

<http://www.2dplay.com/orbit/orbit.swf>*

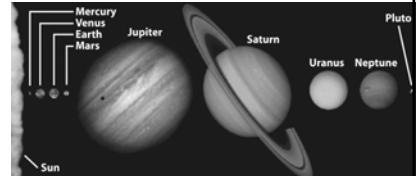
- In class we discussed the “capture theory” of the Moon. I said that capture is “dynamically” unlikely. Try this game that simulates the dynamics of an object and try to put the object in orbit around of the planets. It is not so easy.
- But I mentioned that the moons of Mars are thought to have been captured. Why?
 - More on capture theory: http://www.windows.ucar.edu/tour/link=/earth/moon/capture_theory.html&edu=elem

* Not in lecture notes posted yesterday. Will post link on web page.



Outline for 09 November (Thursday)

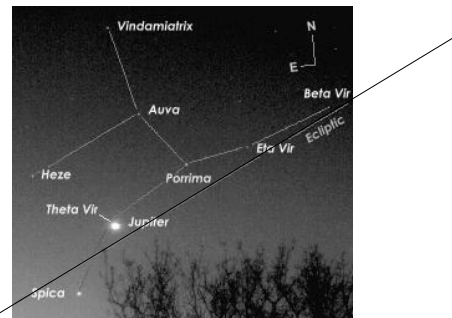
- Jupiter and Saturn
 - Orbit
 - Surface
 - Atmosphere
 - Moons



Key Words

- liquid metallic hydrogen
- noble gases
- nonthermal radiation
- thermal radiation
- oblate, oblateness
- plasma
- synchrotron radiation
- tidal force

It is hard to see!



<http://homepage.ntworld.com/mjpowell/Astro/Naked-Eye-Planets/Naked-Eye-Planets.htm>

table 14-1 Jupiter Data

Average distance from Sun:	5.203 AU = 7.783×10^8 km
Maximum distance from Sun:	5.455 AU = 8.160×10^8 km
Minimum distance from Sun:	4.950 AU = 7.406×10^8 km
Eccentricity of orbit:	0.048
Average orbital speed:	13.1 km/s
Orbital period:	11.86 years
Rotation period:	9 ^h 50 ^m 28 ^s (equatorial) 9 ^h 55 ^m 29 ^s (internal)
Inclination of equator to orbit:	3.12°
Inclination of orbit to ecliptic:	1.30°
Diameter:	142,984 km = 11.209 Earth diameters (equatorial) 133,708 km = 10.482 Earth diameters (polar)
Mass:	1.899×10^{27} kg = 317.8 Earth masses
Average density:	1326 kg/m ³
Escape speed:	60.2 km/s
Surface gravity (Earth = 1):	2.36
Albedo:	0.44
Average temperature at cloudtops:	-105°C = -162°F = 165 K
Atmospheric composition (by number of molecules):	86.2% hydrogen (H ₂), 13.6% helium (He), 0.2% methane (CH ₄), ammonia (NH ₃), water vapor (H ₂ O), and other gases

table 14-2 Saturn Data

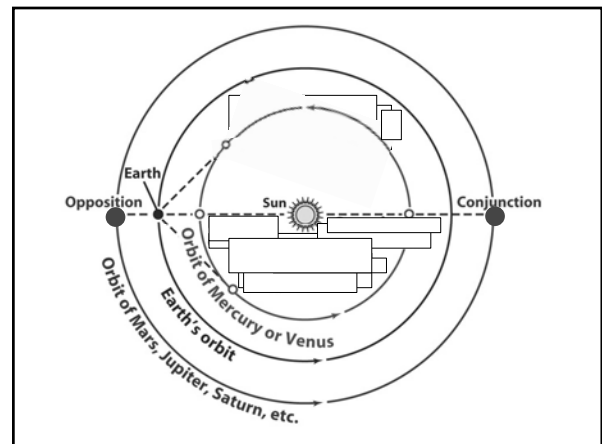
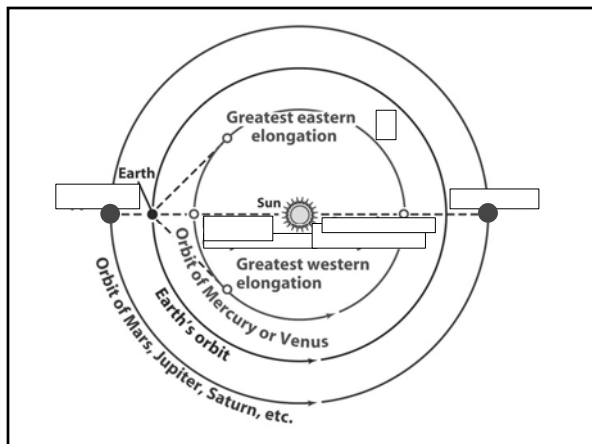
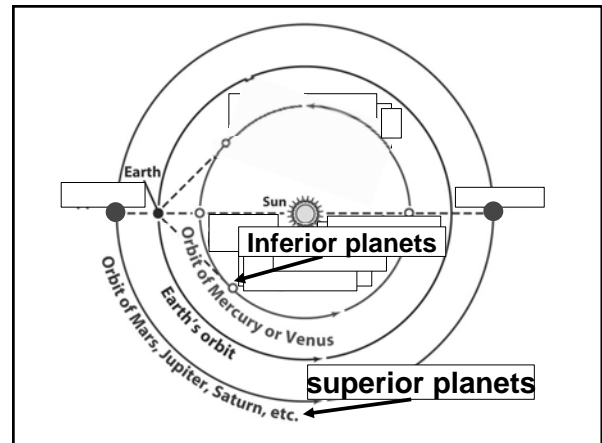
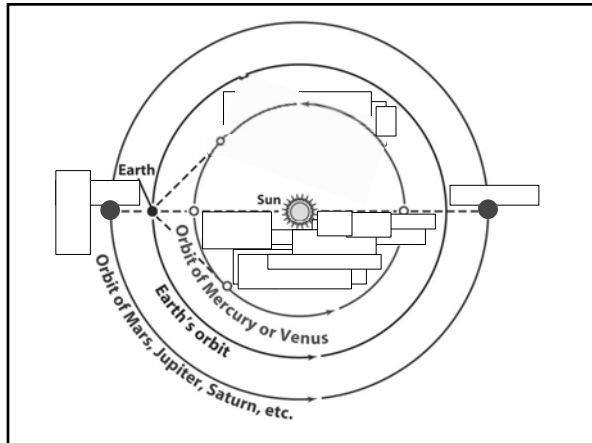
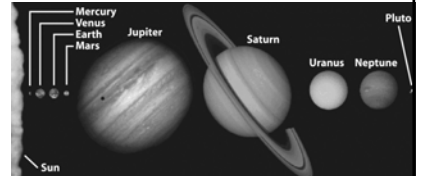
Average distance from Sun:	9.572 AU = 1.432×10^9 km
Maximum distance from Sun:	10.081 AU = $1.508 \times 3 \times 10^8$ km
Minimum distance from Sun:	9.063 AU = 1.356×10^9 km
Eccentricity of orbit:	0.053
Average orbital speed:	9.64 km/s
Orbital period:	29.37 years
Rotation period:	10 ^h 13 ^m 59 ^s (equatorial) 10 ^h 39 ^m 25 ^s (internal)
Inclination of equator to orbit:	26.73°
Inclination of orbit to ecliptic:	2.48°
Diameter:	120,536 km = 9.449 Earth diameters (equatorial) 108,728 km = 8.523 Earth diameters (polar)
Mass:	5.685×10^{26} kg = 95.16 Earth masses
Average density:	687 kg/m ³
Escape speed:	35.5 km/s
Surface gravity (Earth = 1):	0.92
Albedo:	0.46
Average temperature at cloudtops:	-180°C = -292°F = 93 K
Atmospheric composition (by number of molecules):	96.3% hydrogen (H ₂), 3.3% helium (He), 0.4% methane (CH ₄), ammonia (NH ₃), water vapor (H ₂ O), and other gases

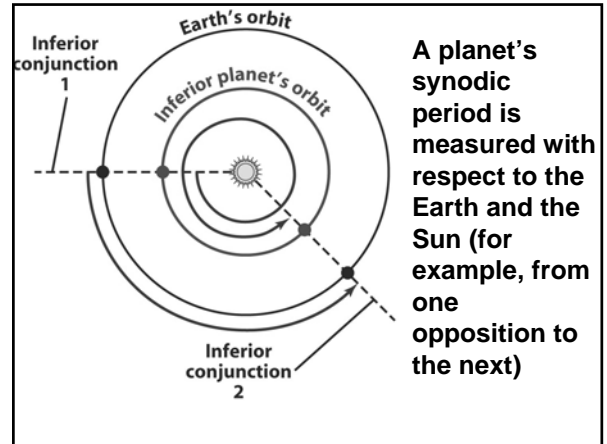
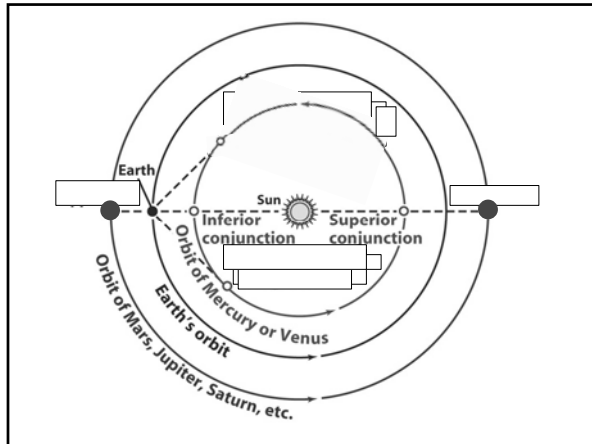
Video On Jupiter (10 minutes)

- *The Complete Cosmos, Jupiter and Saturn: Probing the Planets* (Johnson Center) DVD QB 44.2.C66 2003 disc 4
- On reserve in Johnson Center Library

Outline for 09 November (Thursday)

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Periods*

- Rotational
- Orbital
- Sidereal
- Synodic

} Measured with respect to something that is not rotating or orbiting

* Not in lecture notes posted yesterday

Orbit

- <http://learning.nd.edu/orbital/orbitals.swf>

Question*

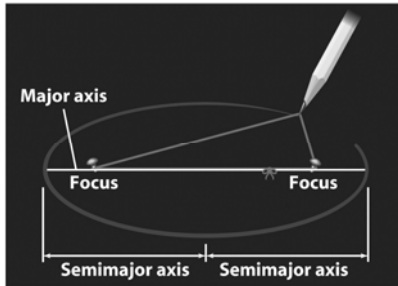
- Which is longer, Jupiter's synodic or orbital period?
- Which is longer, Jupiter's synodic or Saturn's synodic period?
- Guess Jupiter's and Saturn's synodic period.

* Will post on web page as separate pdf

Question

- Which is longer, Jupiter's synodic or orbital period? **orbital**
- Which is longer, Jupiter's synodic or Saturn's synodic period? **Jupiter's**
- Guess Jupiter's and Saturn's synodic period. **A little longer than Earth's orbital period.**

Kepler's Third Law



$$P^2 = a^3$$

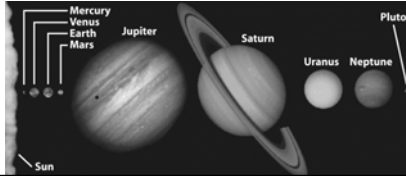
P = planet's sidereal period, in years
 a = planet's semimajor axis, in AU

Long orbital periods of Jupiter and Saturn cause favorable viewing times to shift

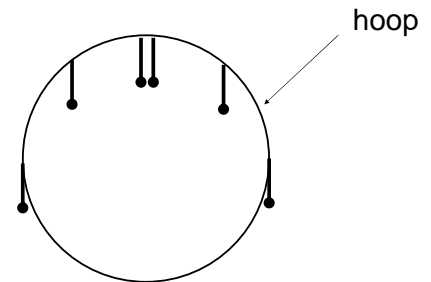
table 14-4 Oppositions of Saturn, 2004–2008				table 14-3 Oppositions of Jupiter, 2004–2008			
Date of opposition	Earth-Saturn distance		Angular diameter (arcsec)	Date of opposition	Earth-Jupiter distance		Angular diameter (arcsec)
	(AU)	(10 ⁶ km)			(AU)	(10 ⁶ km)	
2005 January 13	8.08	1208	20.6	2004 March 4	4.43	662	44.5
2006 January 27	8.13	1216	20.5	2005 April 3	4.46	667	44.2
2007 February 10	8.20	1227	20.3	2006 May 4	4.41	660	44.6
2008 February 24	8.29	1240	20.1	2007 June 5	4.30	644	45.7
				2008 July 9	4.16	622	47.3

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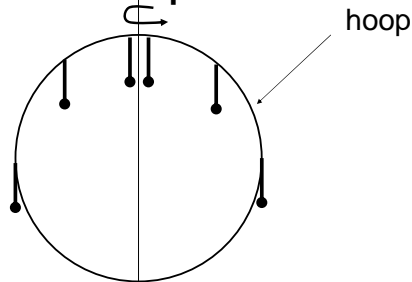


How to get Oblate*

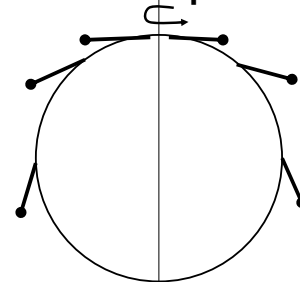


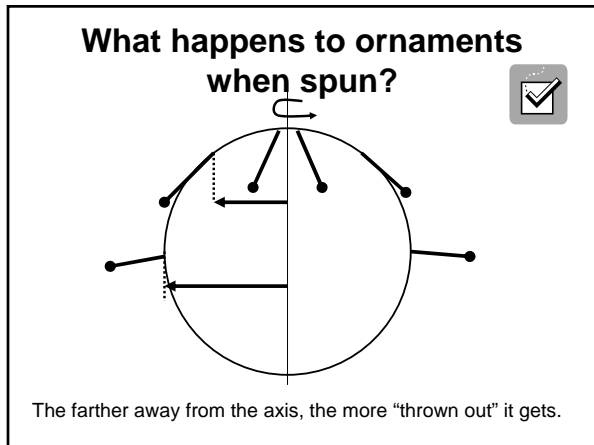
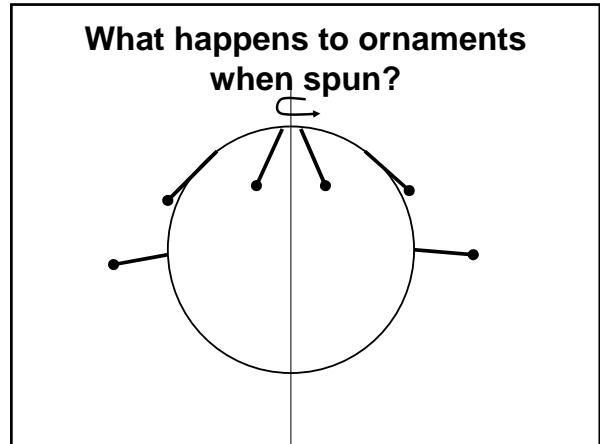
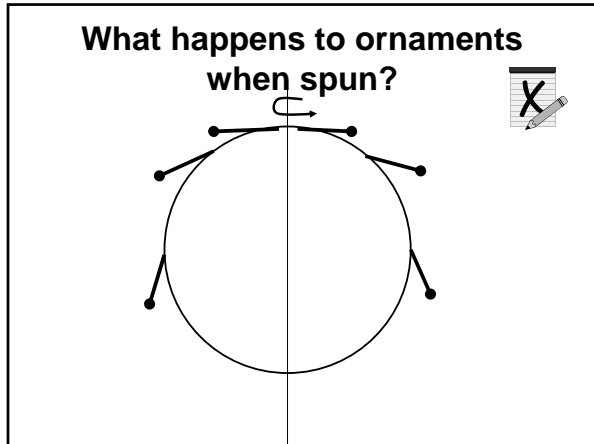
* Will post on web page as separate pdf

What happens to ornaments when spun?



What happens to ornaments when spun?





The oblateness of Jupiter and Saturn reveals their rocky cores

- Jupiter probably has a rocky core several times more massive than the Earth
- The core is surrounded by a layer of liquid "ices" (water, ammonia, methane, and associated compounds)
- On top of this is a layer of helium and **liquid metallic hydrogen** and an outermost layer composed primarily of ordinary hydrogen and helium
- Saturn's internal structure is similar to that of Jupiter, but its core makes up a larger fraction of its volume and its liquid metallic hydrogen mantle is shallower than that of Jupiter

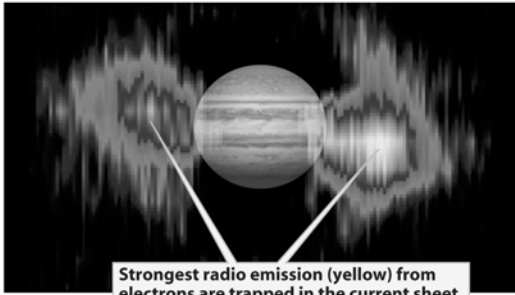
Metallic hydrogen inside Jupiter and Saturn endows the planets with strong magnetic fields

- Jupiter and Saturn have strong magnetic fields created by currents in the metallic hydrogen layer
- Jupiter's huge magnetosphere contains a vast current sheet of electrically charged particles
- Saturn's magnetic field and magnetosphere are much less extensive than Jupiter's

Jupiter and Saturn have extensive magnetospheres

- The Jovian magnetosphere encloses a low-density plasma of charged particles
- The magnetosphere exists in a delicate balance between pressures from the plasma and from the solar wind
- When this balance is disturbed, the size of the magnetosphere fluctuates drastically

Synchrotron Radiation



Charged particles in the densest portions of Jupiter's magnetosphere emit synchrotron radiation at radio wavelengths