Topic C

"The Other Planets" (Part 1. Orbit Characteristics)

(Web Version: 02-09-01)

Comparative Planetology

Classification in Science

In Topic C

- Want to understand "***role of classification***"

  "***Division of items into systematically ordered groups or categories***"

- Goals
  - Identify/summarize major planetary characteristics
  - Discover organization of planetary properties
  - Demonstrate structural or evolutionary relationships
  - Understand how classification is a key to origins

Open Study Guide

Table 5
Some Solar System Regularities

Table 6
General Planetary Properties

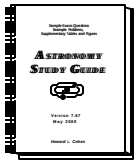


Table 6

- Do <u>not</u> memorize numbers
- Find what numbers "trying to tell you"
- For example, look for . . .
  - Patterns & possible arrangements or groups
  - Similarities & differences
  - Extremes
  - Interesting cases
  - Anomalies (peculiarities)

Table 6 Notes

- Don't understand a term?
- Need more info?
- Last column gives <u>note numbers</u>
  - Notes found on pages following table
  - Look at notes first before asking question

What Does This Mean?

"Most very early Martians just sit under new planets"

"My very energetic mother just served us nine pies"

Learn Names
(In Correct Order!)

SUN
1) Mercury
2) Venus
3) Earth
4) Mars
5) Jupiter
6) Saturn
7) Uranus
8) Neptune
9) Pluto

Objects Have Symbols
(Do *Not* Need to Know)

SUN
1) Mercury
2) Venus
3) Earth
4) Mars
5) Jupiter
6) Saturn
7) Uranus
8) Neptune
9) Pluto

Not Used

What is the Solar System?

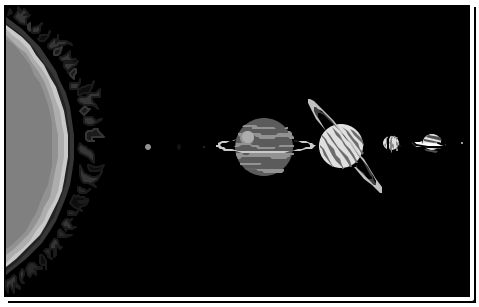
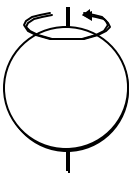


Table 5 Item 1

System of the Sun

- Sun
  - Contains over 99% of material
  - Spins once in about a month (Only Mercury & Venus slower)
- Conclusions
  - Has most of solar system's mass
  - Spins (rotates) slowly

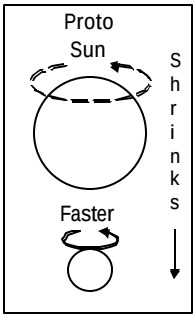


"Spin Problem"

- Most origin models predict rapid spin
- Current theories:

  Sun forms from large dust & gas cloud

- Cloud shrinkage predicts spin rate should increase



"Spin Problem"

- Most origin models predict rapid spin
- Current theories:

  Sun forms from large dust & gas cloud

- Cloud shrinkage predicts spin rate should increase

Analogous to spinning ice skater

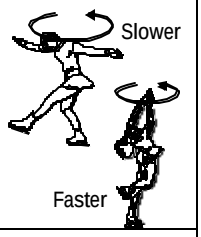


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Table 5 Item 2a

Number of Planets?

Nine (?) major planets orbit around Sun

– Why question mark?

- Answer #1:
  -
  -
- Answer #2:

14

Which Are Planets?

All solar system objects drawn to scale

"Classical" definition?

Earth Jupiter

?

Sun

"Modern" Definition of Star

?

What about "small bodies"

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Which Are Planets?

These are all solar system objects drawn to scale

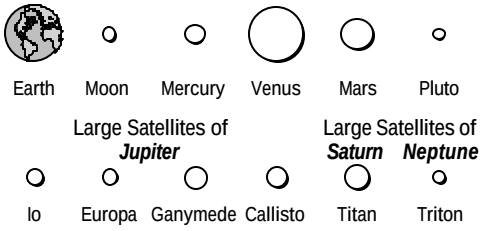

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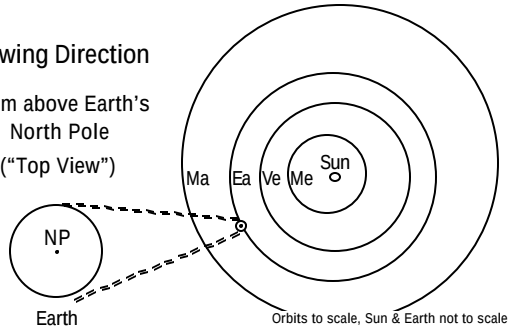
Table 6 Top Row

Inner Planets

Viewing Direction

From above Earth's North Pole ("Top View")



Orbits to scale, Sun & Earth not to scale

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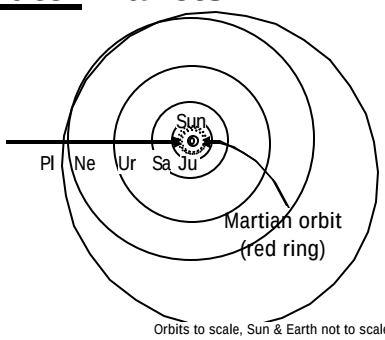
Table 6 Col. Header

Outer Planets

Dividing Line

Asteroid belt between Mars & Jupiter



Orbits to scale, Sun & Earth not to scale

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Table 6
Row 5

Orbit Direction & Eccentricity

All . . .
- ***Directions prograde***
- Eccentricities small
- Know planets with
  - Smallest e
  - Largest e
- Where are next
  - Smallest e?
  - Largest e?

Any Patterns?

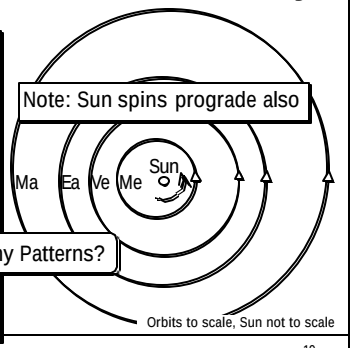


Table 5
Item 2d

Orbit Inclination

- Do orbits lies in same plane?
- Tilt orbits over . . .

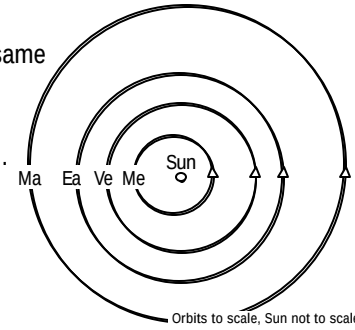
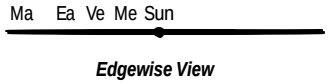


Table 5
Item 2d

Orbit Inclination

All orbits nearly ***coplanar***
(lie nearly in same plane)

Orbit tilt given by ***orbit inclination***



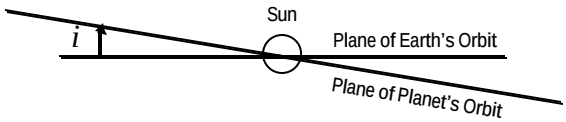
Edgewise View

Orbits to scale, Sun not to scale

Table 6
Row 6

Orbit Inclination (*i*)

Here inclination measured from plane of Earth's orbit

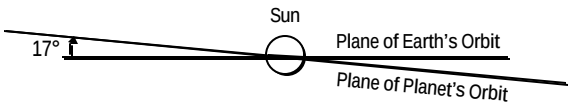


Edgewise View

Table 6
Row 6

Orbit Inclination (*i*)

- Most planets?
  i = 1° to 3°
- Largest?
  Pluto ***i*** = 17°
  Mercury ***i*** = 7°



Edgewise View

Table 5
Item 3b

Revolution & Rotation

Terms often misused . . . define

- ***Revolution*** . . .
  "?"
- ***Rotation*** . . .
  "?"

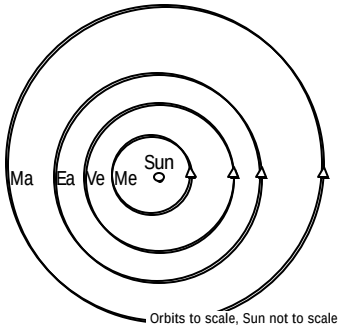
Table 6
Row 7

Rotation Direction

See Note #7

If Rotation Rate

- Positive (**+**)
  Prograde Rotation
- Negative (–)
  Retrograde Rotation



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Rotation Direction

Nearly all rotations?

- ***Prograde***
  (including Sun)
- Same direction as
  revolution

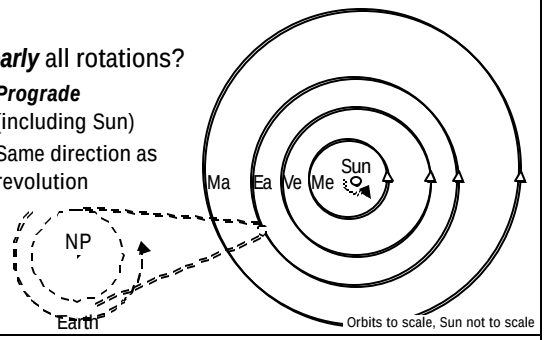

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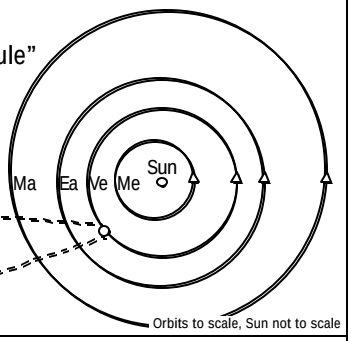
Table 6
Row 7

Retrograde Rotators

"Exceptions to the Rule"

- Venus
- Uranus
- Pluto



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Rotation Rates

Know which objects rotate

- Slowly — rotation long (day or more)
- Fast — rotation short (less than a day)

(Any patterns?)

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Table 5
Item 3a

Obliquity (Axis Tilt)

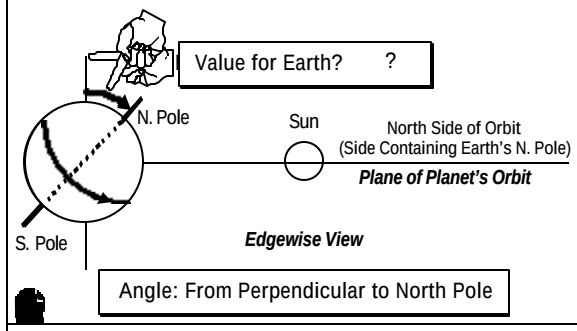

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Table 5
Item 3a

Obliquity Less Than 90°

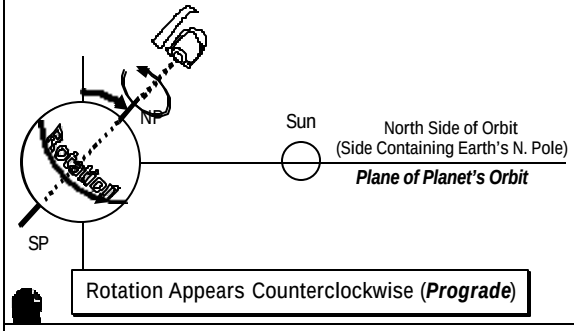

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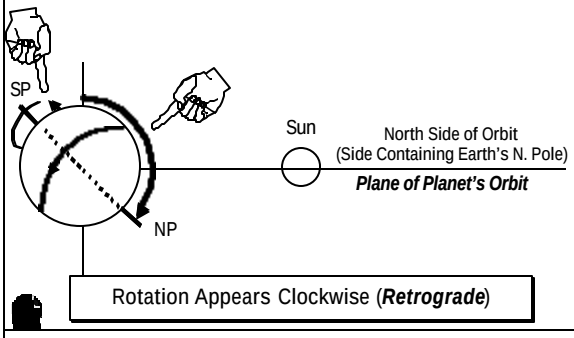
Table 5
Item 3a

Obliquity More Than 90°



Rotation Appears Clockwise (***Retrograde***)

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Table 6
Line 8

The Retrograde Rotators

Data from ***Study Guide*** Table 6

Planet	Obliquity	Period
Venus	177°	243 days
Uranus	98°	2/3 days
Pluto	118°	6-1/2 days

Notice retrograde rotators have ***obliquities*** more than 90°

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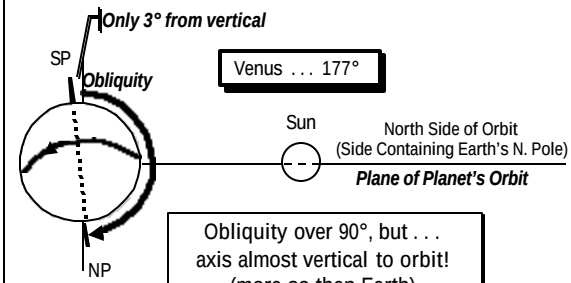
Table 6
Row 8

Example #1: Venus



Venus . . . 177°

Obliquity over 90°, but . . .
axis almost vertical to orbit!
(more so than Earth)

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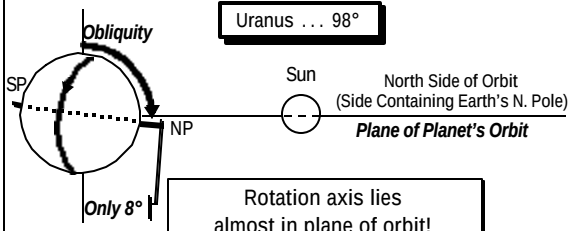
Table 6
Row 8

Example #2: Uranus



Uranus . . . 98°

Rotation axis lies
almost in plane of orbit!

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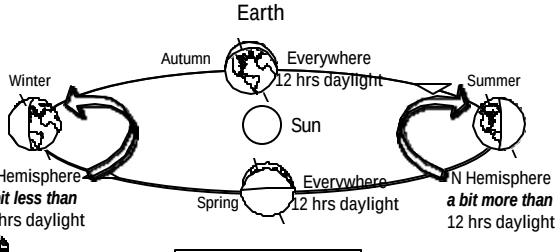
Table 6
Row 8

Axis Tilt

Typically Determines Amount of Daylight & Seasonal Changes*



See pg. 10 in textbook

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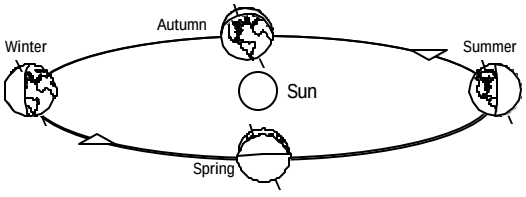
Table 6
Row 8

Summary

If rotation axis nearly perpendicular to orbit plane,
daylight & darkness hours roughly same (except near poles)



Examples on next slide

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Duration of Daylight

Latitude on Earth	Minimum	Maximum
0° (Equator)	12 hrs ⟷	12 hrs
30° (Gainesville, FL)	10 hrs ⟷	14 hrs
40° (New York City)	9 hrs ⟷	15 hrs
60° (Seward, Alaska)	6 hrs	19 hrs
90° (North Pole)	0 hrs	24 hrs

Daylight remain near 12 hours except near polar regions

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Table 6
Rows 2, 7, 8

Contrast with Uranus

Orbit Period = 84 Years; Rotation Period = 17 hours

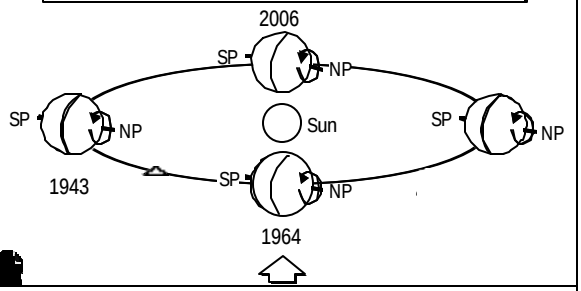

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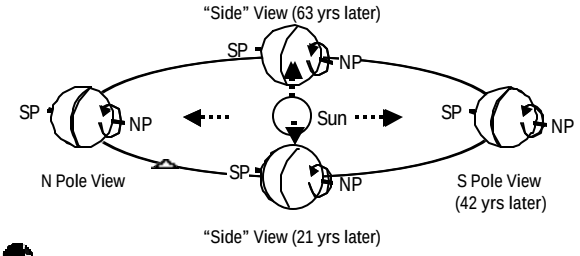
Table 6
Rows 2, 7, 8

View From Earth

What do you see from near middle of solar system?



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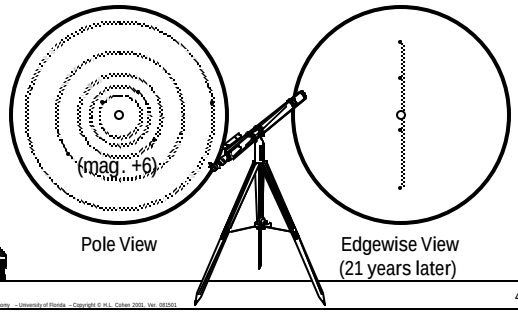
Hubble Space Telescope

Uranus from Earth

View of Uranus and Satellites Through Telescope



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Synchronous Rotation

- Coincidence of rotation/revolution periods
- So — Period Rotation = Period of Revolution
- Examples?
  - Moon
  - Other planetary satellites
- Consequences?

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Table 6
Rows 2 & 8

Synchronous Rotation

Moon

Revolution = 27.3 days
Rotation = 27.3 days

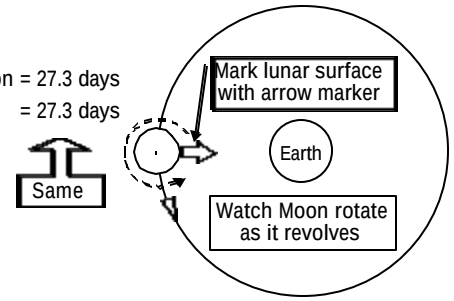

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Table 6
Rows 2 & 8

Synchronous Rotation

- Same side of Moon faces Earth
- From Earth . . .
  - Always see "front side"
  - Never see "back side"

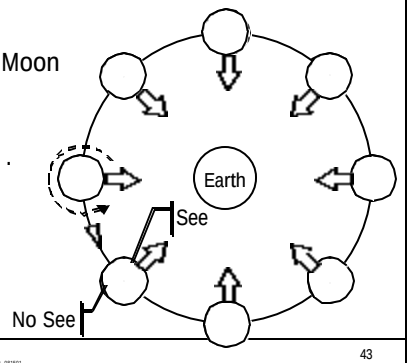

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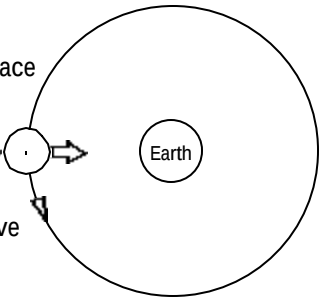
Table 6
Rows 2 & 8

Contrast: No Rotation

Arrow marks fixed point on lunar surface

Suppose Moon does ***not*** rotate



Watch Moon revolve without rotation

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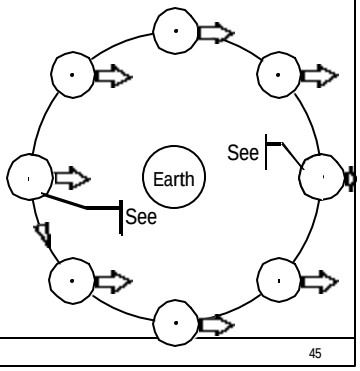
Table 6
Rows 2 & 8

No Rotation

- All sides of Moon face Earth
- From Earth . . .
  - See "front side"
  - Also see "back side"



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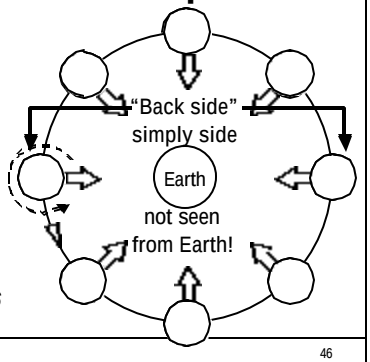
Another Misconception

Sunlight

"Back side" not the dark side

since Sun illuminates all sides as Moon rotates



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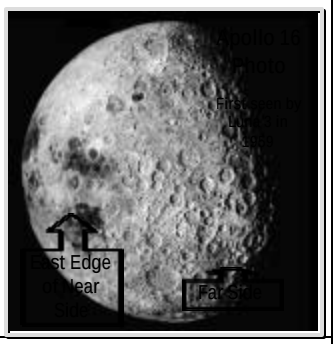
The Moon's "Far Side"

- ✦ Near Side
  - Cratered Highlands
  - Many smooth dark maria (lowland basins)
- ✦ Far Side
  - Extensive, rough & battered cratered highlands
  - Few dark maria



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Synchronous Rotators

From Earth (1995)

Mariner 10 (1974)

- Most satellites incl. large Jovian satellites
- Early error — Mercury
  - Before 1965:
    Rotation thought ***synchronous*** (revolution & rotation = 88 days)
  - 1965:
    Radar observation (using ***Doppler Effect***) showed rotation period = 59 days

Rotation produces effect on radio waves that tells spin rate

D 59d

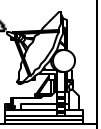

Photo Cred. (left): Planetary System Group: Swedish Vacuum Solar Telescope , La Palma. (right): NASA.

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