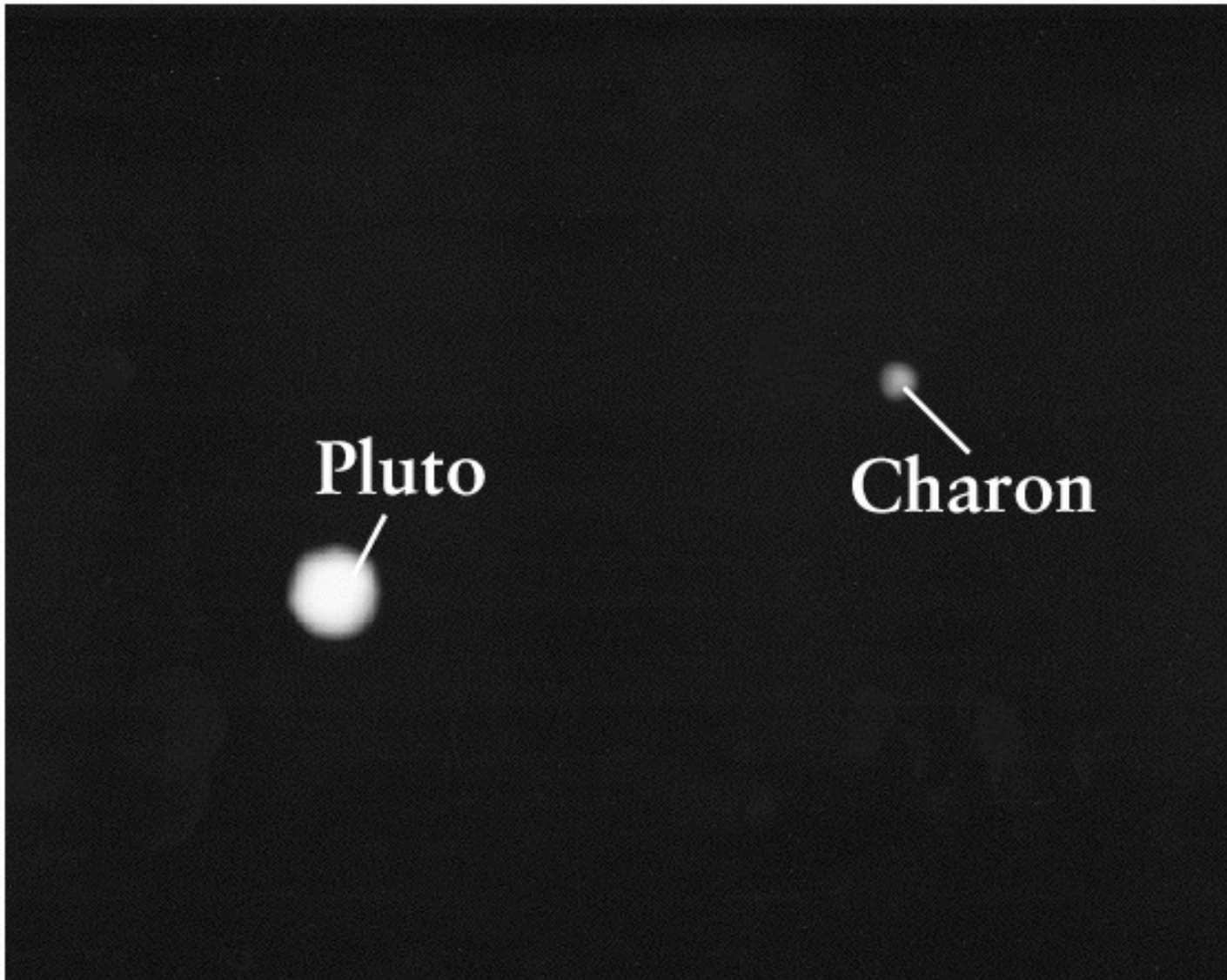


Pluto and Beyond

- Pluto
- Kuiper Belt
- Comets
- Asteroids
- Meteors and Meteorites

Pluto



Pluto and Planet X

- Orbits of Neptune and Uranus suggested that there might be another planet out there
 - Planet X
- After an exhaustive search, Pluto was discovered by Clyde Tombaugh in 1930.
- However, subsequent mass measurements indicate that Pluto is not massive enough to perturb Uranus and Neptune
 - Original measurements were in error
 - There is no planet X

Orbit and Rotation

- Highly eccentric orbit:

$$e = 0.25, a = 39.44 \text{ AU}, i = 17.2^\circ$$

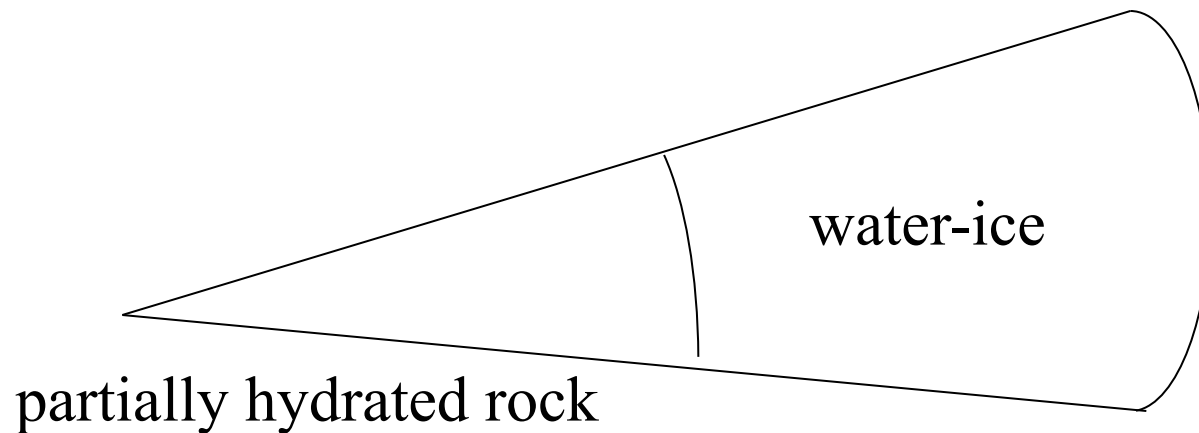
$$\text{from } P^2 = 4 \pi^2 a^3 / GM, \quad P = 248 \text{ years}$$

Because of its eccentric orbit, Pluto is sometimes closer than Neptune (i.e., 1979-1999)

- Rotation period: ~ 6.4 days
 - Axis of rotation close to ecliptic (like Uranus) $\sim 118^\circ$

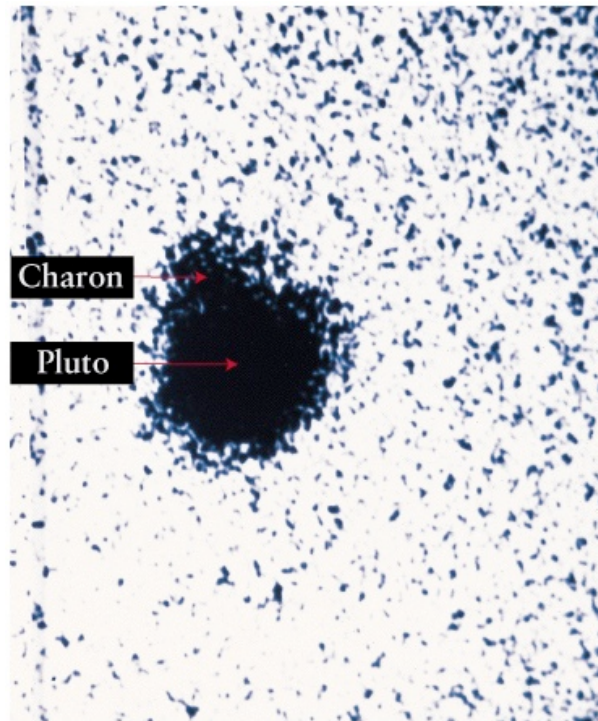
Interior

- Hard to tell:
 - $\langle \rho \rangle = 2060 \text{ kg/m}^3$
- Some surface methane-ice
- Surface temperature $\sim 40 \text{ K}$
- Atmosphere: Methane gas
 - $P \sim 10^{-8} \text{ atm}$



Charon

- Moon discovered in 1978
- Important for mass measurement of Pluto, but orbit truly measures $M_{\text{pluto}} + M_{\text{charon}}$
- M_{charon} probably $\sim 1/6$ of M_{pluto}



Origin?

- With bizarre orbit and composition like Jovian moons, where did Pluto come from?
 - Is Pluto a planet at all? [No longer...]
 - Moon ejected from Neptune's system after cataclysmic encounter?
 - Formed in situ?
- Still heavily debated

Orbits

