# THE SIZE AND STRUCTURE OF THE UNIVERSE

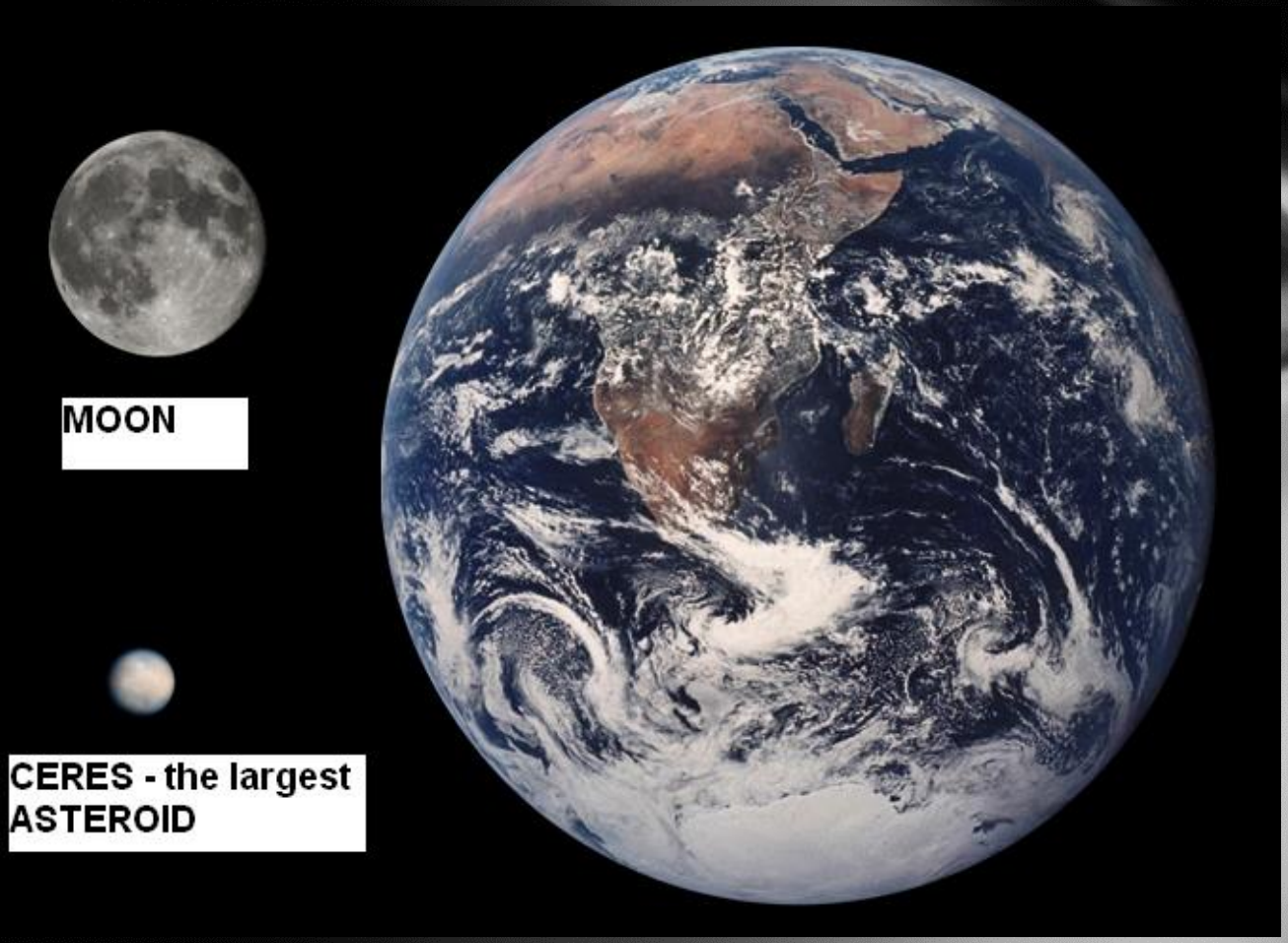
when considering the facts in this presentation, keep in mind:

- **Earth's diameter** (distance across center at widest point) approximately **= 8,000 miles (12,800 kilometers)** (Seems big, doesn't it?)

# Meteors, Comets, Asteroids, Moons

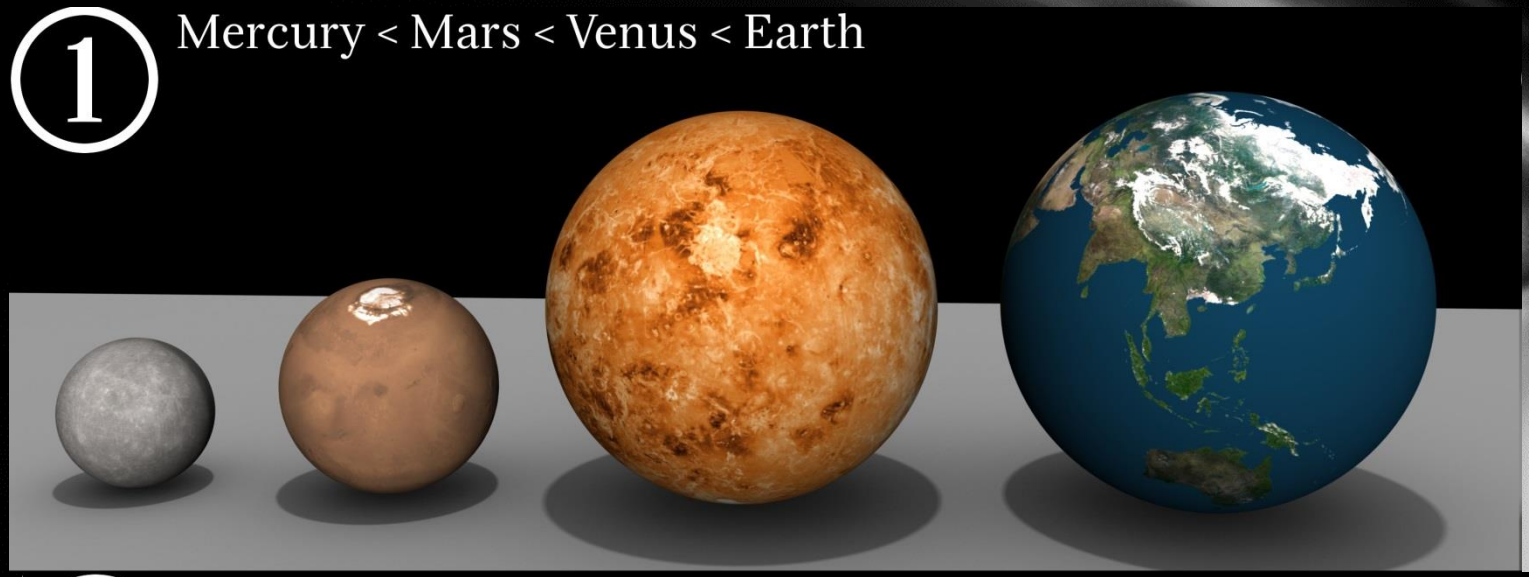
**1. COMETS, METEORS, AND ASTEROIDS** are relatively small "chunks" of rock that usually orbit a star

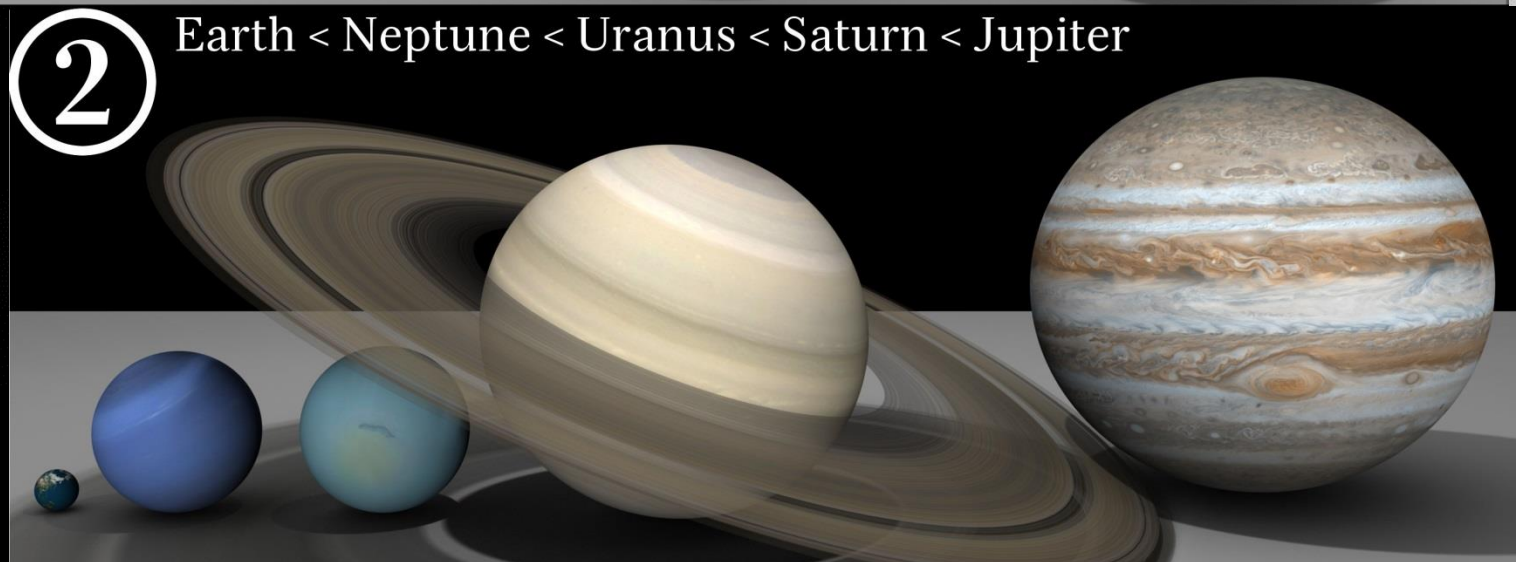
**2. MOONS** are USUALLY larger than comets / meteors / asteroids, but smaller than planets. They ALWAYS orbit a planet, NOT THE SUN

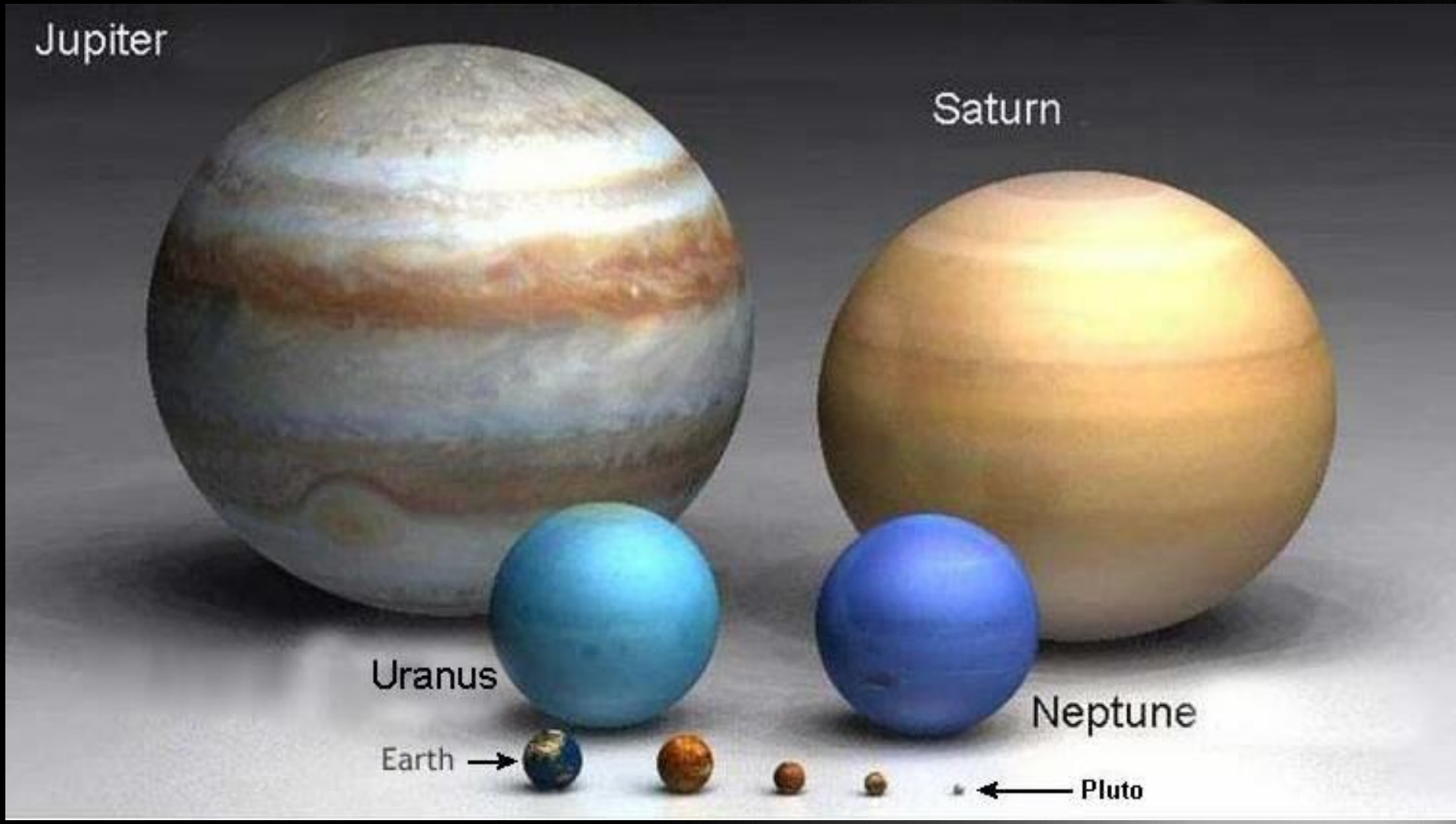


# 3. PLANETS – Bodies that orbit stars.

- The diameter of Jupiter is 142,984 km across. That's 11.2 times bigger than the diameter of Earth. More than 1,300 Earths could fit inside Jupiter

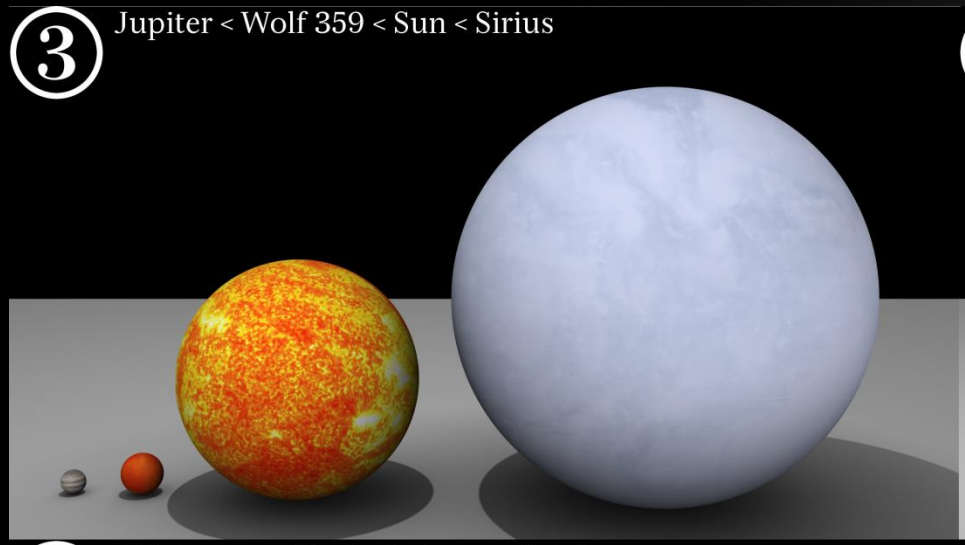


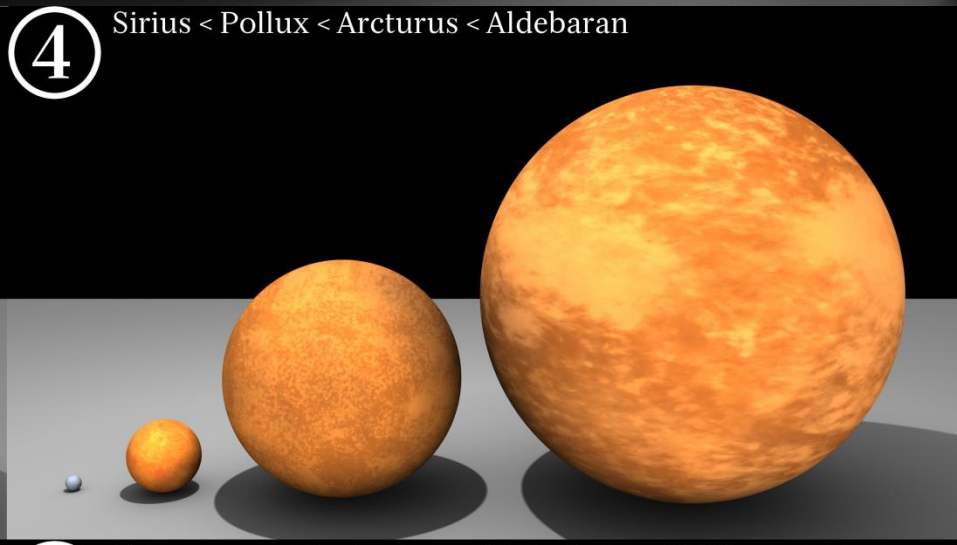



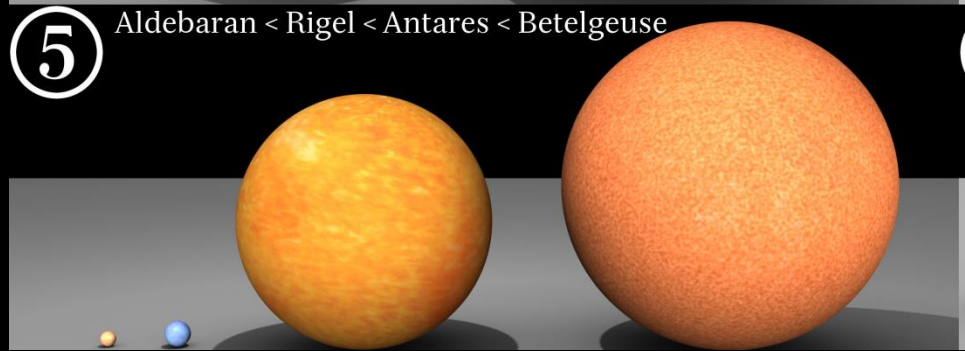

Jupiter
Saturn
Uranus
Neptune
Earth
Pluto

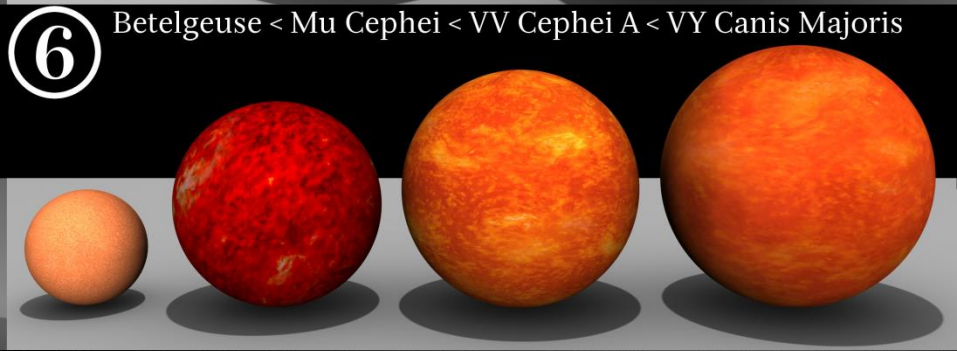
4. **Stars** are balls of gas that produce their own energy by the process of NUCLEAR FUSION; they are the major features of galaxies

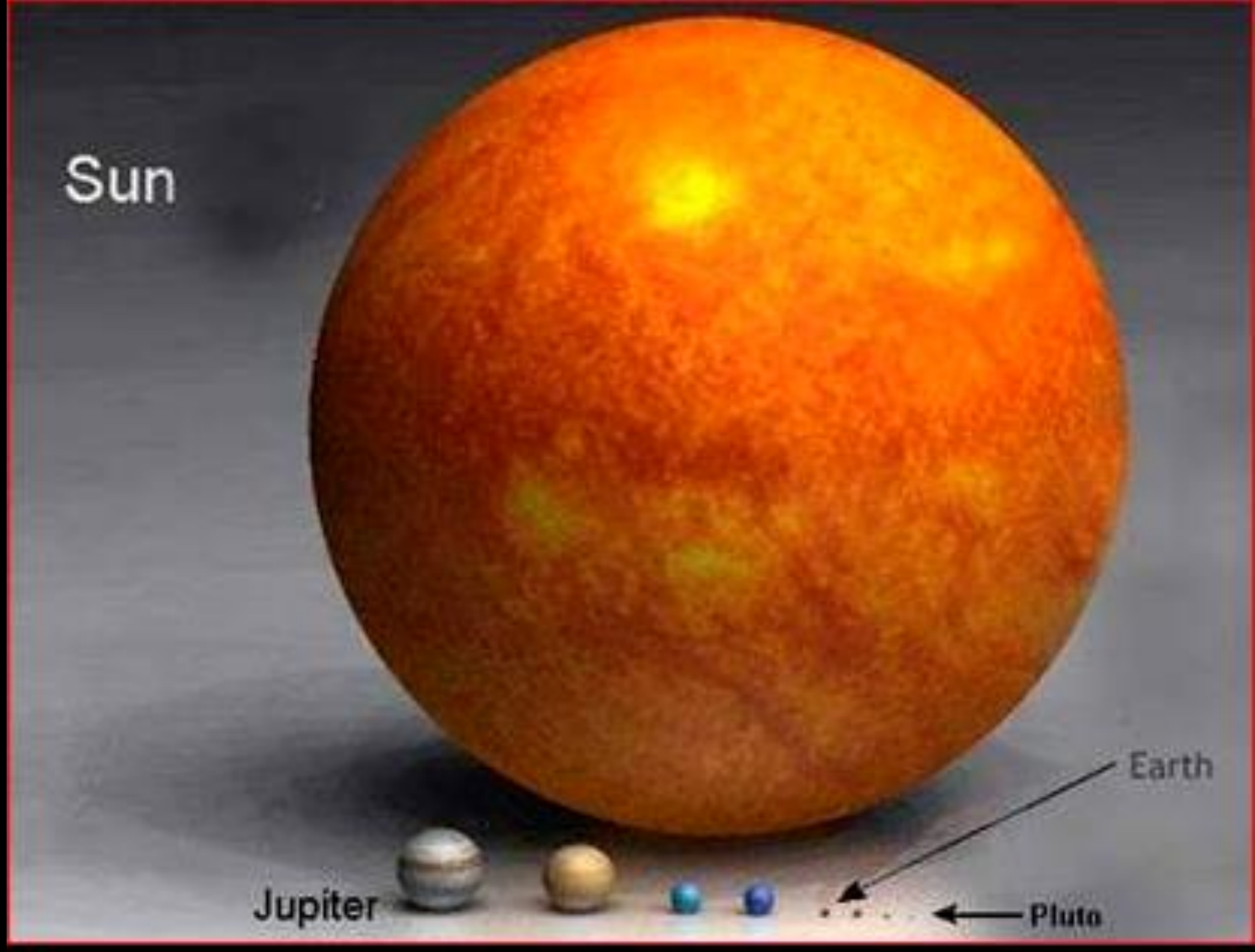
- diameter of the sun (an average star) = 870,000 miles (1,392,000 km.)
- That's over 100,000 times the diameter of the Earth. Over 1,000,000 Earths could fit inside of the Sun

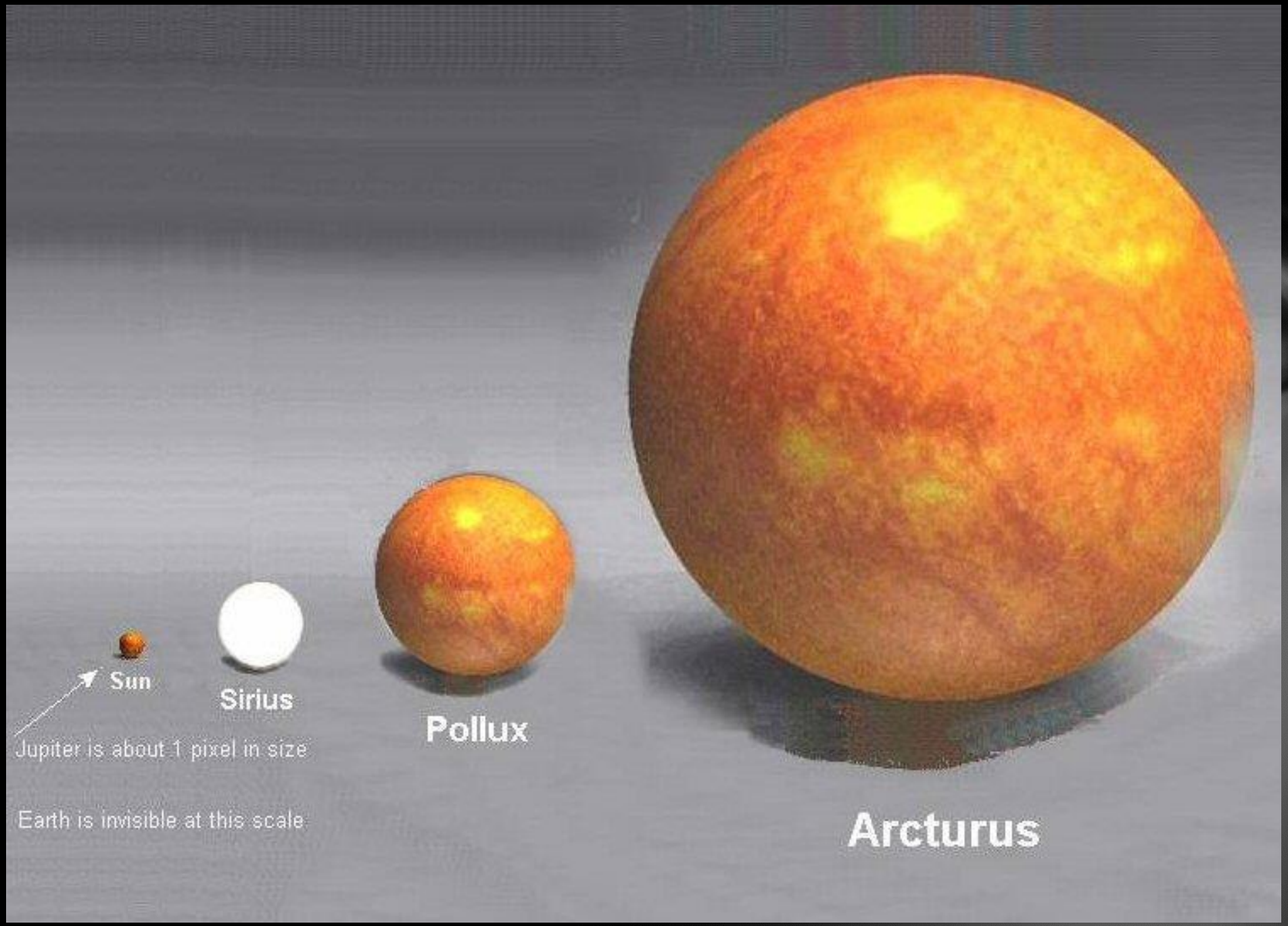


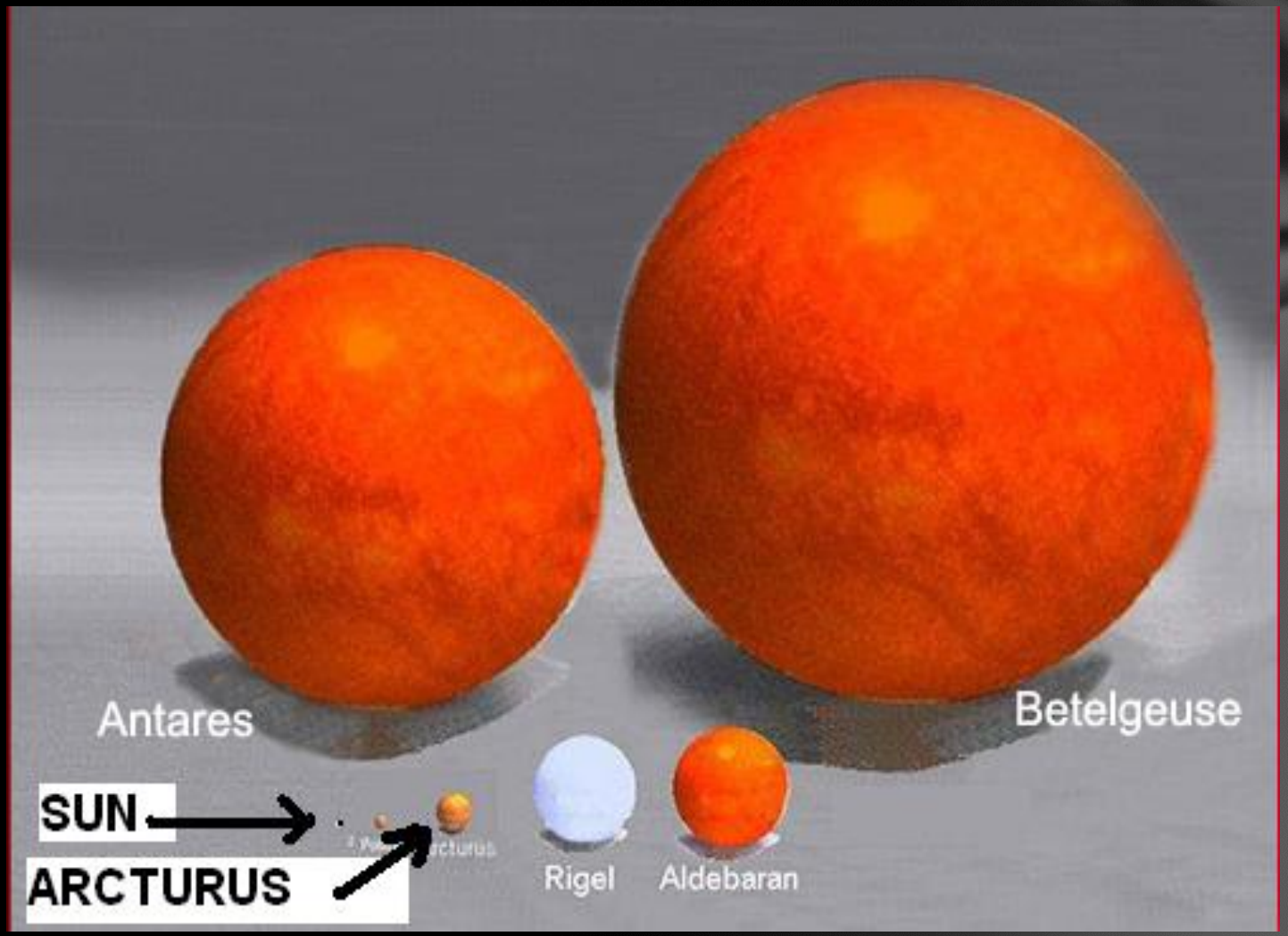




Sun
Earth
Jupiter
Pluto


Sun
Sirius
Pollux
Arcturus
Jupiter is about 1 pixel in size
Earth is invisible at this scale

# The diameter of Betelgeuse is 1,000 times that of the sun, or about 1,000,000 times that of the Earth

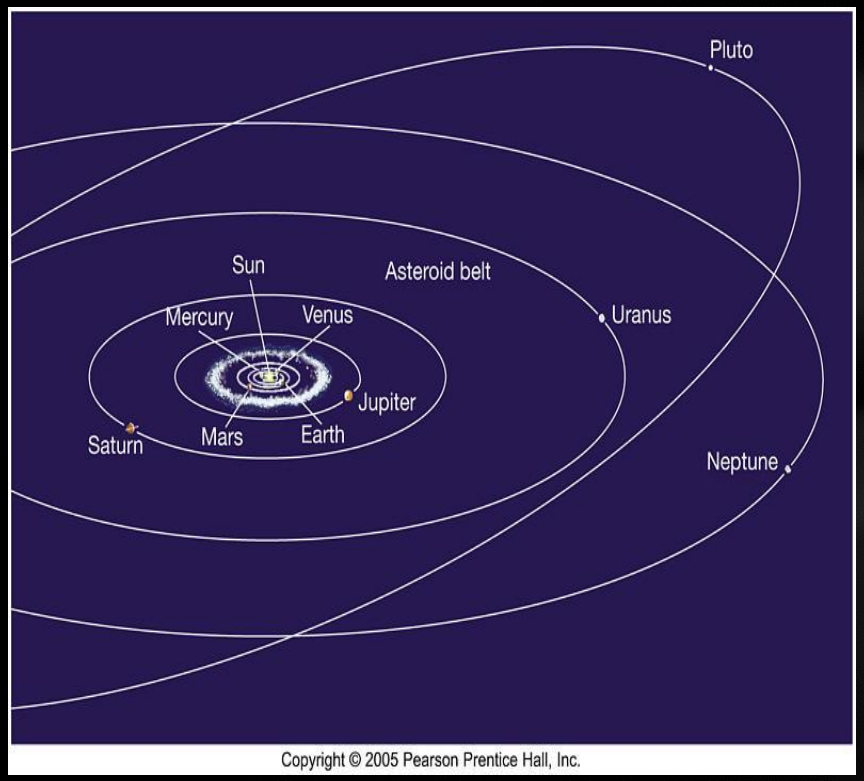
(sun – asteroid belt if at center of solar system instead of sun)

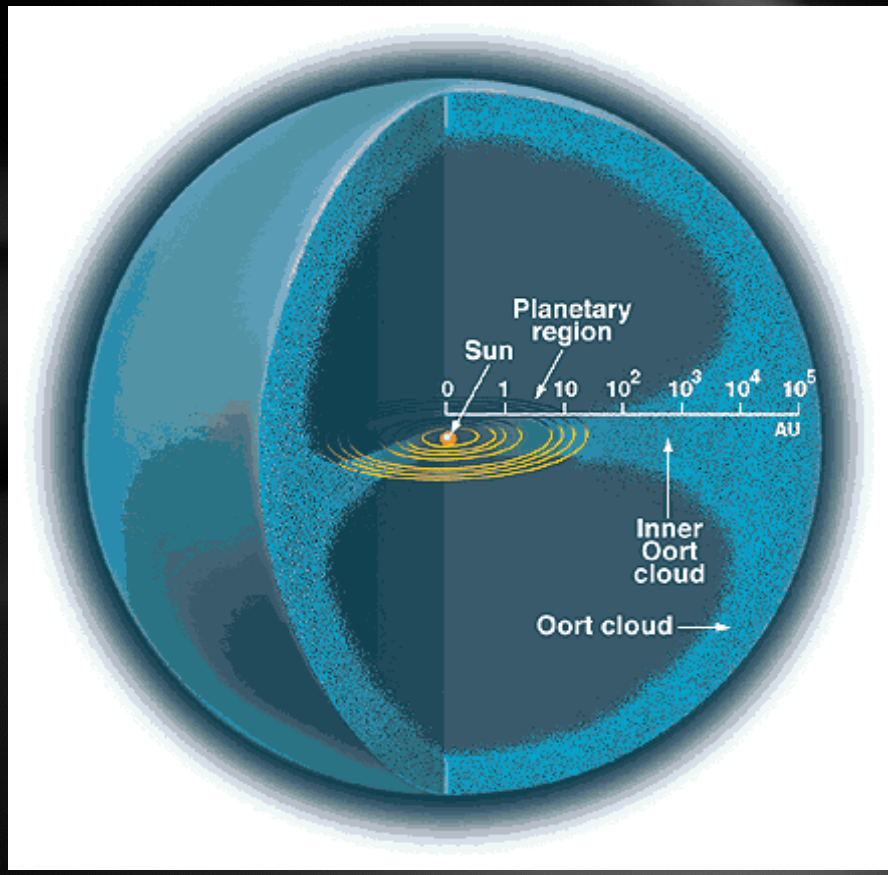


# 5. STAR SYSTEMS:

consist of one or more stars (usually 2 or 3) and the objects (planets, moons, comets, asteroids) that orbit them

OUR STAR SYSTEM IS CALLED THE SOLAR SYSTEM (our sun's name = "sol" : "sol-ar" system)




Over 100 planets have been found OUTSIDE OF OUR SOLAR SYSTEM, orbiting other stars (called EXTRASOLAR PLANETS)

**<u>6. NEBULAE</u>** are HUGE clouds of gas and dust – ranging in size from the size of many stars to 1000's of light years across

***NEBULAE ARE THE "BIRTHPLACES OF STARS" – <u>several star systems can form in one nebula</u>!

***LIGHT YEARS*** **: are used to measure HUGE astronomical objects and distances:**

THE SPEED OF LIGHT = 186,000 MILES / SECOND, OR 300,000 KILOMETERS / SECOND

**ONE LIGHT YEAR : IS DEFINED AS THE *DISTANCE* THAT LIGHT CAN TRAVEL IN ONE YEAR, AND =**

**5.9 TRILLION MILES (5,900,000,000,000)**

or

**9.5 TRILLION KILOMETERS (9,500,000,000,000)**

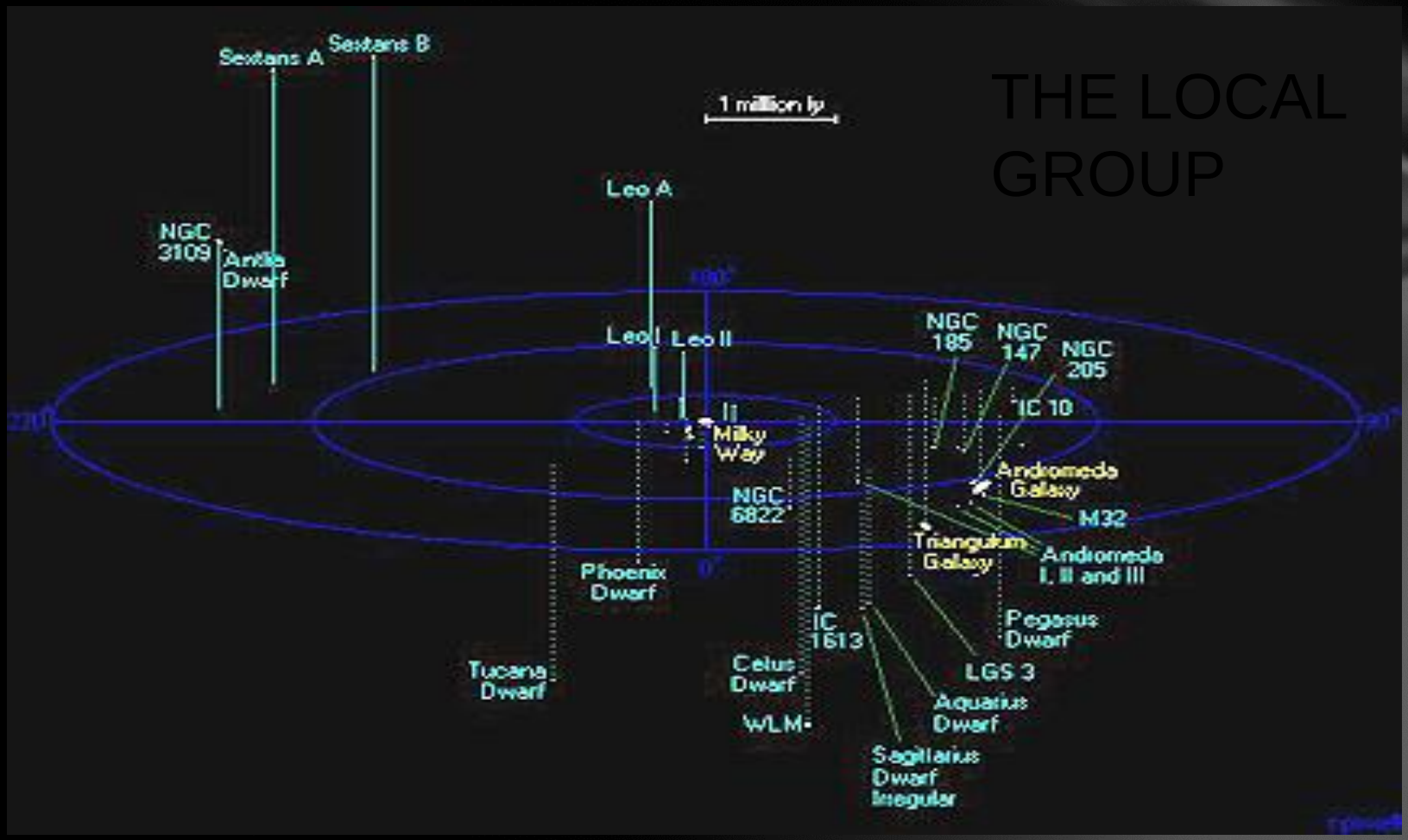
# 6. GALAXIES are the major features of the universe

- **An average galaxy (Milky Way) consists of 100's of billions of stars (100,000,000,000) and a similar # of star systems**
- **Diameter of an average galaxy (Milky Way) = 100,000 LIGHT YEARS**

Each point of light is a CLUSTER OF STARS!!!

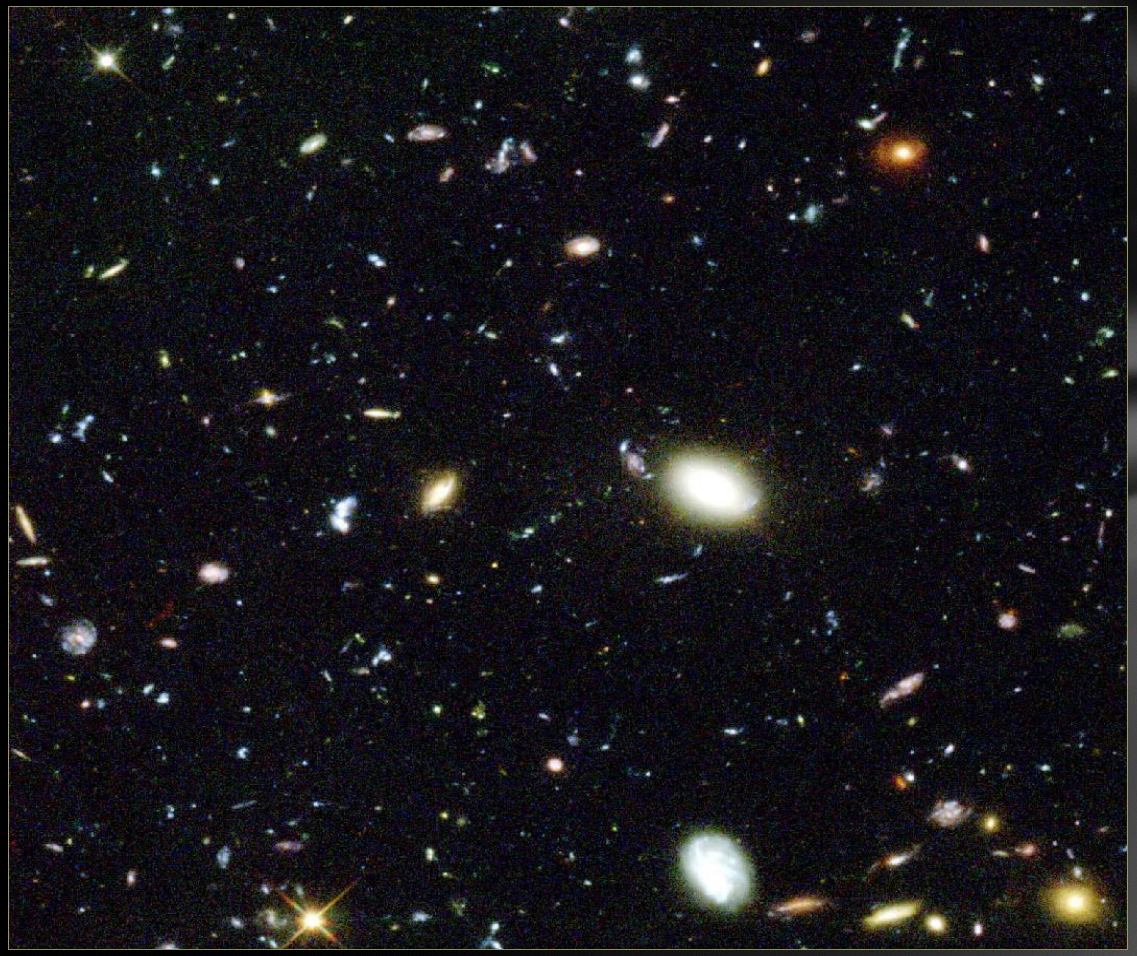
SO, THE MILKY WAY IS APPROXIMATELY **5,900,000,000,000,000,000 MILES LONG**, AND TRAVELLING AT THE SPEED OF LIGHT, IT WOULD TAKE YOU **100,000 YEARS** TO TRAVEL FROM ONE END TO THE OTHER

# 7. GALAXY GROUPS AND CLUSTERS are various sized groups of galaxies "hanging around" together




(remember, each galaxy shown consists of 100's of billions of stars!!!)

# The Hubble Deep Field Photograph



100's of galaxies.  Area of sky photographed = size of Lincoln's eye on a penny.

# OUR LOCAL SUPERCLUSTER

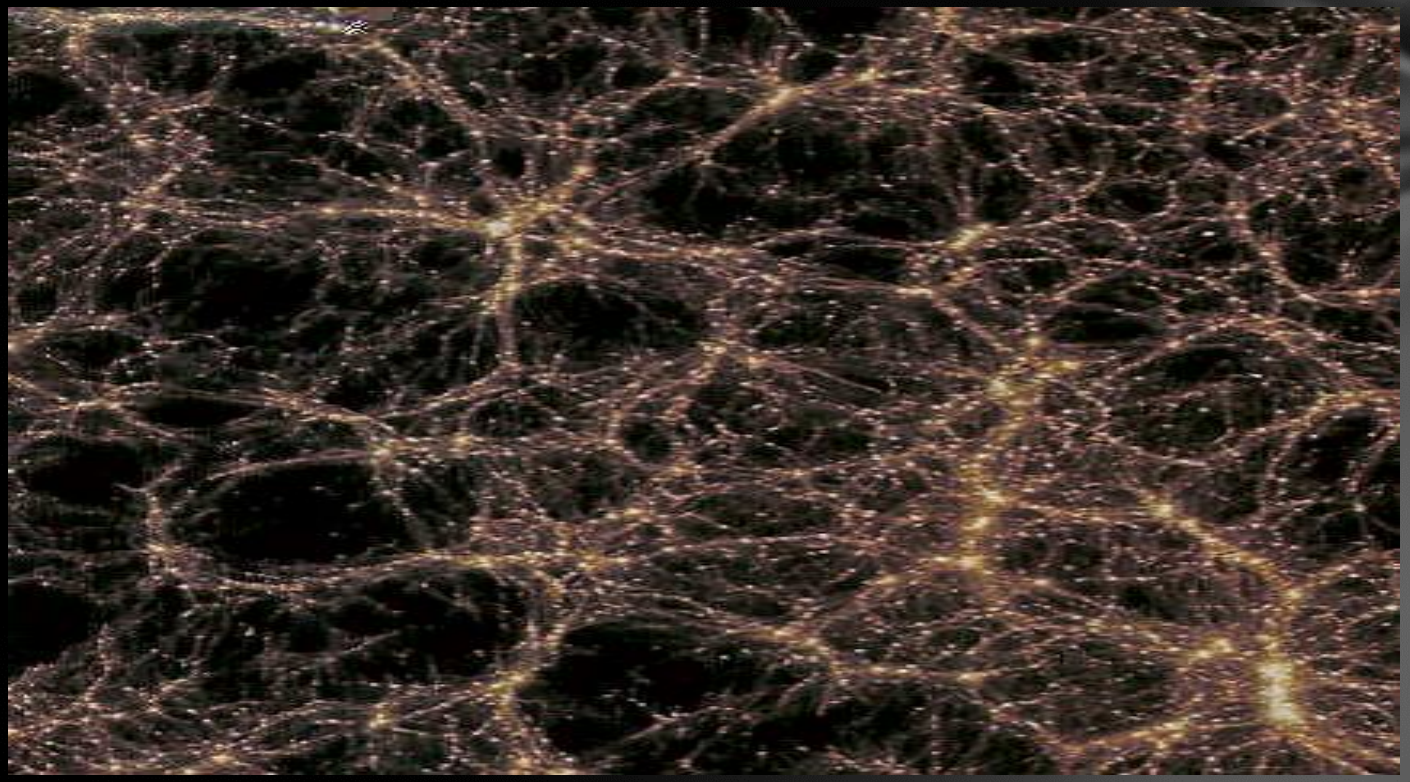
EACH POINT OF LIGHT IS A GALAXY!!!

(1000's per supercluster)

# 8. THE UNIVERSE:

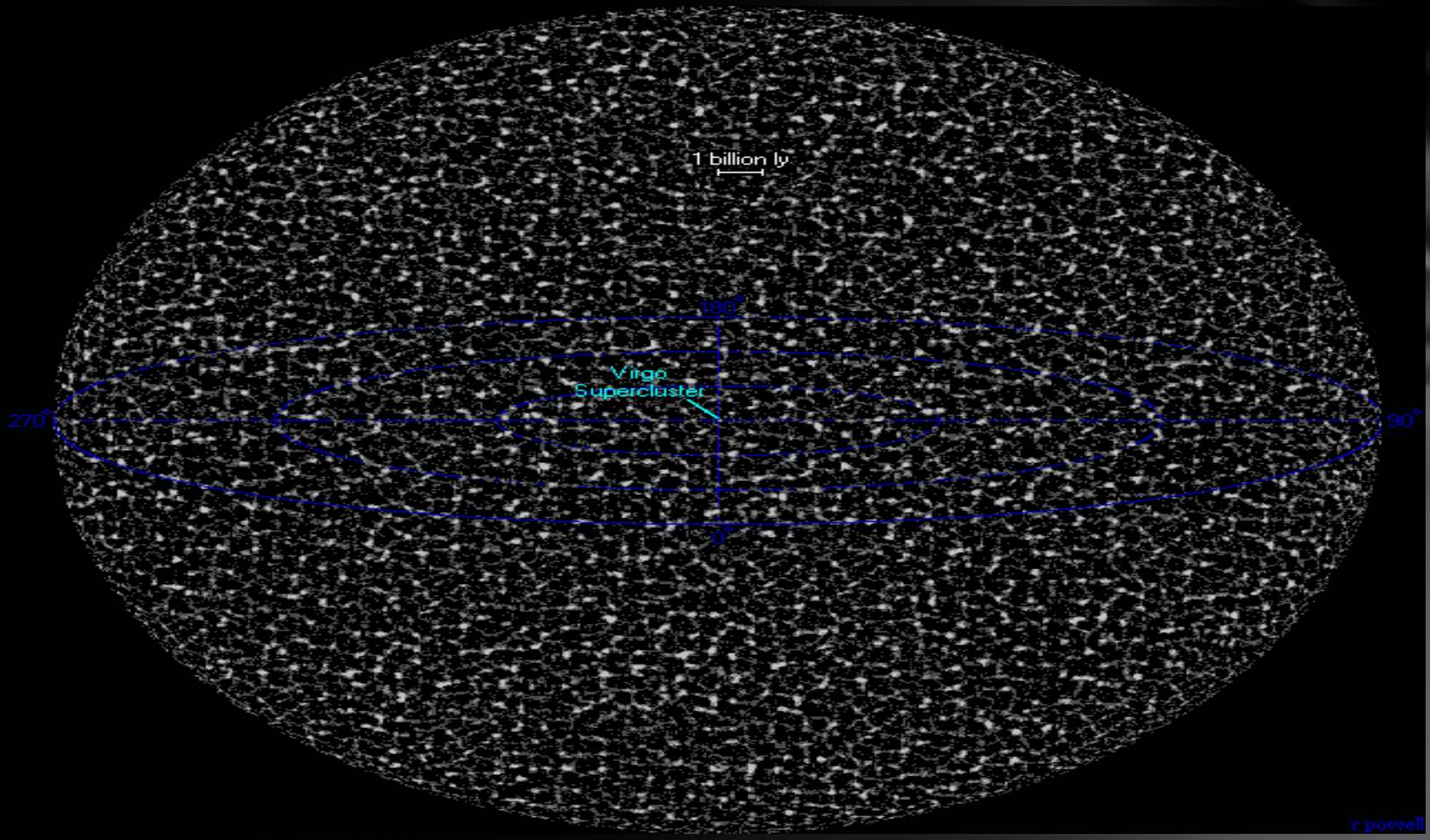
consists of **100's of billions of GALAXIES** (100,000,000,000), and EACH GALAXY HAS 100's of billions of stars, **SO THE UNIVERSE CONSISTS OF APPROXIMATELY 100,000,000,000,000,000,000,000 STARS!!!**

EACH POINT OF LIGHT IS A GALAXY SUPER-CLUSTER!!!



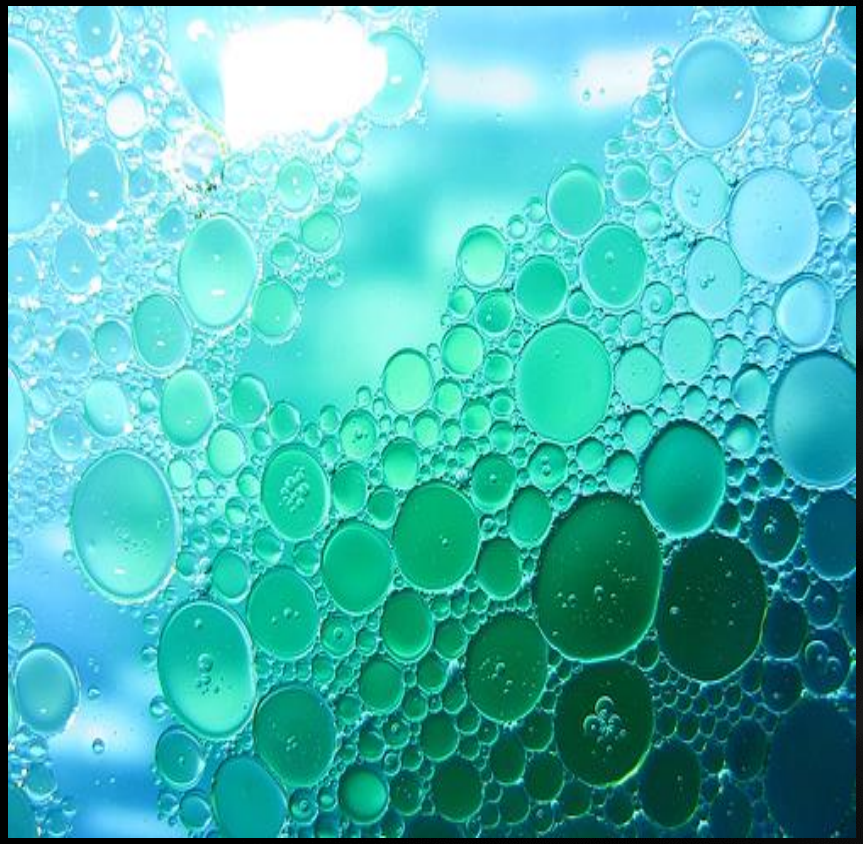
- AGE OF THE UNIVERSE: APPROX. 13.7 BILLION YEARS (13,700,000,000 YRS.)
- **SIZE OF THE UNIVERSE**: APPROX. 90 BILLION LIGHT YEARS, or (**531,000,000,000,000,000,000,000 MILES** (earth' diameter = 8000 miles))

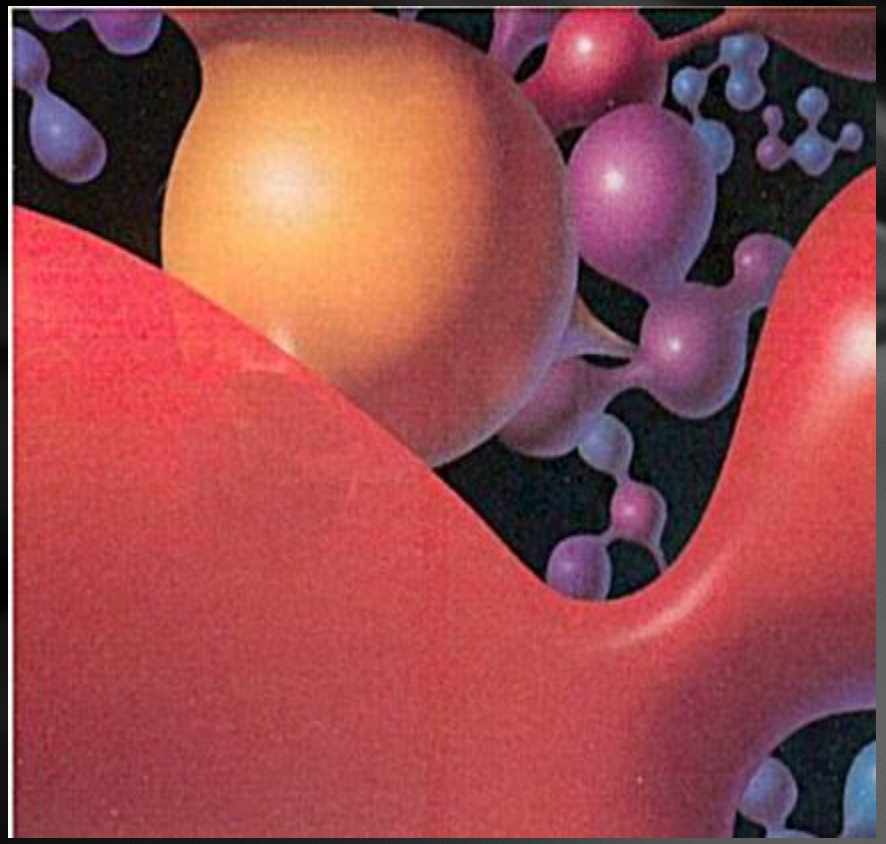
# THE UNIVERSE




Each point of light is a SUPERCLUSTER OF GALAXIES!!!

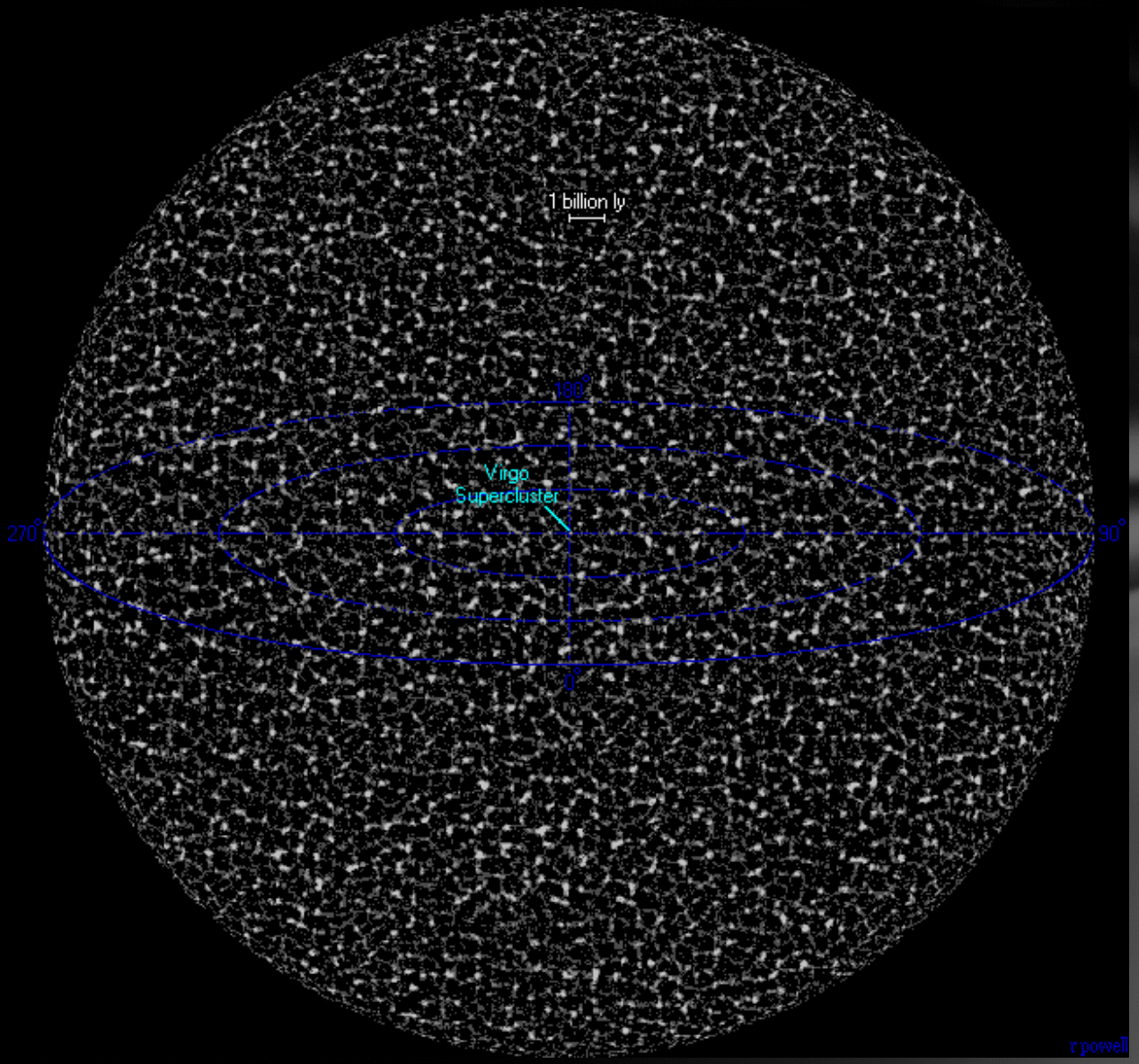
# ? THE MULTIVERSE?





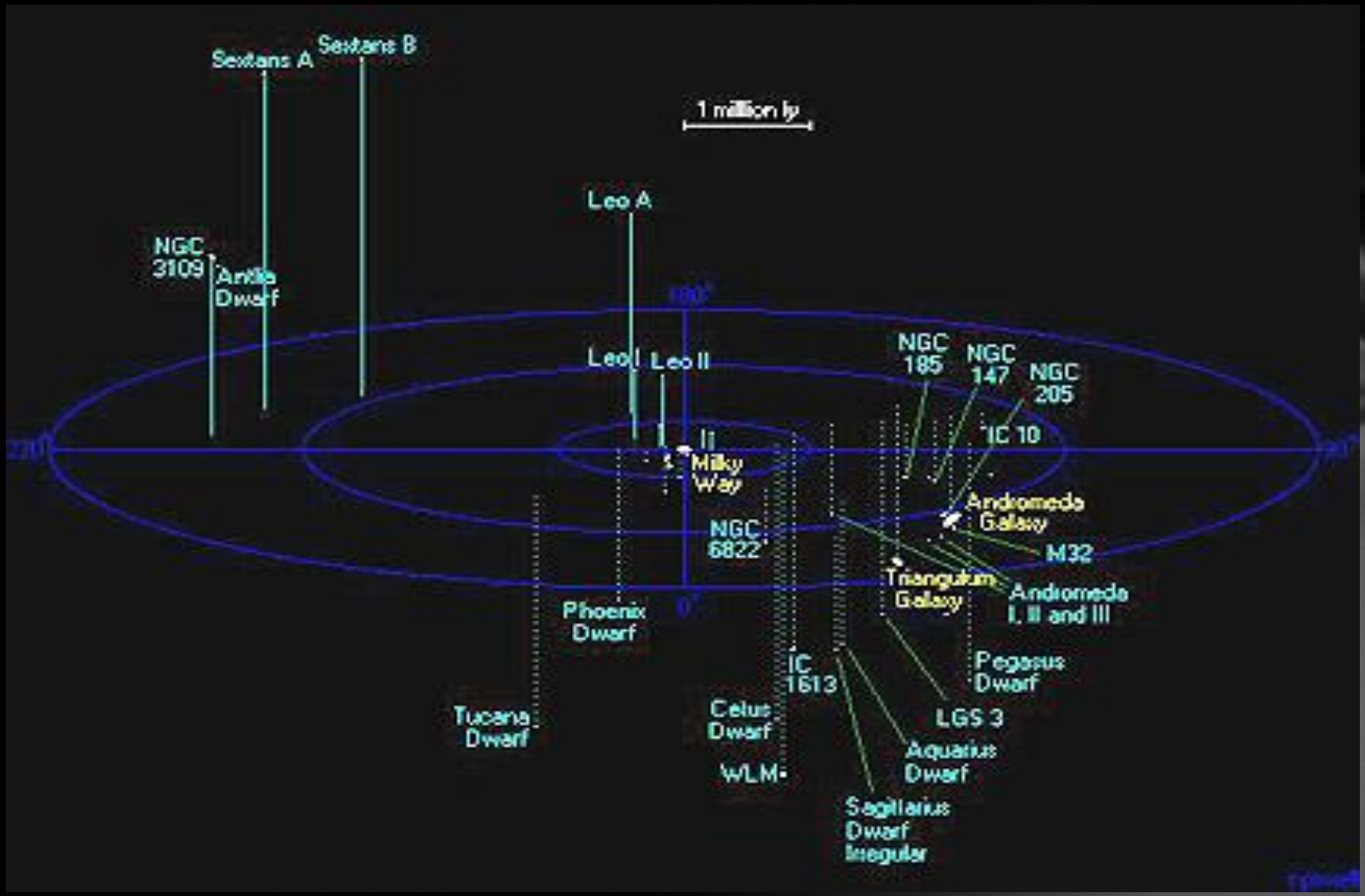
OUR UNIVERSE MAY BE **JUST ONE OF MANY** (DOZENS? HUNDREDS? THOUSANDS? MORE?)

# So, to review and put this all in perspective:



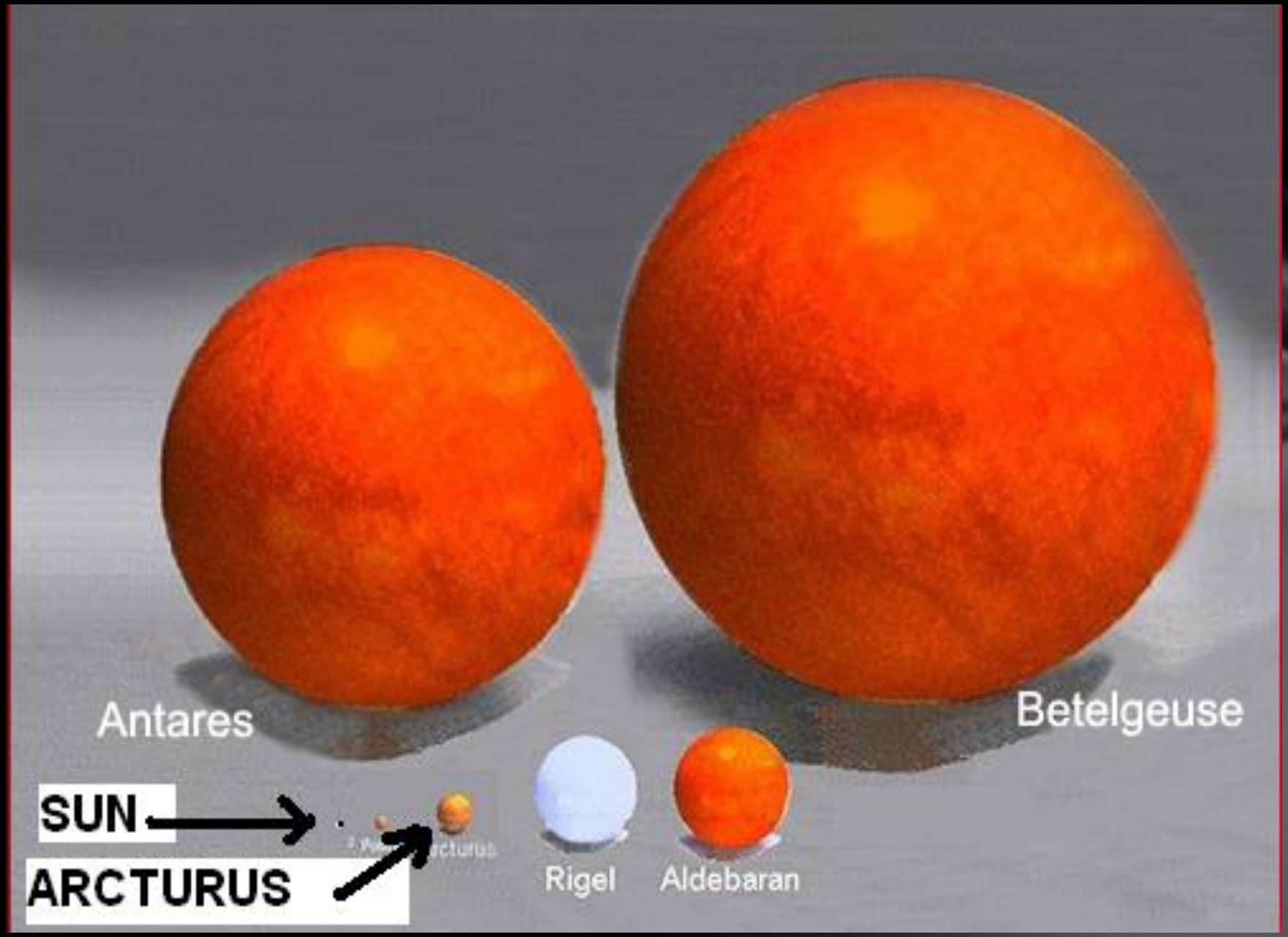

# THE UNIVERSE – PERHAPS ONE OF MANY

GALAXY SUPERCLUSTERS – 10 MILLION IN THE UNIVERSE

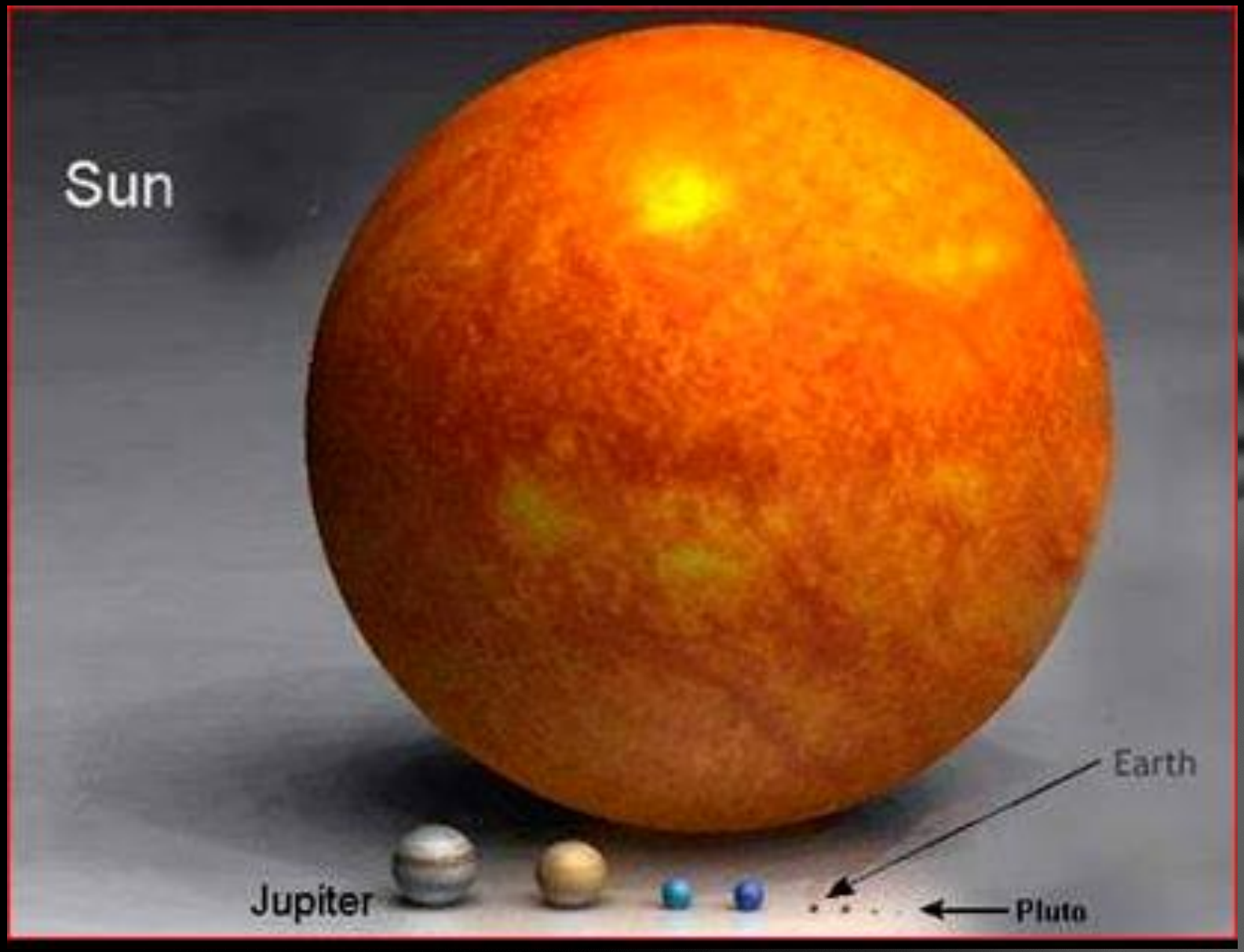



**OUR LOCAL GROUP OF GALAXIES – 10'S TO 100'S PER SUPERCLUSTER**

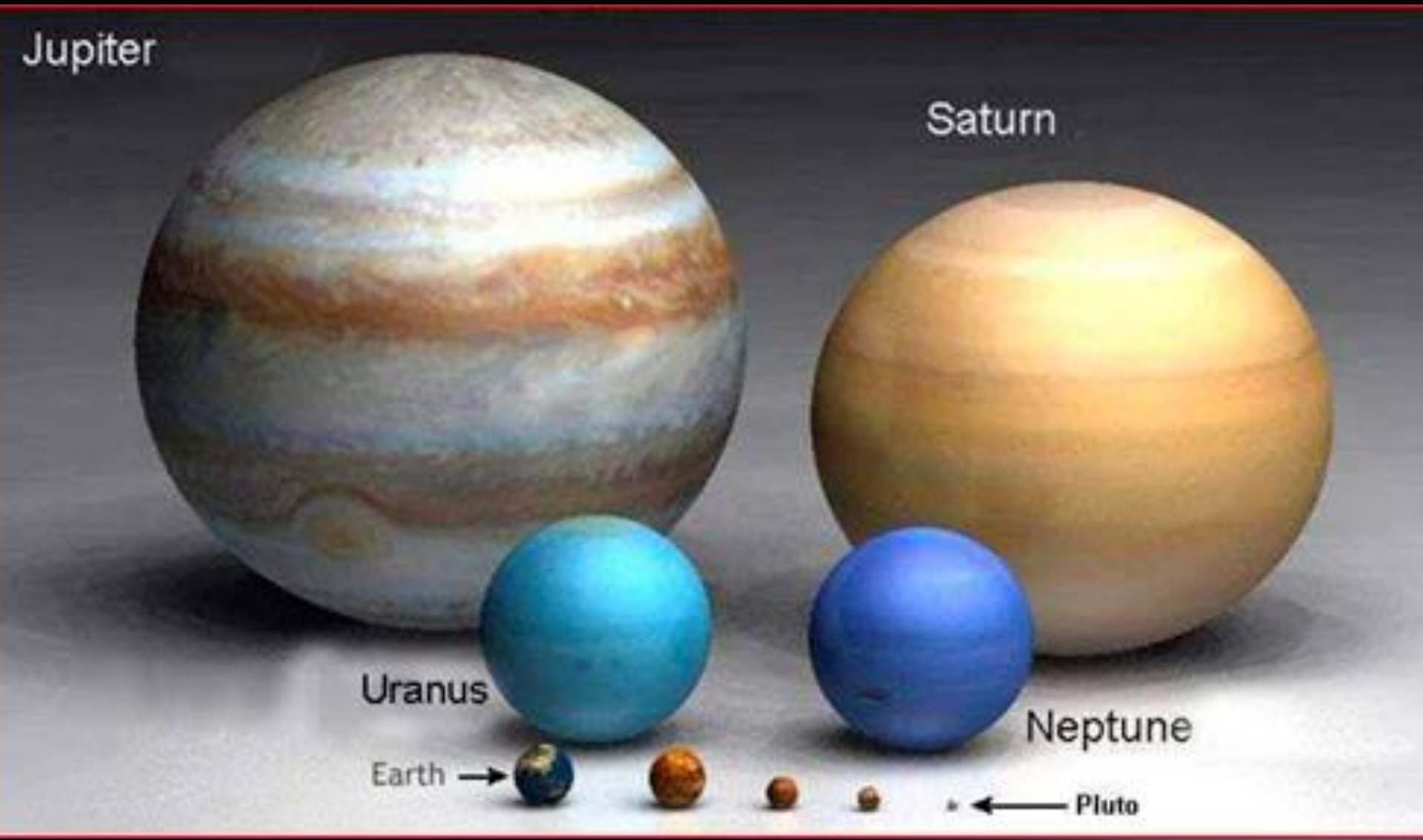
**THE MILKY WAY – ONE GALAXY – 10’S OF BILLIONS IN THE UNIVERSE**




**STARS – 100'S OF BILLIONS PER GALAXY**

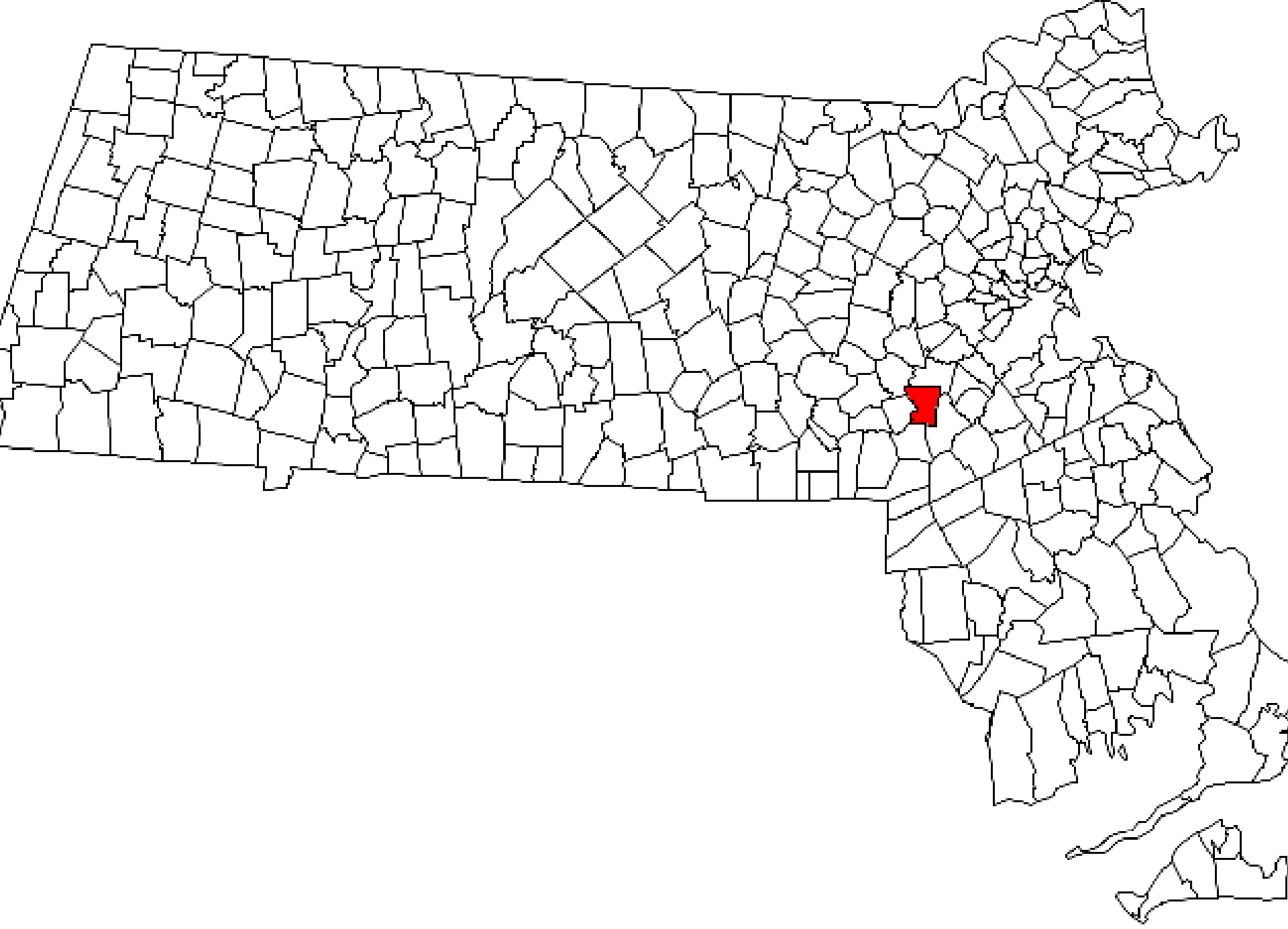



**THE SUN – THOUSANDS OF TIMES SMALLER THAN THE LARGEST STARS**

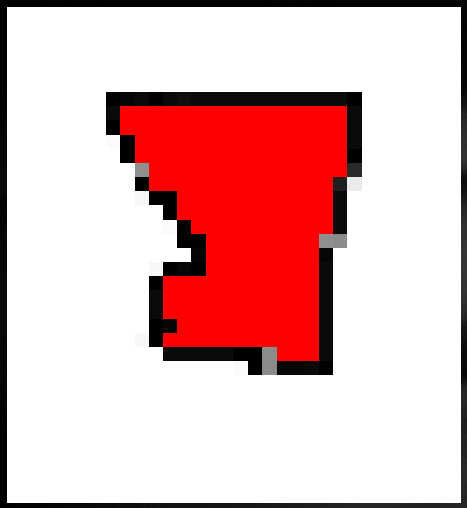



**PLANETS – THOUSANDS OF TIMES SMALLER THAN AVERAGE STARS**

**THE EARTH – HUNDREDS OF TIMES SMALLER THAN THE “AVERAGE” PLANET**



# Good ol' Medfield, Ma

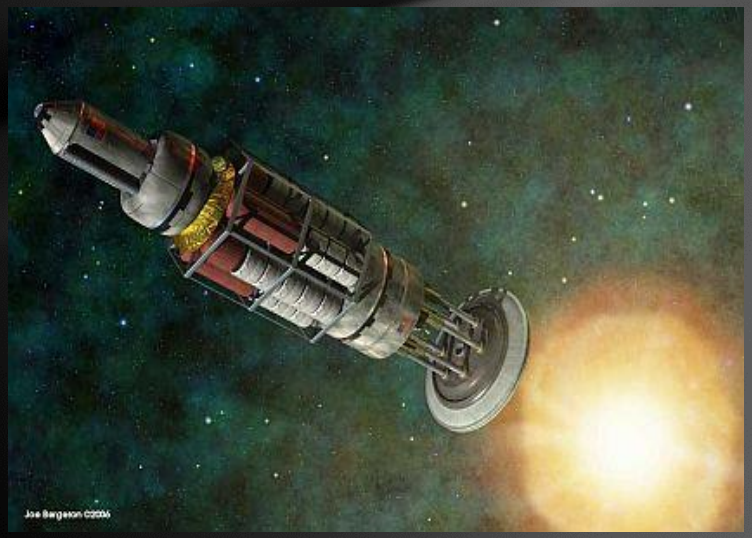


Feeling small???

# A Trip to Neptune….

… would take ≈ 12 years. (Just one way!)

(based on existing spacecraft speeds and the average distance from Earth – Neptune (4.2 Billion Miles))

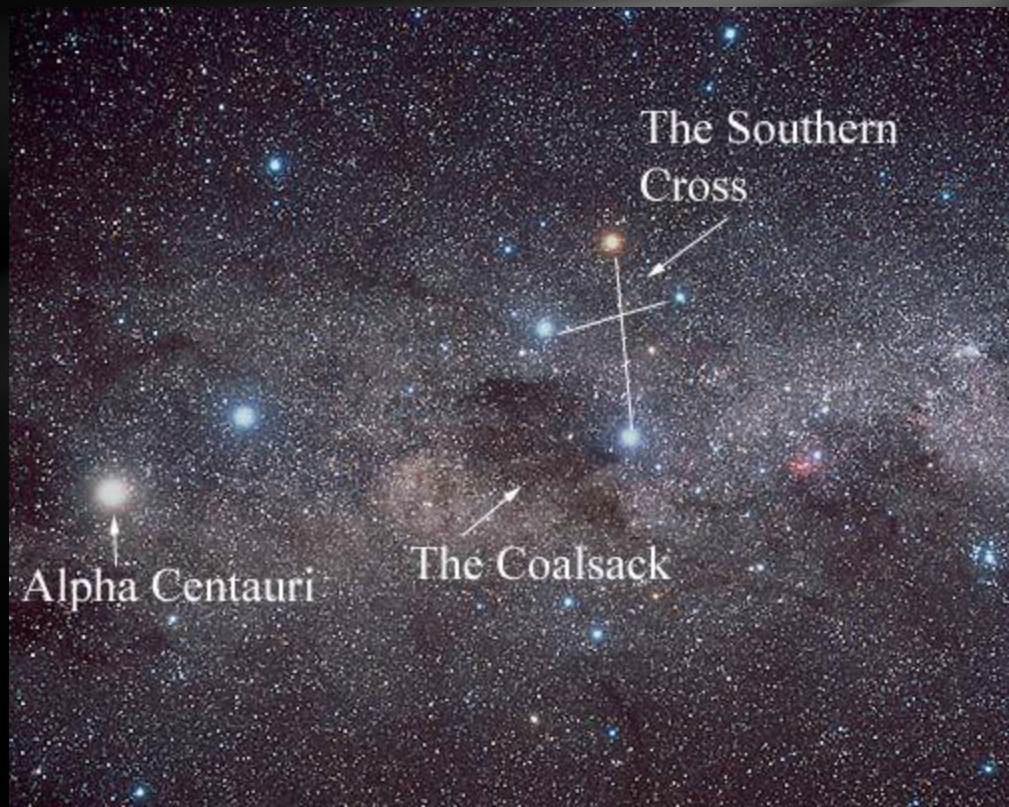


# Distance to closest star

Alpha Centauri is part of a closely orbiting binary about 4.37 light years from Earth.

***Time to get to Alpha Centauri. Fastest:***
**Gravitational assists**

A "future" spacecraft traveling at 150,000 MPH would be 18,748.8 years.

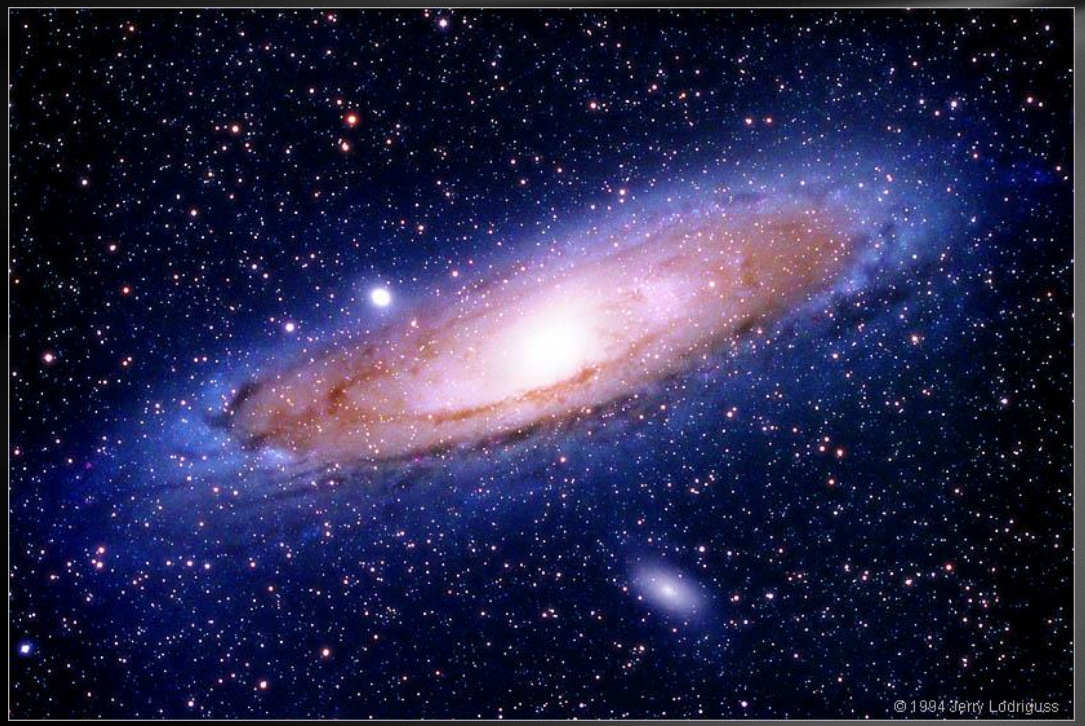


# Trip to nearest galaxy

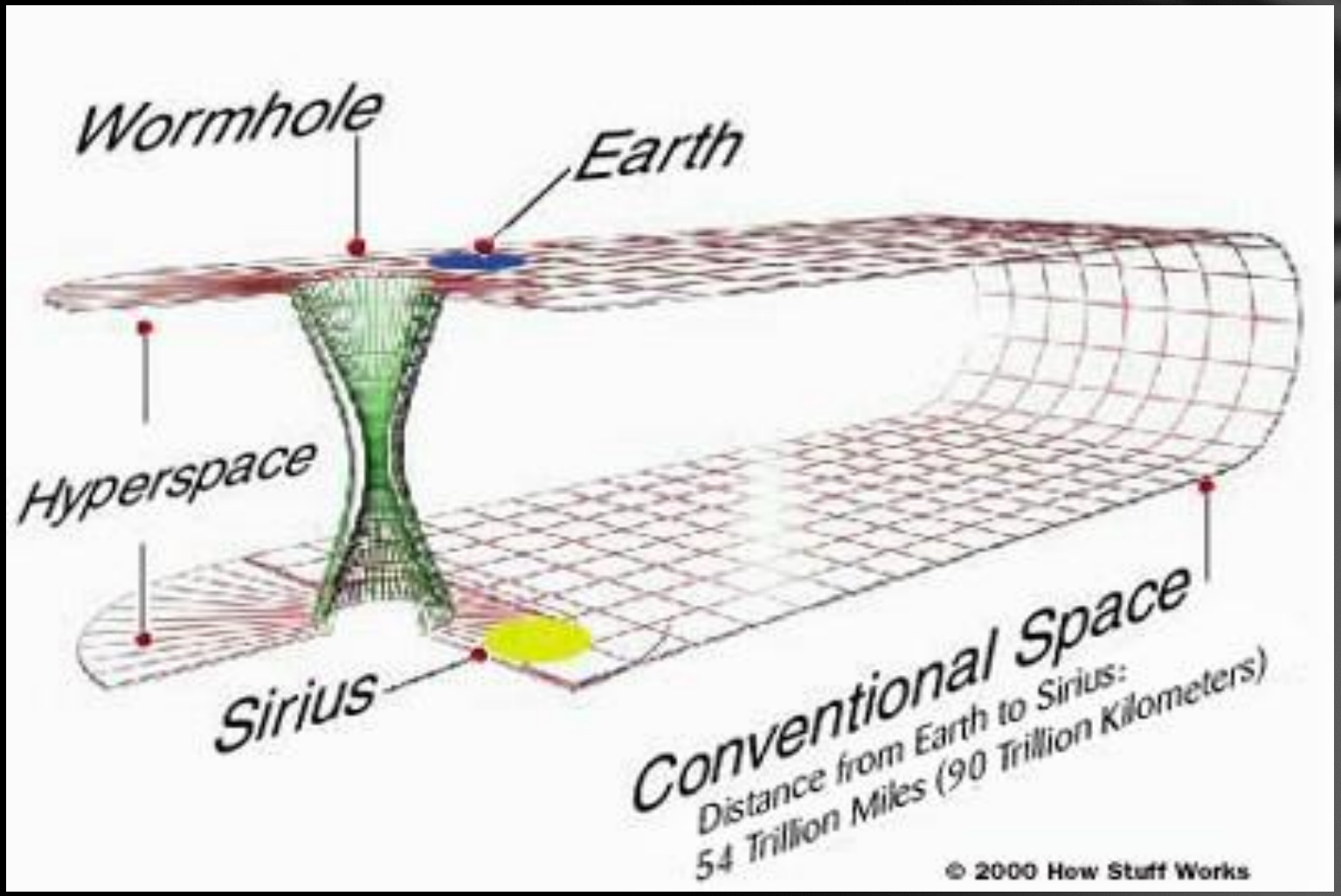
The Andromeda ***Galaxy*** located at a ***distance*** of 2 million light years away

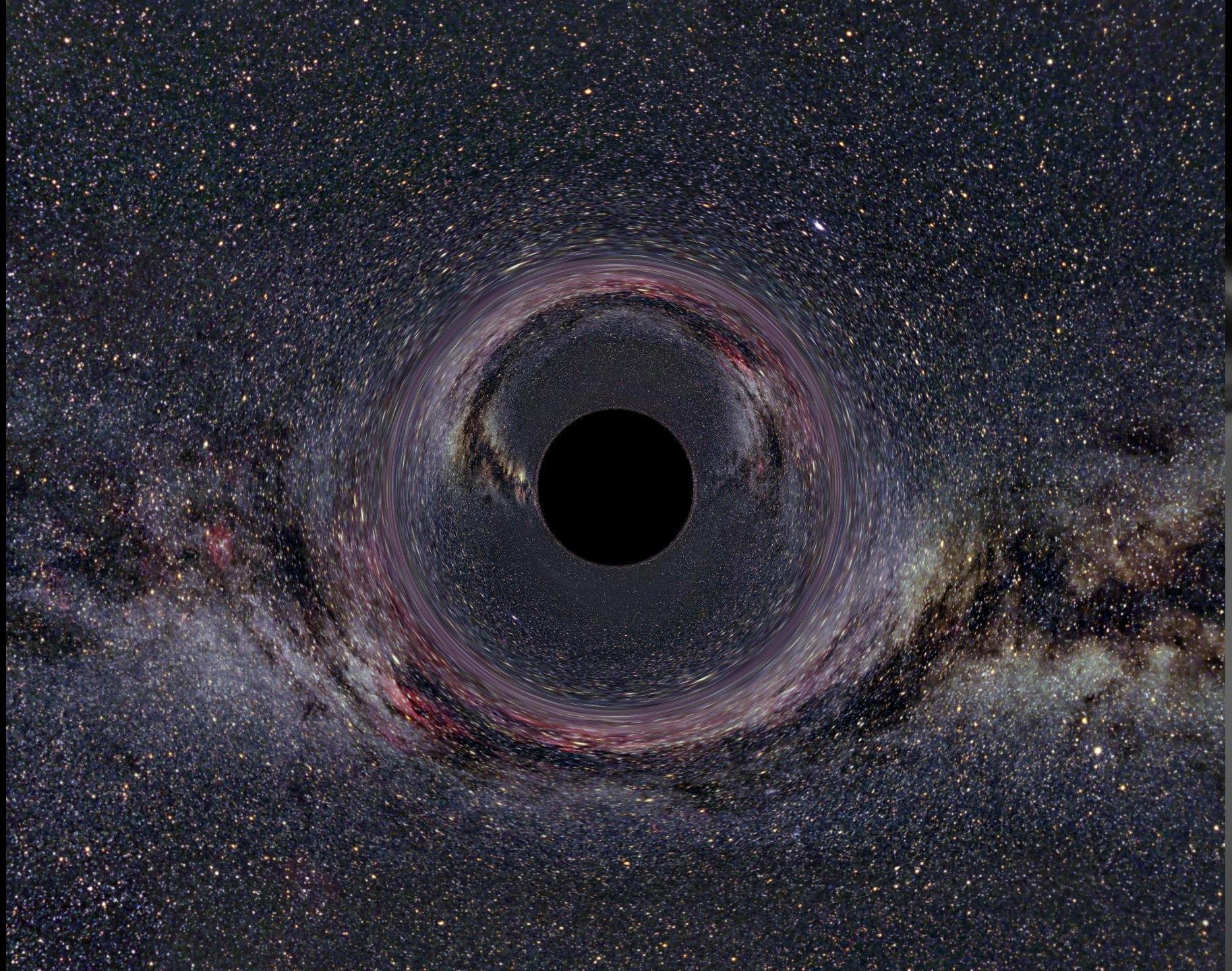
At the speed of light it would take ~2.2 million years.

- At 150,000 MPH, it would take approx. 9 billion years (9,000,000,000 yrs), or 2 times the length of time that the Earth has been in existence



# Worm Holes – "interstellar shortcuts"





# BLACK HOLE

black hole is a region of space that has so much mass concentrated in it that there is no way for a nearby object to escape its gravitational pull.

Black holes are the evolutionary endpoints of stars; at least 10 to 15 times as massive as the Sun.