

Astro 210
Lecture 22
October 15, 2010

Announcements

- HW 6 due
- HW 7 available, due next Friday
- Night Observing raindates: next Monday & Tuesday
info and schedule online
- no class meeting next Wednesday!

Last time: began solar system debris

- asteroids *Q: where?*
- orbits? *www: orbits from top and side*
- ┌ ● *Q: meteor/asteroid connection?*
www: fireballs

what do asteroids look like? From ground, see only largest
but now have visited some (on the way to outer SS)

www: Gaspara

www: Ida & Dactly

Near Earth Asteroid Rendezvous

intercept near-earth asteroid 433 Eros

S-type: stony-iron

large: 35 km long, 14 km wide—Chicago

“potato shaped”

www: NEAR image of 433 Eros

www: NEAR movie

↳ hints of stratification—broken from (much) larger object?

Debris II: Comets

www: Hale-Bopp, Hyakutake, Ikeya-Seki

last month—brightest comet in decades! www: McNaught

Comet Structure: “dirty snowball” **nucleus:** ~ 10 km
solid: ices (H_2O , CO_2 , CH_4), embedded dust grains

very elliptical orbits: changing $r \rightarrow$ changing T

far from Sun: completely frozen

as approach: ice \rightarrow vapor (sublimation)

dust, gas released $\rightarrow 10^6$ km **coma**

www: HST Hale-Bopp: coma & jets, nucleus unresolved

pressure from sunlight & solar “wind” of particles

ω
 \rightarrow **tails:** Ion, dust

iClicker Poll: Comet Tails

Cometary dust and ions (=ionized atoms)

feel pressure from sunlight, solar wind of particles

⇒ result in comet tail

Where do comet tails point?

A away from the Sun

B behind the comet (i.e., opposite comet's velocity vector)

ion tail: small, low-momentum particles

→ carried by solar wind

→ points away from Sun

dust tail: larger, higher-momentum particles

→ retain \vec{v} component in comet direction

→ non-radial arc tracing comet path

NASA Mission: Stardust

at 1.86 AU from Sun (2.6 AU from earth)

fly by comet P/Wild 2, collect samples of dust, gas

returned to earth last year: parachute, caught by airplane

“fresh” comet, hasn’t lost all of its original material

→ learn about interstellar dust grains

→ output of stars and building blocks of planets

Comet Orbits

“Long Period”: $P > 10^5$ yr

→ $a > 2000$ AU!

all orientations → not just ecliptic

Oort Cloud

spherical comet “reservoir” at 3000–100,000 AU

not observed directly!

probably did not form there....

ejected by Jovian planets in early SS?

“Short Period”: $P < 200$ yr

lie in ecliptic

→ not from Oort cloud → **Kuiper Belt**

◦ $a = 30 - 100$ AU

www: Outer solar system sketch

first Kuiper belt object detected in 1992
a.k.a., *Trans-Neptunian* objects; today, tally is hundreds
typically \sim few% – 10% size of Pluto
probably formed where they are now
estimates: 70,000 KBO's
total mass $\sim 0.1M_{\text{Earth}}$

also: some comets strongly deflected,
have orbits with very small perihelion
(i.e., *very* close to Sun).

www: sun-grazing comets

Pluto

Orbit

$a = 39.5$ AU, $P = 285$ yr, $e = 0.25$ – largest for planet

Properties

$\rho_{\text{avg}} \simeq 2000$ kg/m³ → ice, rock surface: N₂ ice
atm: very thin, $P = 10^{-5}$ earth

www: HST image

Pluto's Moon: Charon – together a “double planet” system

Mass $M_P + M_C = 0.0024M_{\text{Earth}}$; $M_C \simeq 0.12M_P$

$R_P = 720$ km, $R_C = 395$ km

both spins, orbit have same period:

- system tidally locked into co-rotation
- each keeps same face to other

similar to comet nucleus, Kuiper Belt object

Pluto: smallest planet or largest KBO?

Pluto: History and Status

Clyde Tombaugh (1930): Pluto discovered in sky scan
totally unlike its outer planet neighbors

1930's-1950's: Kuiper belt idea proposed

1990's: Kuiper belt objects discovered

2002–present: more large outer solar system objects

- Quaoar (“Kwawar”): \approx 60% Pluto size
- Sedna: \approx 70% Pluto size
- “Xena” → Eris: **larger** than Pluto!!

all are spherical rocky iceballs

largest of huge population of object beyond Neptune

orbits more elliptical than planets, but still \approx in ecliptic

♁ → “transneptunian objects” or Kuiper belt objects

smaller Kuiper belt members sometimes scatterer → comets

To Be Or Not To Be

2006: International Astronomical Union redefines “planet”
Pluto demoted to “dwarf planet”
along with Ceres (asteroid belt), and KBO’s Eris + 2 others

Revise your vote—or not: Is Pluto a full-fledged, non-dwarf planet?

- A** No way! Good riddance!
And I’ve got my eye on you, Neptune!
- B** Umm, probably not?
- C** Umm, probably so?
- D** Yes way! Pluto was robbed! Long live Pluto!