Physical Properties of the Planets

Kinematic Properties: Where is it and how does it move?

Size, shape, and orientation of the orbit (a, ε; i, ω, Ω)

Location in the orbit and orbital motion (P, T)

Axial inclination and rotation period (i_{rot}, P_{rot})

Physical Properties: Dimensions, Compositions, Conditions

Size and Shape (R, e)

Mass (M)

Mean Density (<ρ>)

Chemical Composition

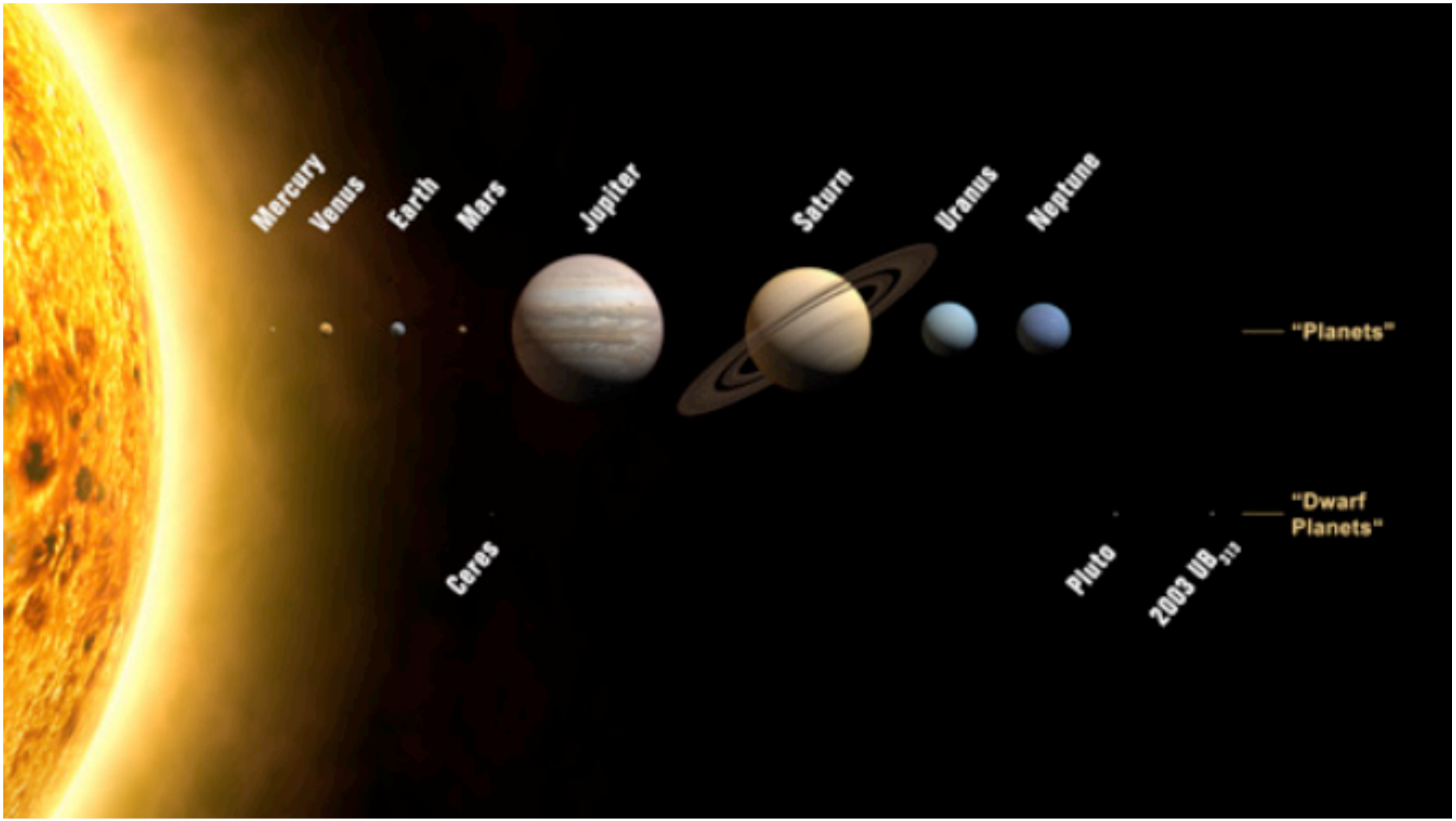
Physical Conditions (Temperature, Pressure, etc.)

Atmosphere: Meteorology (Wind & Weather)

Surface: Topography (Mountains, Craters, Plains,..)

Interior: Structure

Age


Mercury
Venus
Earth
Mars
Jupiter
Saturn
Uranus
Neptune
"Planets"
Ceres
Pluto
2003 UB313
"Dwarf Planets"

Basic Physical Properties of a Planet

Dimensions: Size & Shape

Measurements of Angular Radius

$\sin\alpha = R/d$

Observing Transits and Occultations (Timing)

Albedo (Reflectivity) Based Estimates of Size

Quantities

Mean Radius: R

Volume: $V = (4/3)\pi R^3$

Shape: Oblateness: $e = \Delta R/R$

$\Delta R = R_{equatorial} - R_{polar}$

Mass & Composition

Mass Determinations

Use Newton's Version of Kepler's Third Law

$$M + m = a^3/P^2$$

(**a** in astronomical units, **P** in years, **M** and **m** in solar units)

Planet's Orbit about the Sun: $1 + m_{planet} = a^3/P^2$

Satellite's Orbit about the Planet: $M_{planet} + m_{satellite} = a^3/P^2$

The Mean (Average) Density

$$\rho = \text{Mass/Volume} = 3M/4\pi R^3$$

Examples

$\rho_{water} = 1.00$ gm/cm^3

$\rho_{air} = 0.0013$ $\rho_{gasoline} = 0.70$ $\rho_{iron} = 7.8$

$\rho_{Earth} = 5.52$ $\rho_{Sun} = 1.41$ $\rho_{Jupiter} = 1.33$ $\rho_{Saturn} = 0.71$

Physical Properties of the Planets

Planet	Mass M/M_{Earth}	Radius R/R_{Earth}	Density $\rho(gm/cm^3)$	Gravity g/g_{Earth}	Albedo A	Oblateness *e*
Mercury	0.055	0.382	5.43	0.377	0.13	0.0
Venus	0.815	0.949	5.25	0.905	0.72	0.000
Earth	1.000	1.000	5.52	1.000	0.39	0.003
Mars	0.107	0.533	3.93	0.379	0.18	0.007
Ceres	0.0002	0.074	2.08	0.028	0.11	0.068
Jupiter	317.9	11.2	1.33	2.36	0.70	0.063
Saturn	95.18	9.45	0.71	0.91	0.75	0.098
Uranus	14.54	4.01	1.24	0.79	0.61	0.023
Neptune	17.13	3.88	1.67	1.12	0.62	0.017
Pluto	0.0021	0.18	2.0	0.07	0.3	0:
Sun	3.32×10^5	109	1.41	27.9	-	$< 5 \times 10^{-5}$

“Terrestrial” and “Jovian” Planets

The Jovian and Terrestrial Planets form two distinct classes based upon their kinematic and physical properties.

- **The Terrestrial Planets are those nearest the Sun.**
- **The Terrestrial Planets are the slower rotators.**

- **The Jovian Planets are significantly the larger.**
- **The Jovian Planets are much more massive.**
- **The Jovian Planets are of Significantly lower mean density.**

The Jovian Planets are more oblate.

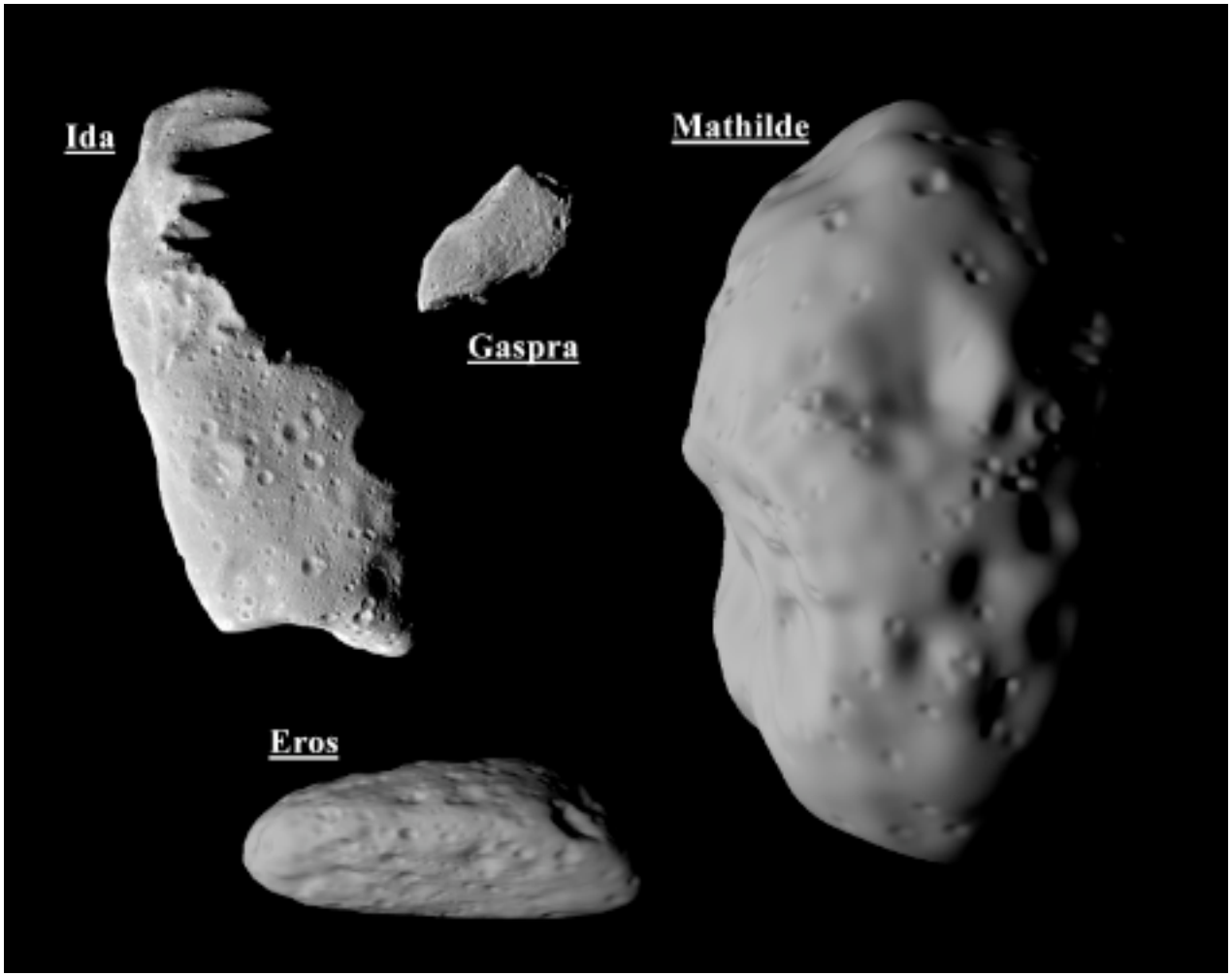
The Terrestrial Planets are basically solid bodies with atmospheres of almost negligible mass.

The Jovian Planets are largely gaseous bodies with relatively small ice-dominated cores.

Terrestrial Planets

The Jovian Planets

Asteroids:

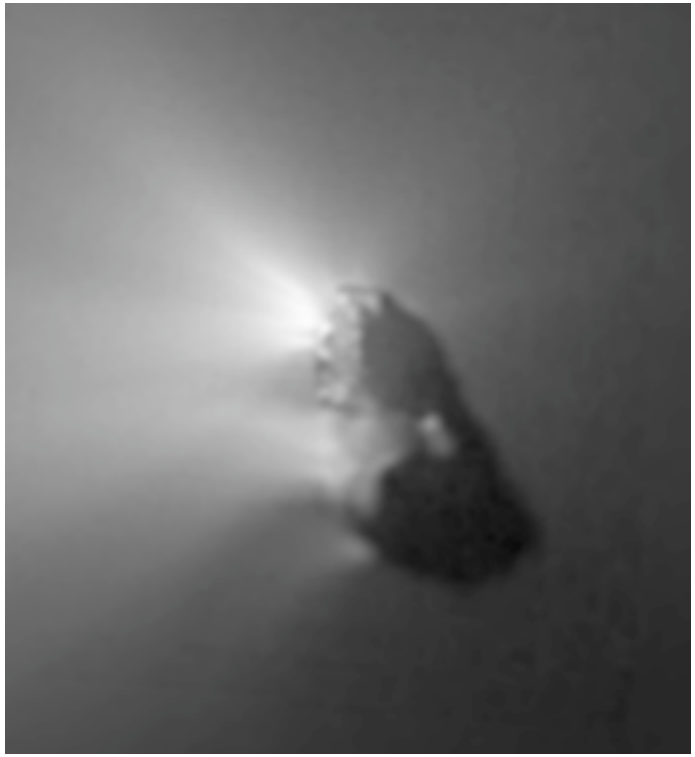


Rocky bodies of basically “terrestrial” composition.

Comets

"Dirty Snowballs"

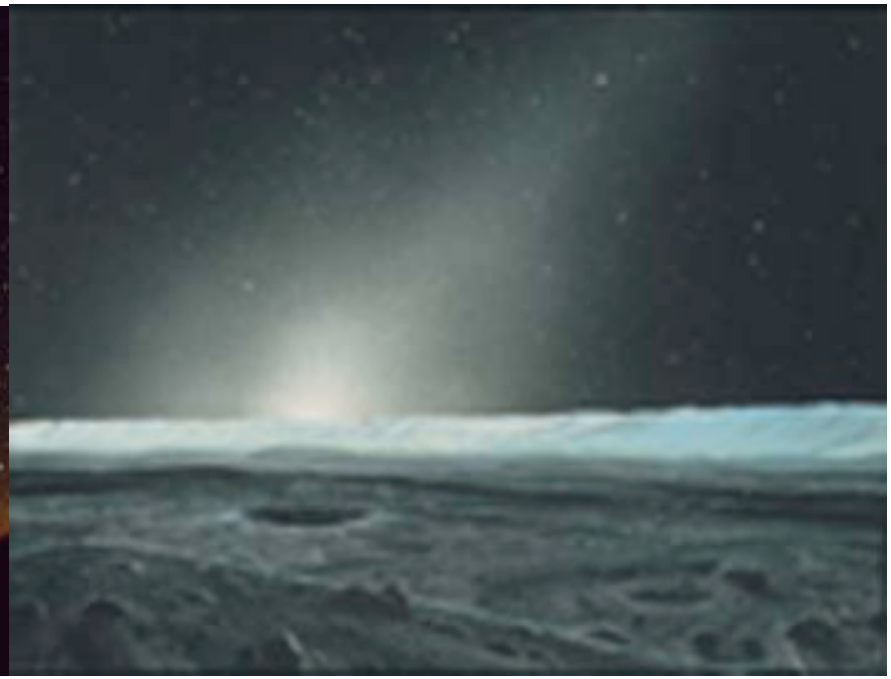
A small icy nucleus and a larger gaseous coma and tail



Icy bodies of basically "jovian" composition.

Interplanetary Dust

Before Sunrise - on the Earth



After Sunset - on the Moon

Small solid dust grains of basically “terrestrial” composition.