NRC·CNRC

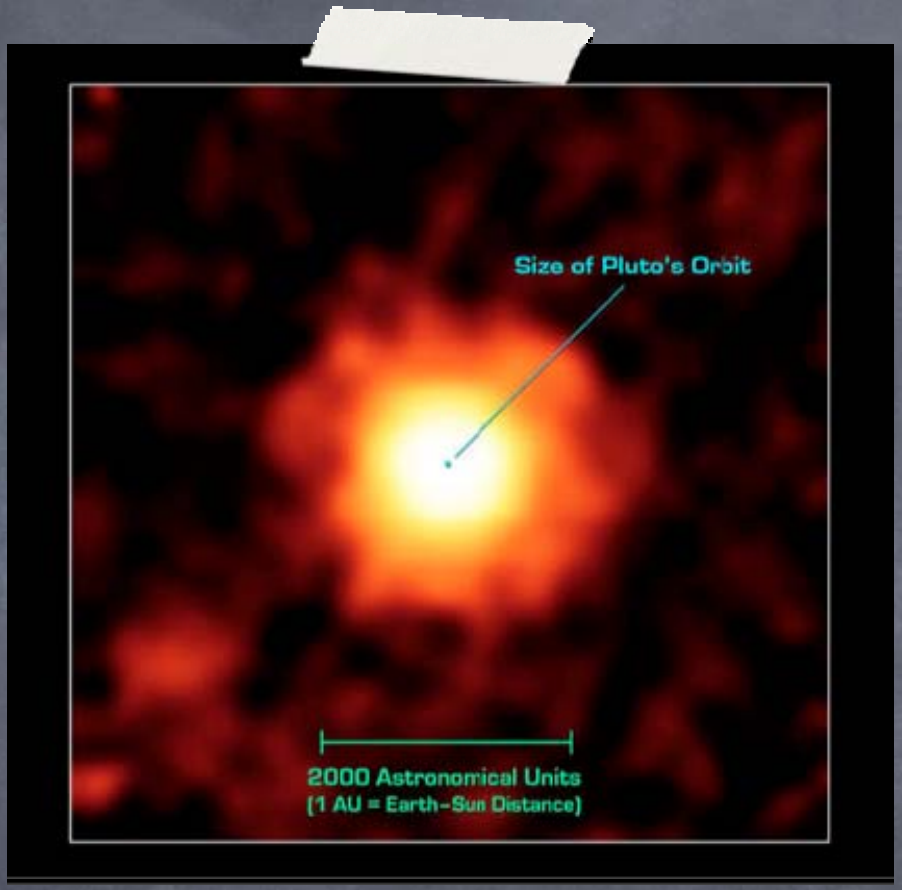
Herzberg Institute of Astrophysics

Postcards from the Edge

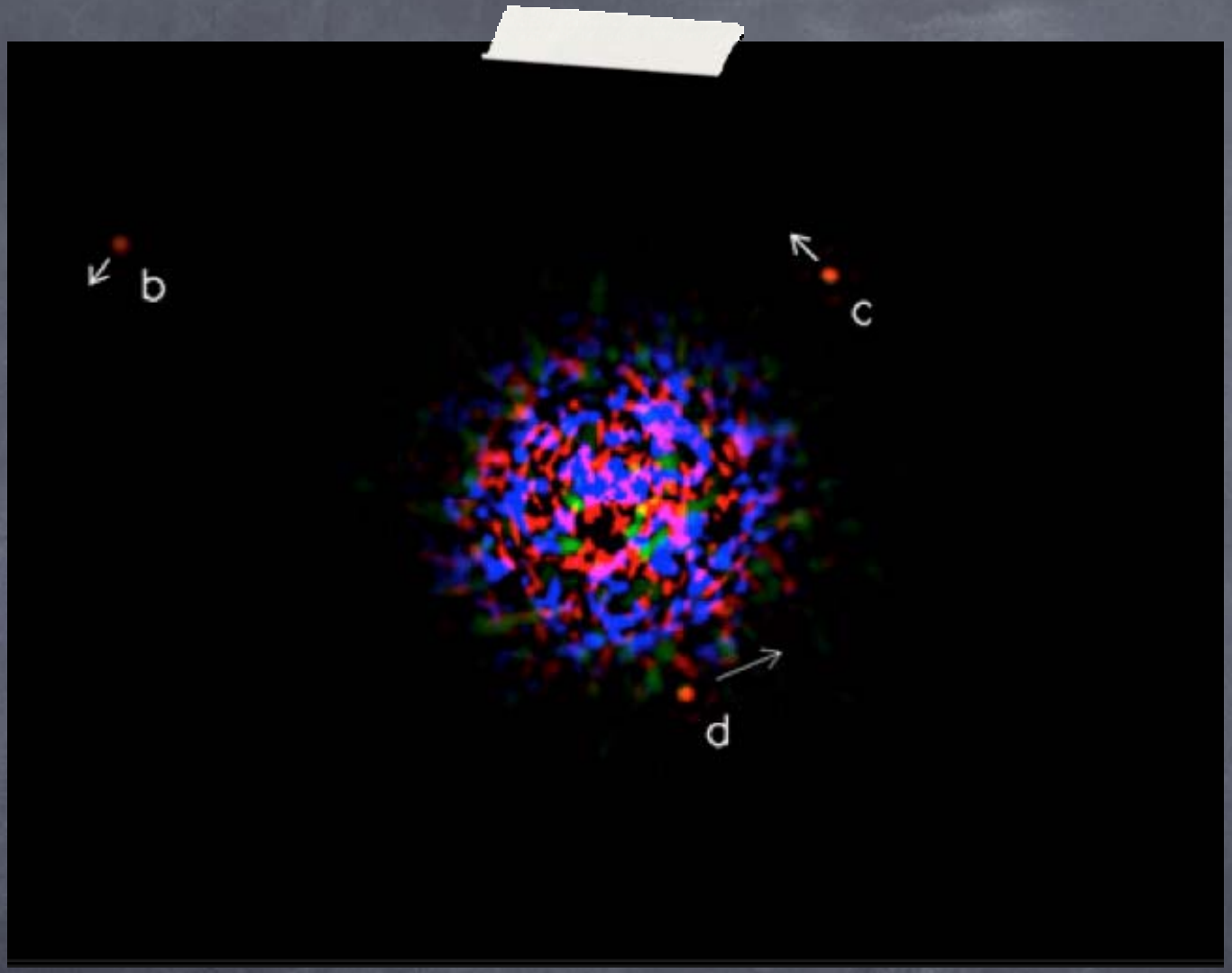
JJ Kavelaars

National Research Council Canada
Conseil national de recherches Canada
Canada

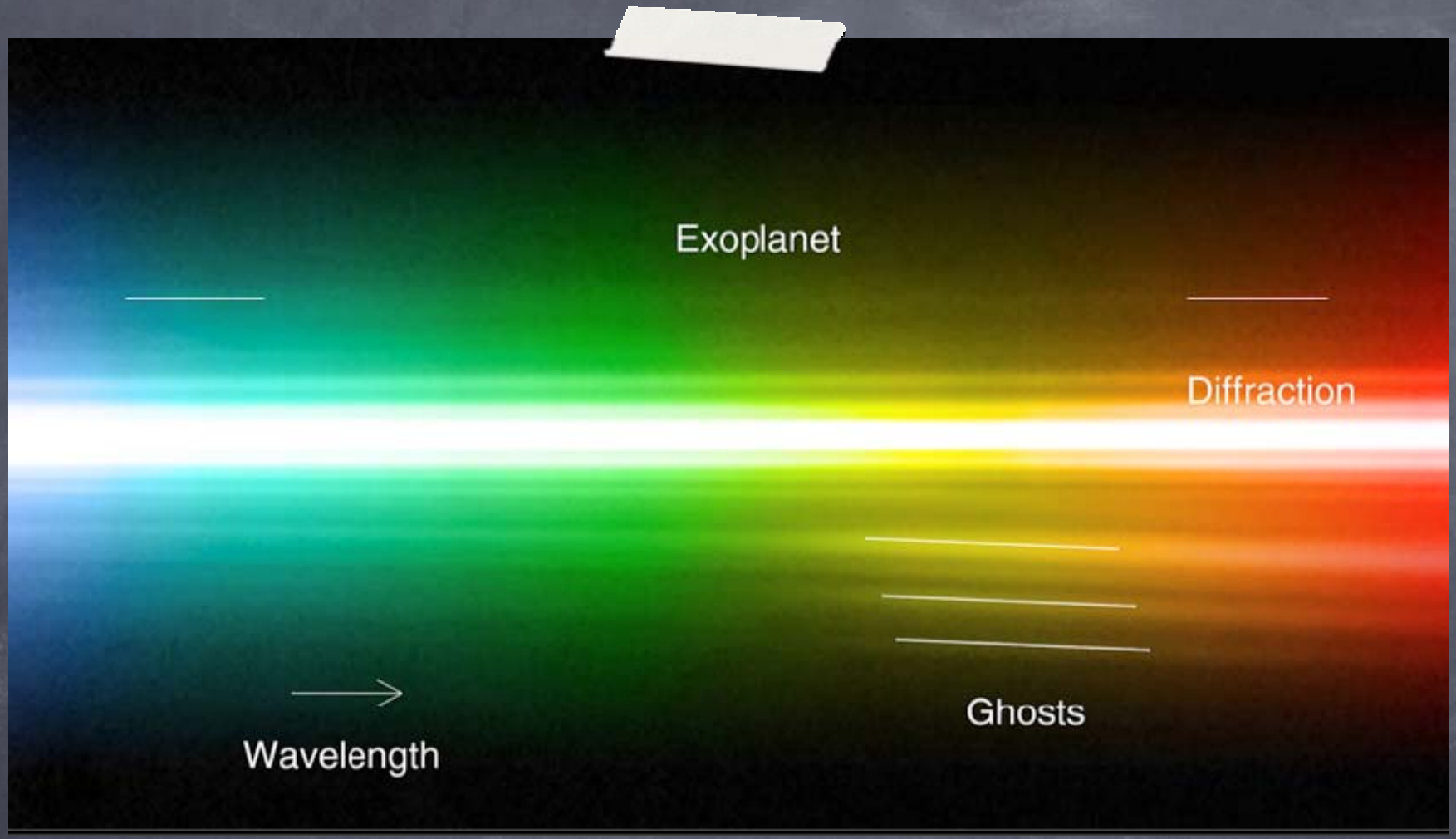
Extra-Extra....



HR 8799 in the sub-mm



HR 8799 (Marios et al.)



Spectra! (Janson, et al.)

Background ....

Glencoe District High School

GDHS

Some personal info...

- Show your work.
- Check the spelling.
- Redo you math.

And then...

- 4 years at University of Guelph (Theoretical Physics).
- 8 years at Queen's University (Kingston, ON) studying observational Astronomy.
- 4 years as a 'Postdoctoral Fellow' at McMaster University.
- Now a 'Senior' Research Officer with the National Research Council of Canada.

Yesterday....

- Taught a class on Planetary Science
- Discussed with 3 students their research projects (2nd, 3rd and 4th).
- Talked with one of my graduate students about a manuscript he has now submitted.
- Discussed operation of the Canadian Advanced Network for Astrophysics Research which is a project of the Canadian Astronomy Data Centre which is located at the Herzberg Institute for Astrophysics that is part of the National Research Council of Canada.
- Took my kids to see Avatar....

Astronomer

What is an Astronomer?

- Me!
- Curious about why things are they way they are.
- Enjoys the abstract, but from a practical perspective.
- Driven to solve problems, enjoys math and interaction with colleges.

What do they Study?

- Meteors, asteroids, comets, planets, disks of gas and dust, forming planets, normal stars, collapsing stars, extinct stars, black holes, associations of stars, clusters of stars, small galaxies, large galaxies, super massive black holes, super massive galaxies, groups of galaxies, clusters of galaxies, super clusters, clusters of clusters, cosmic structures, the big-bang, nucleosynthesis, general relativity, newtonian dynamics, cosmic chemistry...

- ...particles from the earlier universe, cosmic rays, dark matter, dark energy, material strength, optics, electronics, photonics, database systems, programming languages, applied mathematics, applied physics, engineering, astrobiology, interaction of light and matter.....

The Origin of Structure in the Universe.

The Solar System
and
Pluto

The Planets

Terrestrial

- Mercury
- Venus
- Earth
- Mars

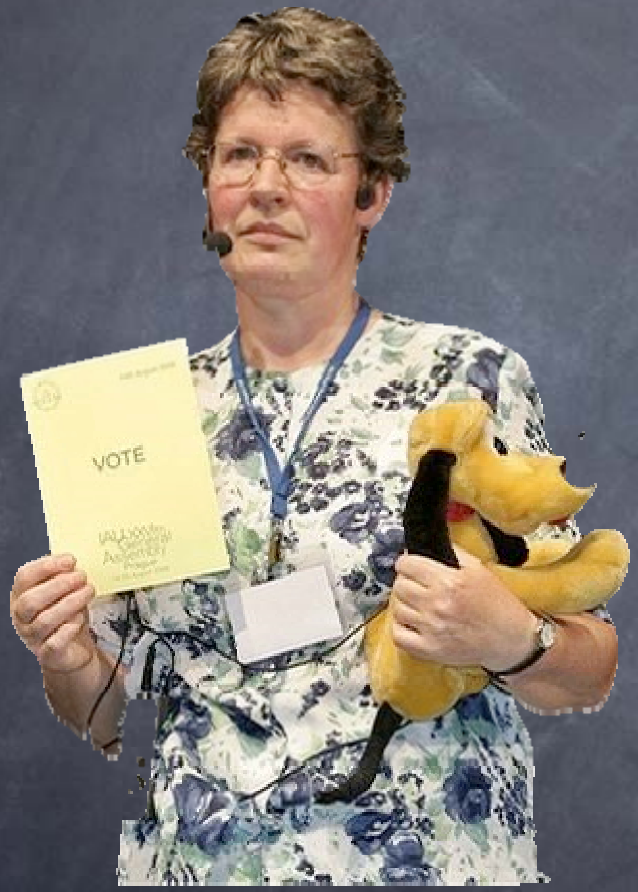
The Asteroid Belt...

Giants

- Jupiter
- Saturn
- Uranus
- Neptune

- ~~Pluto~~

The Vote…



A few voted against

Many voted for

A "classical planet" is a body that,

is in **orbit around the Sun**,

*has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (***nearly round***) shape, and*

has cleared the **neighbourhood around** *its orbit*

A "dwarf planet" is a body that,

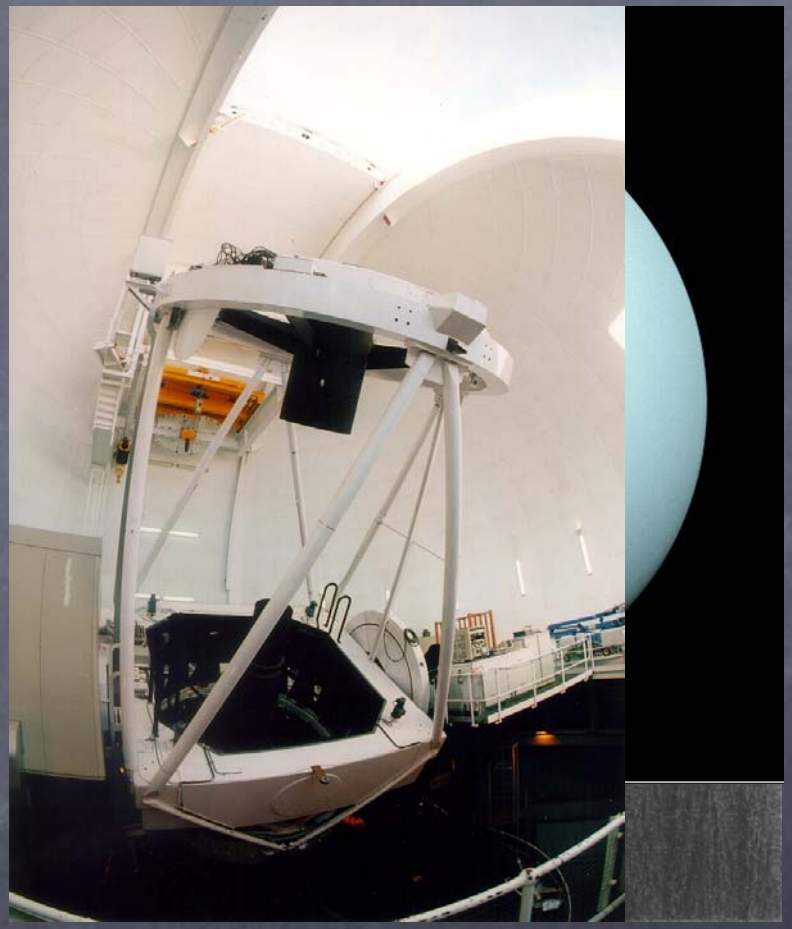
(a) is in orbit around the Sun,
*(b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (***nearly round***) shape,*
(c) has not cleared the neighbourhood around its orbit, and
(d) is not a satellite.


www.drdale.com

Less Recent History

Sir William Herschel

- Discovered Uranus: 13 March 1781
- Instrument: 7 ft reflector



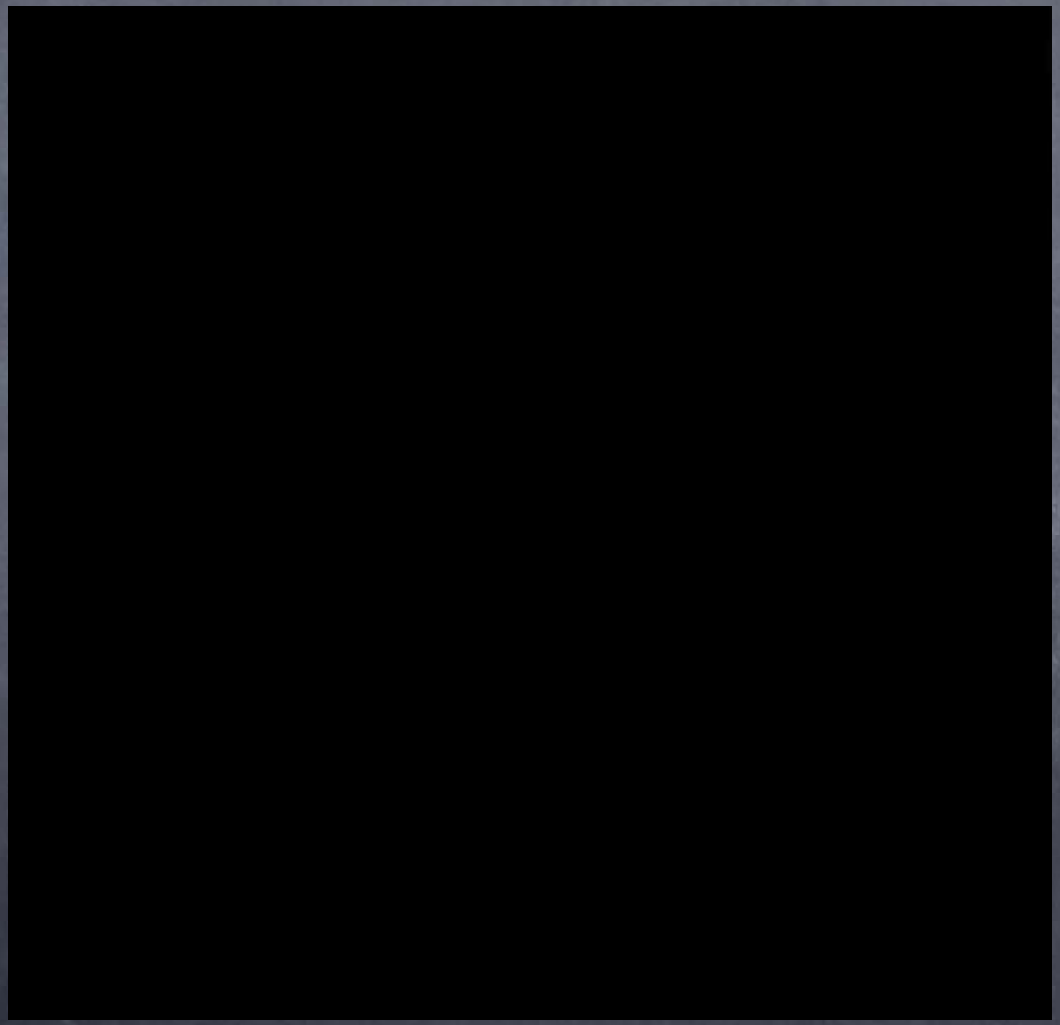
JC Adams
U-J-J Le Verrier

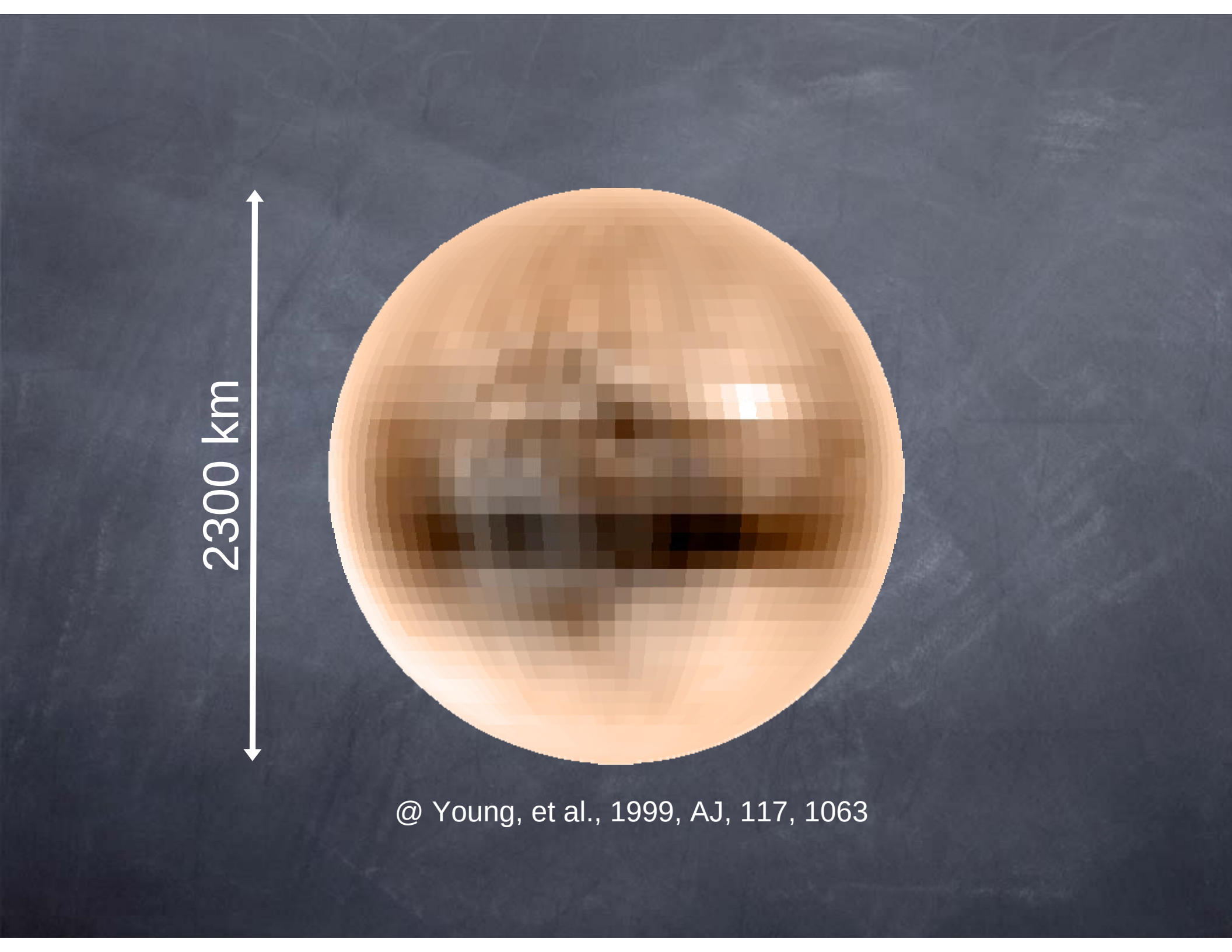
- Position computed by Adams and Le Verrier
- First observed by Galle and d'Arrest Sept 23, 1846

Clyde Tombaugh 1906-1997

- 9th planet predicted based on Uranus and Neptune
- ephemeris errors that were errors....

Crazy Rotating Frame





@ Young, et al., 1999, AJ, 117, 1063

What angular size is each pixel in the image?

5 000 000 000 km

50 km

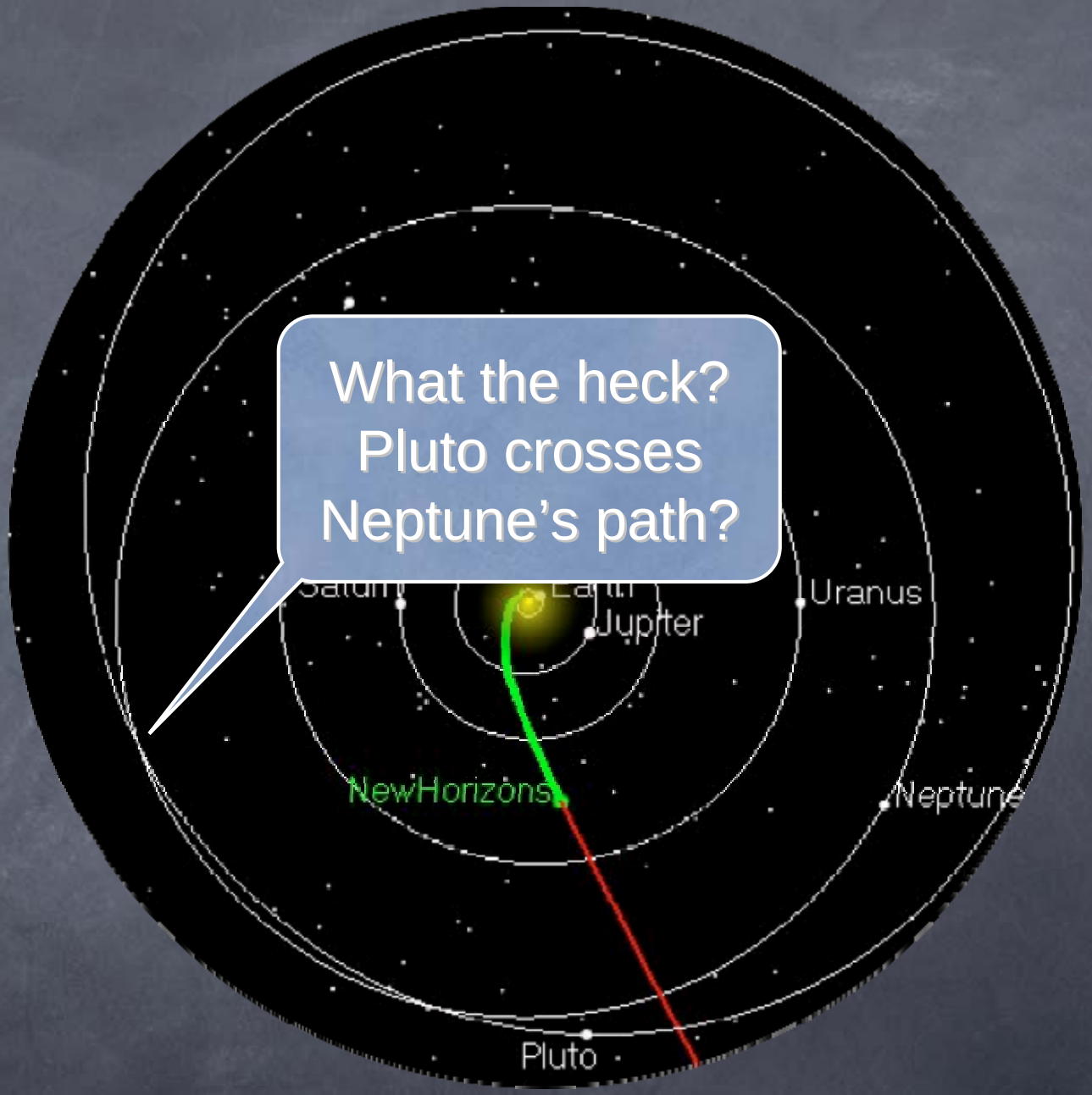
$\Omega = 50/5E9 = 1E\text{-}8$ radians = 0.002 arcsec

cf. 206265'' / radian

The width of strand of hair seen from the back of the classroom.

New Horizons Launch,
Kennedy Space Flight Center
Florida, 19-Jan-2006

@NASA



@JHUAPL

Science Goals

The Short Life of a Comet

- Oort Cloud
- Edgeworth-Kuiper Belt

Edgeworth, Kuiper, Fernandez or Ip?

- Edgeworth wrote in his 1949 notes that received very little reading.
- Kuiper suggested there must be source of comets in a paper in 1952.
- 1982 Fernandez and Ip demonstrated that this area works as the source of comets.

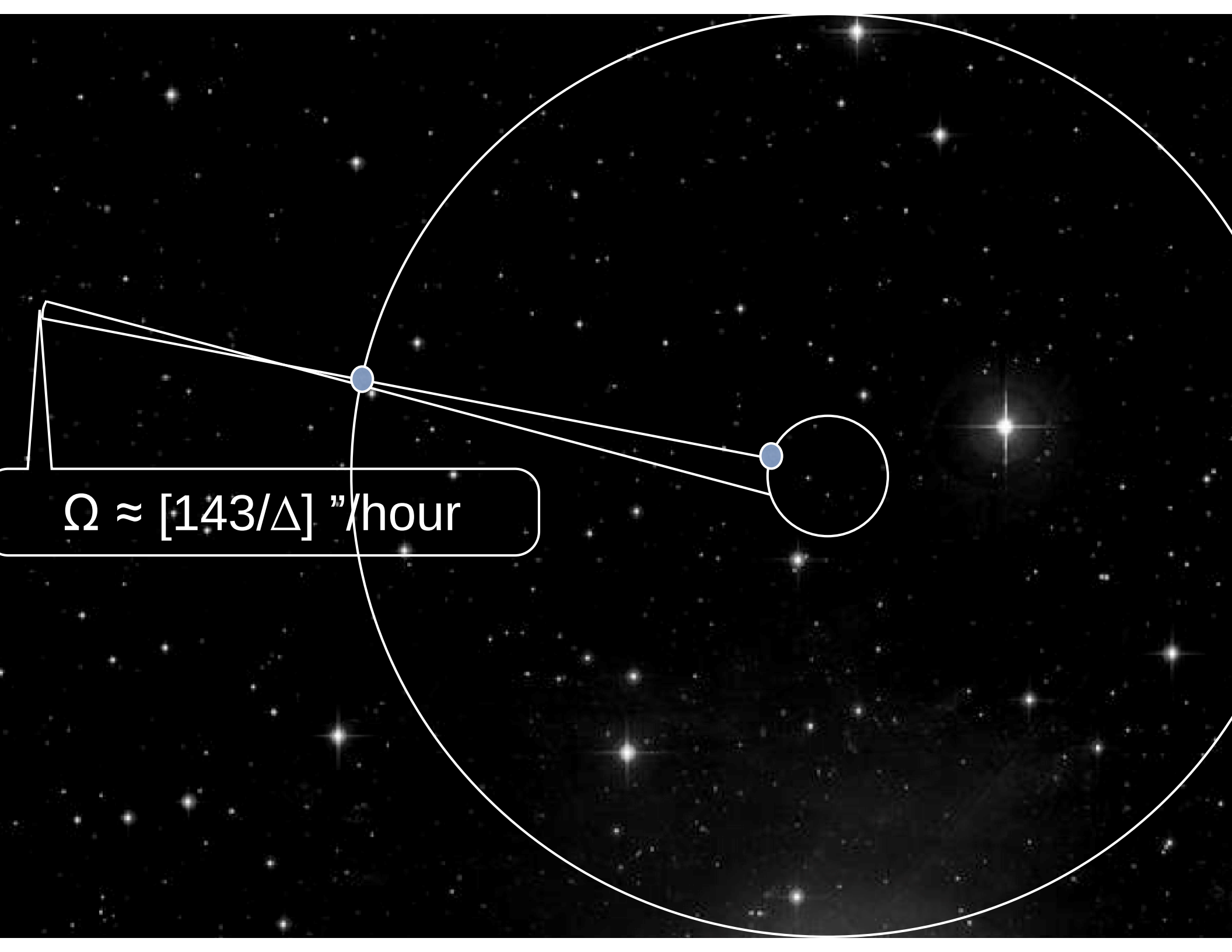
- Orbital evolution of the giant planets.
- Formation time-scale.
- Delivery of Earth’s water.
- Clues to life elsewhere.

Sample Collection.

Mauna Kea Ridge Line

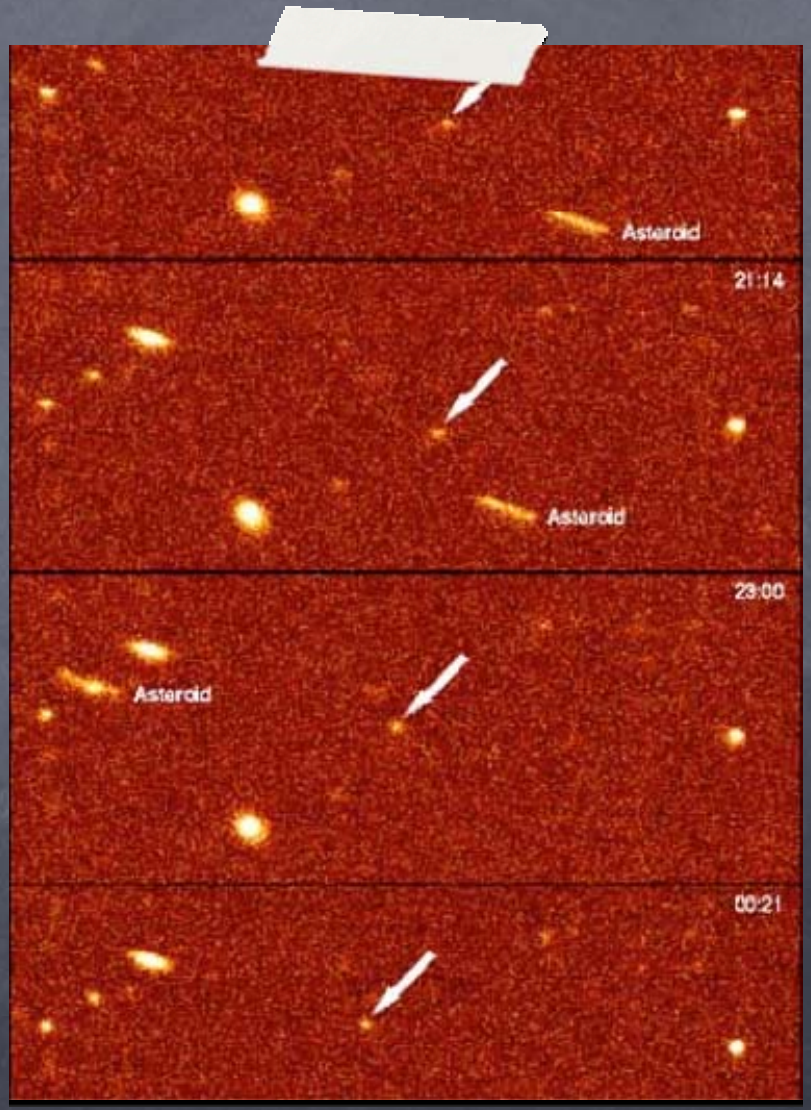
L2 Flip

Morning Ice


Ω ≈ [143/Δ] ”/hour

Jewitt and Luu?

- Discovery in 1991 of the objet now known as 1992 QB_1
- Followed by an avalanche of discoveries
- One known in 1992, 1500 known today.



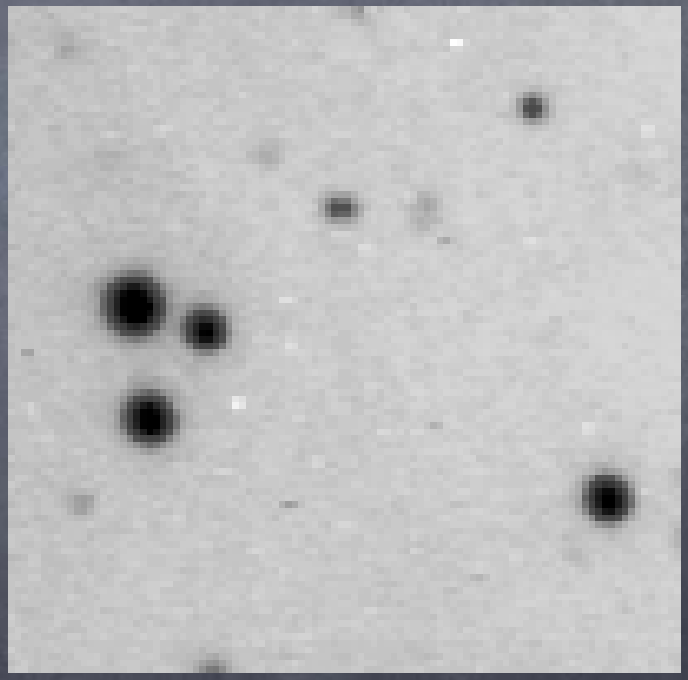

1998 WH_{24}
1999 KR16
1994 GV_9
1994 VK_8
1994 TB
2000 EB173
1997 CR_{29}
1993 SB
2000 EB173
1998 VG44
1995 DA_2
1992 QB_1
1994 TB
1999 HX11
1999 HX11
1993 SC
2002 LM60
1996 TP_{66}
1994 JS
1994 JQ_1
1996 SZ_4
1994 JR_1
1996 TO_{66}
1997 CU29
2000 GN171
1998 SN165

The Current Picture

at most part of it.

The Kuiper belt.. 2009

- 25-40% of objects are in a resonance
- 15% or so confined to a thin disk
- 15% or so in a thick disk.
- remainder scattering of Neptune



Binary KBOs

- about 10% of the ‘thin’ disk objects are binary
- the current number density of the belt is too low to form such binaries
- the primordial density was much higher

The curious case of QW322

- separation is 4” at 40 AU: about 100,000 km
- Each member of the pair is about 200 km diameter and have masses of about 41000 kg