

Seeking God in Einstein's Universe Into the Vastness

Aileen A. O'Donoghue

Why God & Einstein?

My personal journey
trying to make sense of the universe
that I am in love with

☆ Intellectual Journey

🌍 love of nature drove me to study forestry then geology, then astronomy and physics

☆ Spiritual Journey

🌍 have a nagging sense of "who-ness" to the universe ... a sense of relationship with a higher, loving intelligence

This SOAR Course

- ☆ Some of the incredible wonders we've discovered about our universe:
 - 🌍 Scale of things
 - 🌍 Origins of the elements we're made of
 - 🌍 Origin & evolution of the universe
 - 🌍 Weirdness of matter & energy
- ☆ How I connect these to my sense of God
 - 🌍 How weird is God?
 - 🌍 What can we know about God?
 - 🌍 What do others say about God?

This SOAR Course

☆ 9/7: Into the Vastness

🌍 A bit about my journey

🌍 Discussion of your interests

› Why are you here? What do you hope for?

🌍 Cosmic scales of space & time

☆ 9/14: In the Beginning

🌍 Origin & Evolution of the universe

☆ 9/21: The Substance of Ourselves

🌍 Origin of elements we & Earth are made of

☆ 9/28: The Children of Earth

🌍 History of Earth & Life

Faith and Science

- ☆ Can science and faith be integrated within?
 - 🌐 SCIENCE - data, questioning, challenging
 - 🌐 FAITH - transient, ineffable experiences of us and others throughout history that can't be reproduced or challenged.
- ☆ Current US culture says "no".
 - 🌐 Because faith is defined as literalist & fundamentalist?
- ☆ Vatican Observatory says "yes".
 - 🌐 Staffed by scientist/priests since 1582
 - 🌐 But can the world views be integrated?

Define Science and Religion

☆ Define science

- 🌍 Systematic study of the sensory universe
- 🌍 Based on reproducible data

☆ Define faith

🌍 A gift

- › Religious/Spiritual experiences come unbidden
- › We don't have to invent everything for ourselves

... but we must examine what we're given!

🌍 A decision

- › Experiences can be interpreted as interactions with God
OR as coincidence, accident, etc.

🌍 Not contrary to reason

- › Faith in God ≠ belief in magic
- › Faith is not (or need not be) blind or stupid

Faith is A Gift

☆ A sense of a "whoness" to the universe

🌍 Unbidden, difficult to deny

☆ Grew up in a Catholic family

🌍 Learned the rituals

🌍 Learned the prayers

🌍 Learned some of the tradition

🌍 Sense of a whoness affirmed ... imprinted?

🌍 Found the Church (big C) hooey

› Didn't follow its own teachings

› Seemed stuck in middle ages

 ∩ sexism, hierarchy, costumes ...

› Taught rules, not the spiritual journey

Faith is a Decision

☆ Left Church when I left for college

🌍 Attributed my sense of whoness to nature

☆ Lost need for God to create the universe or us

🌍 Laws of physics, chemistry & biology enough

☆ Lost belief in God

🌍 Sense of whoness = brain damage

due to childhood exposure to incense

🌍 Tried to ignore it, deny it as "unscientific"

But the universe was too lonely!

Faith is a Decision

- ☆ Found "Godless" universe too lonely
 - 🌍 The "imprinting" of a Catholic childhood?
 - 🌍 A character flaw?
- ☆ Read & thought about the question (*secretly!*)
- ☆ Realized great minds come down on both sides
 - 🌍 No absolutely compelling argument either way
- ☆ Realized I could **choose** to believe that my sense of whoness was a sense of God.

Experiences that seem like interaction with God ...

Brain Damage?

Coincidence?

God?

Faith is not Contrary to Reason

☆ Does not require

- 🌐 Disregarding personal experience of the world
- 🌐 Believing that laws of nature get suspended

God is clever!

☆ The universe is weird!

- 🌐 Weird enough for light to be particle & wave at the same time!

- 🌐 Weird enough for me to exist

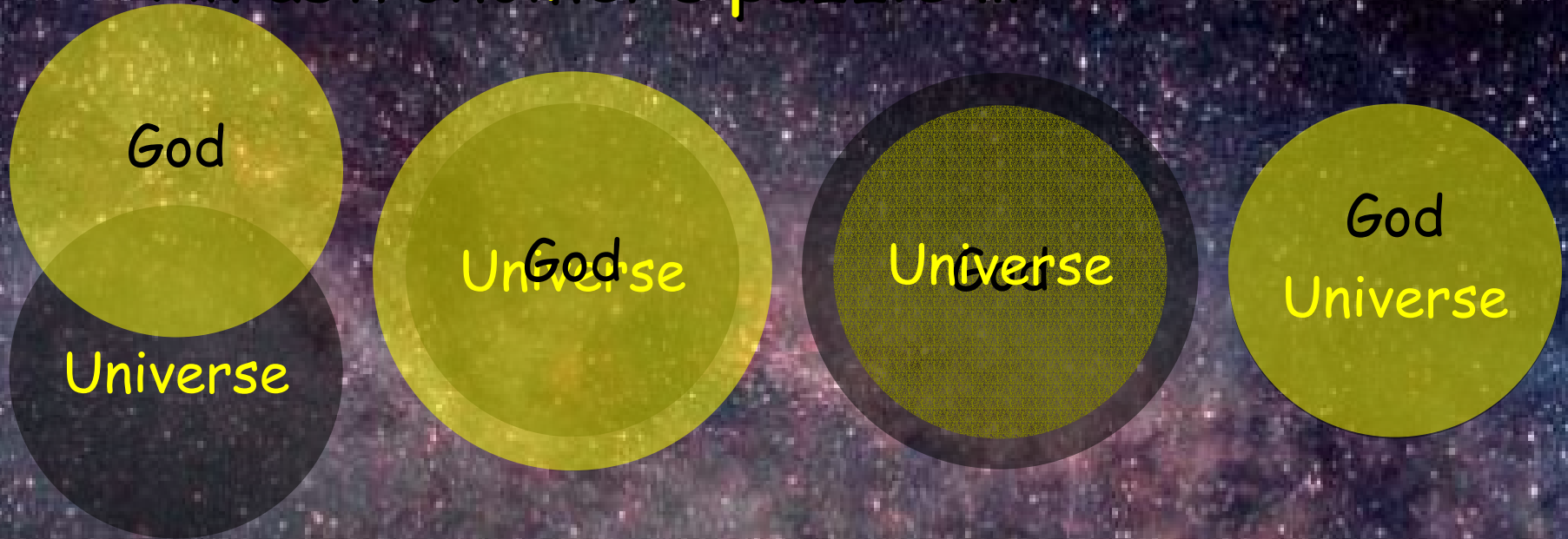
... and I'm fairly weird!

- 🌐 May be weird enough for God to exist

... so how weird is God?

God as Creator

☆ An astronomer's puzzle ...



"We do not need God to explain the universe as we see it today. But once I believe in God, the universe as I see it today has a great deal to say about that God."

-- Fr. George Coyne, S.J.

AOD's View of S & R

☆ Both are seeking "truth"

🌐 Seeking understanding of the universe

› Exterior world = science

› Interior world = faith

} Not that these worlds are truly separate!

☆ Both require human community

🌐 Experiments can be done alone in a basement

🌐 Science requires testing, challenging and vetting by the scientific community

🌐 Spiritual experiences can be had alone anywhere

🌐 Faith, seeking truth, requires reflecting, analyzing, comparing one's experience with others'

Both science and religion can produce kooks in the absence of skeptical community!

AOD's View of S & R

☆ Science and religion are ways of trying to figure out the universe

☆ Both science and religion require

🌐 Questioning the data

🌐 Testing the conclusions

🌐 Open inquiry

🌐 Realistic skepticism

} The role of skeptical scientific & religious communities.

☆ Both science and religion require

🌐 Faith ...

... in the reality of our experience

... in our ability to understand & know { the universe.
God.

Comments & Discussion

What are you seeking here?

Population of the Cosmos

~100 Billion Galaxies =
 10^{11} Galaxies

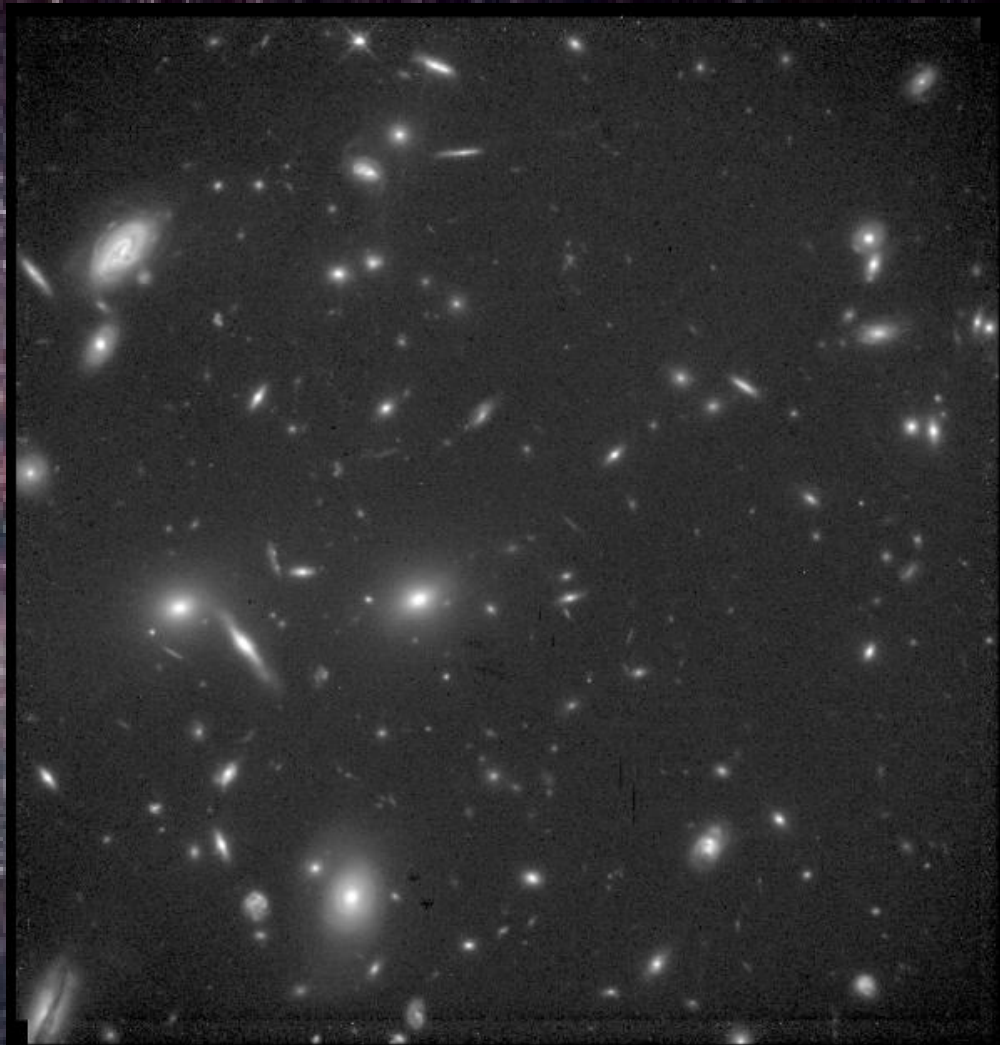
~ 100 Billion Stars in
each galaxy =

$(10^{11} \text{ stars})(10^{11} \text{ Galaxies})$
= 10^{22} stars

~ 10 planets around each
star =

10^{23} planets

... potentially lots of
company, but it's very
far away!

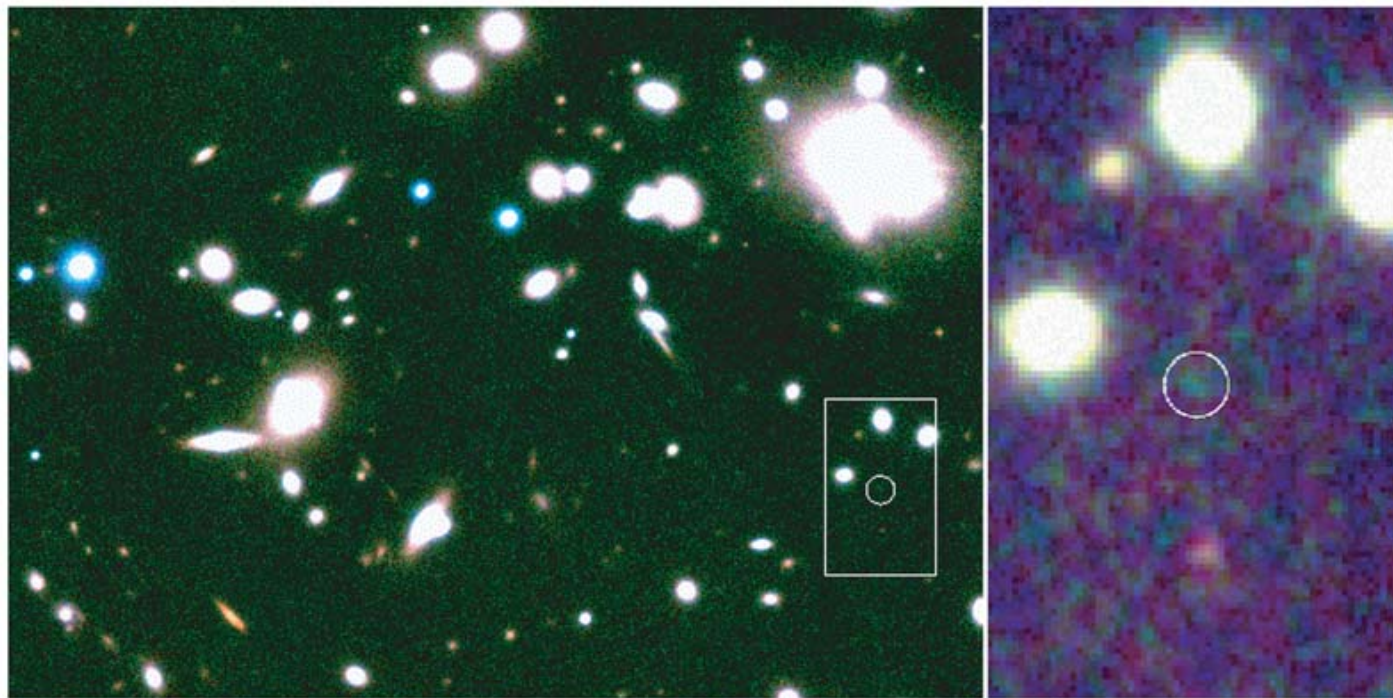


Distant Galaxy Cluster

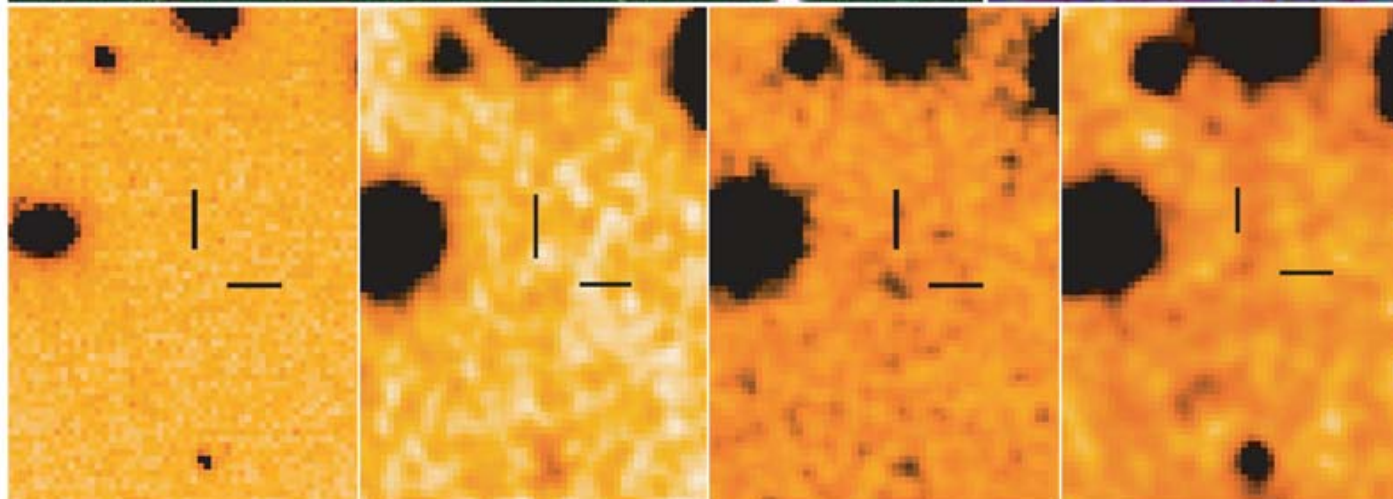
HST · WFPC2

Earth

Earth
95



Large-scale
cosmic structure



Solar System

N

FO

Abell 1835 IR1916 - the Farthest Galaxy - Seen in the Near-Infrared
(VLT ANTU + ISAAC)



Universe Mostly Empty Space

☆ For proton = golf ball

🌐 electrons 300 yards away (1800 times smaller)

☆ Sun is 100 times size of Earth

🌐 squeeze out space between atoms

⇒ Sun is size of Earth (12,756 km = 7,926 mi)

🌐 squeeze out space within atoms

⇒ Sun is 10 km (6.2 miles) in diameter

⇒ 0.0008% of the sun is matter!

Motion of Earth

Rotation on axis

$v_{\text{Equator}} \sim 1000 \text{ mph}$, $v_{\text{Canton}} \sim 700 \text{ mph}$

Orbit about Sol

$v_{\text{Earth}} \sim 70,000 \text{ mph}$

Orbit about center of Milky Way

$v_{\text{Sun}} \sim 560,000 \text{ mph}$

Milky Way in Local Group

$v_{\text{MW}} \sim 280,000 \text{ mph}$

Local Group falling toward Virgo Cluster

$v_{\text{LG}} \sim 1,750,000 \text{ mph}$

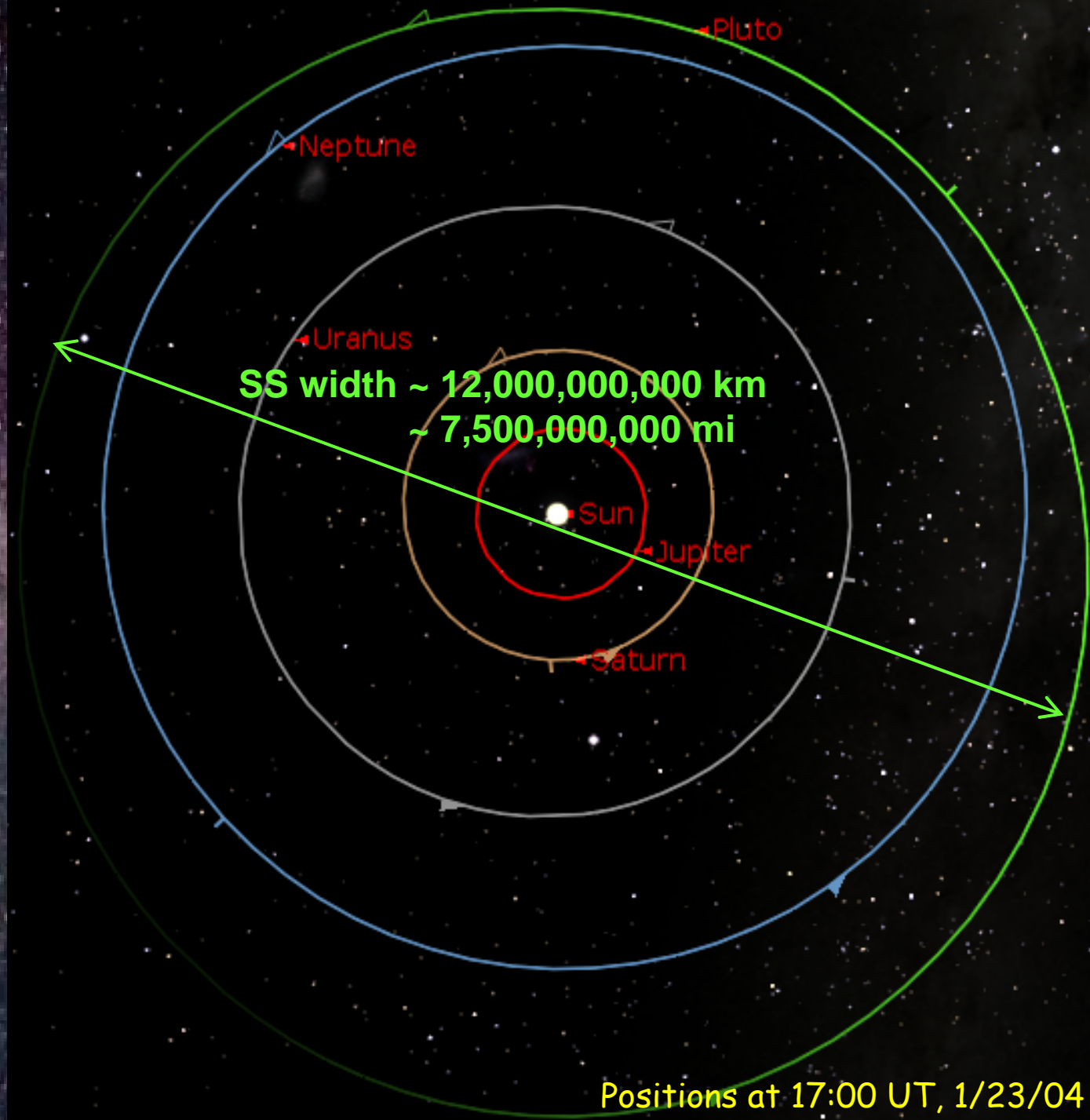
Solar System

Inner
Worlds:
Mercury,
Venus,
Earth,
Mars



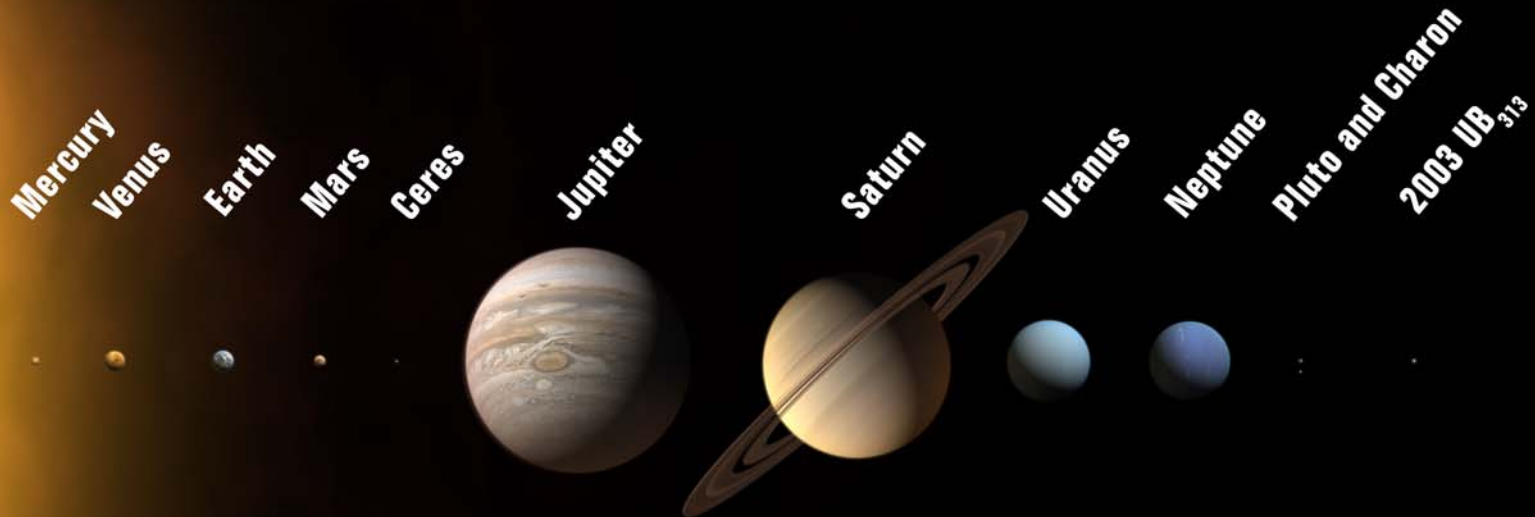
Solar System

Outer
Worlds:
Jupiter,
Saturn,
Uranus,
Neptune,
Pluto



Solar System Sizes

☆ Sun's diameter is 100 times Earth's



☆ Moons

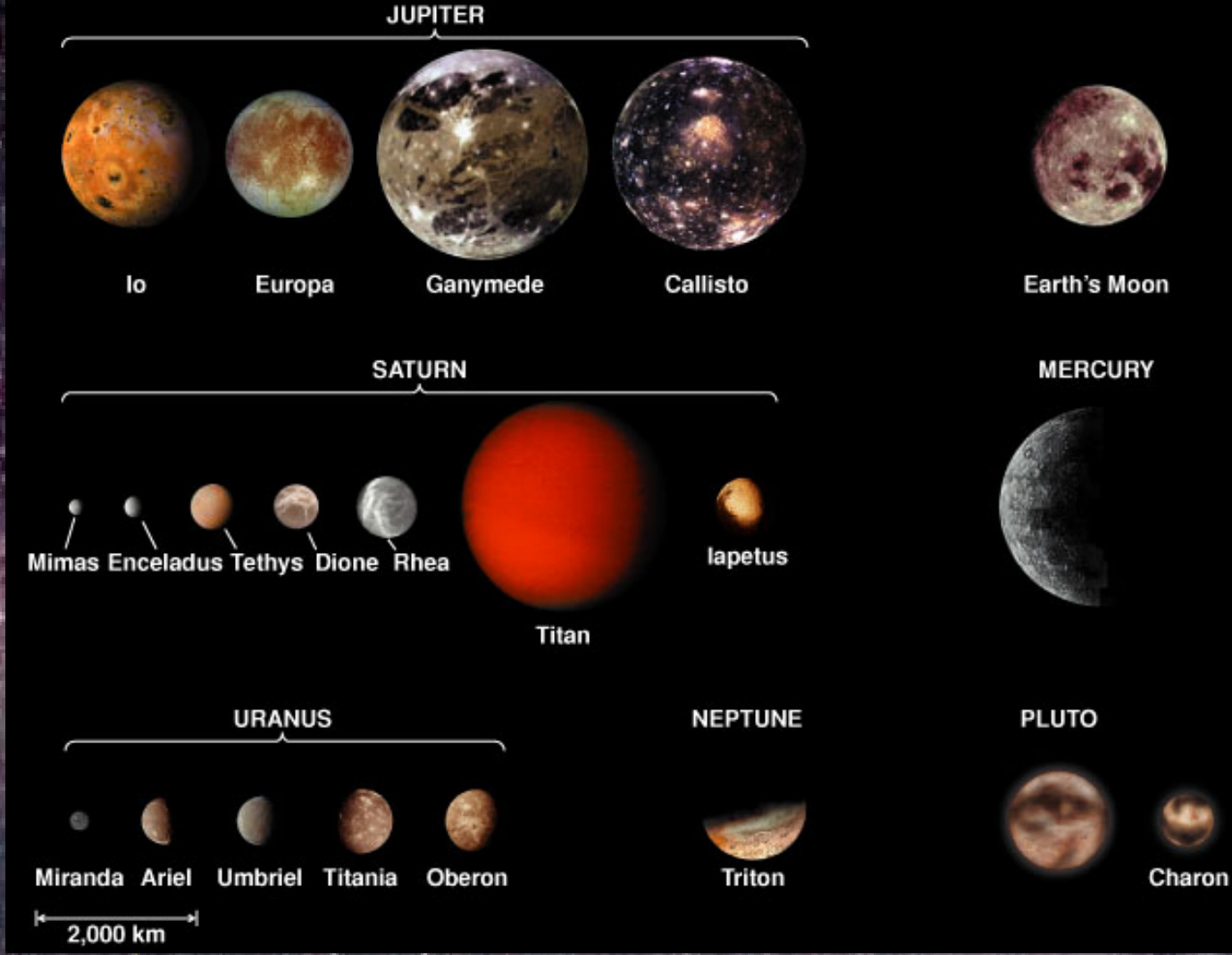
♁ ⊕ - Luna
 ♀ ♂ - Phobos, Deimos

♃ ♃ - Loads!
 ⋃ Io
 ⋃ Europa,
 ⋃ Ganymede,
 ⋃ Callisto

♅ ♃ - Loads!
 ⋃ Titan,
 ⋃ Mimas

♁ ♃ - Loads: Miranda

♁ ♃ - Loads: Triton



Contents of the Solar System

NASA Photojournal

Visit the JPL websites >

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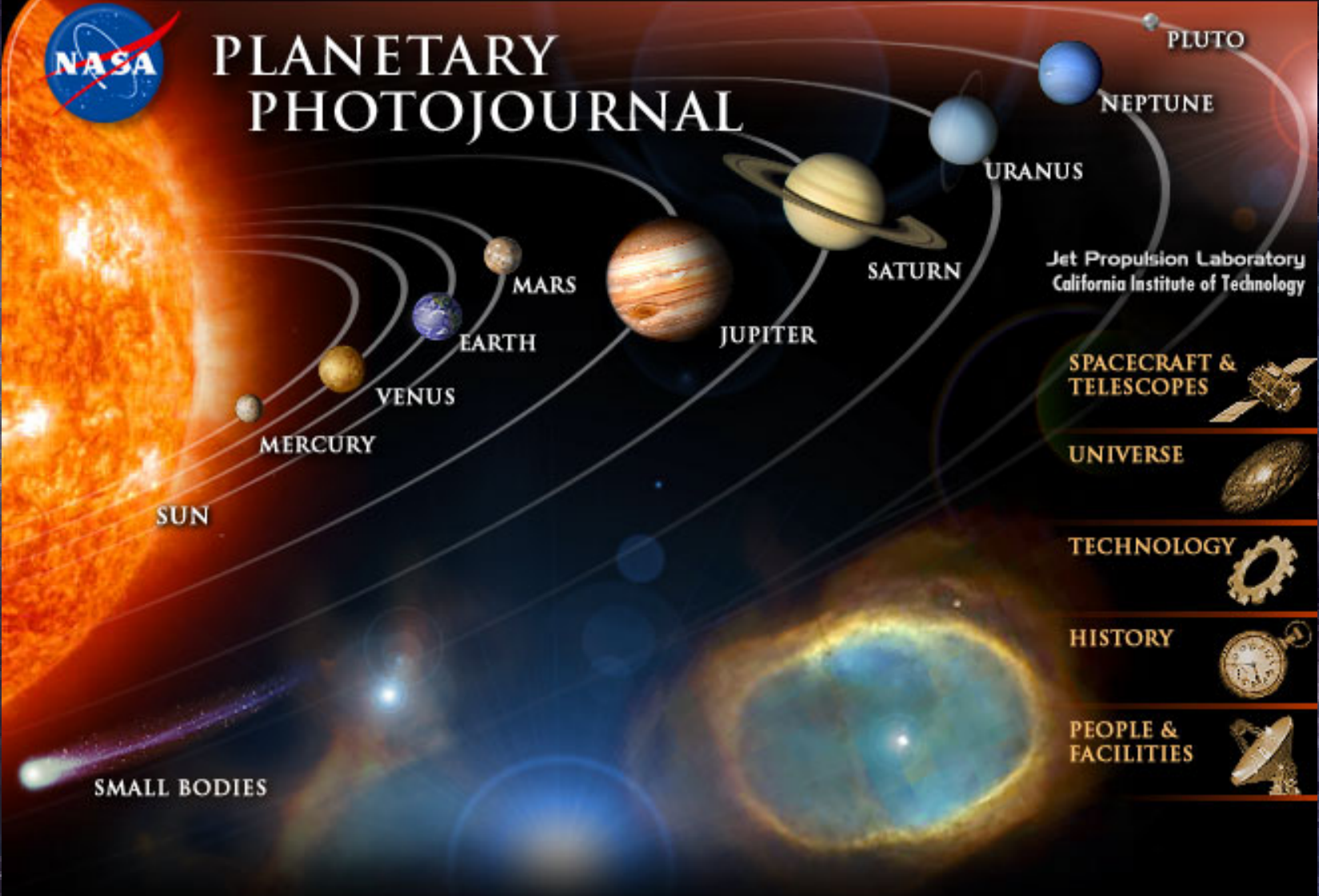
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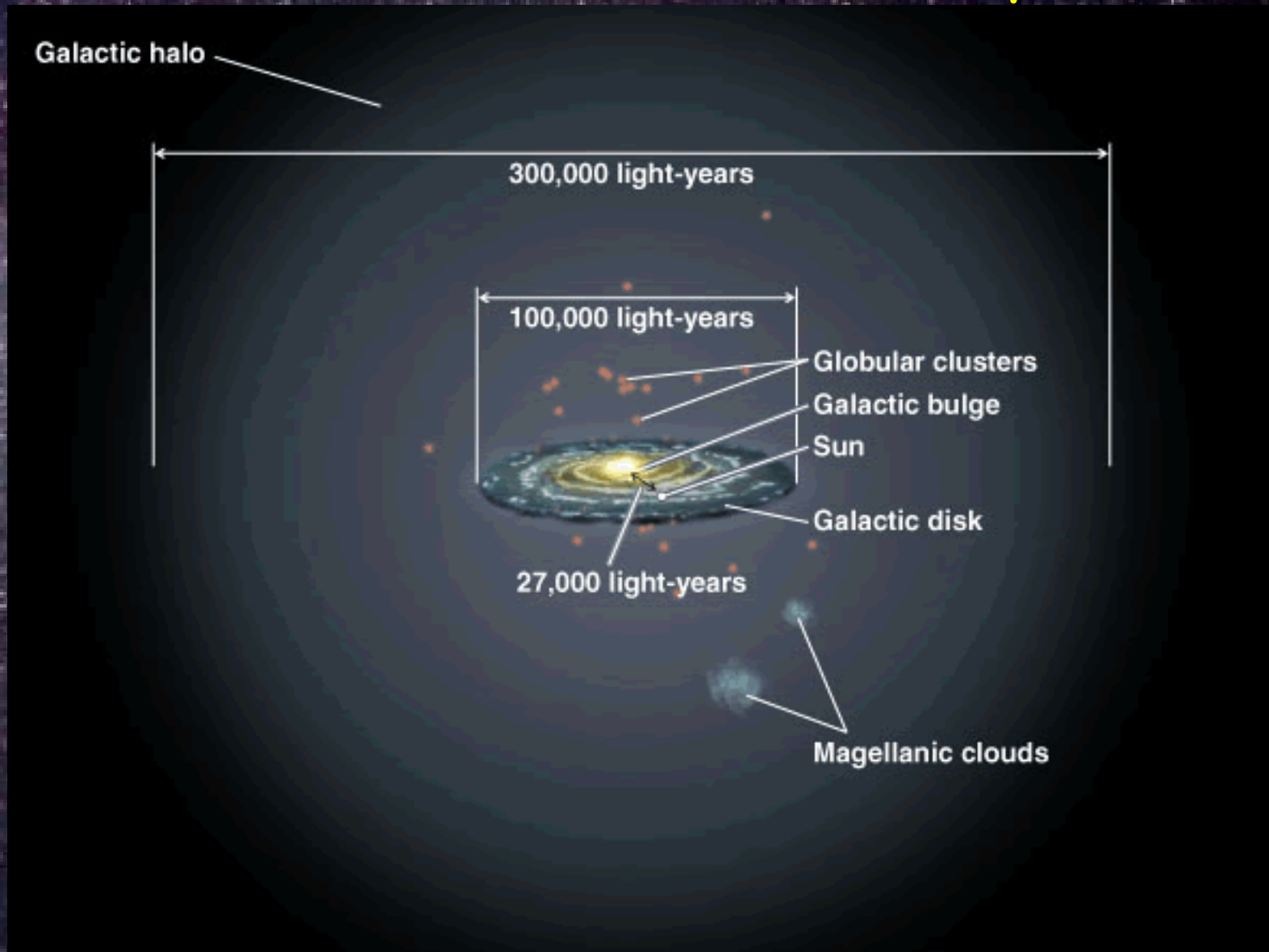
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The Milky Way Galaxy

~ 300 Billion Stars, some with planets



The Milky Way Galaxy

Sun ~ 30,000 ly
from center

Galactic Year
~225,000,000 yr
(Sol is ~22)

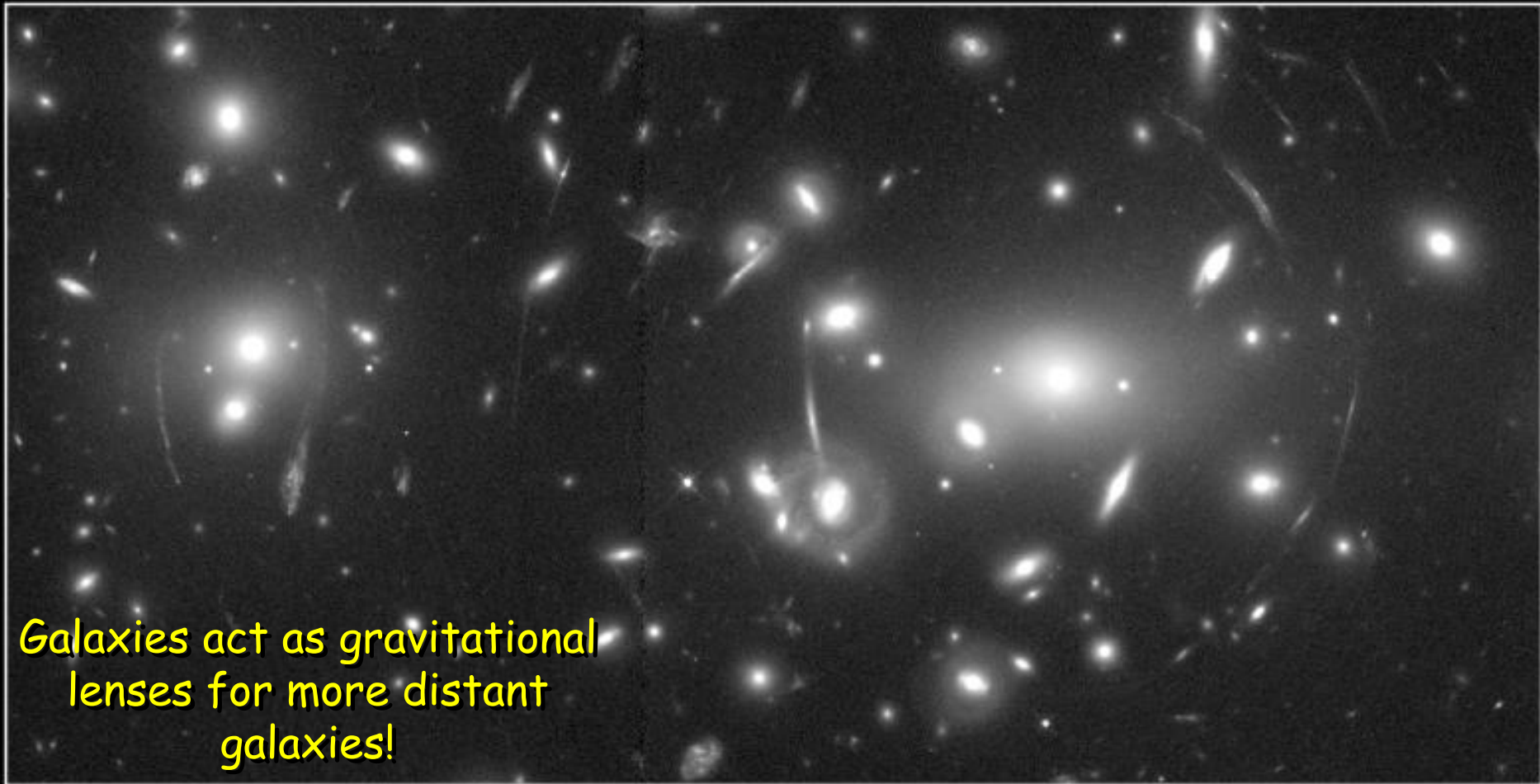


M87, a galaxy much like the Milky Way

<http://www.eso.org/outreach/press-rel/pr-1999/pr-18-99.html>

Clusters of Galaxies

Hundreds to thousands of galaxies bound by gravity



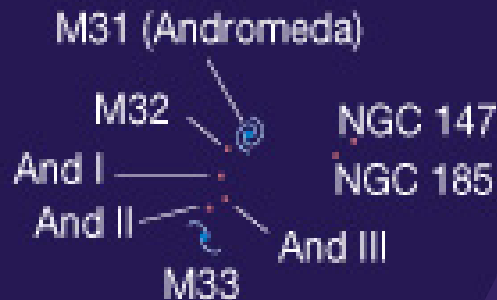
Galaxies act as gravitational
lenses for more distant
galaxies!

Gravitational Lens in Abell 2218

HST · WFPC2



Clusters of Galaxies

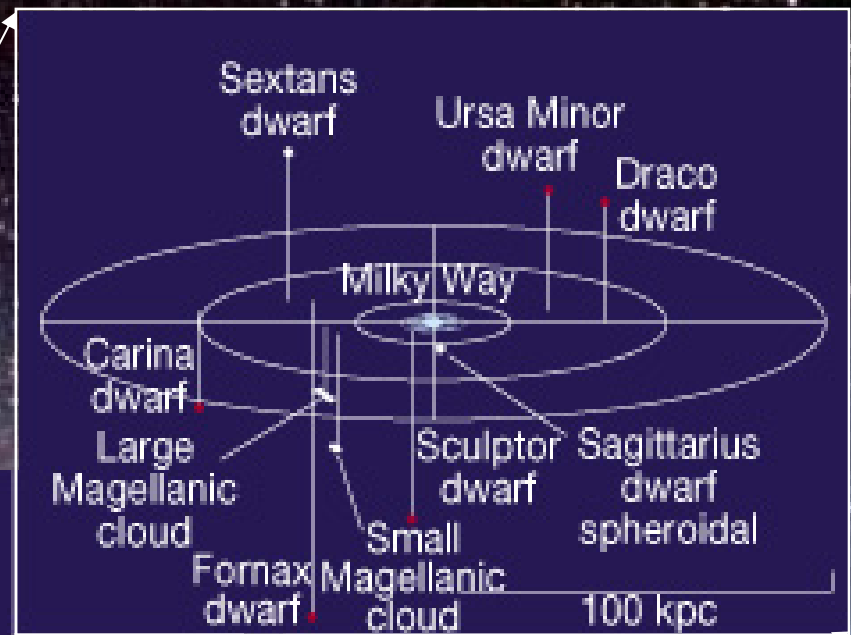


IC 1613



NGC 6822

0 pc 500,000 pc 1,000,000 pc



Sol is in the "Local Group" part of Virgo Supercluster

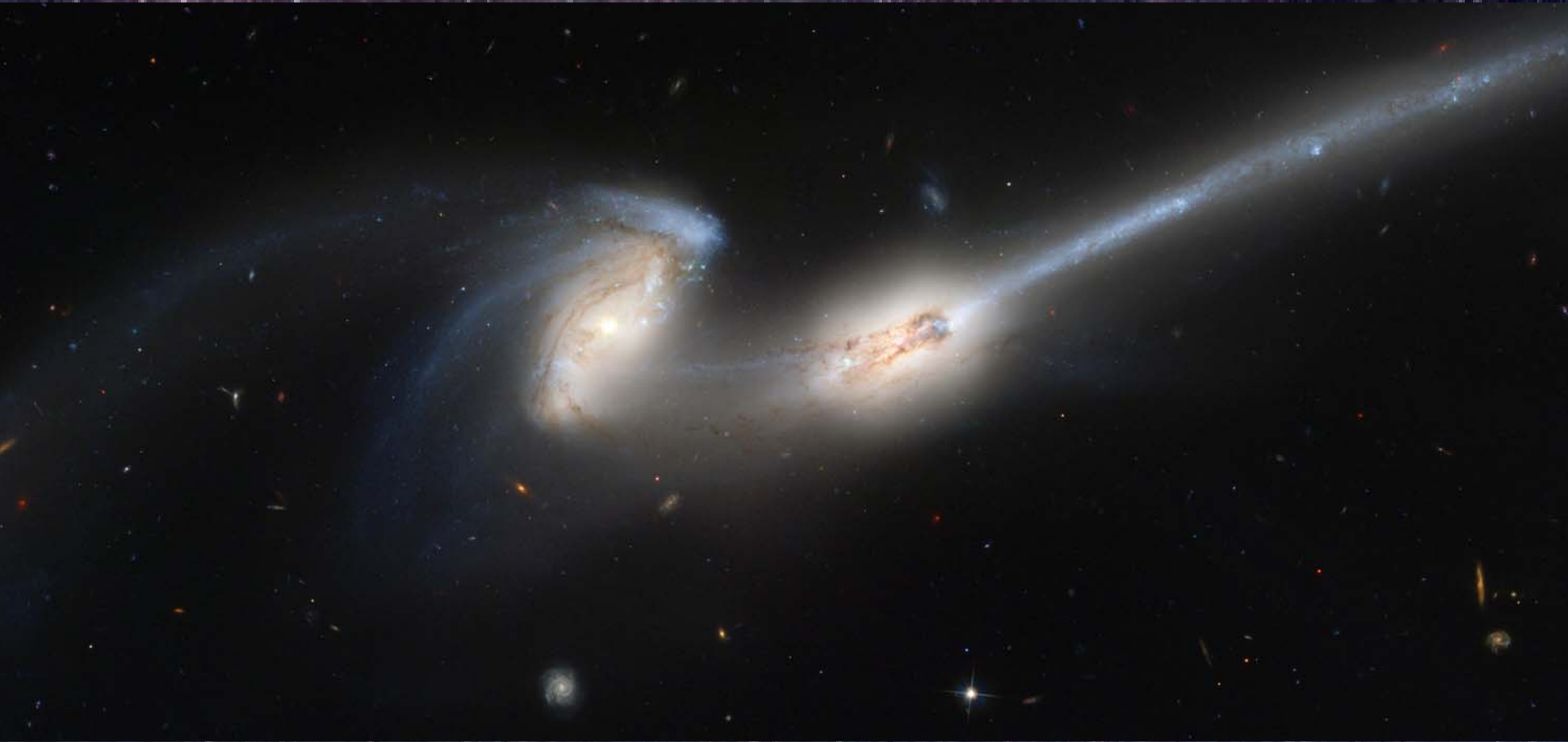
Fate of the Milky Way

- ☆ Andromeda Galaxy & MW approaching
- 🌐 will meet in about 2 billion years

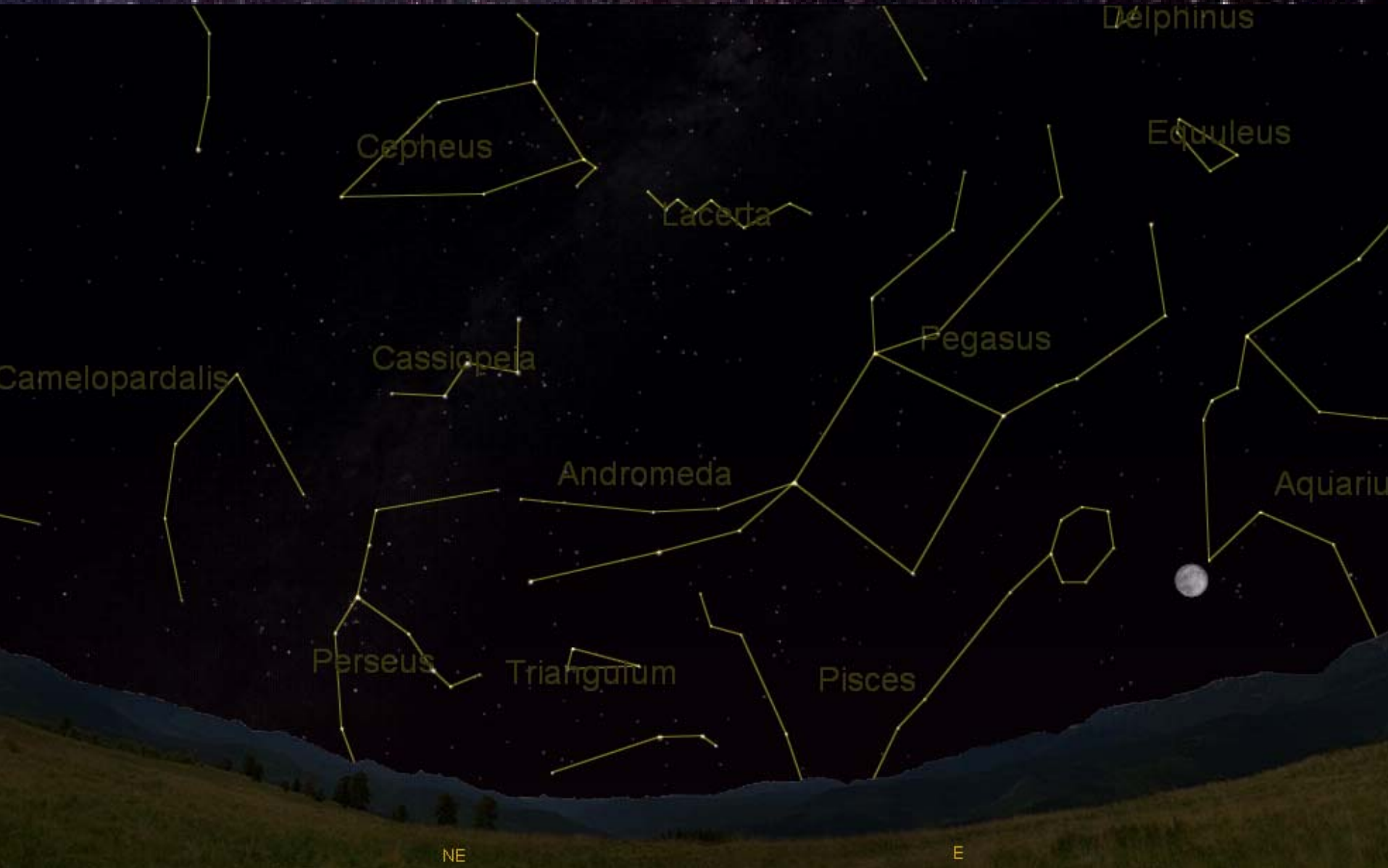


Fate of the Milky Way

- ☆ Sun likely to fly off in gravitational tide



The Sky Tonight



Cassiopeia

Pegasus

Andromeda

Observing Opportunities:
Tuesdays ~9:15 pm when it's clear
TONIGHT: 9 pm (with telescope)

NE

E

To be continued ...