Astronomy 1050: Survey of Astronomy

Instructor: Dr. Rajib (Rah-jeeb) Ganguly

TAs: Mark Reiser, Dan Lyons

SI: Jacquelyn Wolfgang

Who are we?

- Rajib Ganguly
  - PhD Astronomer
  - ``Research Scientist'' (growth of black holes, formation of galaxies)
- Mark Reiser
  - Former grad student in Astronomy
- Dan Lyons
  - Former undergrad in Astronomy
  - Grad student in Astronomy Education Research
- Jacquelyn Wolfgang
  - Undergrad in Education
  - Stellar student in Astro 1050 from Spring ‘08

Today's Plan: Where's the Syllabus?

- Diagnostic Survey
- Popsicle sticks
- Office Hours – Five options, choose two
  - M 10-11AM, T 4-5PM, W 2-3PM, F 9-10AM, F 4-5PM
- Expectations for course
  - Write down three things you want to learn
  - Add in anything from the tour

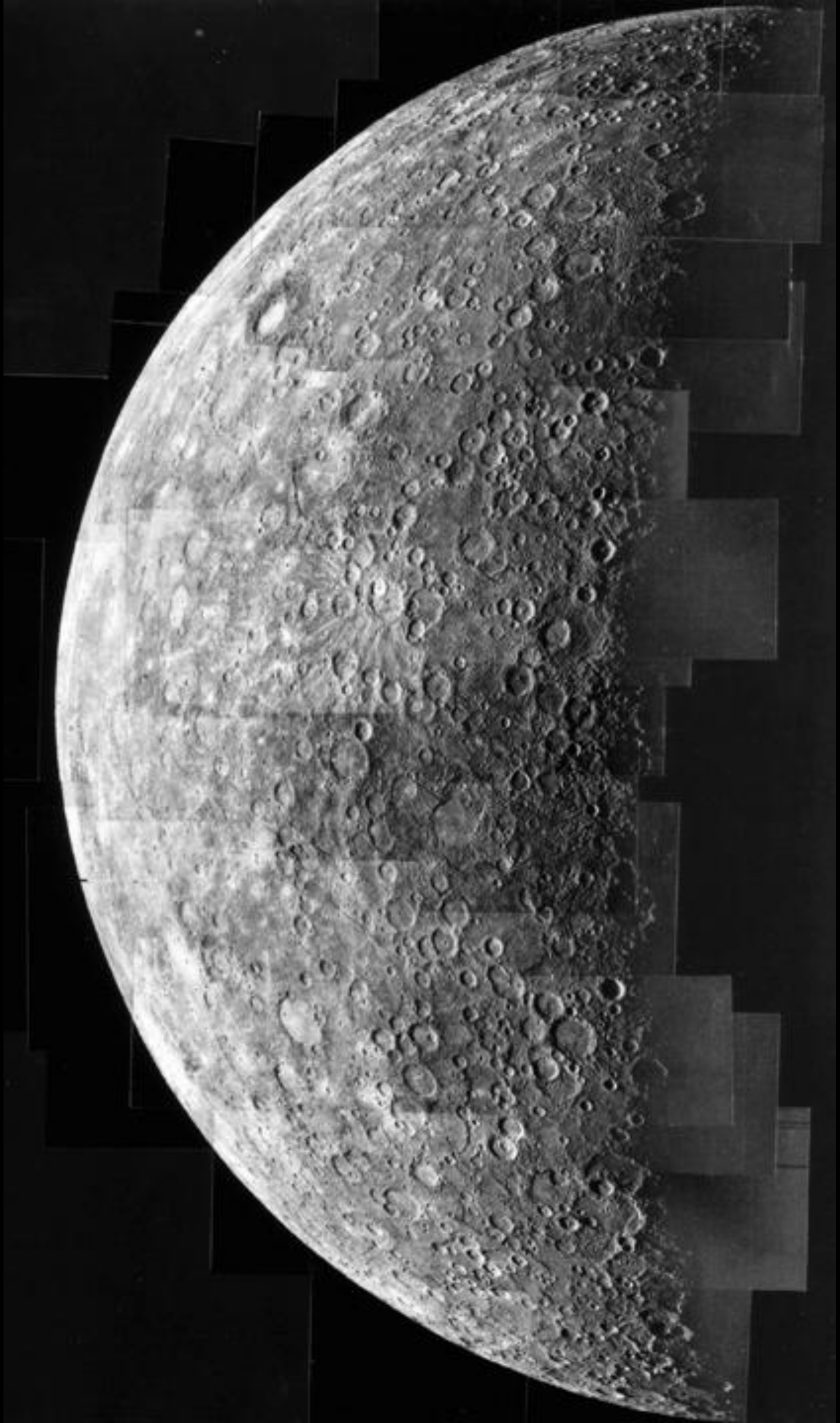
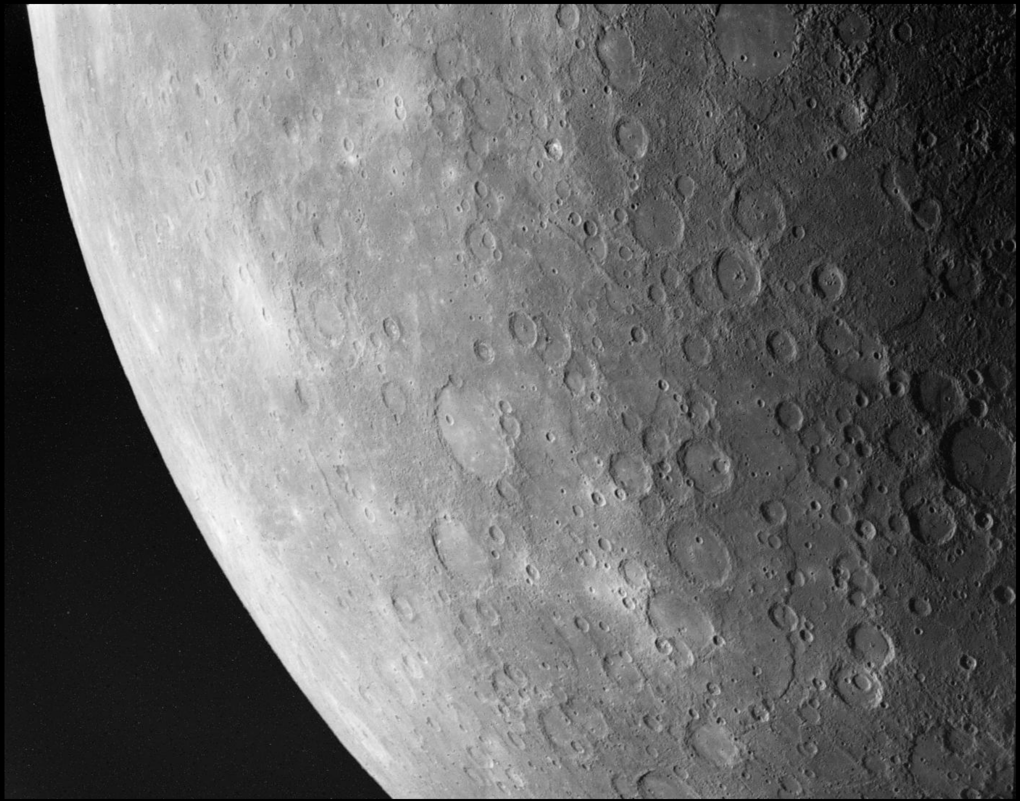
Night Sky over Mauna Kea w/ Moon and Venus

View of Earth from the International Space Station

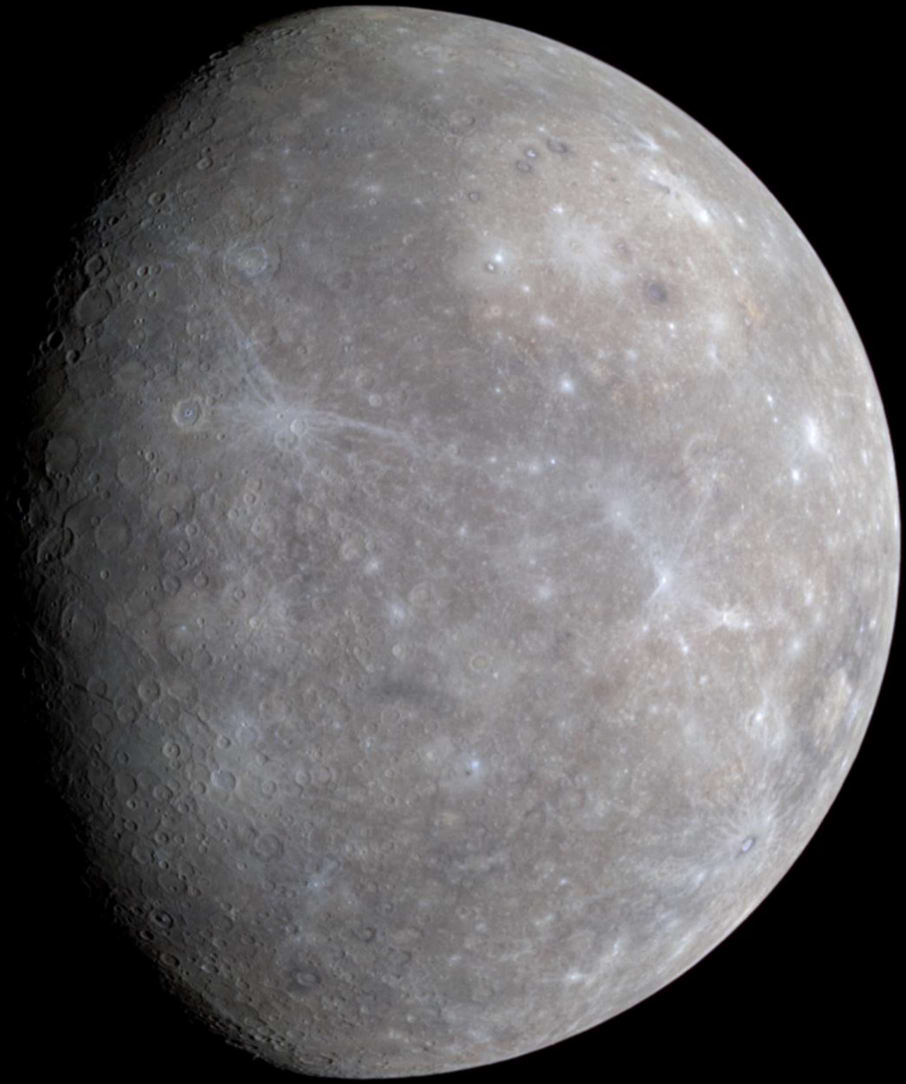
… from the Apollo 17 astronauts POV

Moon/Luna/Lune/Chand

Sun/Sol

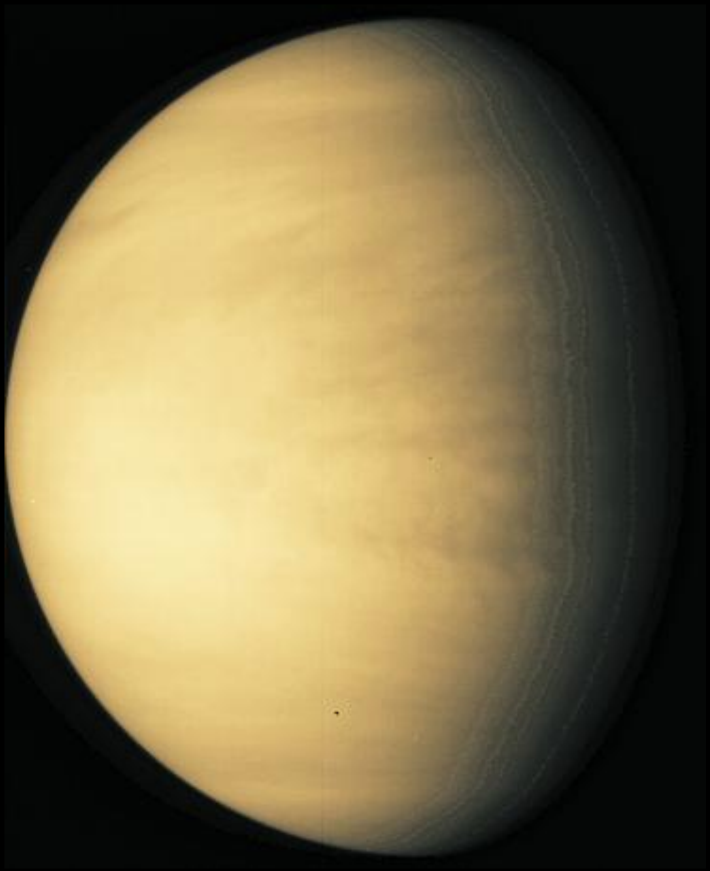



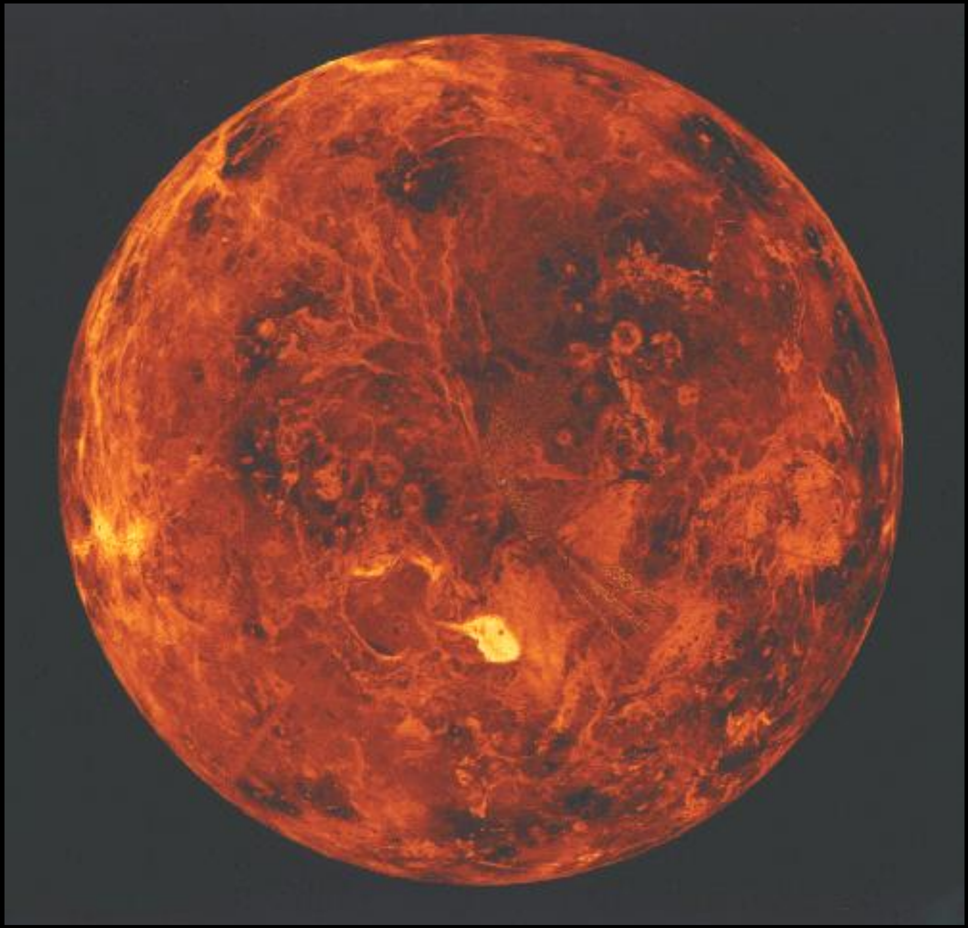
Mercury courtesy of Mariner 10

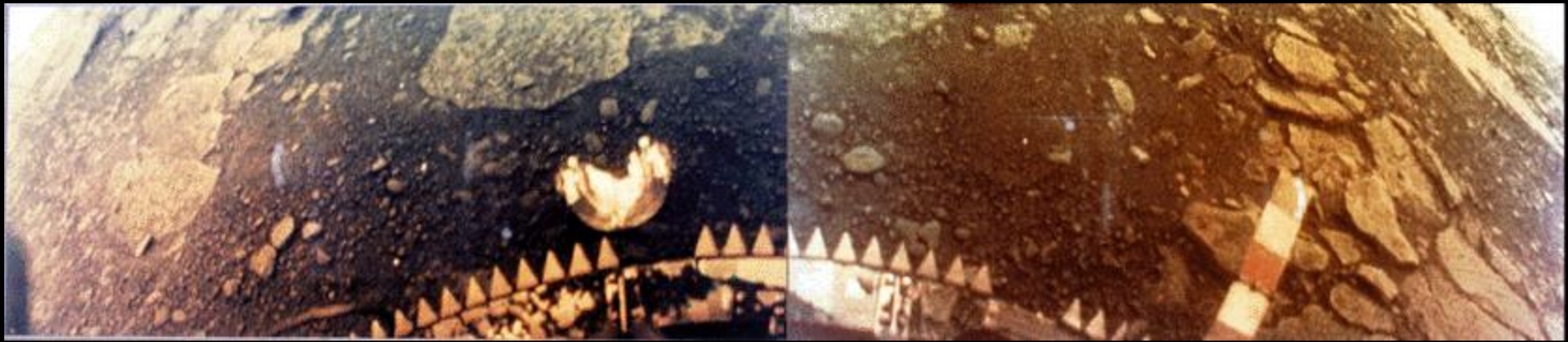


Mercury courtesy of Messenger

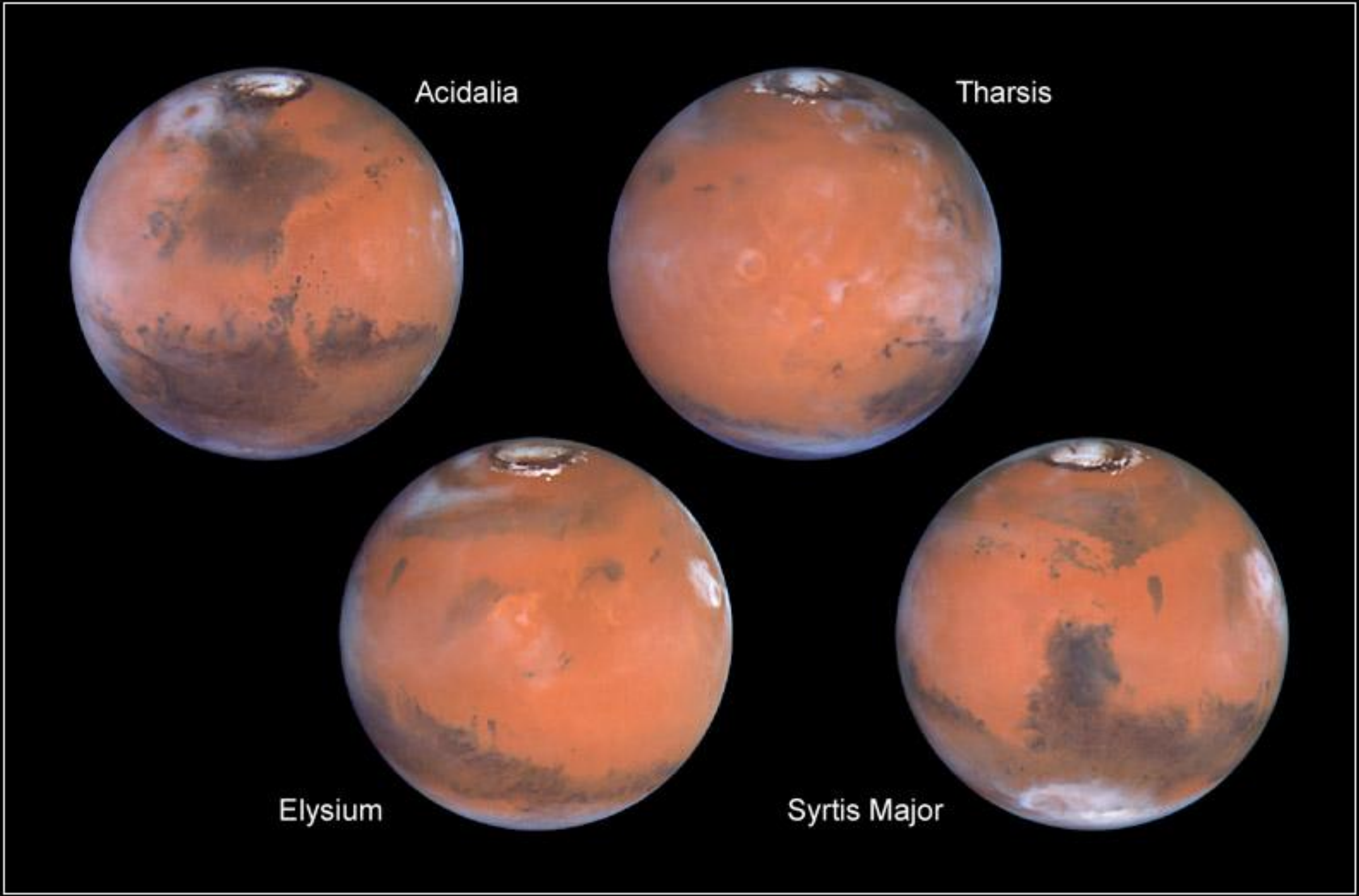
Venus… hot, muggy, unpleasant







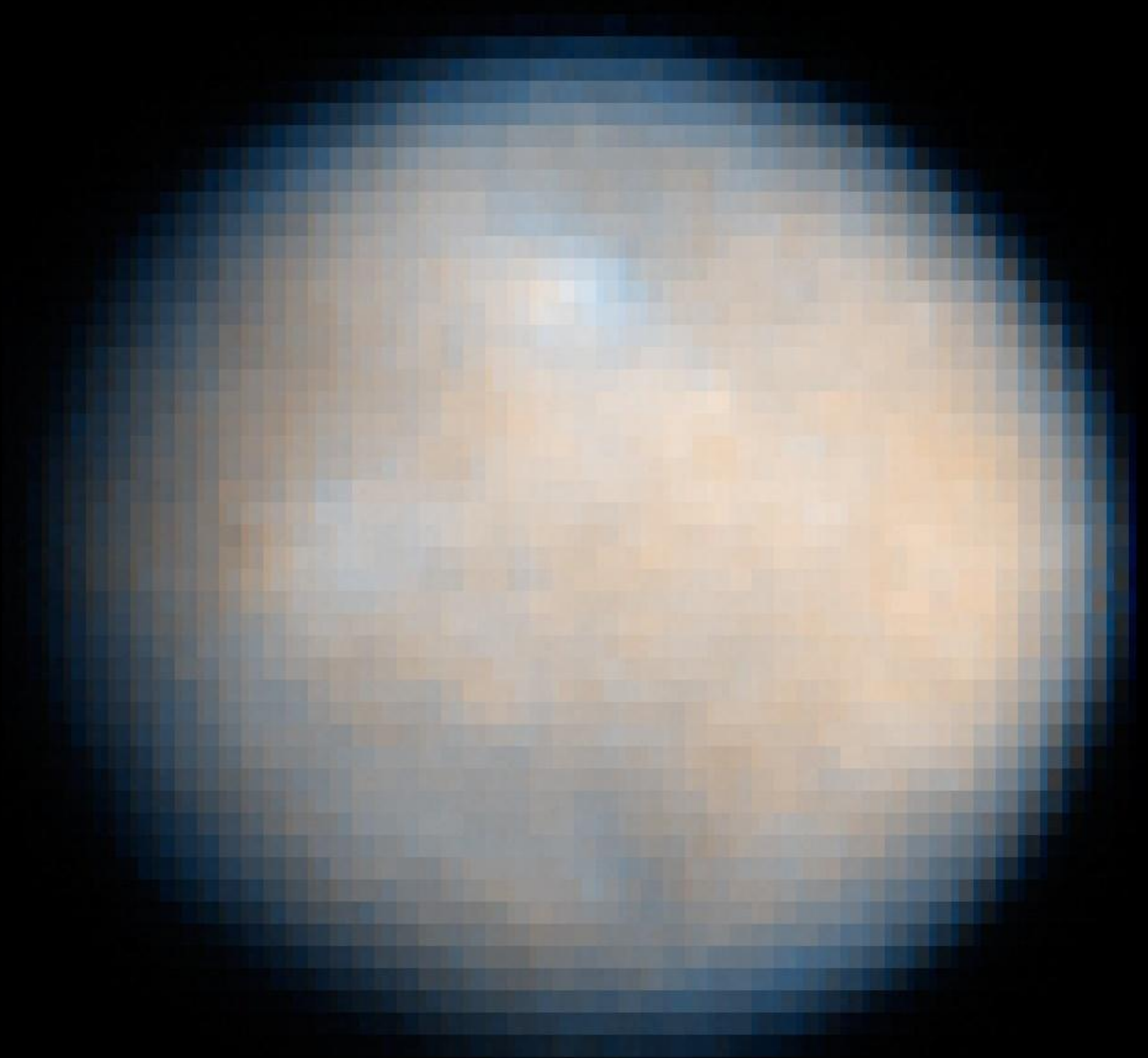
… from the Terra EOS satellite



Mars • April-May 1999 **HST • WFPC2**

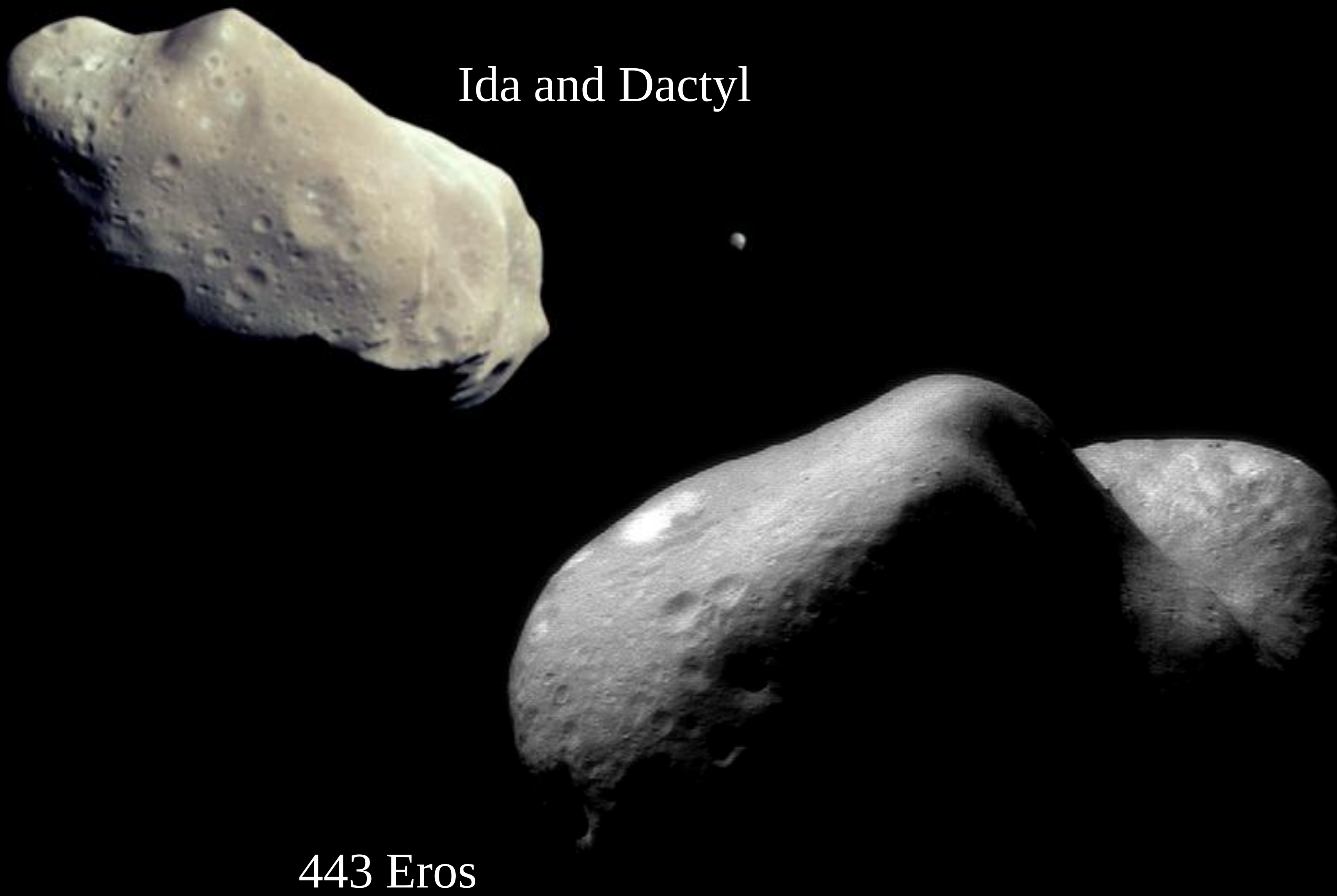
PRC99-27 • STScI OPO

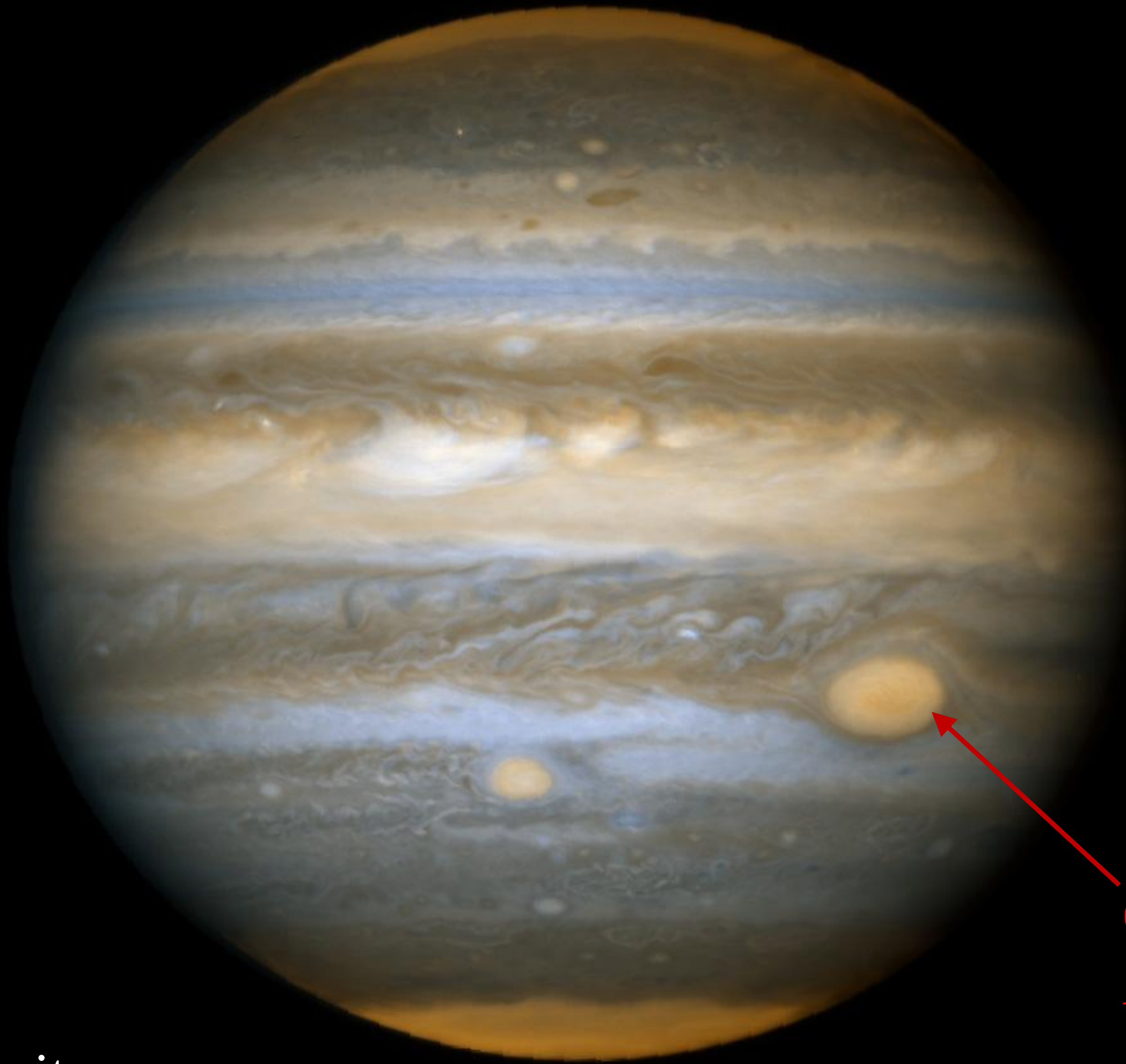
S. Lee (University of Colorado), J. Bell (Cornell University), M. Wolff (Space Science Institute) and NASA



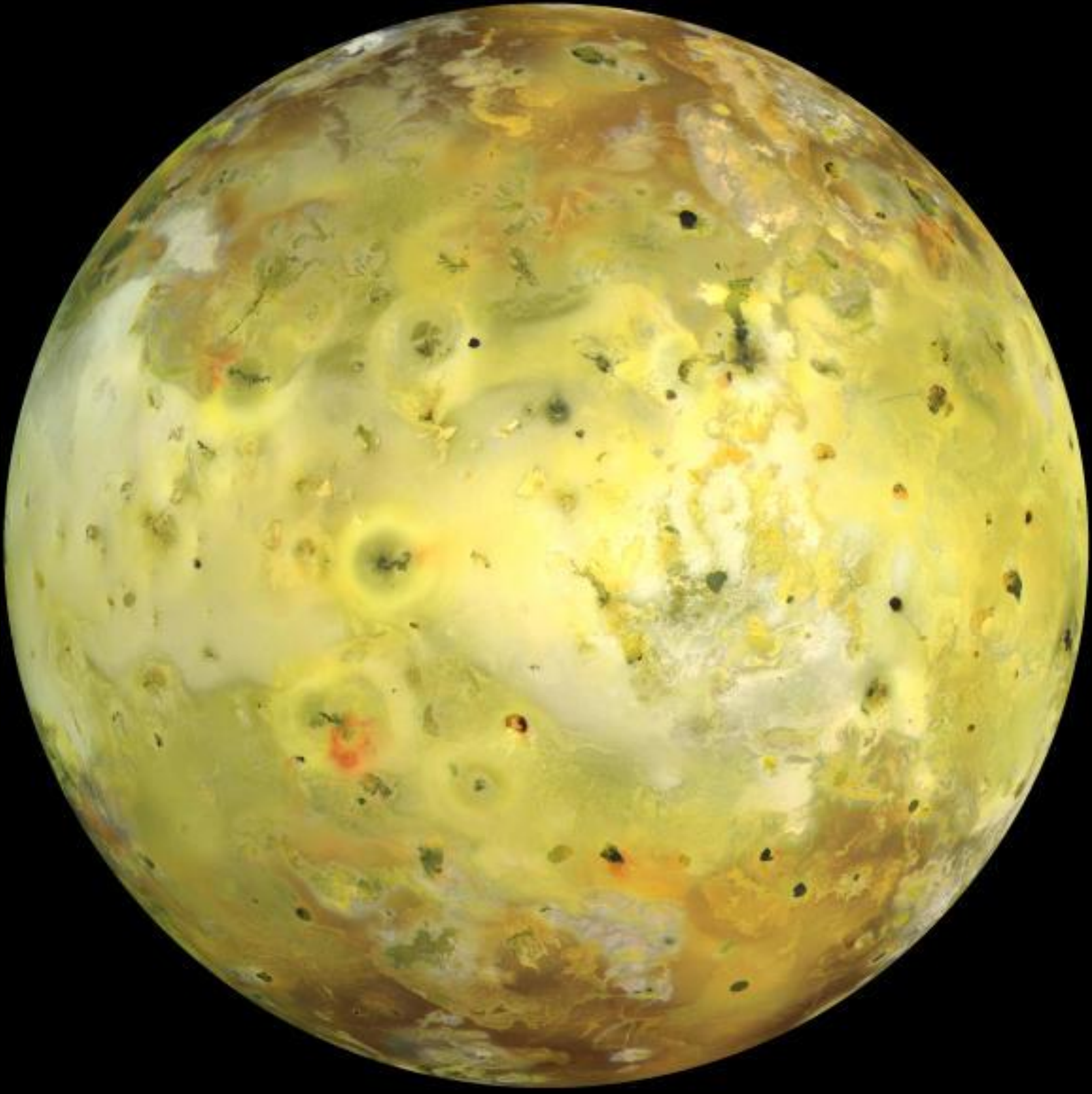
Ceres viewed by Hubble

4 Vesta as viewed by Hubble…


Ida and Dactyl
443 Eros

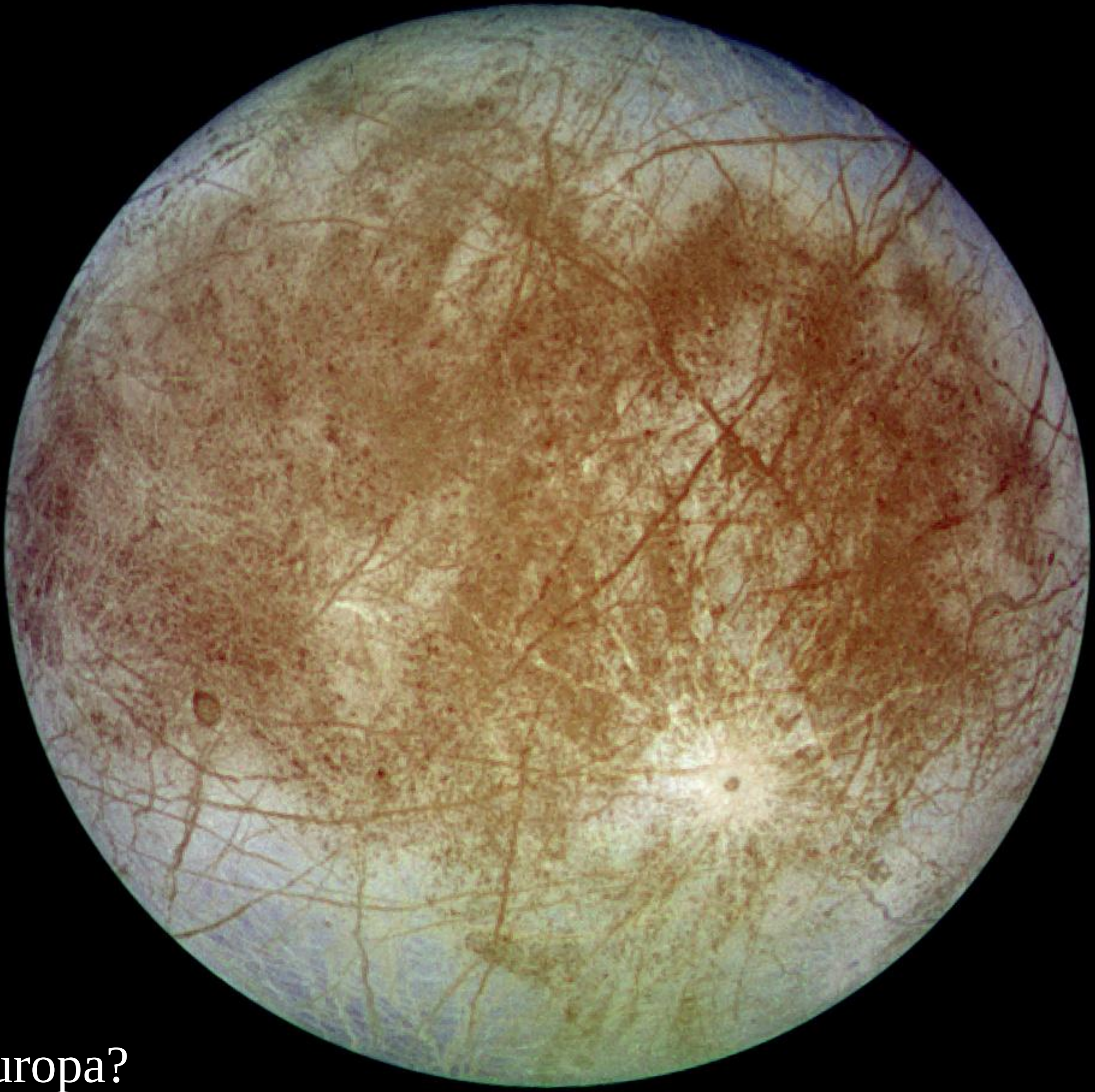


Jupiter



Io

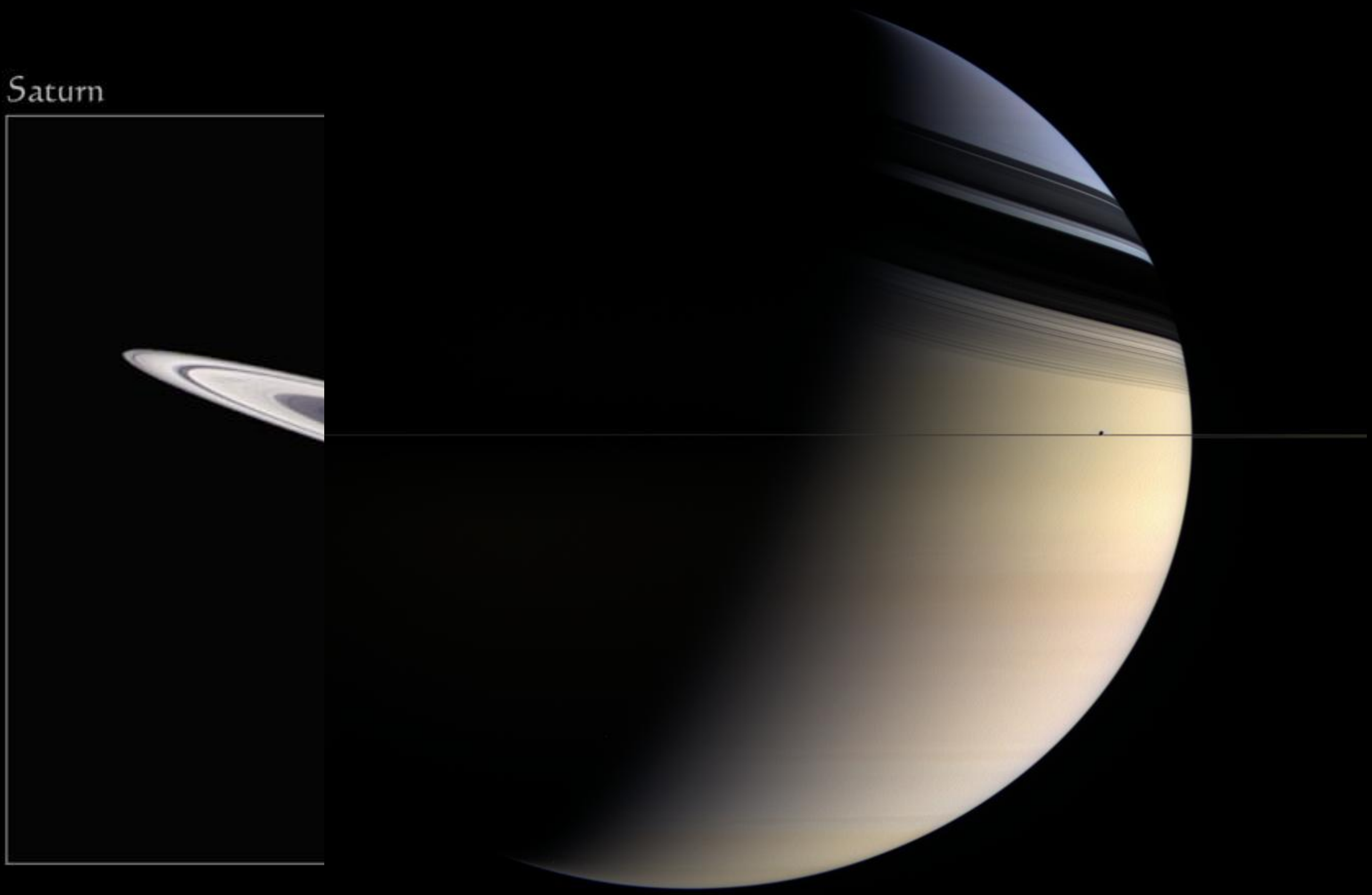
Callisto



Life on Europa?

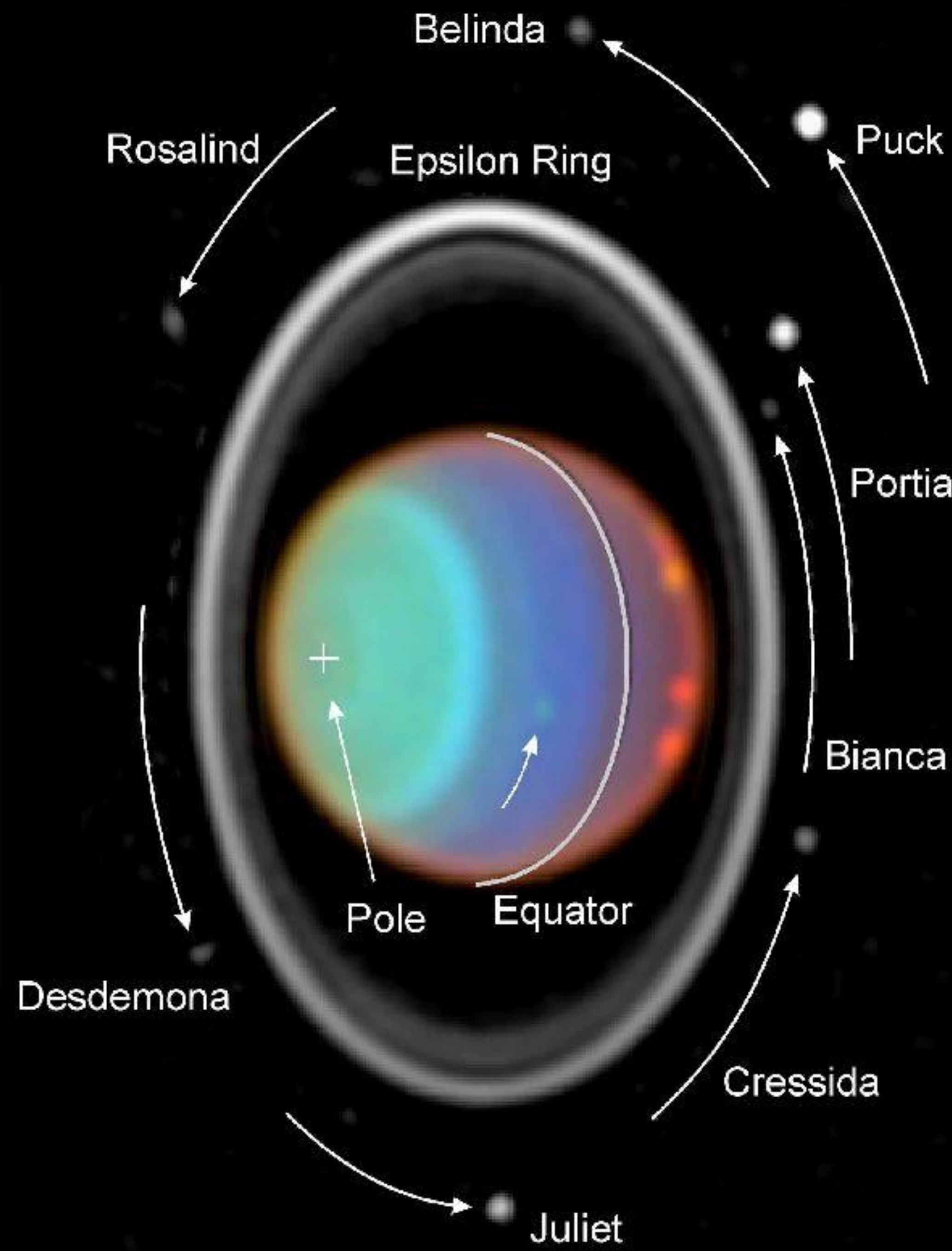
Big, bad Ganymede

Saturn



PRC98-29 • Space Telescope Science Institute • Hubble Heritage Team

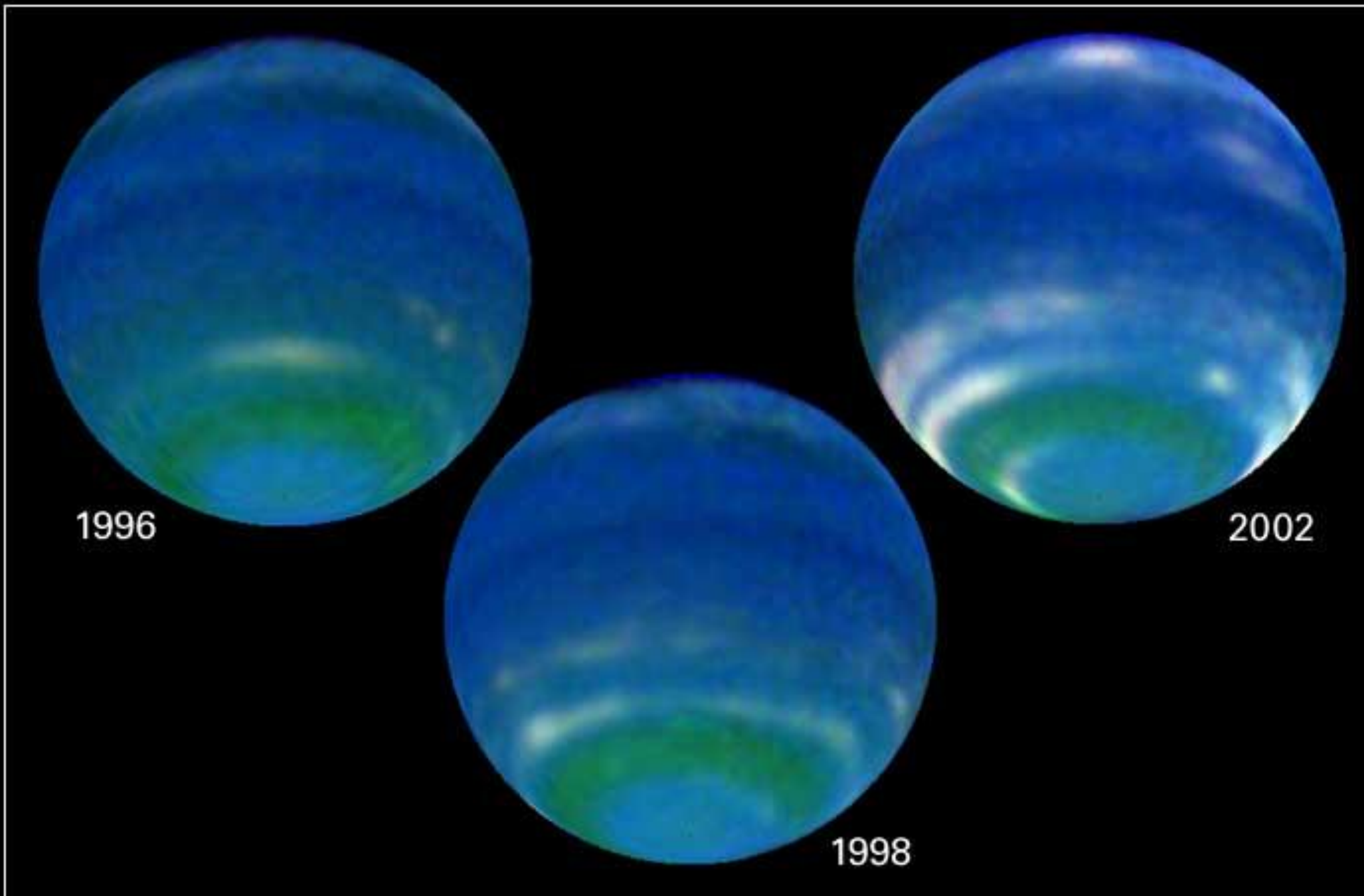

Dione
Hyperion
Epimetheus
Iapetus



Belinda
Puck
Rosalind
Epsilon Ring
Portia
Bianca
Pole
Equator
Desdemona
Cressida
Juliet

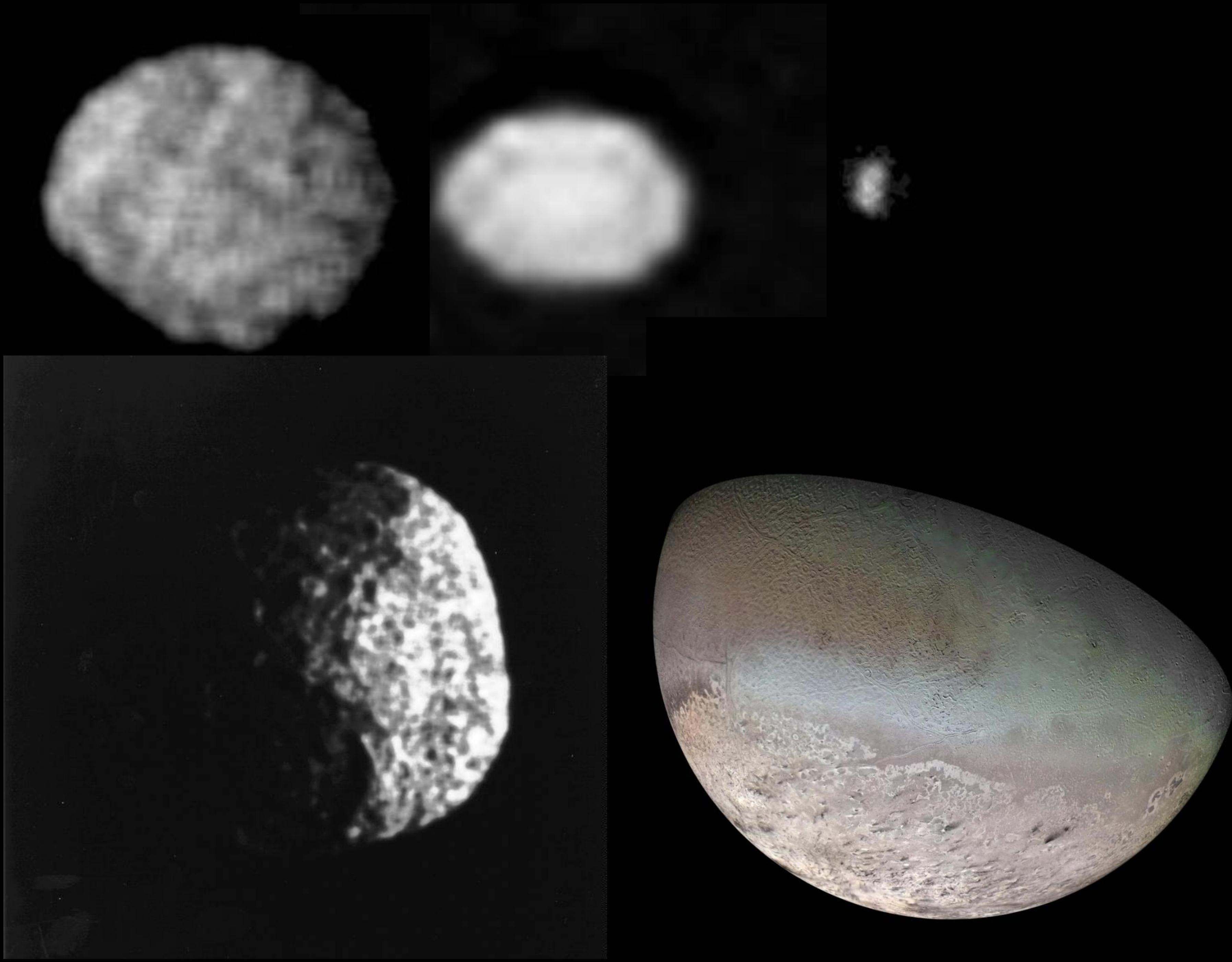
Neptune

Hubble Space Telescope ▪ WFPC2

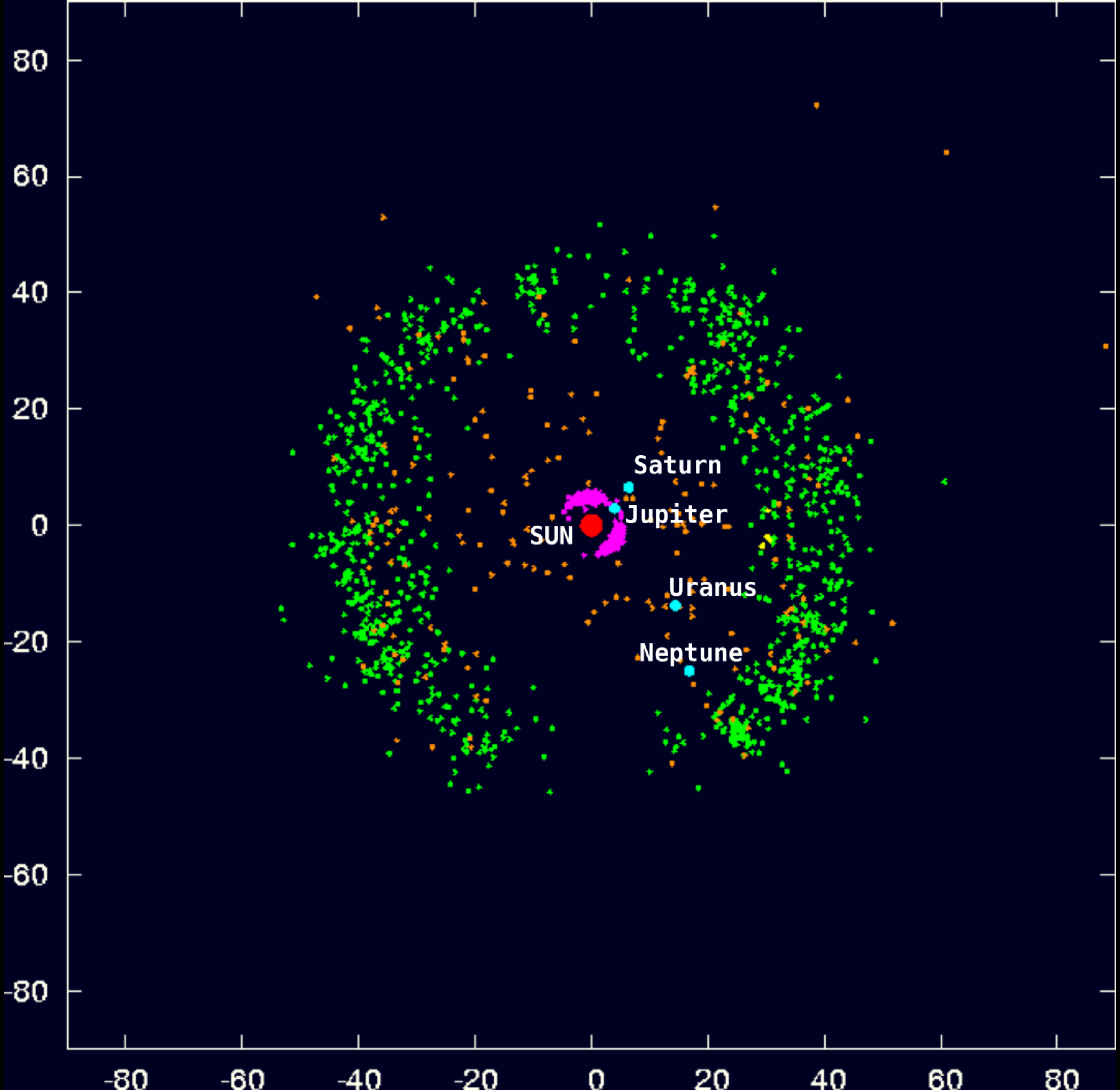


NASA, L. Sromovsky and P. Fry (University of Wisconsin)

STScI-PRC03-17

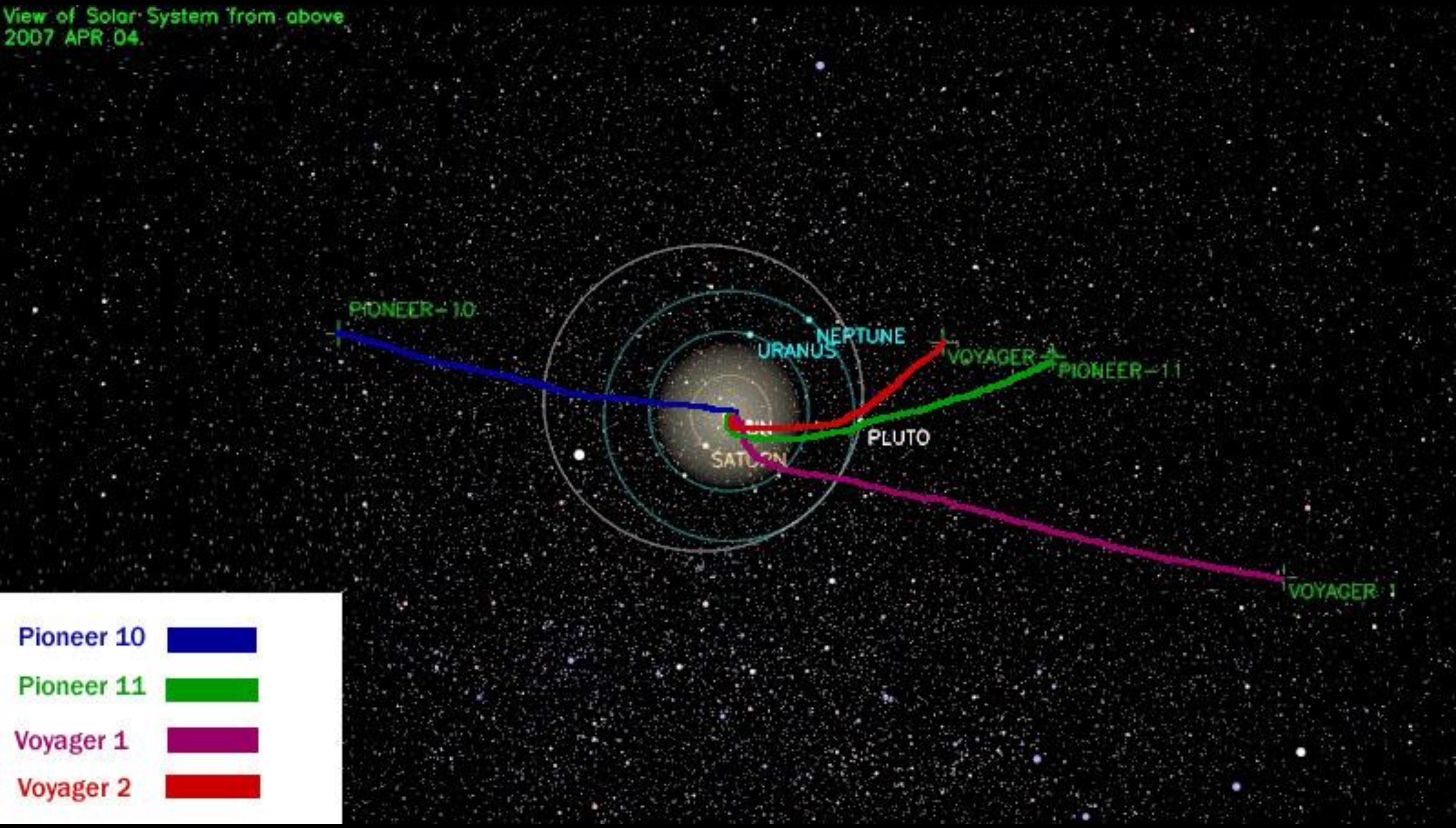


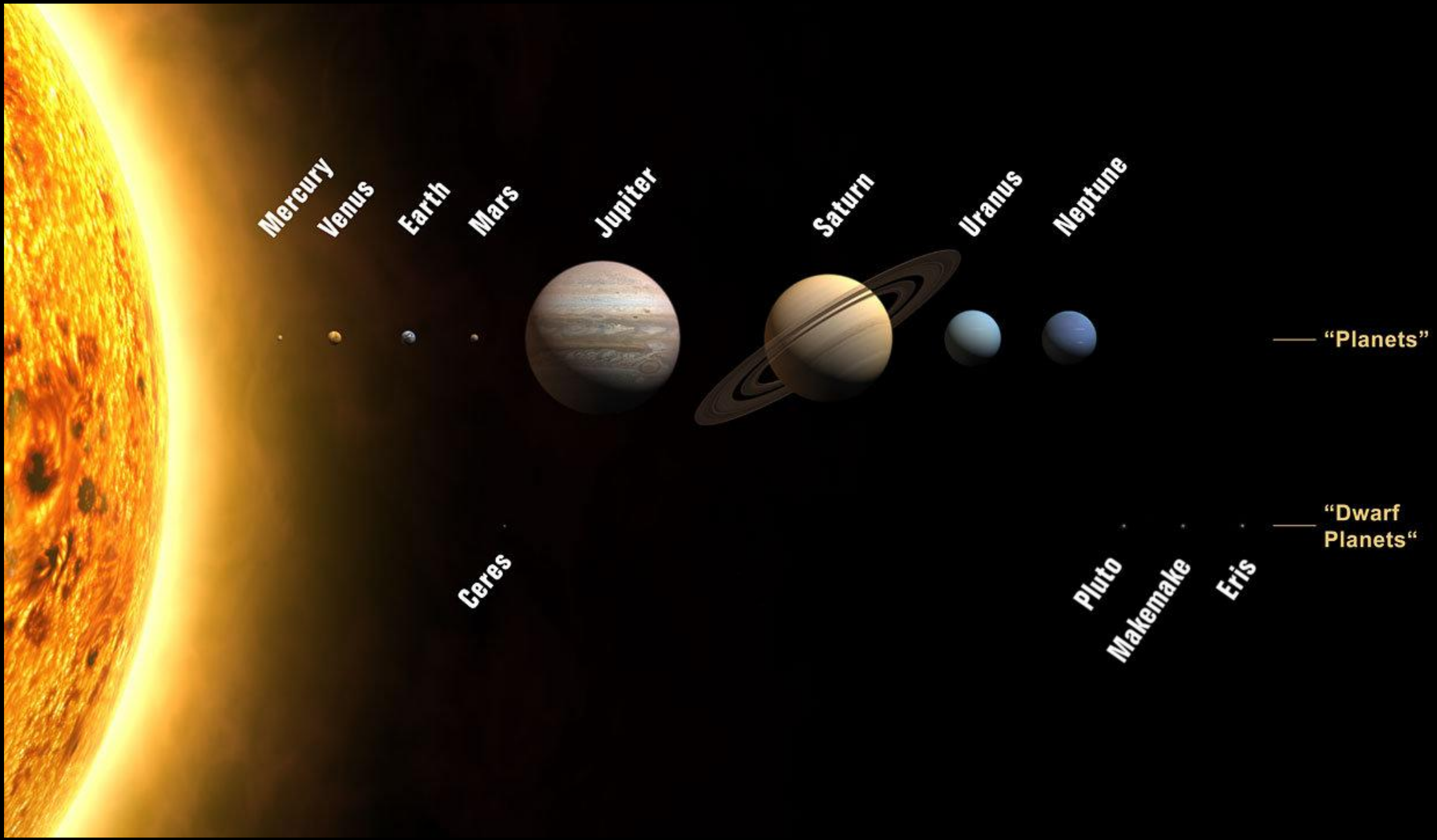

Pluto
Nix
Hydra
Charon



Saturn
Jupiter
SUN
Uranus
Neptune
80
60
40
20
0
-20
-40
-60
-80

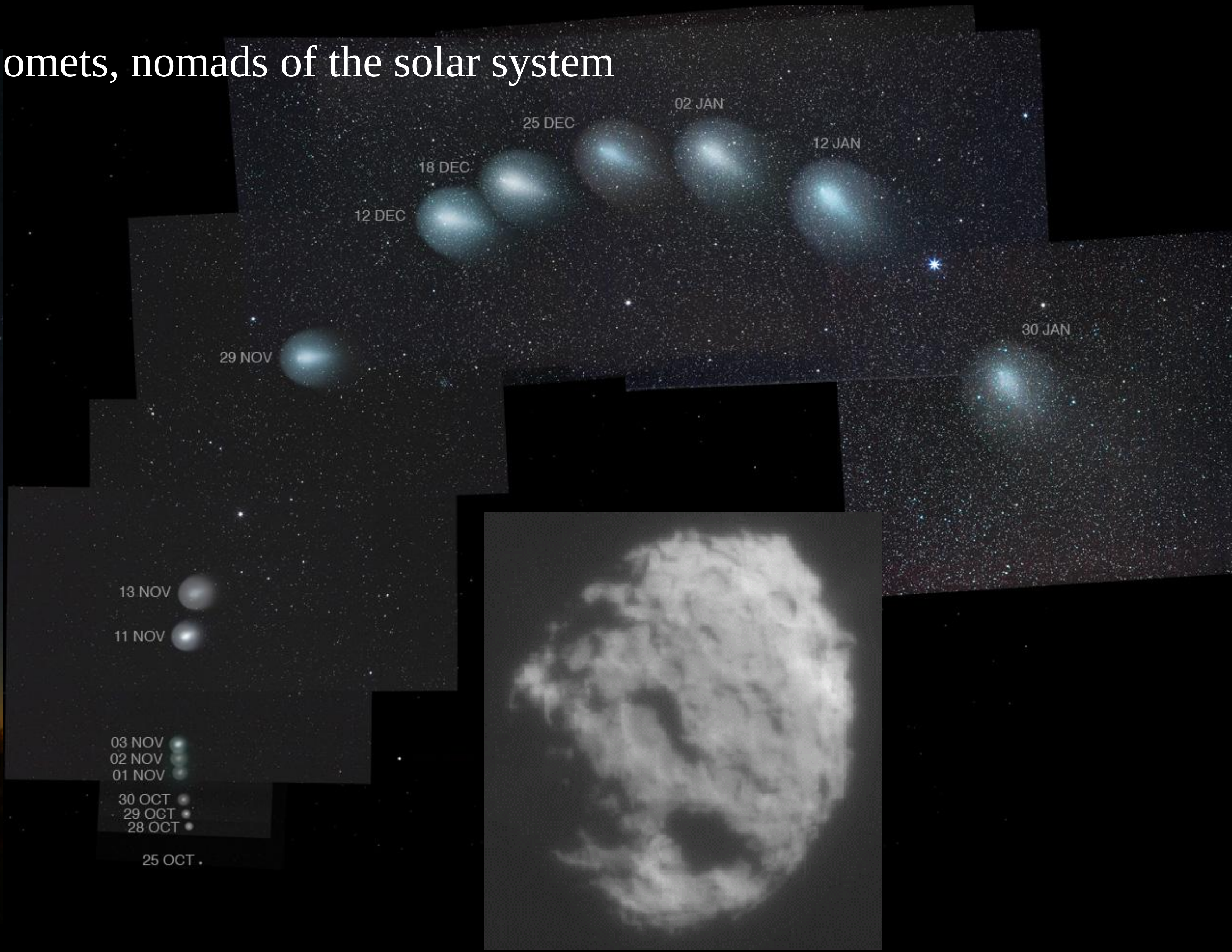
Largest known trans-Neptunian objects (TNOs)

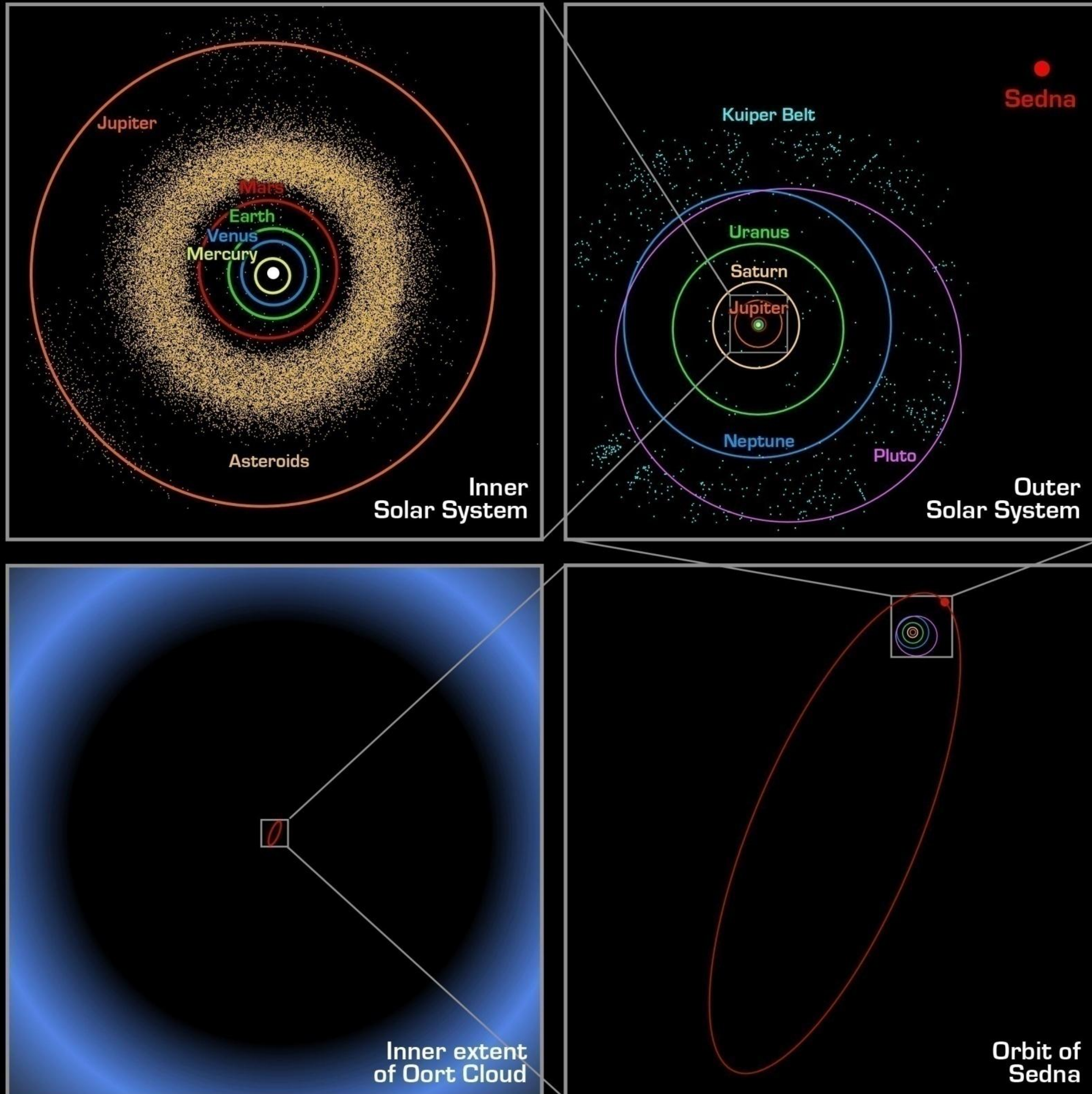

View of Solar System from above
2007 APR 04
PIONEER-10
NEPTUNE
URANUS
VOYAGER-2
PIONEER-11
PLUTO
SATURN
VOYAGER-1
Pioneer 10
Pioneer 11
Voyager 1
Voyager 2



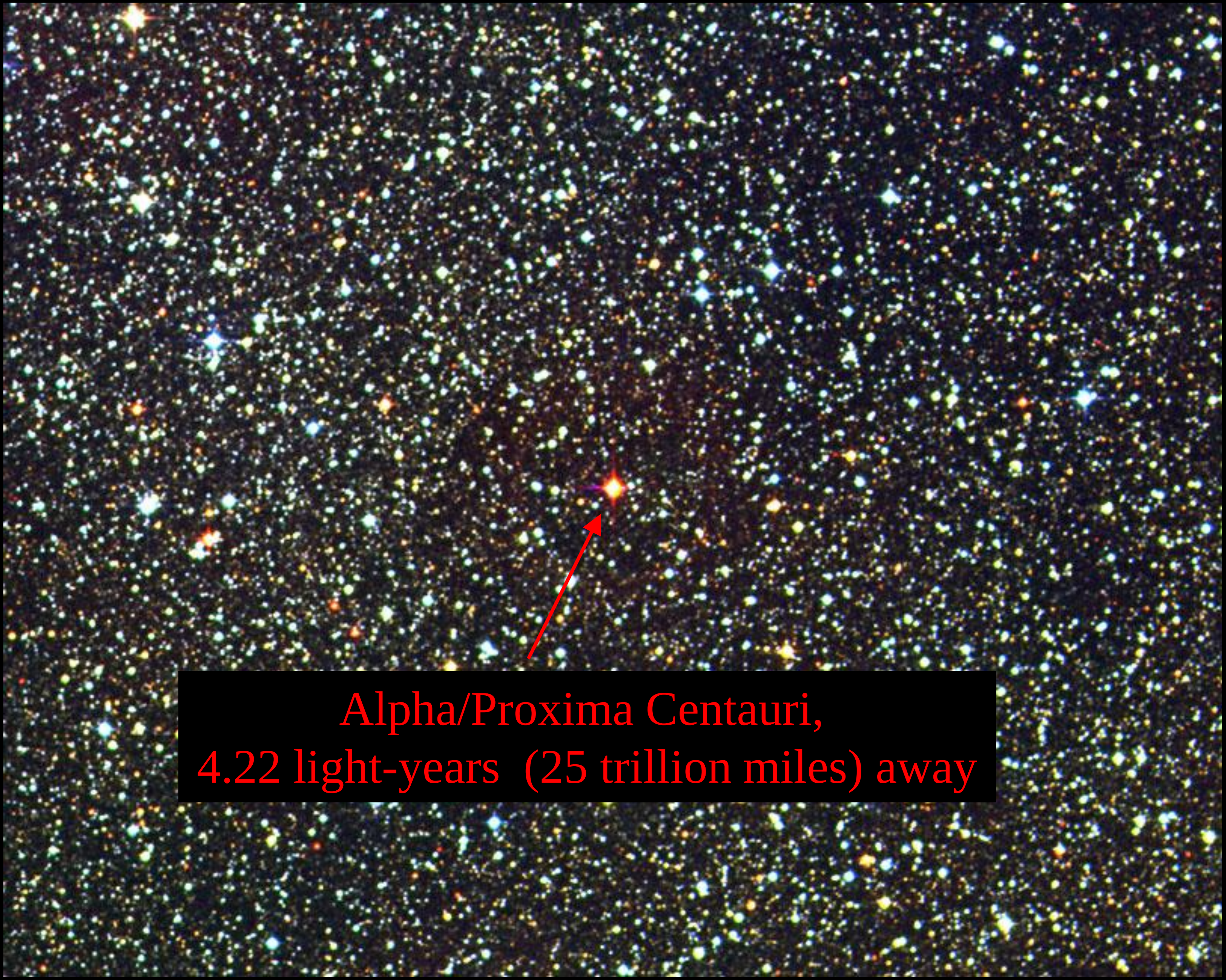
Solar System (as of 2008)

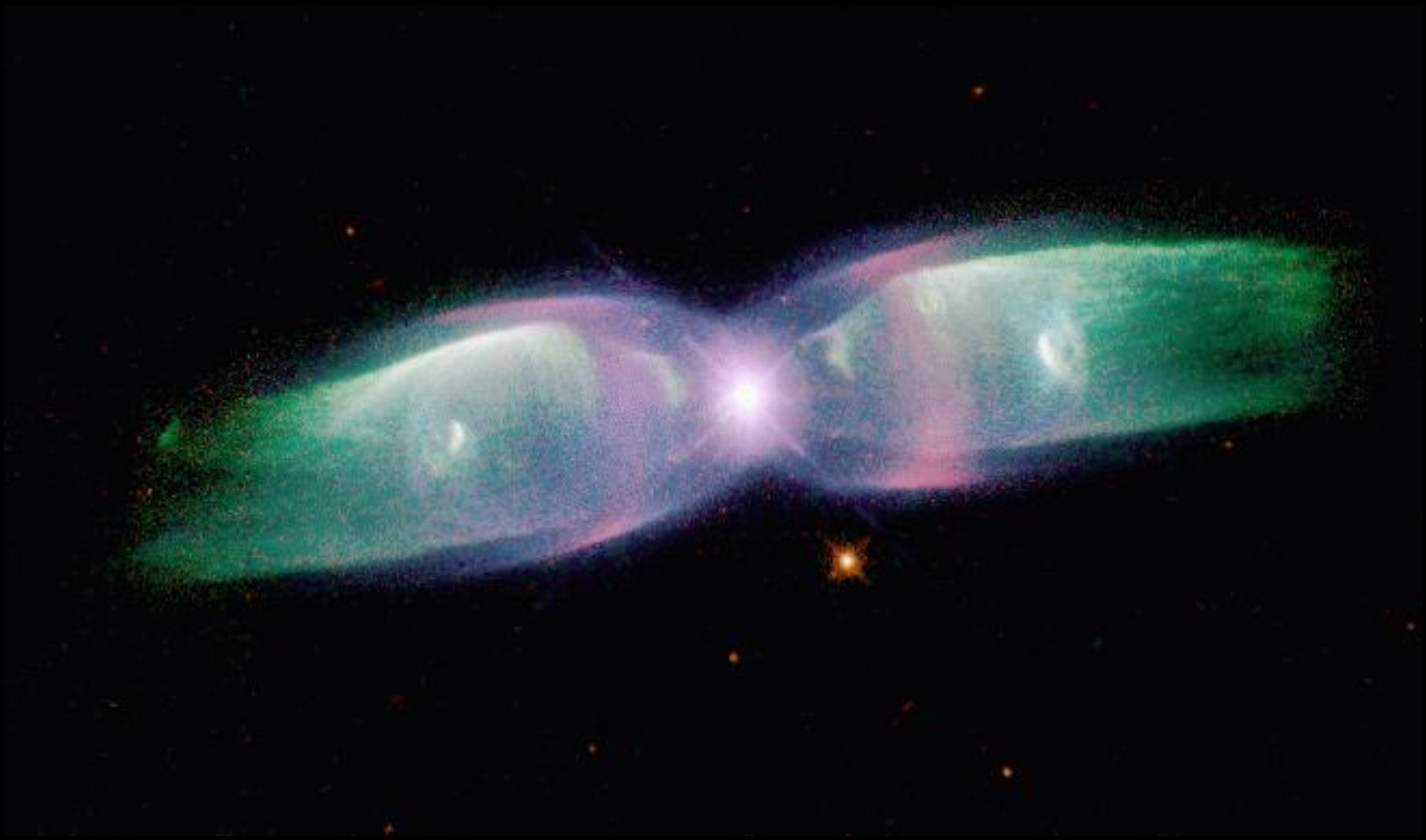
Comets, nomads of the solar system



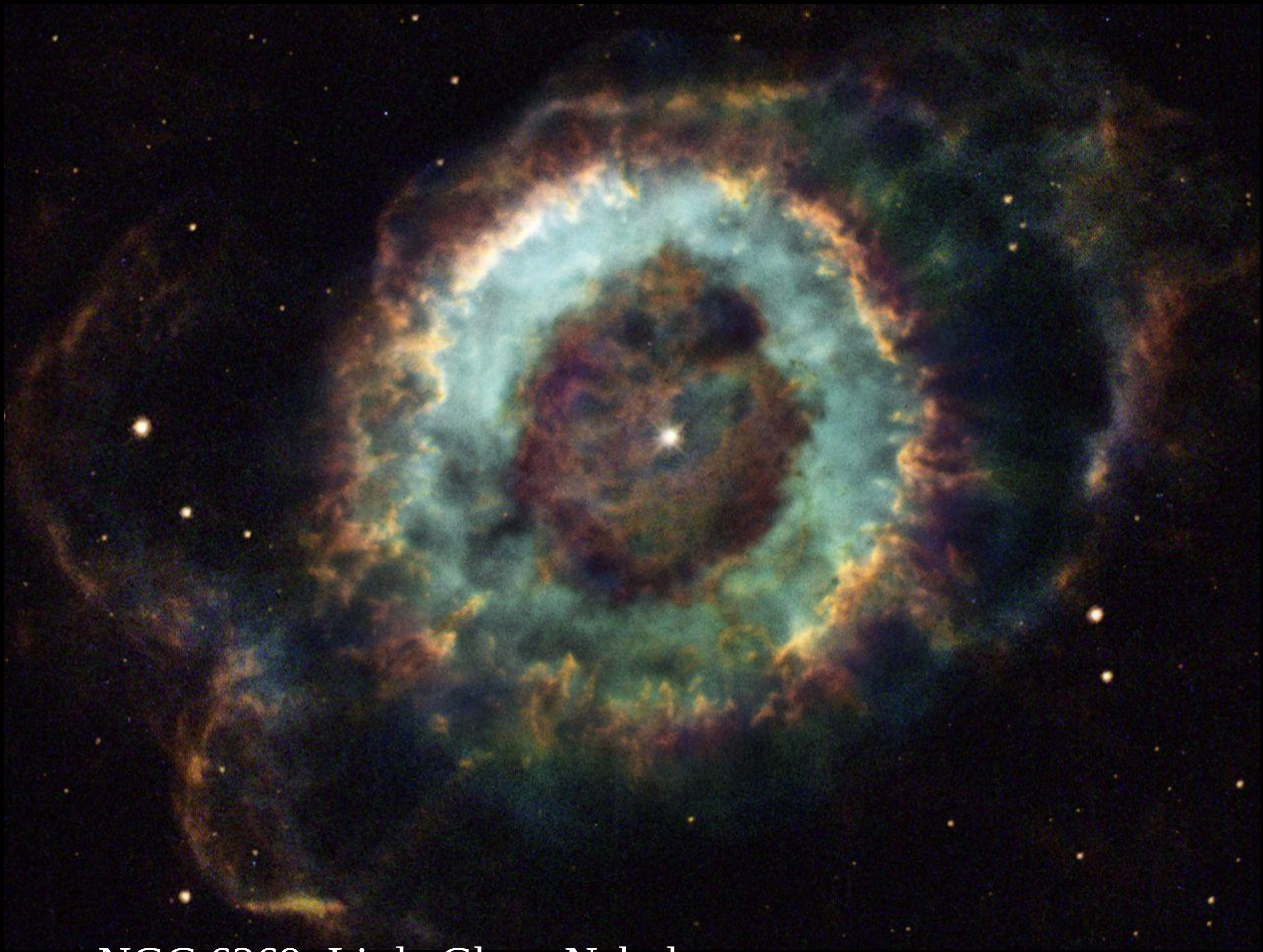


Jupiter
Mars
Earth
Venus
Mercury
Asteroids
Inner
Solar System
Sedna
Kuiper Belt
Uranus
Saturn
Jupiter
Neptune
Pluto
Outer
Solar System
Inner extent
of Oort Cloud
Orbit of
Sedna

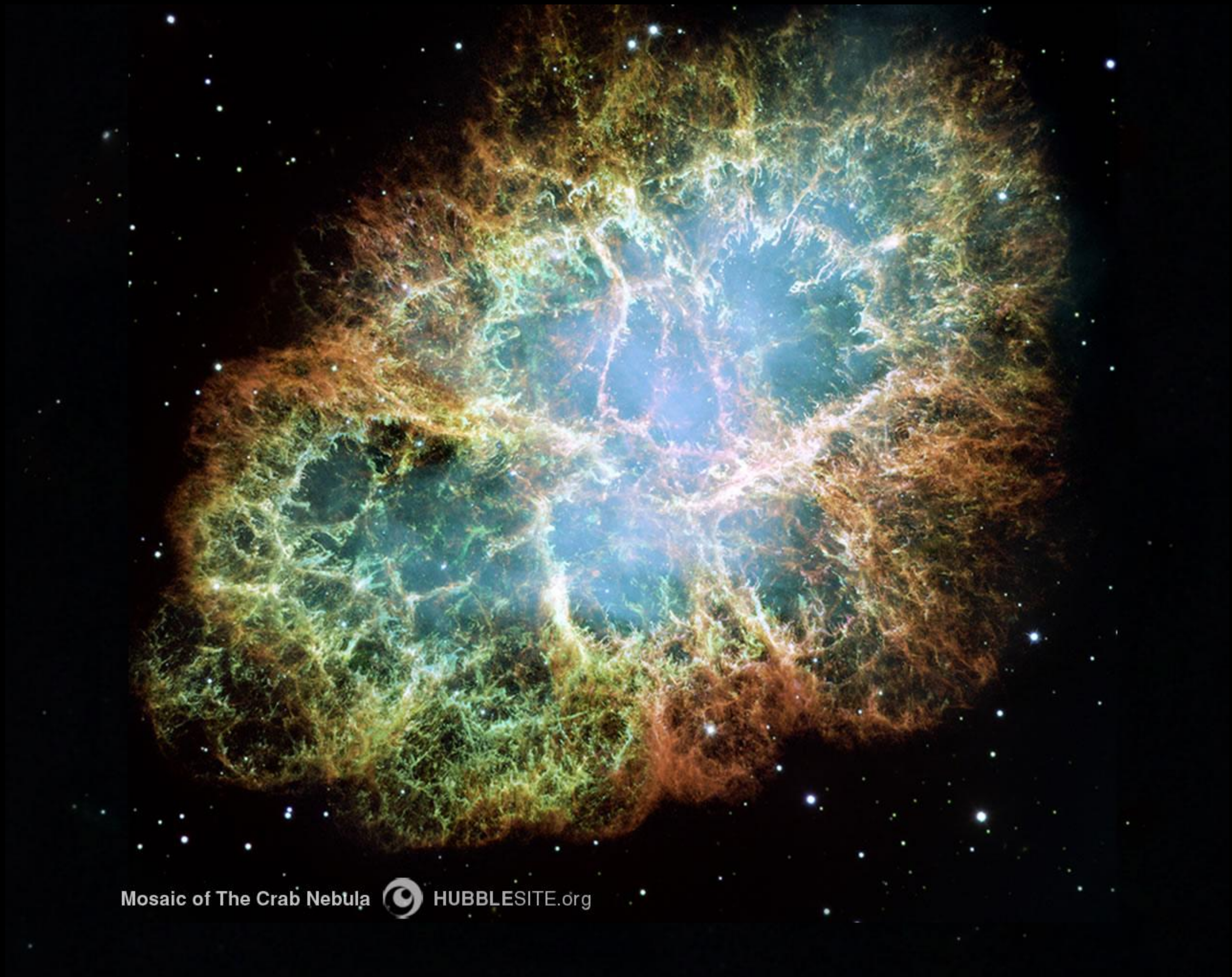

Alpha/Proxima Centauri,
4.22 light-years (25 trillion miles) away



M2: Butterfly Nebula



NGC 6369: Little Ghost Nebula

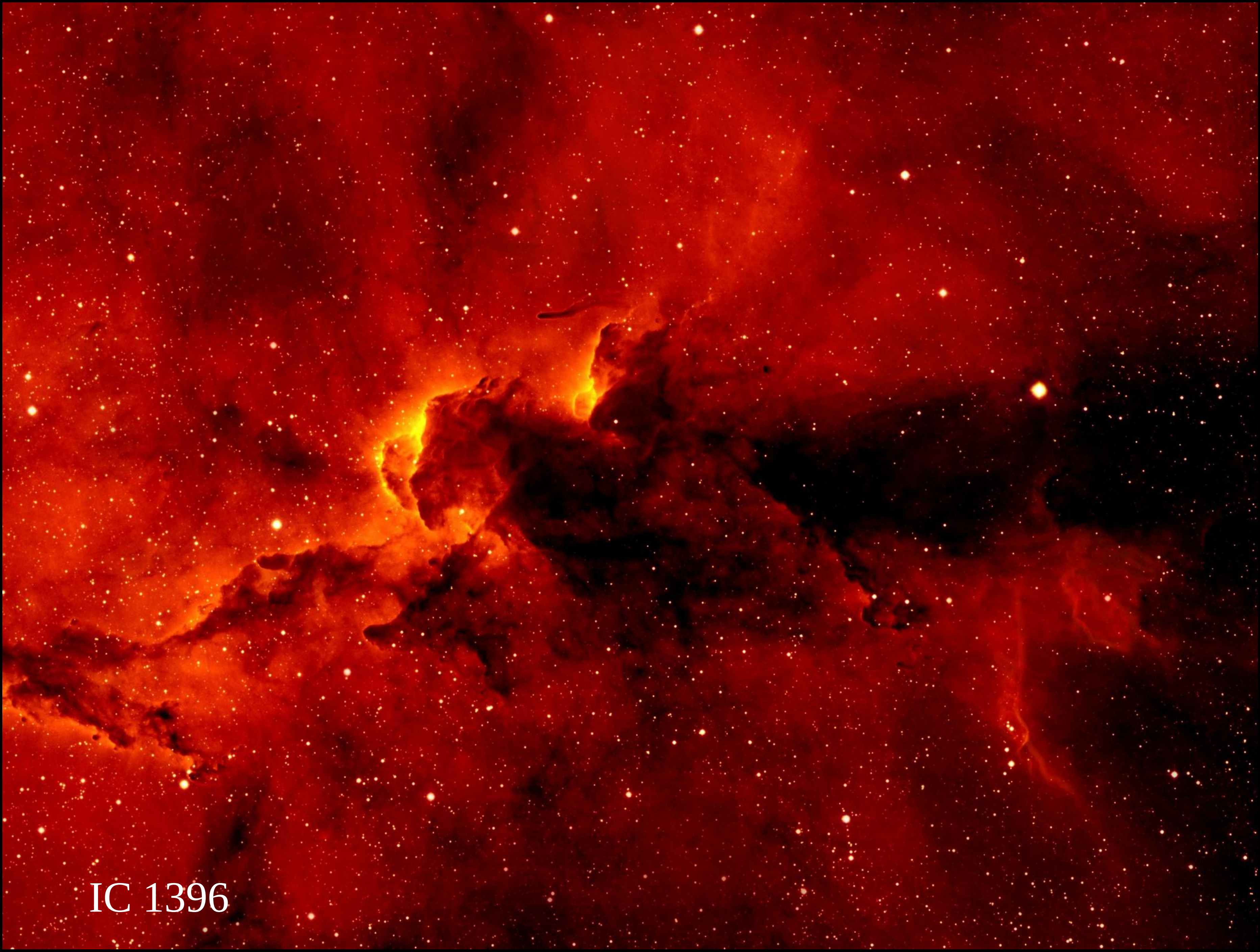

Mosaic of The Crab Nebula
HUBBLESITE.org

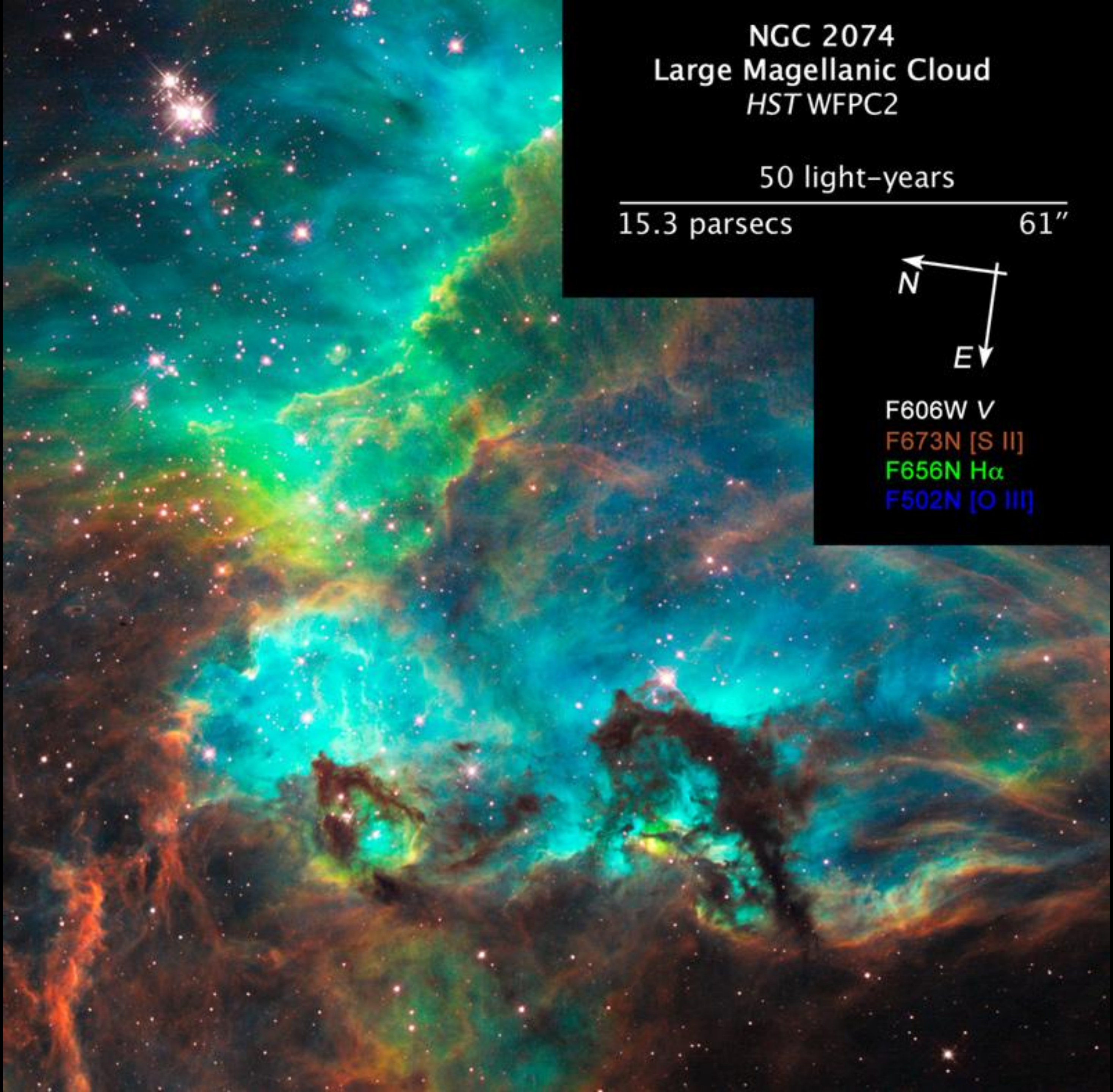
Cœlum ASTRONOMIA
www.coelum.com

The Fox Fur Nebula by CFH

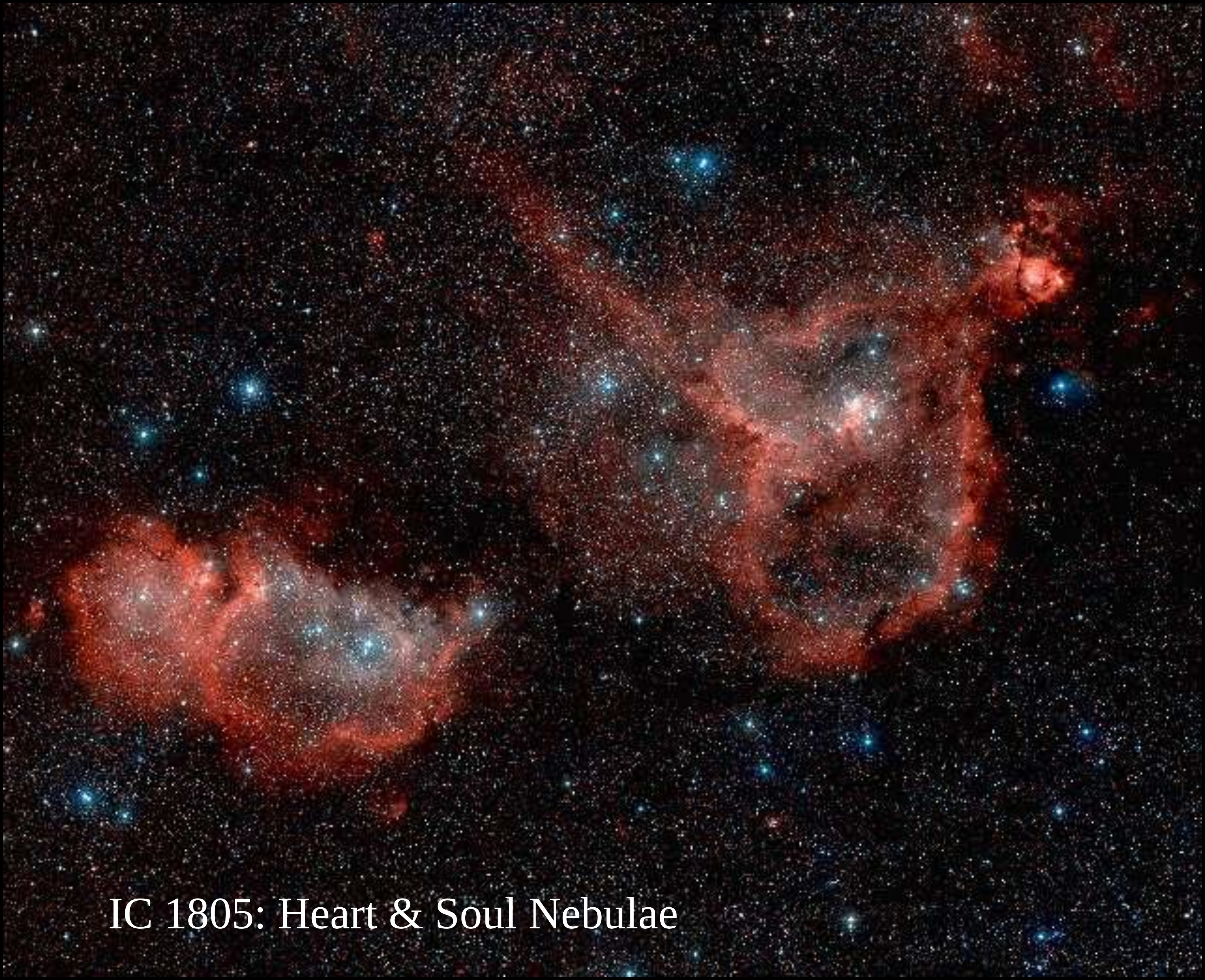
Star-Birth Clouds • M16 HST • WFPC2

PRC95-44b • ST ScI OPO • November 2, 1995
J. Hester and P. Scowen (AZ State Univ.), NASA


IC 1396



100000 orbits in space for Hubble!


IC 1805: Heart & Soul Nebulae

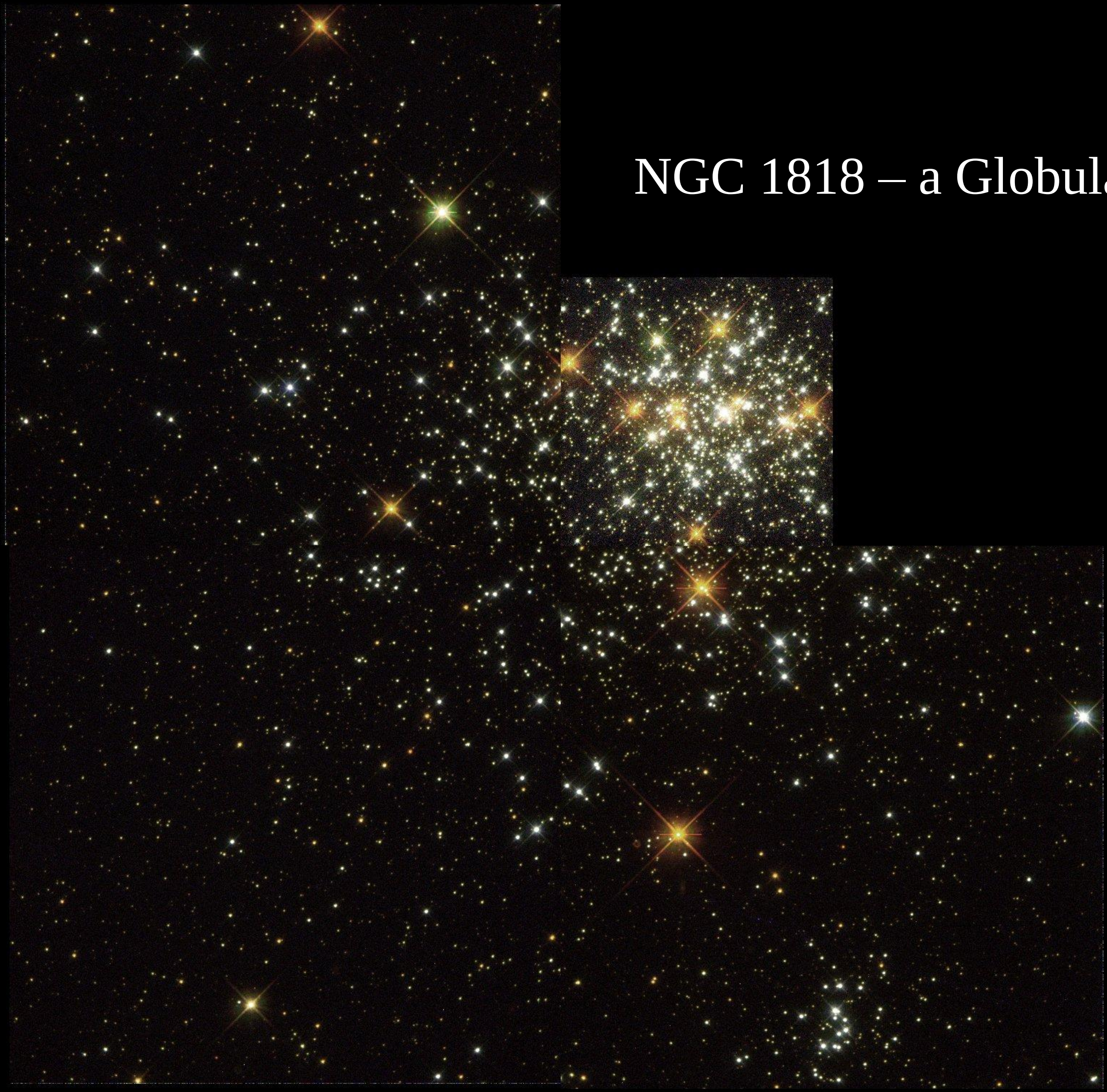
IC 2118:
Witch Head
Nebula

(Jay Leno
Nebula?)

NGC 1435

M 45: The Pleiades or Seven Sisters (Subaru)

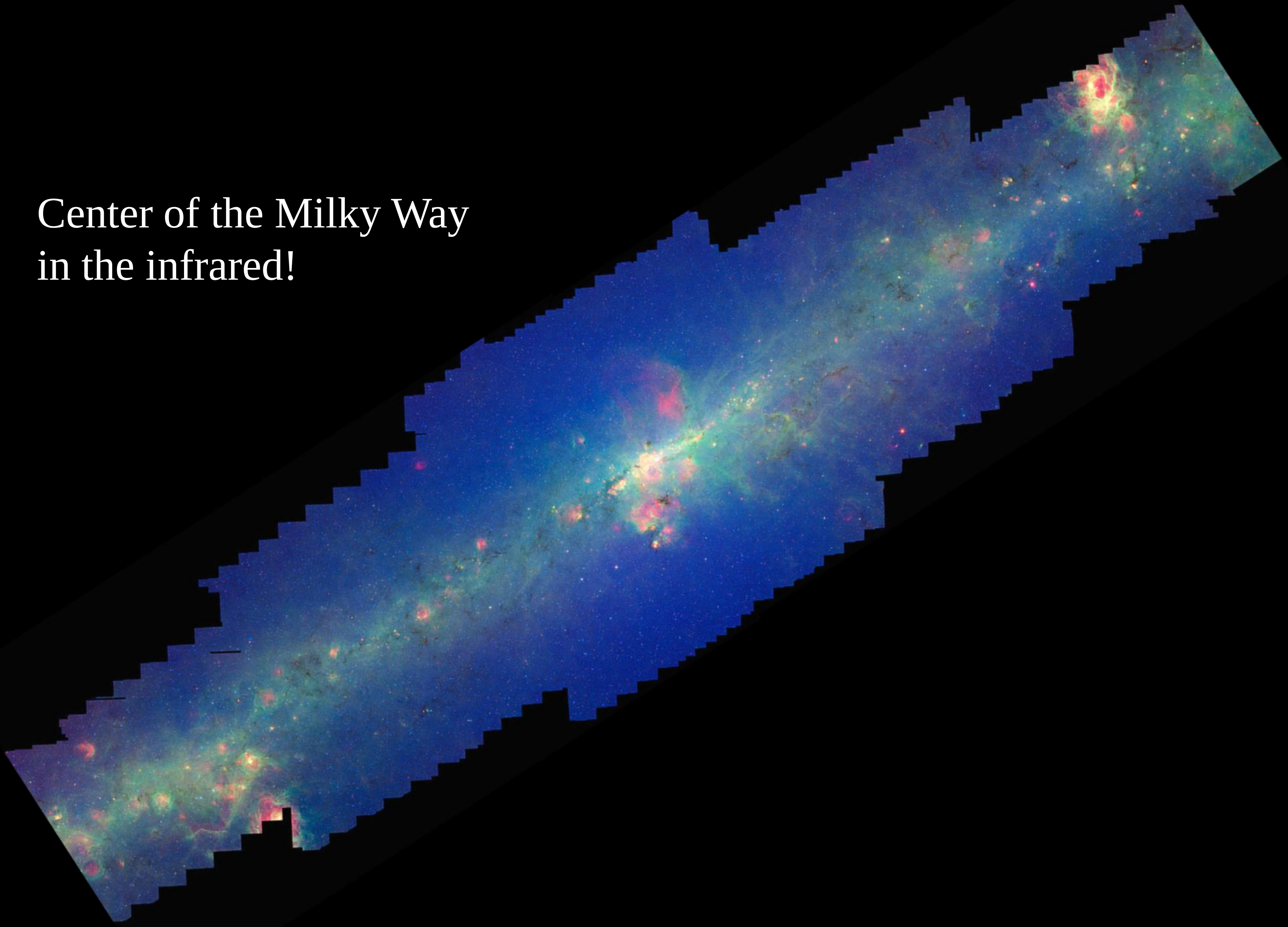
NGC 1818 – a Globular Cluster



Globular Cluster discovered in the infrared by
UW Astronomy Professor Henry Kobulnicky!

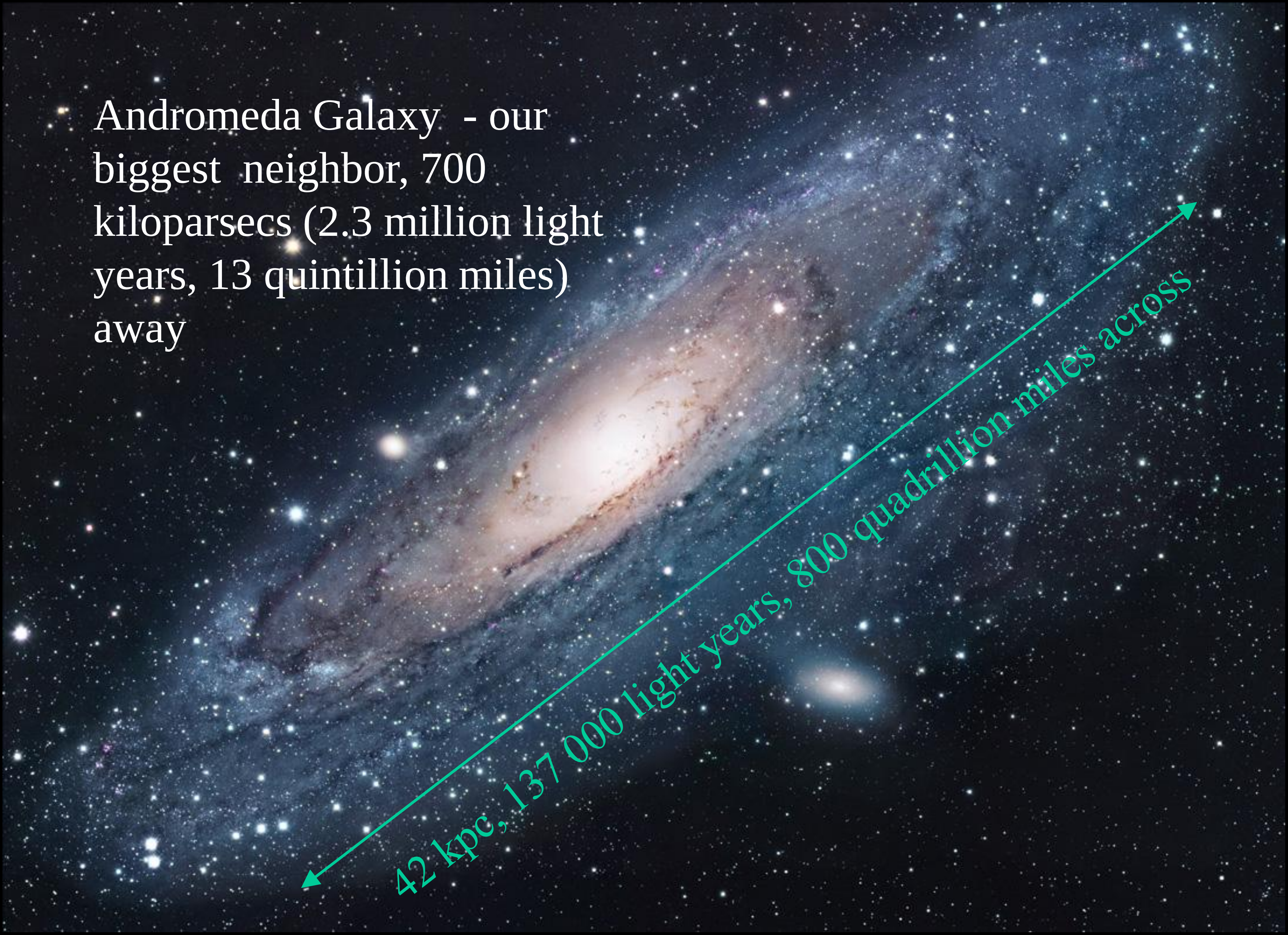
Milky Way: Our “insider’s outside” view of the Galactic Center about 26 000 light years (150 quadrillion miles) away

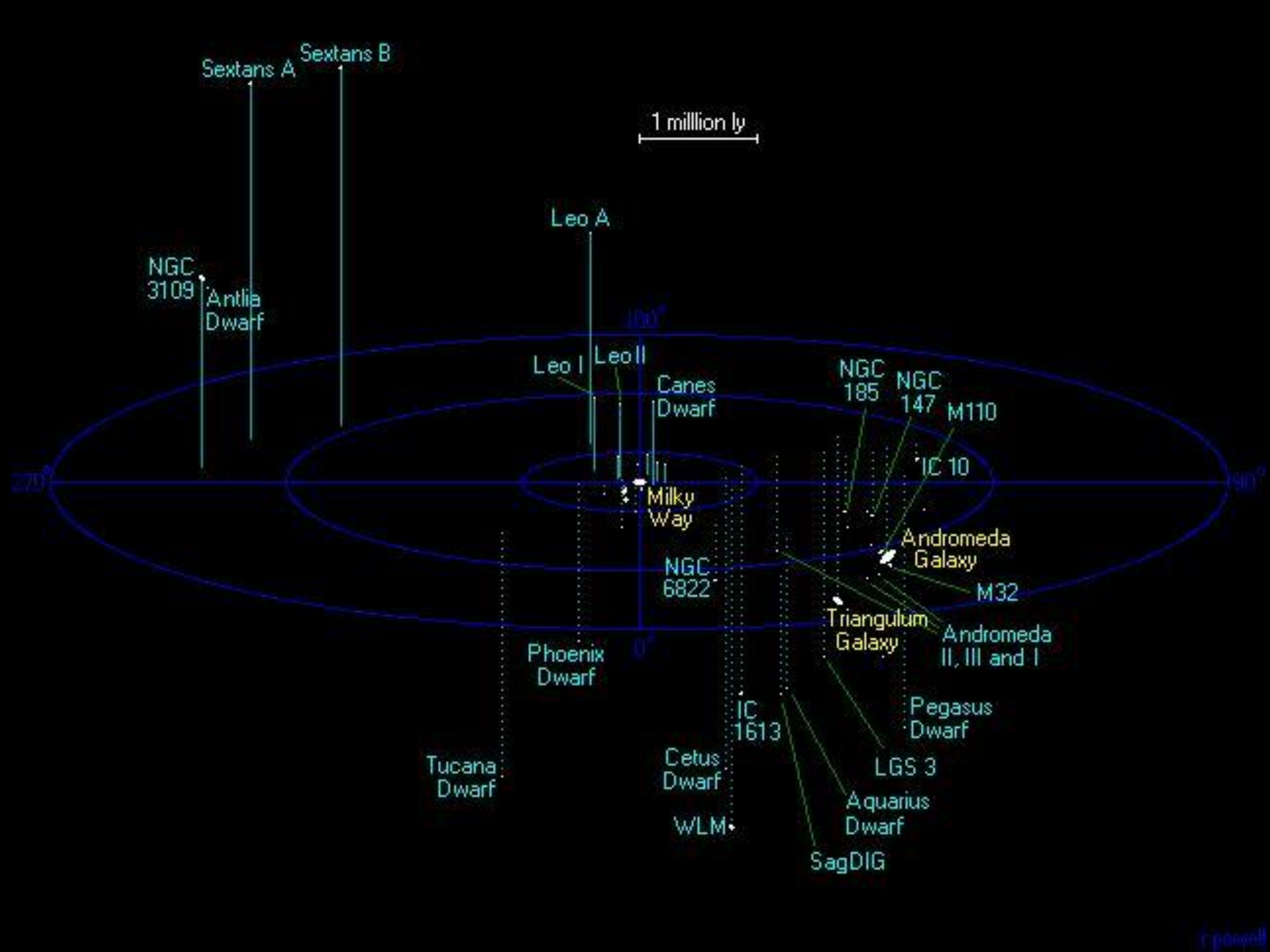
Center of the Milky Way
in the infrared!



Large Magellanic Cloud - a wimpy Milky Way companion

Andromeda Galaxy - our biggest neighbor, 700 kiloparsecs (2.3 million light years, 13 quintillion miles) away





Sextans A
Sextans B
1 milllion ly
Leo A
NGC 3109
Antlia Dwarf
180°
Leo I
Leo II
Canes Dwarf
NGC 185
NGC 147
M110
270°
IC 10
90°
Milky Way
Andromeda Galaxy
NGC 6822
M32
Triangulum Galaxy
Andromeda II, III and I
0°
Phoenix Dwarf
IC 1613
Pegasus Dwarf
Tucana Dwarf
Cetus Dwarf
LGS 3
Aquarius Dwarf
WLM
SagDIG
r powell


Coelum
Astronomia
The Pinwheel Galaxy by
CFH
© CFHT

Barred Galaxy NGC 1365
(VLT UT1 + FORS1)

ESO PR Photo 08a/99 (27 February 1999)


NGC 4881
Coma Cluster
HST · WFPC2
PF95-07 · ST ScI OPO · January 1995 · W. Baum (U.WA), NASA
1/27/95 zgl

Coelum Astronomia

The Giant Elliptical Galaxy Messier 87 by CFH

Galaxies NGC 2207 and IC 2163

Hubble Heritage

NASA and The Hubble Heritage Team (STScI) • Hubble Space Telescope WFPC2 • STScI-PRC99-41

The Mice • Interacting Galaxies NGC 4676

Hubble Space Telescope • Advanced Camera for Surveys

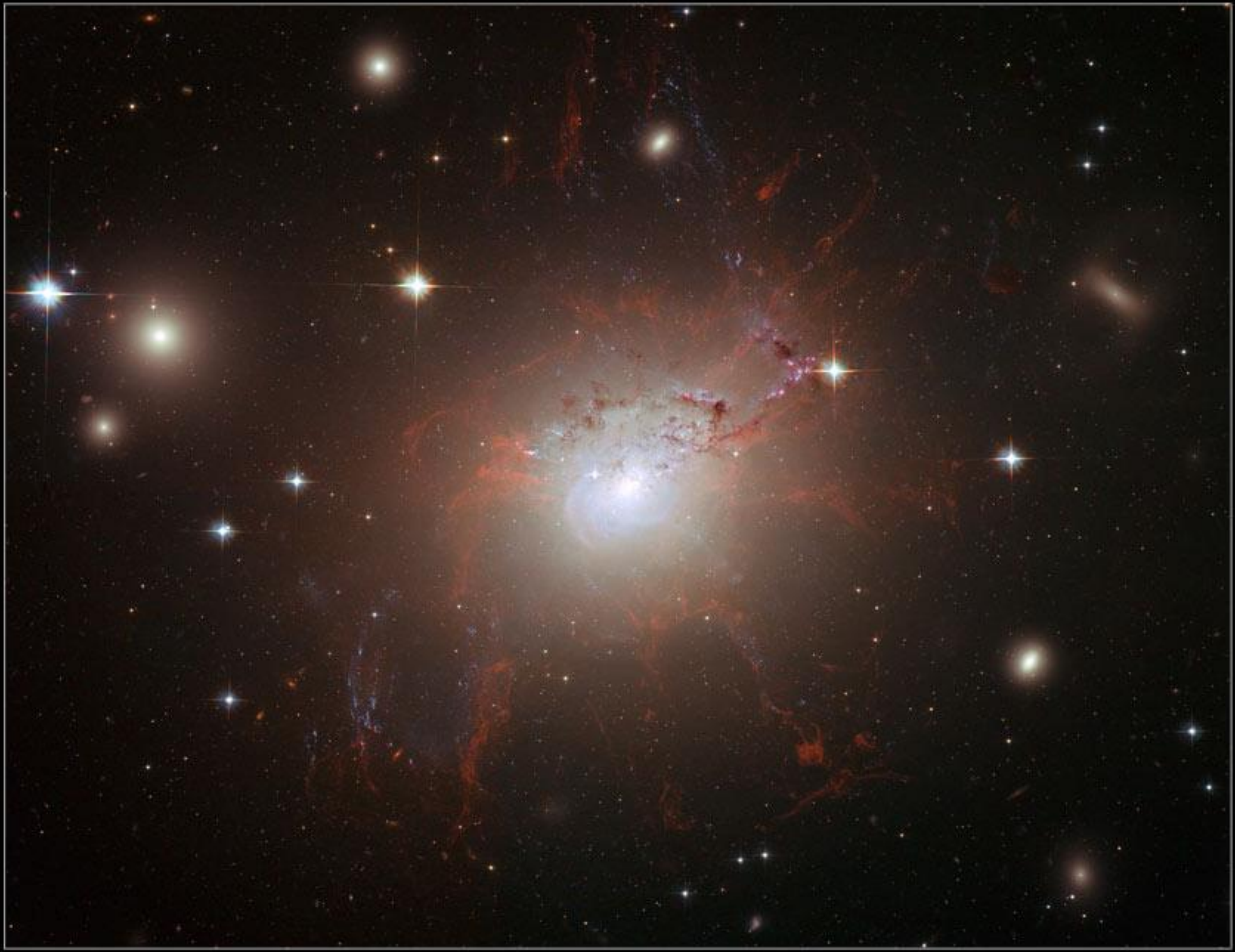
NASA, H. Ford (JHU), G. Illingworth (UCSC/LO), M. Clampin (STScI), G. Hartig (STScI) and the ACS Science Team • STScI-PRC02-11d

Elliptical Galaxy NGC 1316

Hubble Heritage

NASA, ESA, and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope ACS • STScI-PRC05-11

Active Galaxy NGC 1275



Hubble Heritage

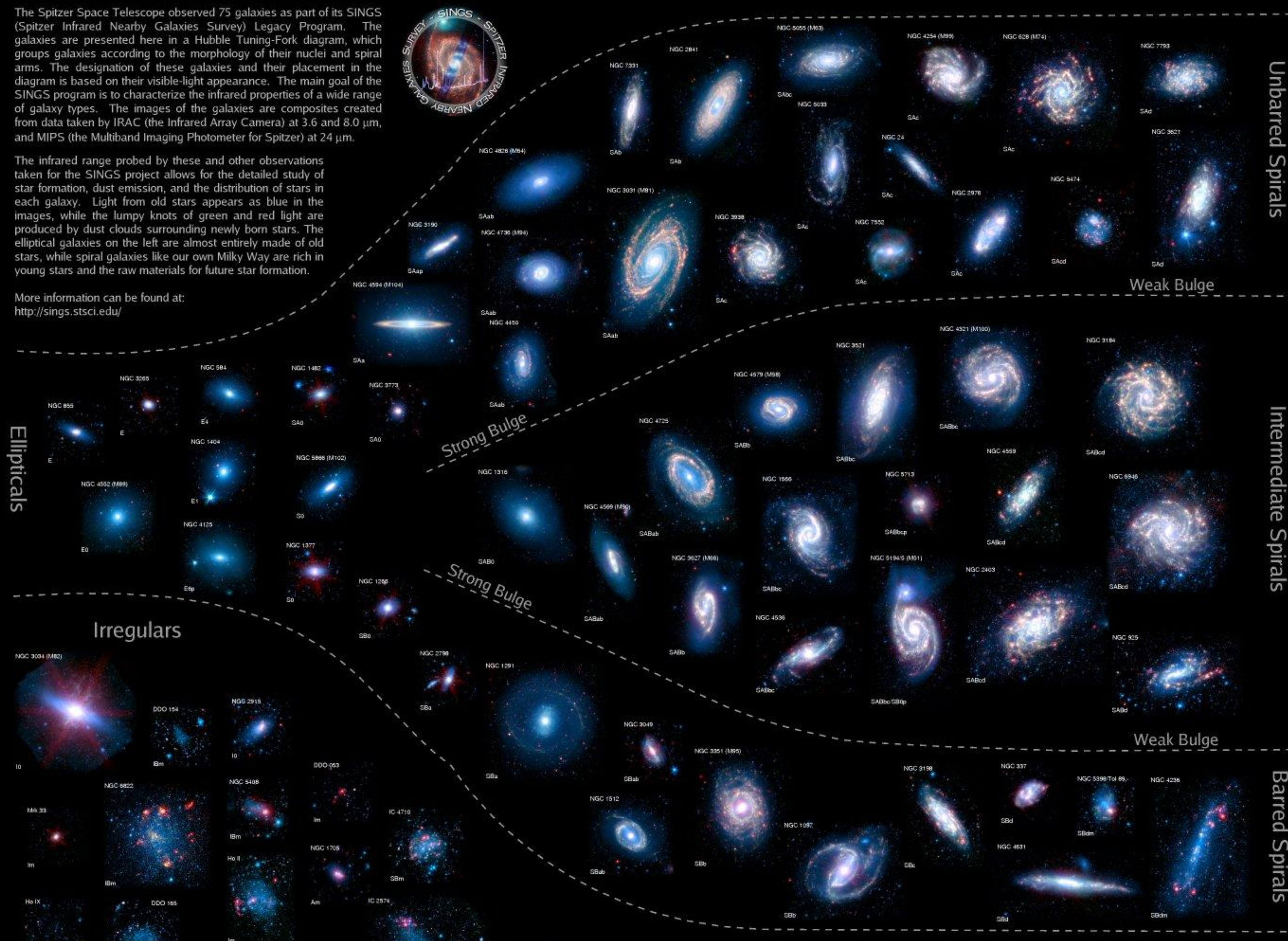
NASA, ESA, and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration • *Hubble Space Telescope* ACS • STScI-PRC08-28

The Spitzer Infrared Nearby Galaxies Survey (SINGS) Hubble Tuning-Fork

The Spitzer Space Telescope observed 75 galaxies as part of its SINGS (Spitzer Infrared Nearby Galaxies Survey) Legacy Program. The galaxies are presented here in a Hubble Tuning-Fork diagram, which groups galaxies according to the morphology of their nuclei and spiral arms. The designation of these galaxies and their placement in the diagram is based on their visible-light appearance. The main goal of the SINGS program is to characterize the infrared properties of a wide range of galaxy types. The images of the galaxies are composites created from data taken by IRAC (the Infrared Array Camera) at 3.6 and 8.0 μm, and MIPS (the Multiband Imaging Photometer for Spitzer) at 24 μm.

The infrared range probed by these and other observations taken for the SINGS project allows for the detailed study of star formation, dust emission, and the distribution of stars in each galaxy. Light from old stars appears as blue in the images, while the lumpy knots of green and red light are produced by dust clouds surrounding newly born stars. The elliptical galaxies on the left are almost entirely made of old stars, while spiral galaxies like our own Milky Way are rich in young stars and the raw materials for future star formation.

More information can be found at:
http://sings.stsci.edu/



Poster and composite images created from SINGS observations by Karl D. Gordon (Oct 2007)
Blue=IRAC 3.6μm (stars)
Green=IRAC 8μm
(aromatic features from dust grains/molecules)
Red=MIPS 24μm (warm dust)

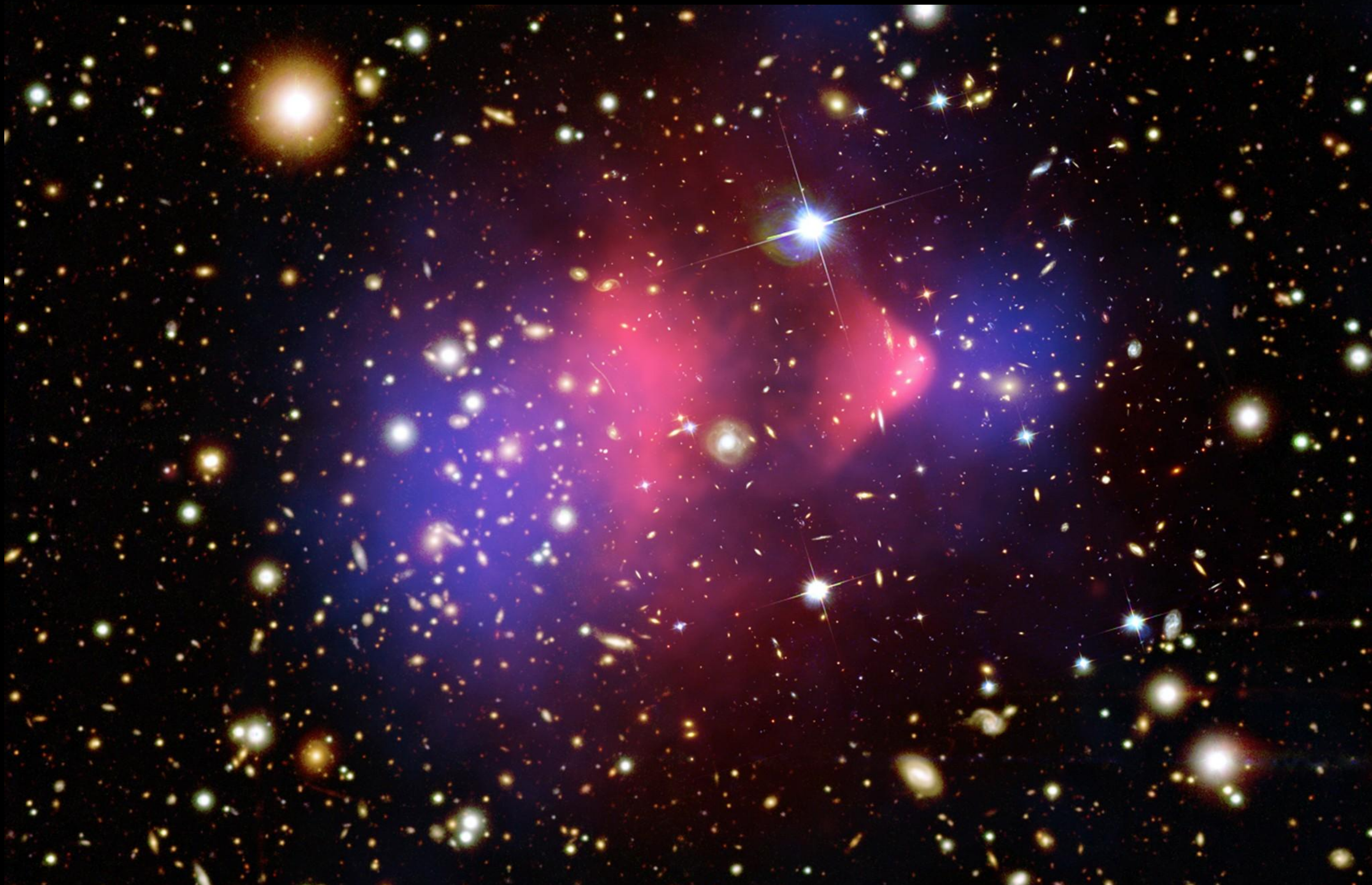
SINGS Team

Robert Kennicutt, Jr. (Principle Investigator), Daniela Calzetti (Deputy Principle Investigator), Charles Engelbracht (Technical Contact), Lee Armus, George Bendo, Caroline Bot, Brent Buckalew, John Cannon, Daniel Dale, Bruce Draine, Karl Gordon, Albert Grauer, David Hollenbach, Tom Jarrett, Lisa Kewley, Claus Leitherer, Aigen Li, Sangeeta Malhotra, Martin Meyer, John Moustakas, Eric Murphy, Michael Regan, George Rieke, Marcia Rieke, Helene Roussel, Kartik Sheth, J.D. Smith, Michele Thornley, Fabian Walter & George Helou

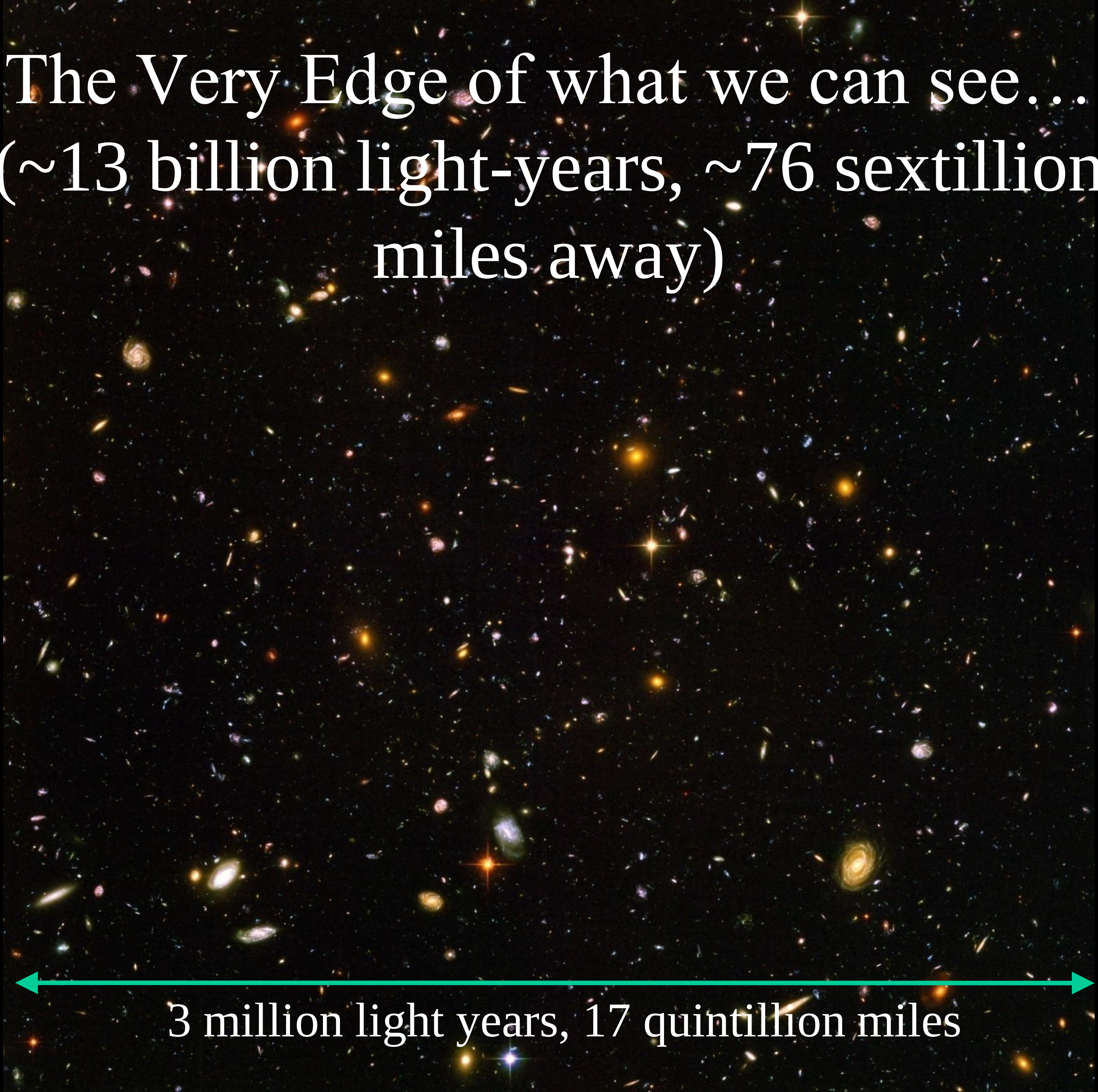
Coma Cluster

99 megaparsec, 321 million light years, ~2 sextillion miles

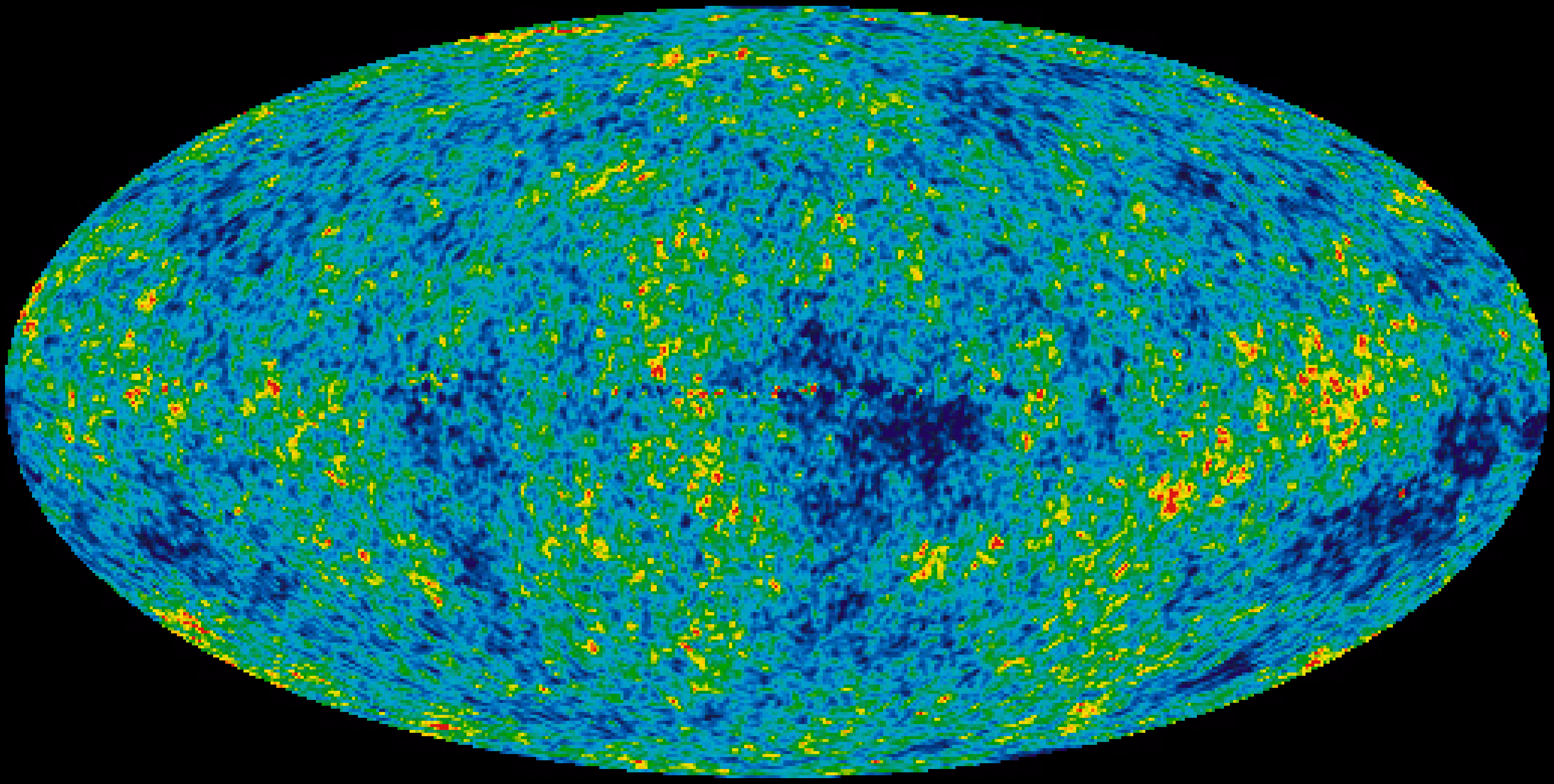
Bullet Cluster… Evidence for Dark Matter?



The Very Edge of what we can see… (~13 billion light-years, ~76 sextillion miles away)



The Very Edge of what we can see… (13.7 billion light-years, ~80 sextillion miles away)



Today’s Plan

- Homework, Course web page (not wyoweb)
- Popsicle sticks
- Class Demographics
- Syllabus
- Semester Project

Homework

- (Yes, on the first day… no whining)
- Find the class website from http://physics.uwyo.edu/~ganguly
- Watch *Cosmic Voyage* before the end of the week.
- There will be a short quiz on Friday that you will have to answer in class regarding the video. (Yes, on the first week… no whining)

Syllabus: Contact Information

Rajib Ganguly	**Mark Reiser**	**Dan Lyons**	**Jacquelyn Wolfgang**
PS 117	PS 107	Wyo Hall 434A	PS 132 (for SI)
307-766-3053 307-399-6361	307-399-3387	262-496-5519	
Ganguly @uwyo.edu	Reiser @uwyo.edu	Danjlyons @gmail.com	Jwolfgan @uwyo.edu

Syllabus: Course Description

According to registrar… "ASTRO 1050 consists of three lecture periods and a two-hour laboratory in observational and laboratory astronomy. Observing sessions are scheduled after dark and held when weather permits. Designed primarily for non-science majors. Students who have taken ASTR 2310 may not earn credit in ASTR 1050. Prerequisite: MATH 1000 or passing the mathematics proficiency examination at Level 3. (Normally offered both semesters)"

Syllabus: Course Description

“ASTRO 1050 is an introductory course for non-science majors. It provides a broad introduction to Astronomy including:

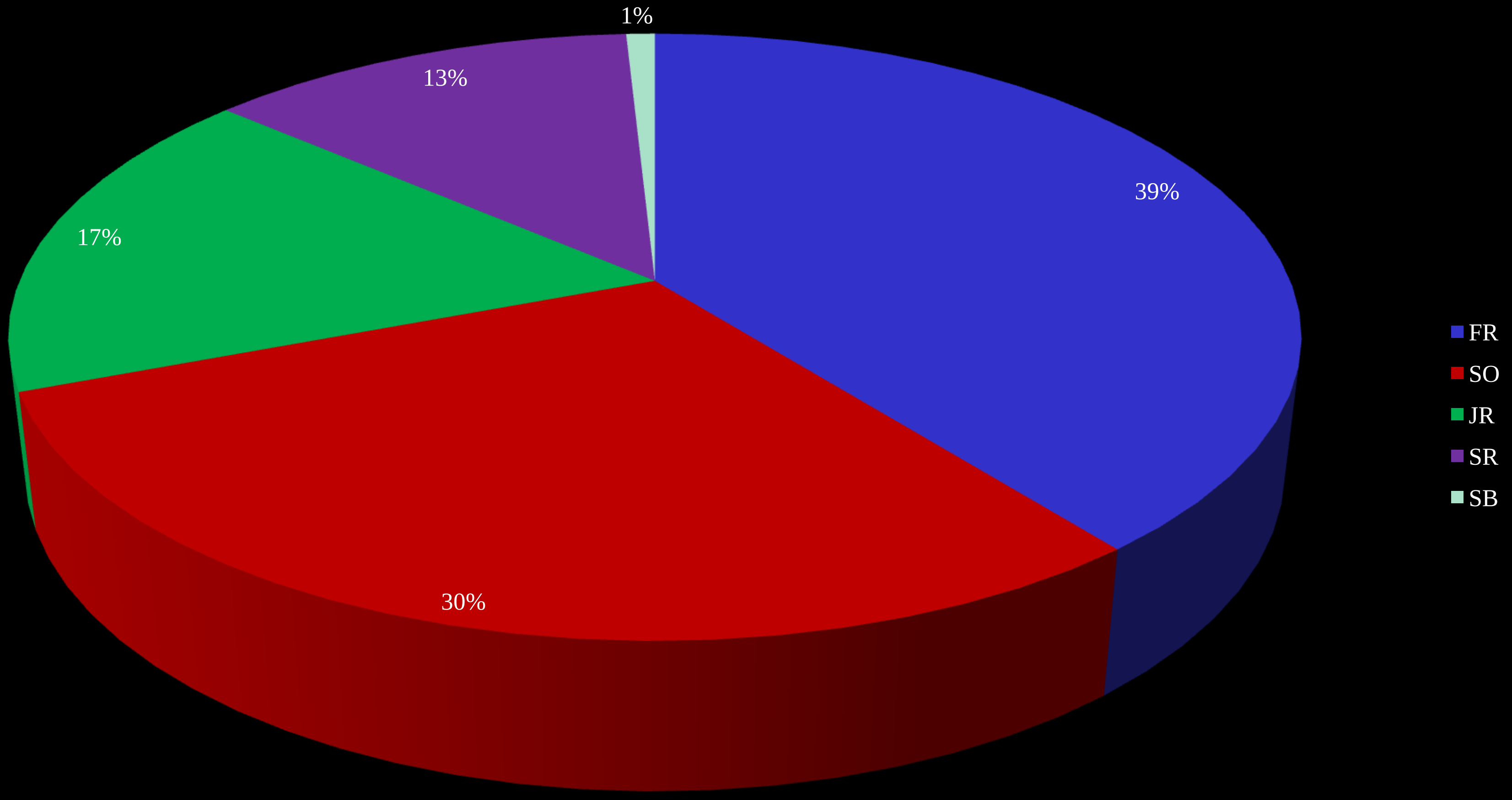
(1) daily, monthly and yearly patterns in the sky;
(2) basic physics of gravity, light, and atoms;
(3) formation of the solar system;
(4) stars and stellar evolution;
(5) galaxies, cosmology, and the evolution of the Universe; and
(6) the fundamental tenets of science and the scientific process.

The goal of this course is to cover most of the areas of modern astronomy at a level which requires only basic mathematics.”

Syllabus: Resources

- Required:
  - *Astronomy Notes* by Nick Strobel
    - http://www.astronomynotes.com
  - Various *Wikipedia Articles*
  - *Lecture Tutorials for Introductory Astronomy* by Prather et al.
    - Workbook for in-class exercises
    - MUST BE PURCHASED NEW
  - Loose-leaf paper for in-class assignments ("quizzes")
  - Lab notebook for Semester Project (Lab #1)
- Optional:
  - Any astronomy text

Class Demographics



Class Demographics

Raise your hand if you:

- Are majoring or plan to major in a science
- Are majoring or plan to major in a physical science
- Have or plan to pursue an advanced (post-baccalaureate) degree
- All of the above

Conclusions

- I/we are not like you – we're freaks.
  - We majored in a science.
  - We came back to school and did (or are doing) a more advanced degree.
- We shouldn't expect you to think like we do, with our years of training.
- The best way for us to teach you is to guide you in teaching each other
  - Learner-centered teaching

Example: Montillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then brachter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.

- What is traxoline?
- Where is traxoline montilled?
- How is traxoline quaselled?
- Why is it important to know about traxoline?

Instructional Philosophy

- Less lecture, more engagement
- Inspire you to ask question (like the ones you asked on Monday)
- Provide you with tools and resources to get your answers to the question you have
- We will play the roles of a coach, a trainer, or a navigator.
- It will be up to you to gain the knowledge you seek.

Day-to-day Class Structure

- Short mini-lectures
  - Combined with assigned reading, these will provide enough information for you to create your own knowledge
- Followed by guides to help you create knowledge and understand concepts
  - Think-pair-share questions
  - Lecture tutorials (your book)

Instructional Philosophy

- Active engagement with nearly daily group activities
- Attendance at all classes is MANDATORY
  - Quizzes primarily for attendance/participation
  - University-sanctioned excused absences…
- Carefully studying the assigned readings/watching is REQUIRED

Think-pair-share Questions

- A multiple-choice question that will test your understanding of an important concept
- Step 1: Read the question to yourself. Think about the answer that is correct. Prepare your card for voting.
- Step 2: Vote (on the count of three).
- Step 3: If 60-80% agree, proceed to Step 4. If more than 80% of you agree, then we will move on. If less than 60% of you agree, then we'll try to figure out why.
- Step 4: Find a person that you disagree with. Within 30 sec, convince that person that you are right. Then prepare to vote again. Go back to Step 2.

Example:
What is the brightest star in the sky?

- A: Polaris
- B: Sirius
- C: Sun
- D: Moon
- E: None of the above

Today’s plan

- Disruptions…
- Motivation for Lecture Tutorials
- Assessment and Grading
- Semester Observing Project
- Quiz
- Scale models and Scientific Notation
- LT: Size of Sun, Milky Way Scales

No Disruptions, Please!

- In order to promote an active, collaborative, and engaging learning environment…
  - Be respectful of others and their answers
  - Do not disrupt the class
  - Death to Cell Phones – Please turn them off (not just silenced unless absolutely necessary…)
- If we catch you talking/texting in class, this will be considered disrespectful/disruptive and we will ask you to leave…

Can Lecture Tutorials intellectually engage students at a level that is more effective than traditional lecture at promoting deep conceptual change?

- Pre-Course: Students take a 68 question survey
  - Pre-Course mean: 30% (n_A=39,n_B=42)
- Post-Lecture: questions administered in subsets
  - Post-Lecture mean: 52% (n ~ 100)
- Post-Lecture Tutorial: questions administered in subsets
  - Post-Lecture Tutorial: 72% (n ~ 100)

Syllabus: Assessment and Grading

- To promote collaborative learning (again!), there will be NO CURVE.
- Grading division
  - 4 credits: 3 from “lecture,” 1 from lab
  - 75% from “lecture,” 25% from lab
- “Lecture” section
  - 3 Midterm exams (30%)
    - No make-ups
    - Lowest will be dropped
  - Comprehensive, compulsory final exam (30%)
  - Participation/Attendance (15%)

Syllabus: Assessment and Grading

- Lab section
  - 13 labs
  - Grading scheme up to TA
- Final score:

$$
\begin{aligned}
\text{Total points} = {} & 0.3 \times (\text{Final Exam}) \\
& + 0.15 \times (\text{Midterm Total}) \\
& + 0.15 \times 100 \times \left({}^{\#\,\text{quizzes}} \big/ {}_{\text{total}\,\#\,\text{quizzes}} \right) \\
& + 0.25 \times (\text{Lab grade})
\end{aligned}
$$

Syllabus: Assessment and Grading

$$\begin{aligned}\text{Total points} = {} & 0.3 \times (\text{Final Exam}) \\ & + 0.15 \times (\text{Midterm Total}) \\ & + 0.15 \times 100 \times \left({}^{\#\text{quizzes}} \big/ {}_{\text{total}\,\#\,\text{quizzes}} \right) \\ & + 0.25 \times (\text{Lab grade})\end{aligned}$$

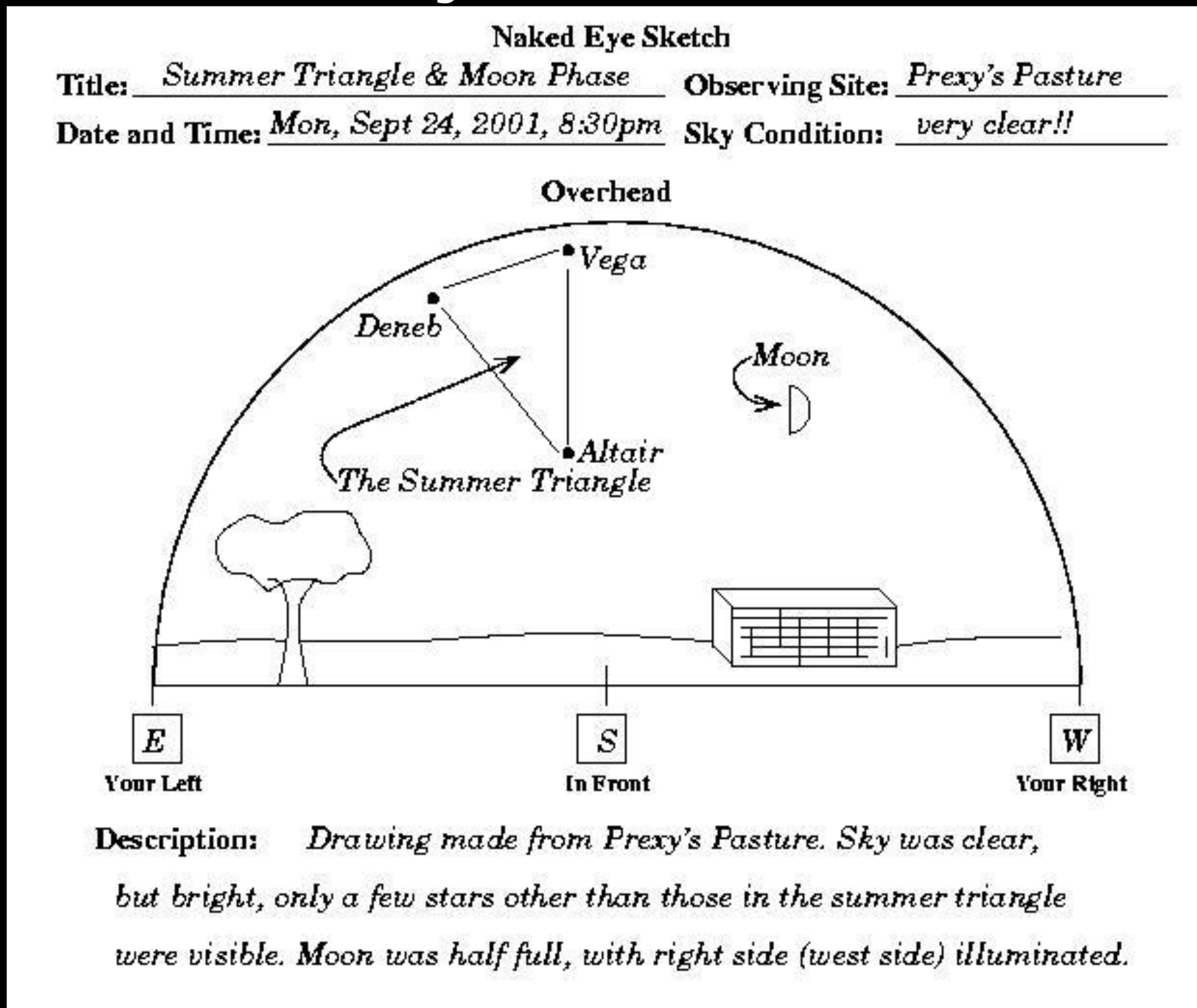
Total Points	Grade
85-100	A
75-84.999…	B
65-74.999…	C
50-64.999…	D
<50	F

No plusses or minus

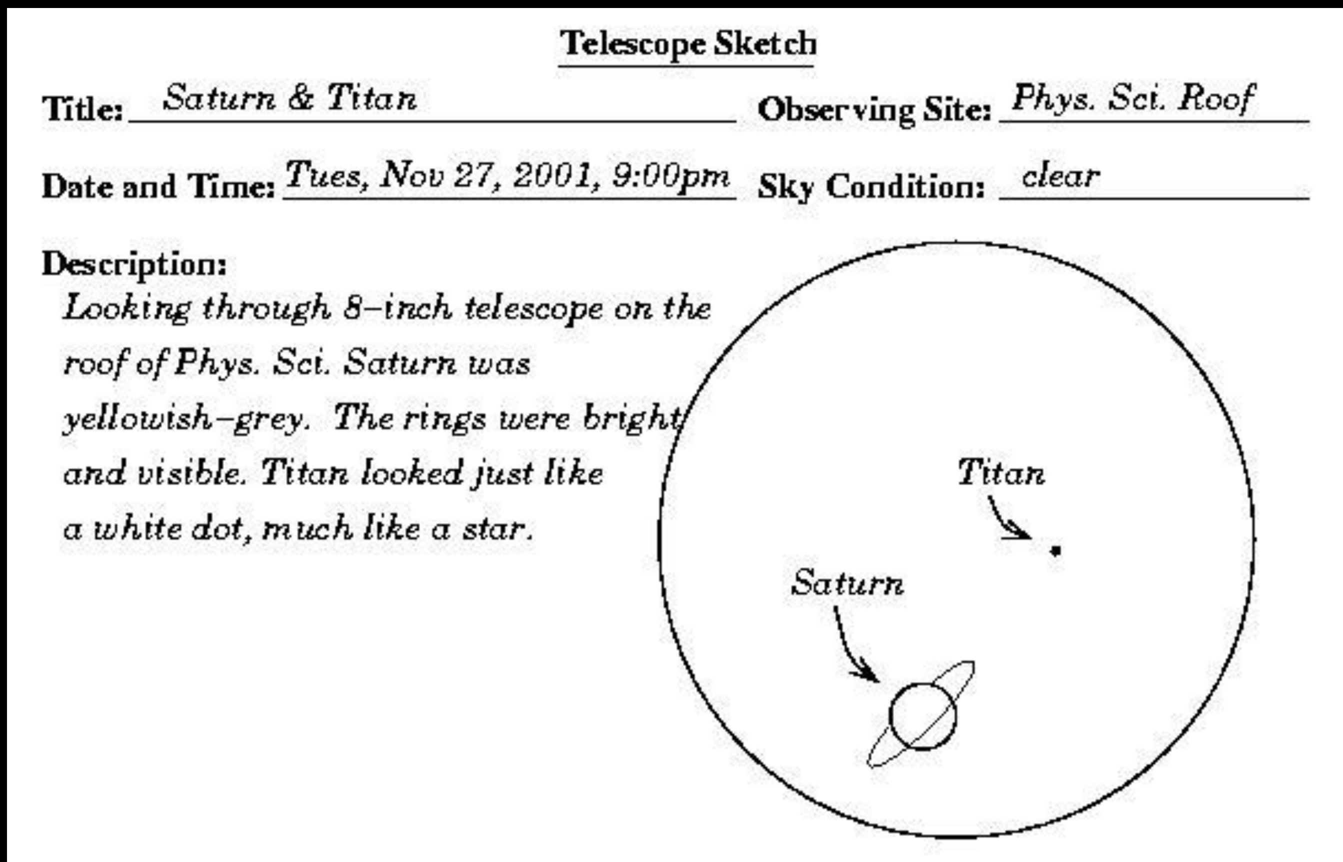
Semester Project

- To Be Done In A Separate Lab Notebook
- Three parts
  - Naked-eye Observations of Constellations
  - Telescope Observations
  - Observations of Moon phases
- Must be checked every month by your lab instructor

Naked Eye Observations



Telescopic Observations



Telescope Sketch

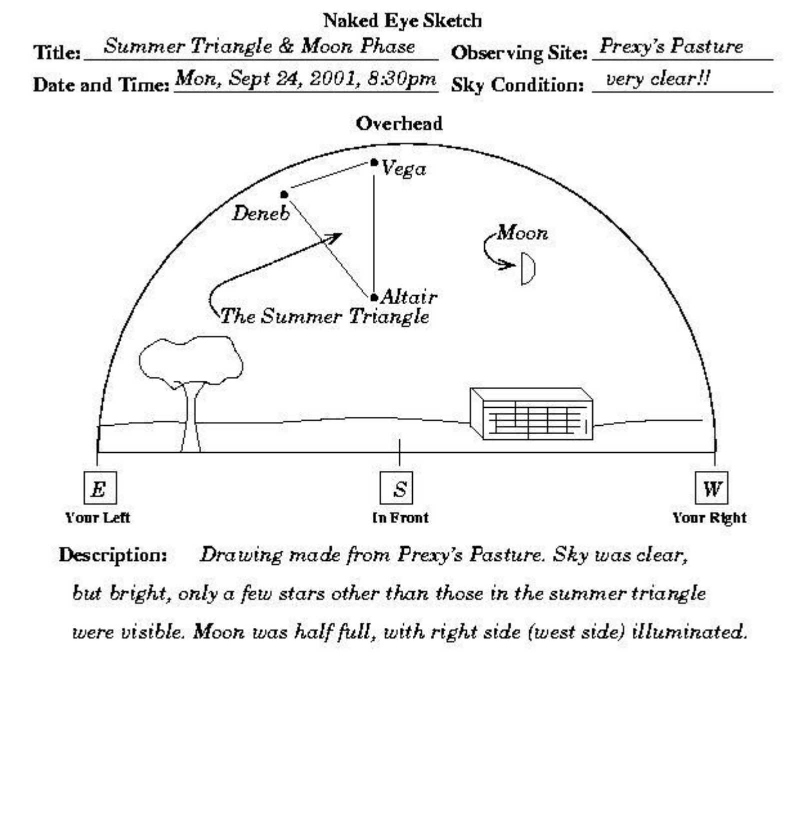
Title: *Saturn & Titan* **Observing Site:** *Phys. Sci. Roof*

Date and Time: *Tues, Nov 27, 2001, 9:00pm* **Sky Condition:** *clear*

Description:
Looking through 8–inch telescope on the roof of Phys. Sci. Saturn was yellowish–grey. The rings were bright and visible. Titan looked just like a white dot, much like a star.

Moon Phase Observations

- Mark/Dan will choose a two week period
- You choose a time
- Carry out 10 observations
- Same style as "Naked-Eye Observations"
- Face S, due E on left, due W on right
- Required information in handout (also on course web page)



Quiz on Friday

Quiz

1. Write your name on a sheet of loose-leaf paper. (If you do not have loose-leaf paper, kindly ask for one from some one.)
2. In a short paragraph, describe the three "cosmic voyages" taken during the video *Cosmic Voyage*.
3. When you are done, turn your quiz in to one of us (Rajib, Matt, Dan, Jacquelyn) and return to your seat. You may only turn in your own quiz.

Think

Pair

Share!

Which of the following correctly arranges objects according to size from smallest to largest?

- A. atom, planet, Sun, galaxy, cluster of galaxies
- B. proton, galaxy, Solar System, cluster of galaxies
- C. proton, star, galaxy, Solar System
- D. Sun, Solar System, cluster of galaxies, nebula

In a manner similar to how the light year is defined, define a ``car day'' as how far a car will travel in one day (24 hours) moving at a speed of 105 kilometers/hour (= 65 miles/hour). Approximately how far would a ``car day'' be in kilometers?

- A. 25 km
- B. 250 km
- C. 2500 km
- D. 25 000 km

Scale of Things

- Need a volunteer…

Scale of Things

- If you gave someone directions from Laramie to Sheridan, what units would you use for distance?
  - 21 0
  - 5 27
  - 1 75
  - 333 …)
- We us listance (or any ers more relatab

Scale of Things

- Sizes, distances, ages, masses, etc. in astronomy are incomprehensibly large…
- Example 1: Mass of the sun
  - 2 000 000 000 000 000 000 000 000 000 000 000 grams = 2×10^{33} grams = 2 decillion grams
- Example 2: Distance from Sun to Neptune
  - 4 500 000 000 km = 4.5×10^{9} km = 4.5 billion km = 30 AU
- Example 3: Distance from Sun to next nearest star (Proxima Centauri)
  - 25 000 000 000 000 miles = 2.5×10^{13} miles = 4.2 light-years = 1.3 parsecs

Lecture Tutorials

- Break up into group of 2-3
  - NO MORE THAN THREE
- In your group, work through the following:
  - Size of the Sun (pages 105-107)
  - Milky Way Scales (pages 123-125)
  - Discuss the answers – don’t be silent!
- Mark, Dan, (Jacquelyn,) and I will be roaming around if you need help…
- If your group finishes, check you answers with another group.

- Take a deep breath.

- Remember how to get to the course web site.
  - Keep up with the assigned readings.

- Where to get help?
  - SI sessions start on Wednesday
    - 6:30-8:30PM, PS 132
  - Office Hours
  - Each other
- Have a great Labor Day weekend!