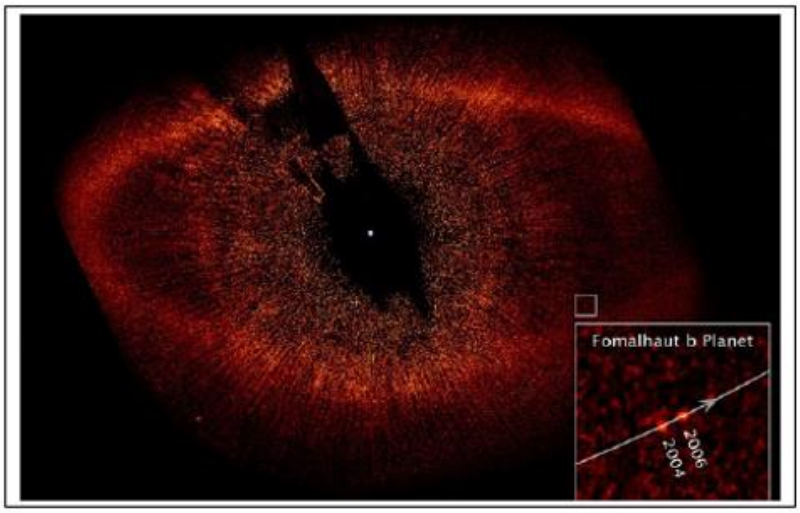
Exploding Star Calculations

Crab Nebula image taken in 2005 by the Hubble Space Telescope.

Problem 1 – What is the average speed of the expanding gas cloud in kilometers/hour?

1 light year = 62,000 AU
1 AU = 150 million kilometers
1 year = 8,760 hours

Distant Planet Detection

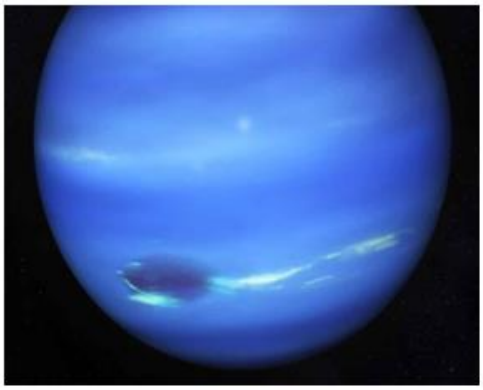


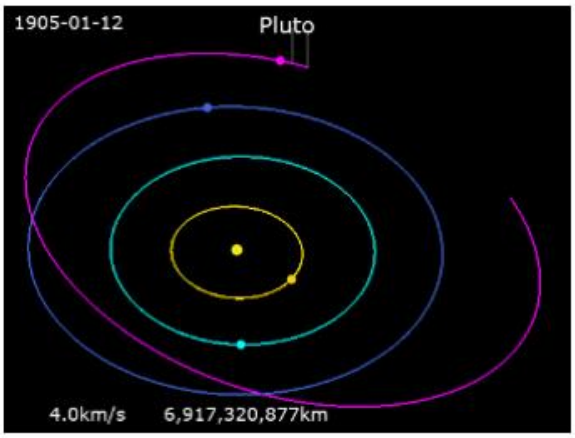
Problem 1 – How far was the planet from the star in 2006?

Problem 2 – How many years would it take the planet to make a full orbit around its star?

(Planet traveled 1.2 AU small box on lower right of image)

The scale of the image is 2.7 AU/millimeter.
1.0 AU = 150 million kilometers
1 year = 8760 hours





Is Neptune Slow or Fast?

Problem 1 – How fast does Neptune orbit the sun?

R = 30 AU = 4.3 billion km
1 orbit = 150 years

Average Planet Speeds

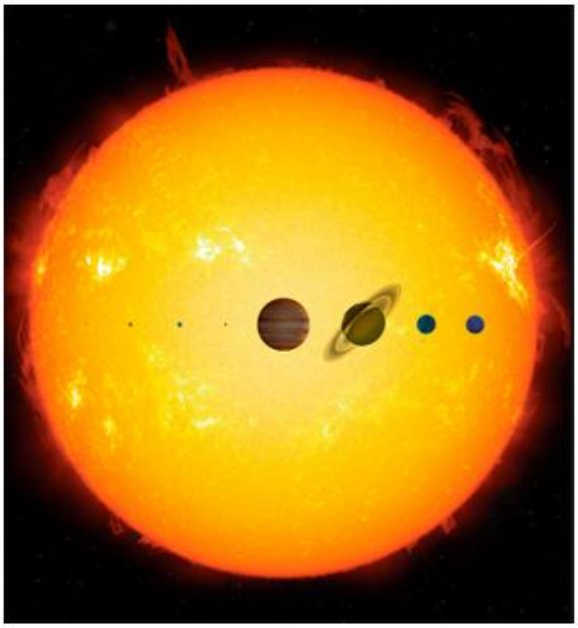
• Mercury:	48 km/s	107,085 mph
• Venus:	35 km/s	78,337 mph
• Earth:	30 km/s	66,615 mph
• Mars:	24 km/s	53,853 mph
• Jupiter:	13 km/s	29,236 mph
• Saturn:	9.7 km/s	21,675 mph
• Uranus:	6.8 km/s	15,233 mph
• Neptune:	5.4 km/s	12,146 mph

Hunting for Planets like Earth

Problem 1 –If the sun is 160-mm on your photograph, what is the area of the Sun's disk in square millimeters?

Problem 2 – If Venus is 1.5mm, what is the area of Venus?

Problem 3 – If Jupiter is 16.4mm, what is the area of Jupiter?



ANSWER KEY

Changes in the Sun's Diameter

1. 70.5 mm
2. 2.1%, 2.1%; total change = 4.2% over 6 months

Supernova Shockwaves / Exploding Stars

1. 7.3 E6 km/hour

Distant Planet Detection

1. 17 billion km
2. 1,176 years

Neptune Fast or Slow?

1. 20,550 km/hr (12,773 mph)

Hunting for Planets

1. 80,400 mm^2
2. 1.13 mm^2
3. 844.5 mm^2

#4 Sun's Diameter

Measure with ruler: Jan: 72mm
July: 69mm

$$\text{Average} = \frac{72+69}{2} = \underline{\underline{70.5\text{ mm}}}$$

% Change? Jan: $\frac{72-70.5}{70.5} \times 100 = \underline{\underline{2.1\%}}$

July $\frac{70.5-69}{70.5} \times 100 = \underline{\underline{2.1\%}}$

Total % change = $2.1\% + 2.1\% = \underline{\underline{4.2\%}}$

Exploding Stars

(#6) Measure: 66mm is the diameter of longest axis

$\therefore$ radius = 33mm

Scale = 0.2 LY/mm

$$33\text{mm}\left(0.2\frac{\text{LY}}{\text{mm}}\right) = 6.5\,\text{LY}$$

2005 − 1054 = 951 years ← how long it's been expanding

$$6.5\,\text{LY}\left(62{,}000\frac{\text{AU}}{\text{LY}}\right)\left(150\text{ million}\frac{\text{Km}}{\text{AU}}\right)$$

= 60 trillion Km in 951 years

$$\Rightarrow 951\text{ years}\left(\frac{365\text{ days}}{1\text{ yr}}\right)\left(\frac{24\text{ hrs}}{1\text{ day}}\right) = 8{,}331{,}000\text{ hrs}$$

$$\Rightarrow \frac{60{,}000{,}000{,}000{,}000\text{ km}}{8{,}331{,}000\text{ hrs}} = 7{,}200{,}000\,\frac{\text{km}}{\text{hr}}$$

Distant Planet Detection

#7

Scale: 2.7 $\frac{AU}{mm}$ Measure: 42 mm

1 AU = 150 million km

$42\,mm\left(2.7\ \frac{AU}{mm}\right) = 113\,AU$

$113\,AU\left(\frac{150\text{ million km}}{1\,AU}\right) = 17\text{ billion km}$

How Long is orbit?

r = 113 AU

C = Circumference = $2\pi r$

$C = 2\pi r = 2\pi(113\,AU) = 710\,AU$

measure: 1.2 AU (traveled) from 2004-06

So in 2yrs it traveled $\frac{1.2\,AU}{710\,AU} = 0.0017$ of full orbit

So a full orbit would take:

$\frac{2\text{yrs}}{0.0017_{orbit}} = \frac{(X)\text{yrs}}{1\text{ orbit}} \Rightarrow X = 1,176\text{ yrs}$

#8 Neptune – how fast?

$4.3E9\ Km = 4.3$ billion Km

1 orbit = 150 years

$$V = \frac{\text{distance}}{\text{time}}$$

Distance = Circumference of circle:

$= 2\pi r = 2\pi (4.3E9\ Km)$

$= 27$ billion Km

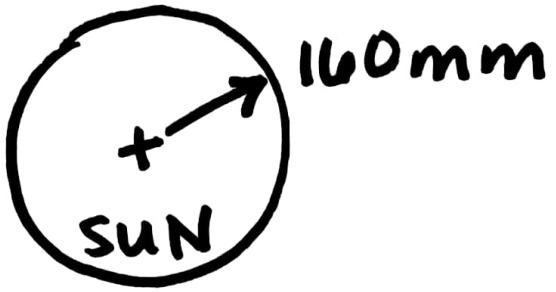
$$\text{time} = 150 yrs \left(\frac{365\ days}{1\ yr}\right)\left(\frac{24\ hrs}{1\ day}\right) = 1.3E6\ hrs = 1.3 \text{ million hours}$$

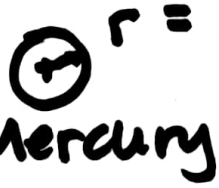
$$V = \frac{27 \text{ billion Km}}{1.3 \text{ million hrs}} = 20{,}550\ Km/hr$$

$(= 12{,}773\ mph)$

Hunt-Kepler #89

Jupiter: r = 16.4 mm





Area of sun: $A = \pi r^2$

$A = \pi (160mm)^2 = \underline{80,400mm^2}$

Area of Mercury: $A = \pi r^2$

$A = \pi (0.6mm)^2 = \underline{1.13mm^2}$

Area of Jupiter: $A = \pi r^2$

$A = \pi (16.4mm)^2 = \underline{844.5mm^2}$

Draw it for real!