Astronomy 2115
General Astronomy

Prof. Diana Dragomir

Course Learning Goals

- Successfully practice the ``scientific method" during the course.
- Use physical principles to describe how stars and galaxies form and evolve over time.
- Learn and construct physical models of astronomical objects to explain observations.
- Recount the scientific story of the universe and our place and time within it.

Astro 2115

Professor: Diana Dragomir

Office Hours: Tuesdays 2h30-3h30pm/Wednesday 9h00-10h00am; Zoom

Class Web page: https://exoplanets.unm.edu/astr2115.html

Course Text: *Universe, 9th,10th or 11th edition*, Freedman, Geller & Kaufmann

Lectures: Recorded lectures will be posted online on UNM Learn

Homework: Reading and homework assignments (roughly weekly) Help is available!
TAs: Ismael Mireles, Zoom,(mirelesi@unm.edu); Craig Taylor (ctaylor98@unm.edu)

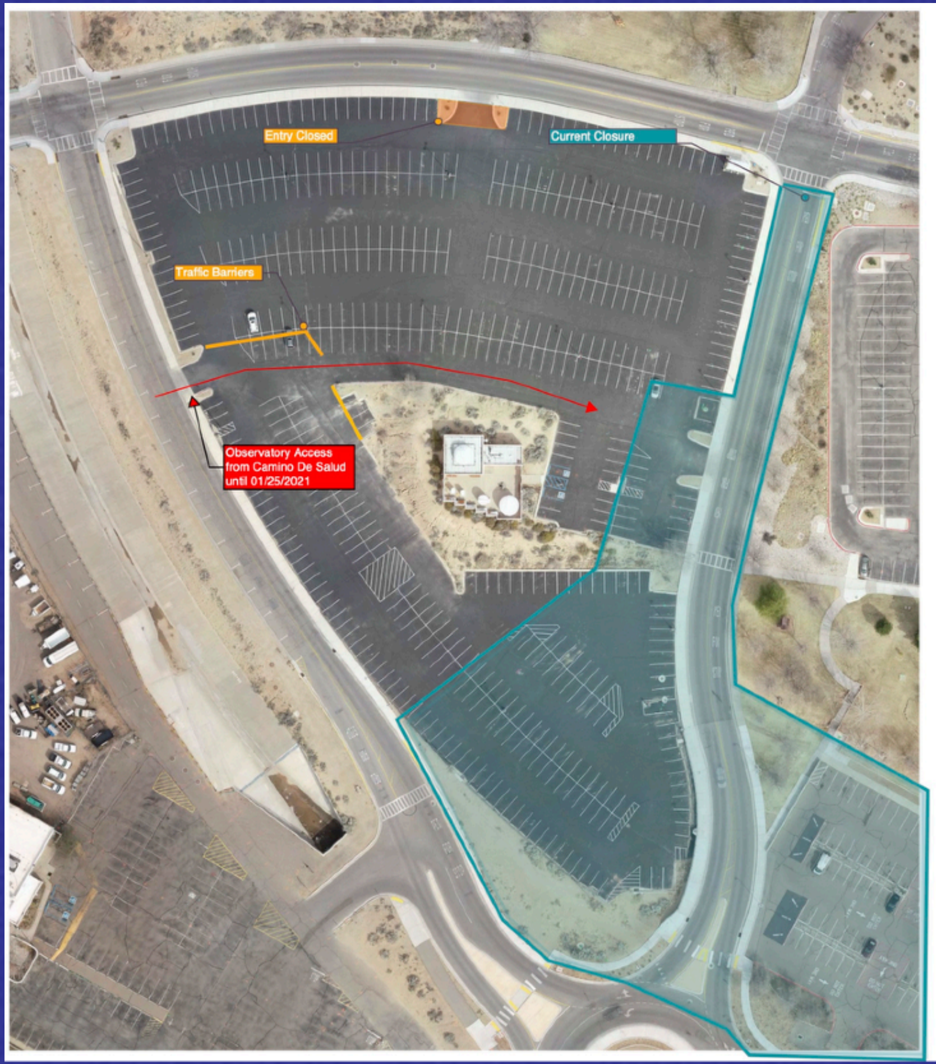
Class Participation: quizzes via zoom polls

Grading: 10% class participation (+ up to 5% extra credit); 25% homework; 50% based on 2 tests (midterm and final); 15% final project. NOTE: there will be NO makeup tests except by prior arrangement.

Announcements

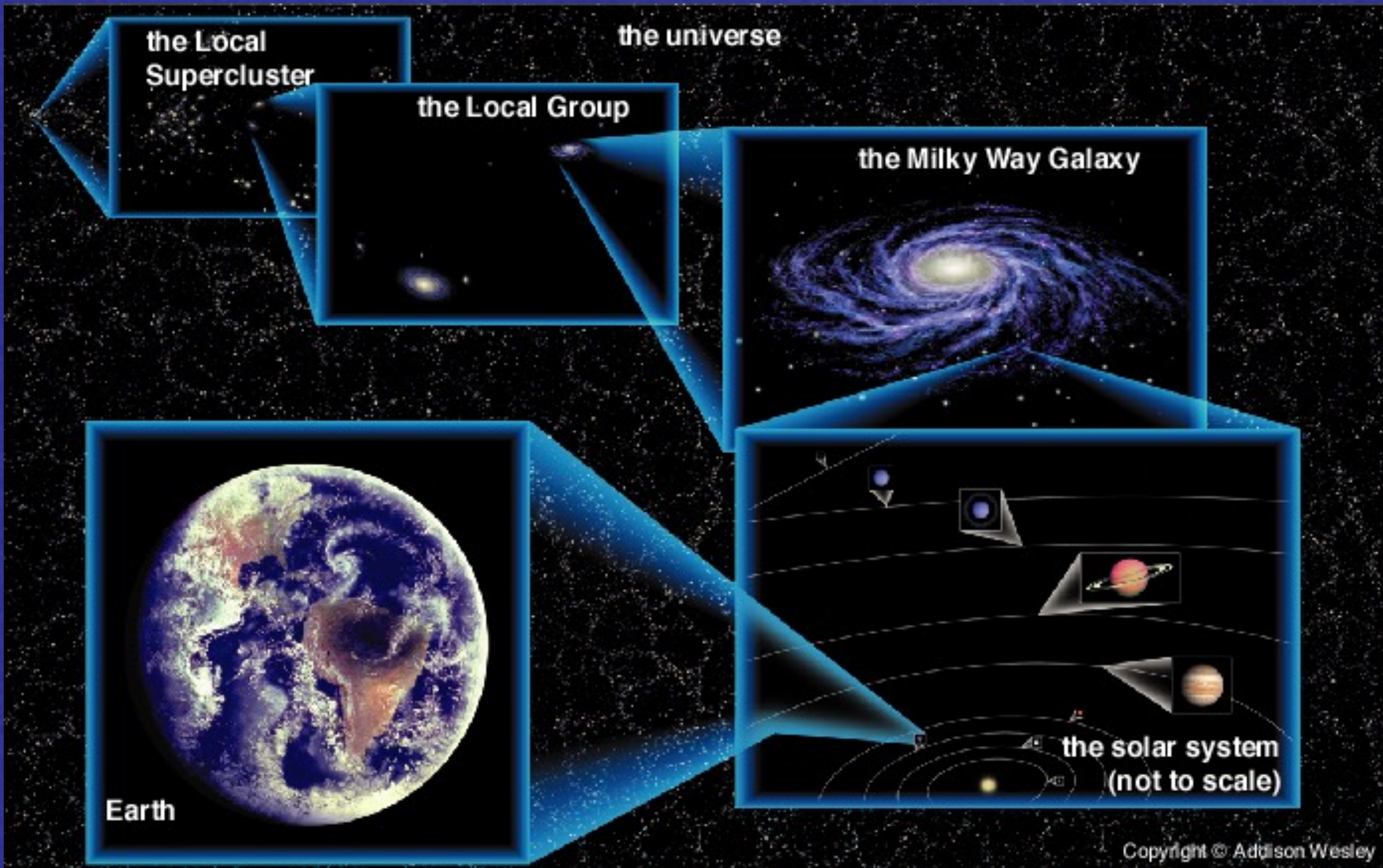
- The Lab is required for all astrophysics majors
- We do have lab this week

- **First Homework is posted and will be due January 28 by the beginning of class;** submit via UNM Learn



Class Participation (via single-question quizzes)

- question will be on material just covered in the lecture
- 10% of final grade
- you must participate in the polls for 20 classes to get the full credit
  - you must participate in <u>every</u> quizz given in each one of those 20 classes
- **Bonus:** if you answer correctly in <u>at least one quizz per class,</u> <u>in at least 20 classes</u>, you will get extra credit of 5% towards your final grade.
  - answering correctly in fewer than 20 classes will still earn you extra credit (but less than 5%)


the universe
the Local Supercluster
the Local Group
the Milky Way Galaxy
Earth
the solar system (not to scale)
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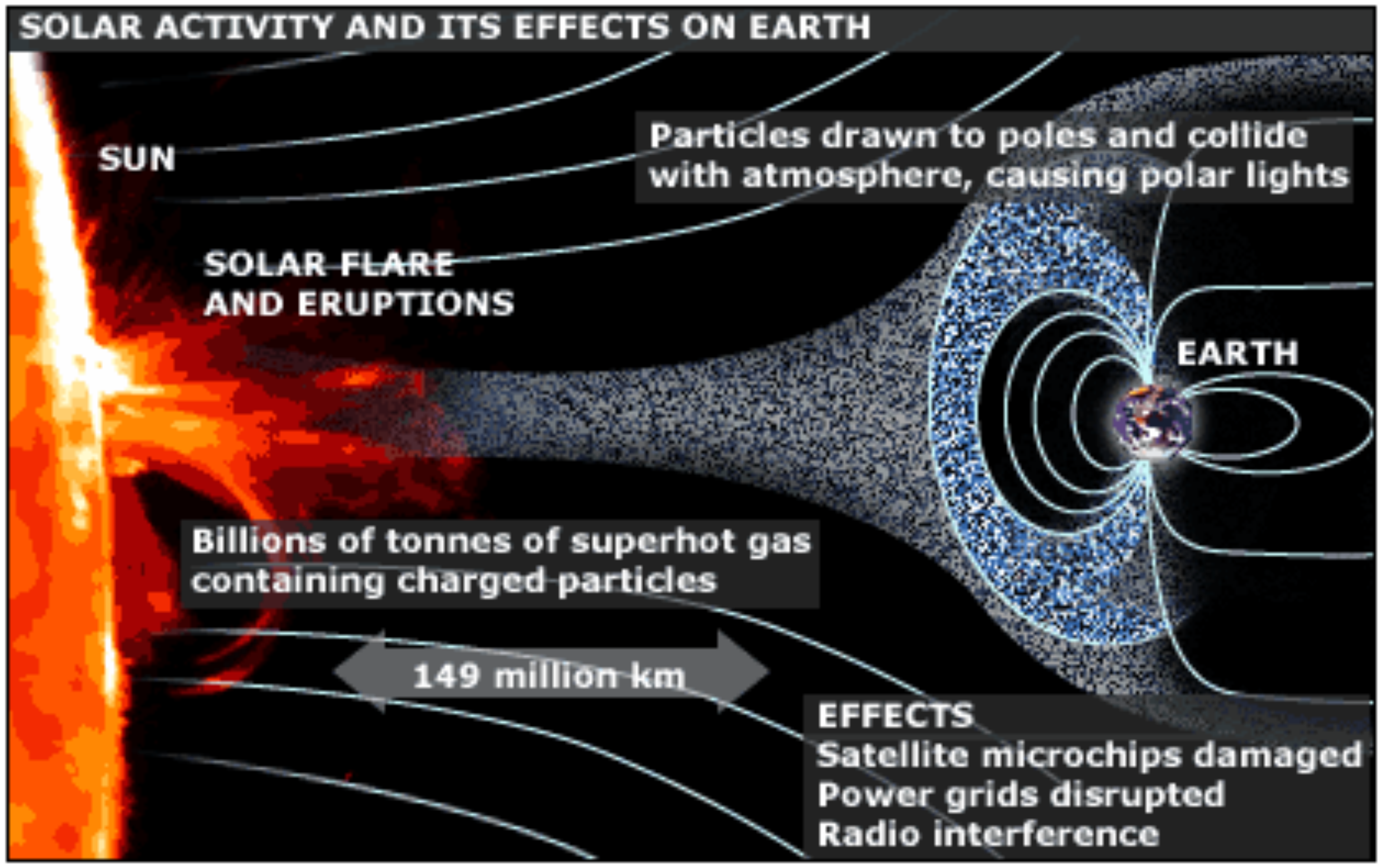
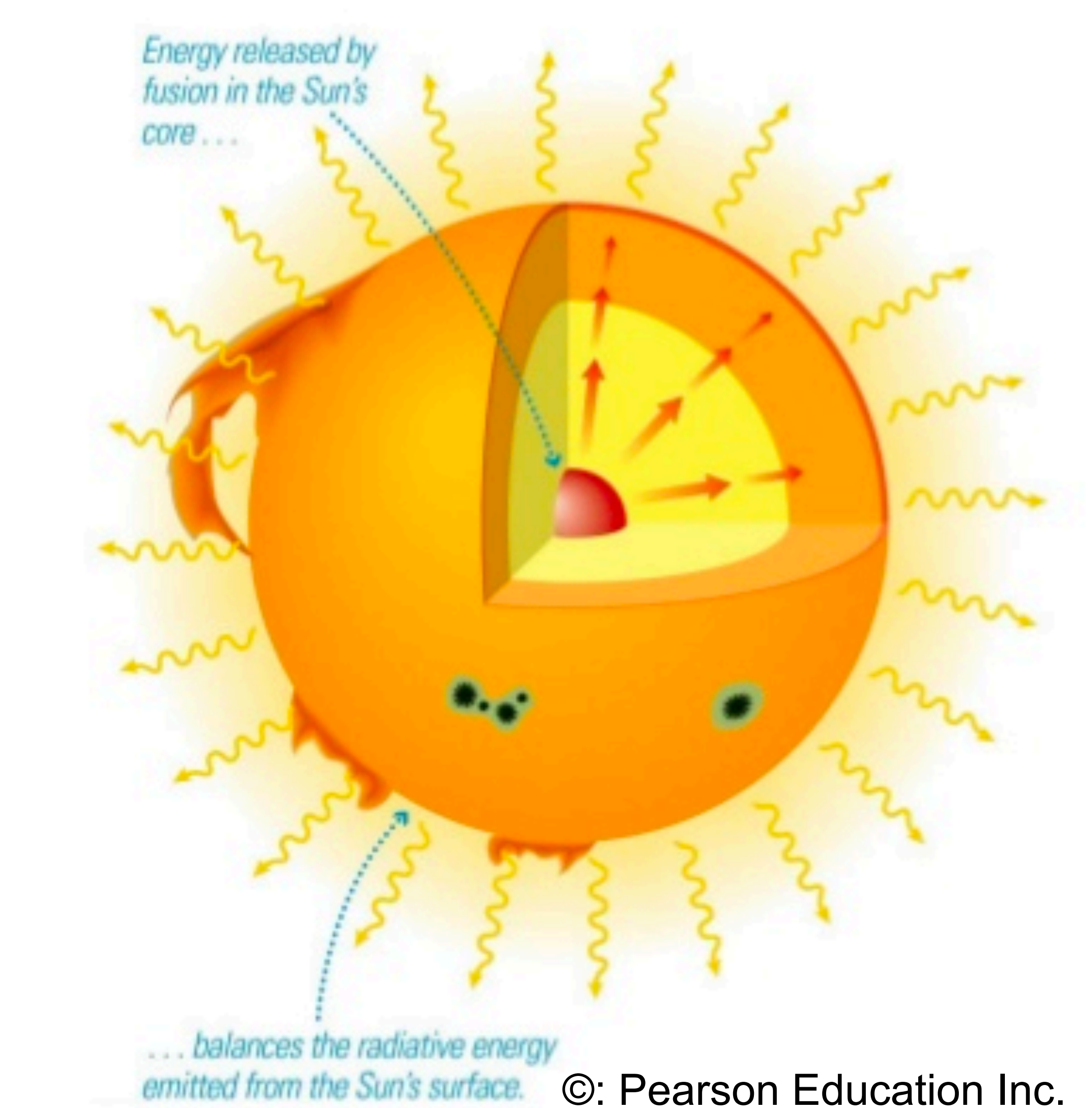
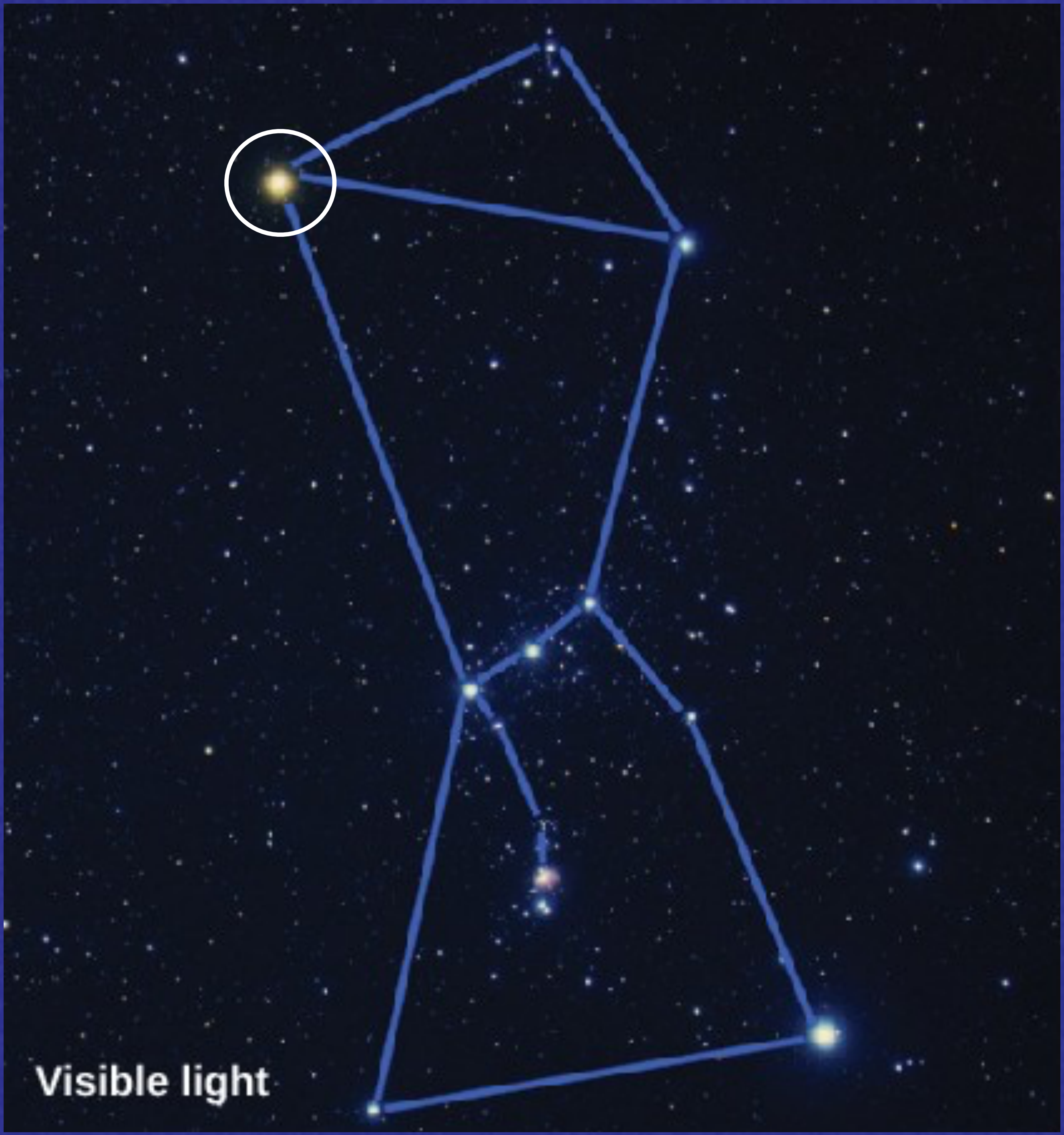
High Solar Activity in Sep. 2017

SDO UV obs on 17Sep6

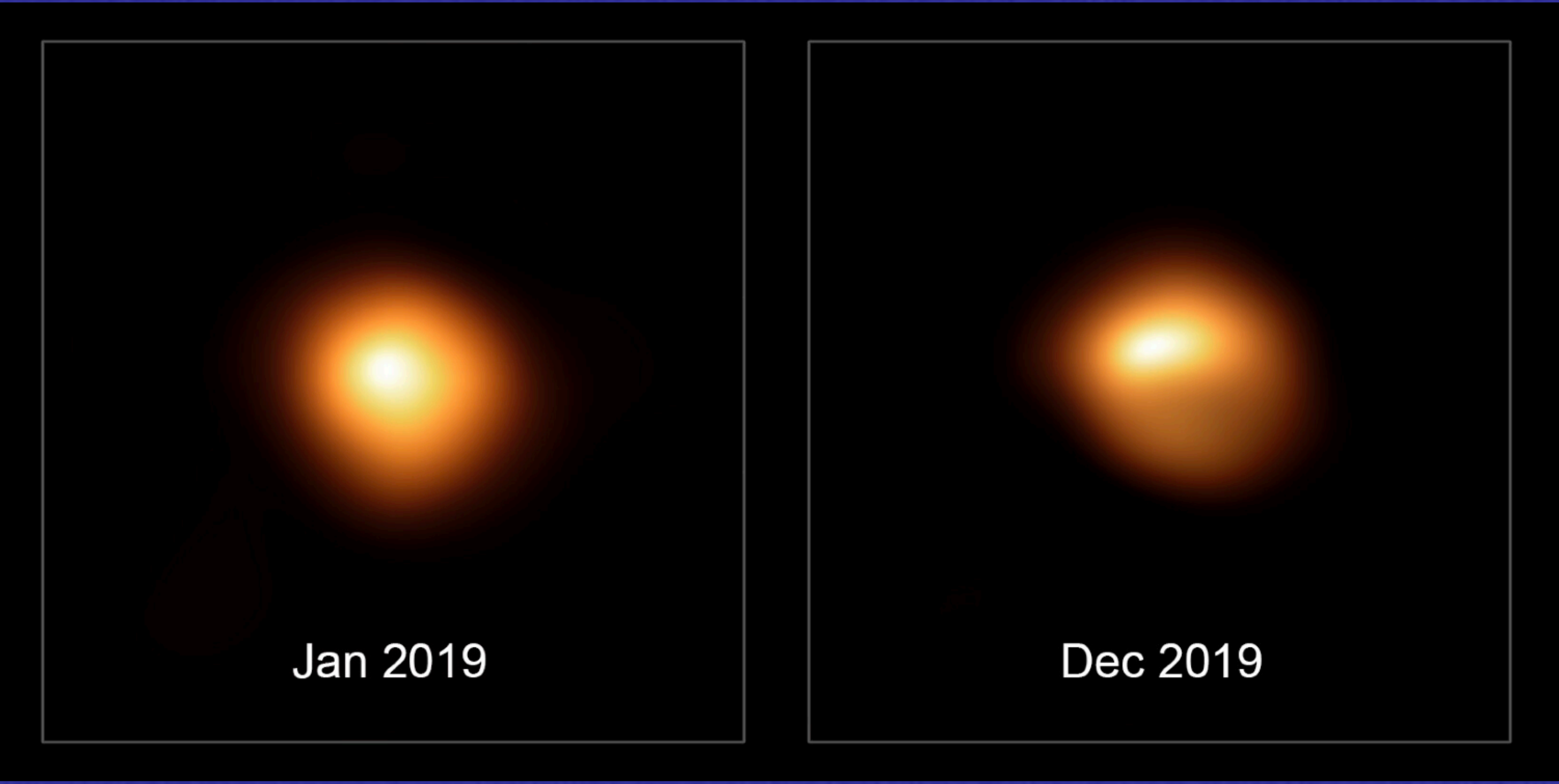

SOLAR ACTIVITY AND ITS EFFECTS ON EARTH
SUN
Particles drawn to poles and collide with atmosphere, causing polar lights
SOLAR FLARE AND ERUPTIONS
EARTH
Billions of tonnes of superhot gas containing charged particles
149 million km
EFFECTS
Satellite microchips damaged
Power grids disrupted
Radio interference

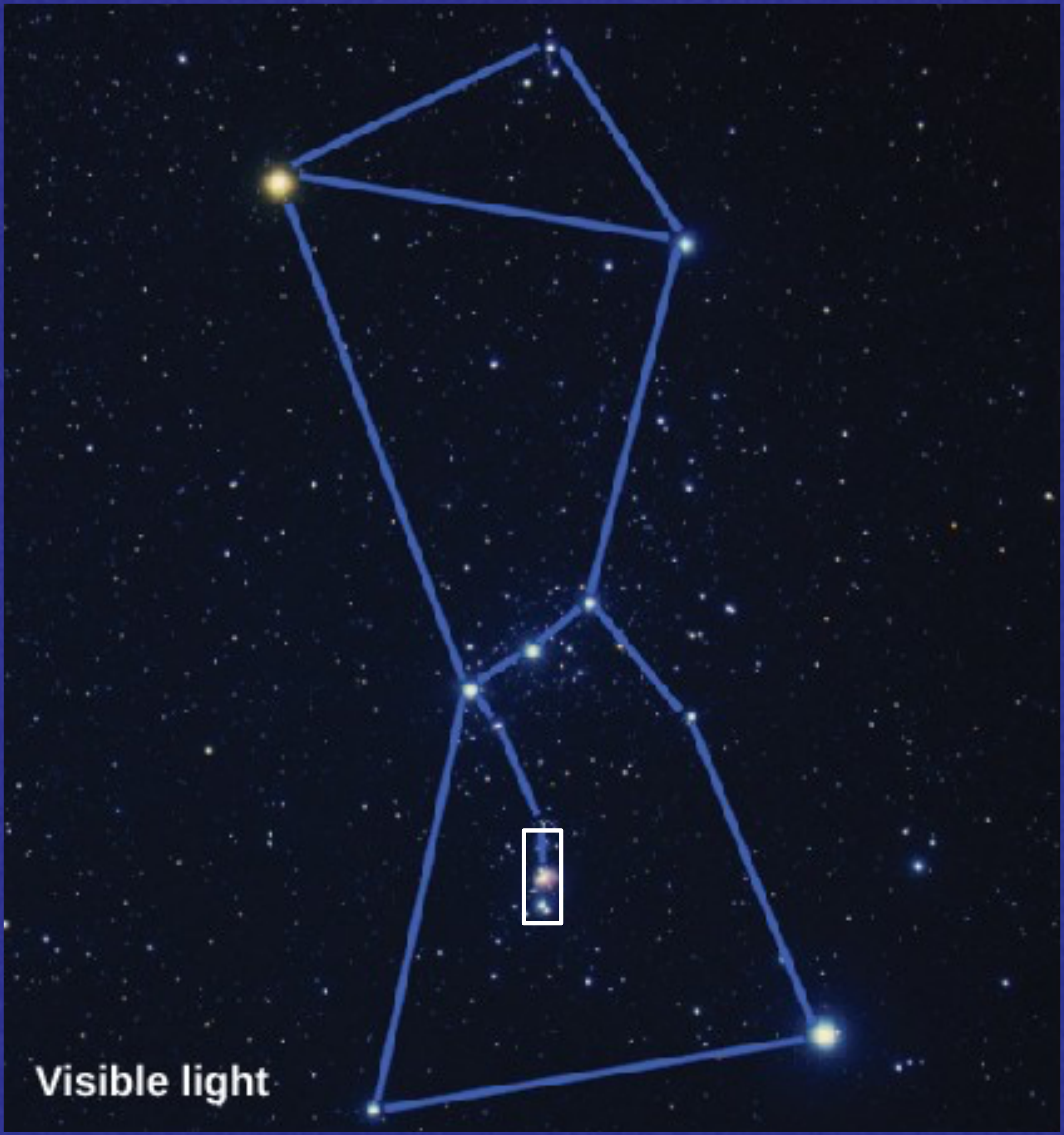

Energy released by fusion in the Sun's core . . .
. . . balances the radiative energy emitted from the Sun's surface.



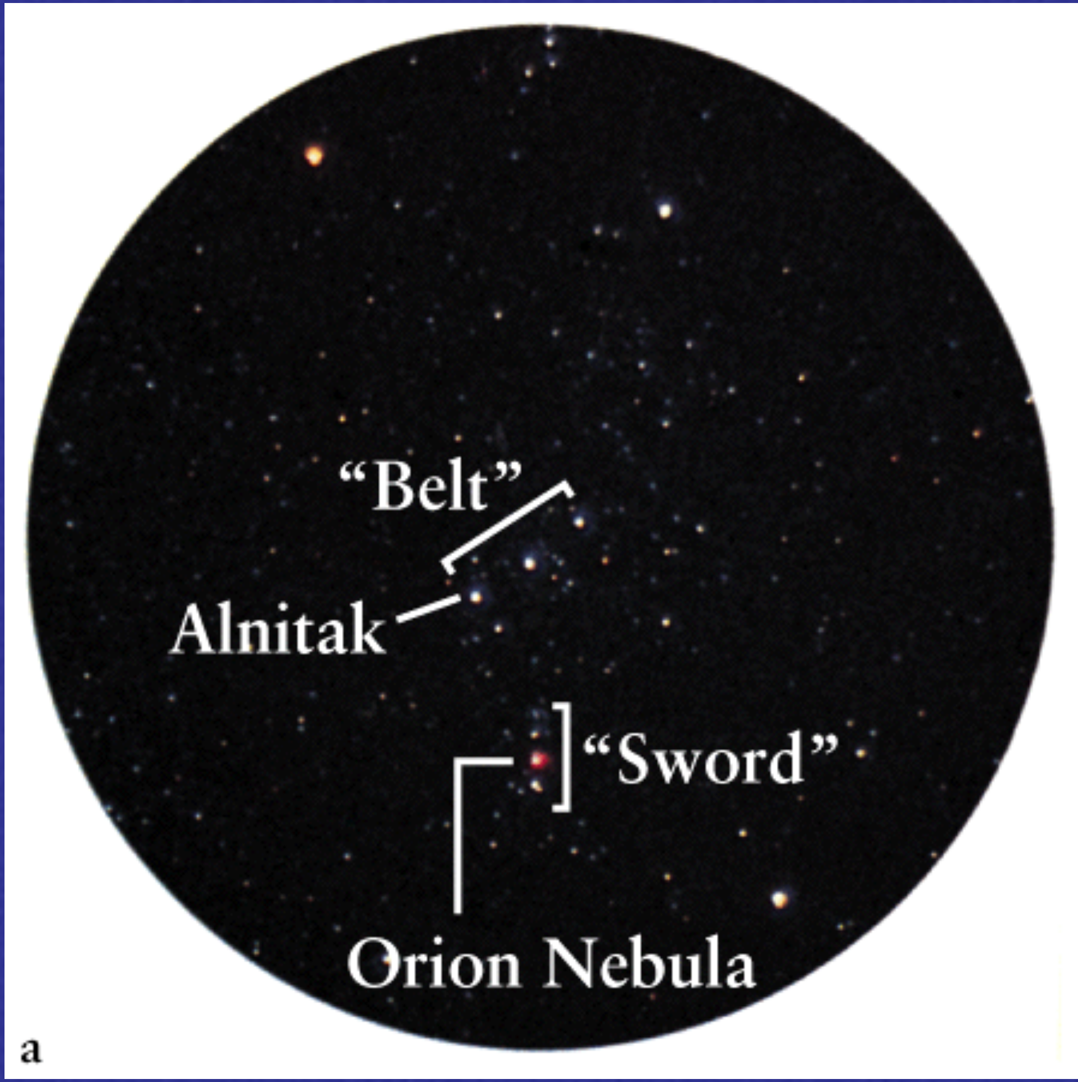
Optical
telescope

Betelgeuse

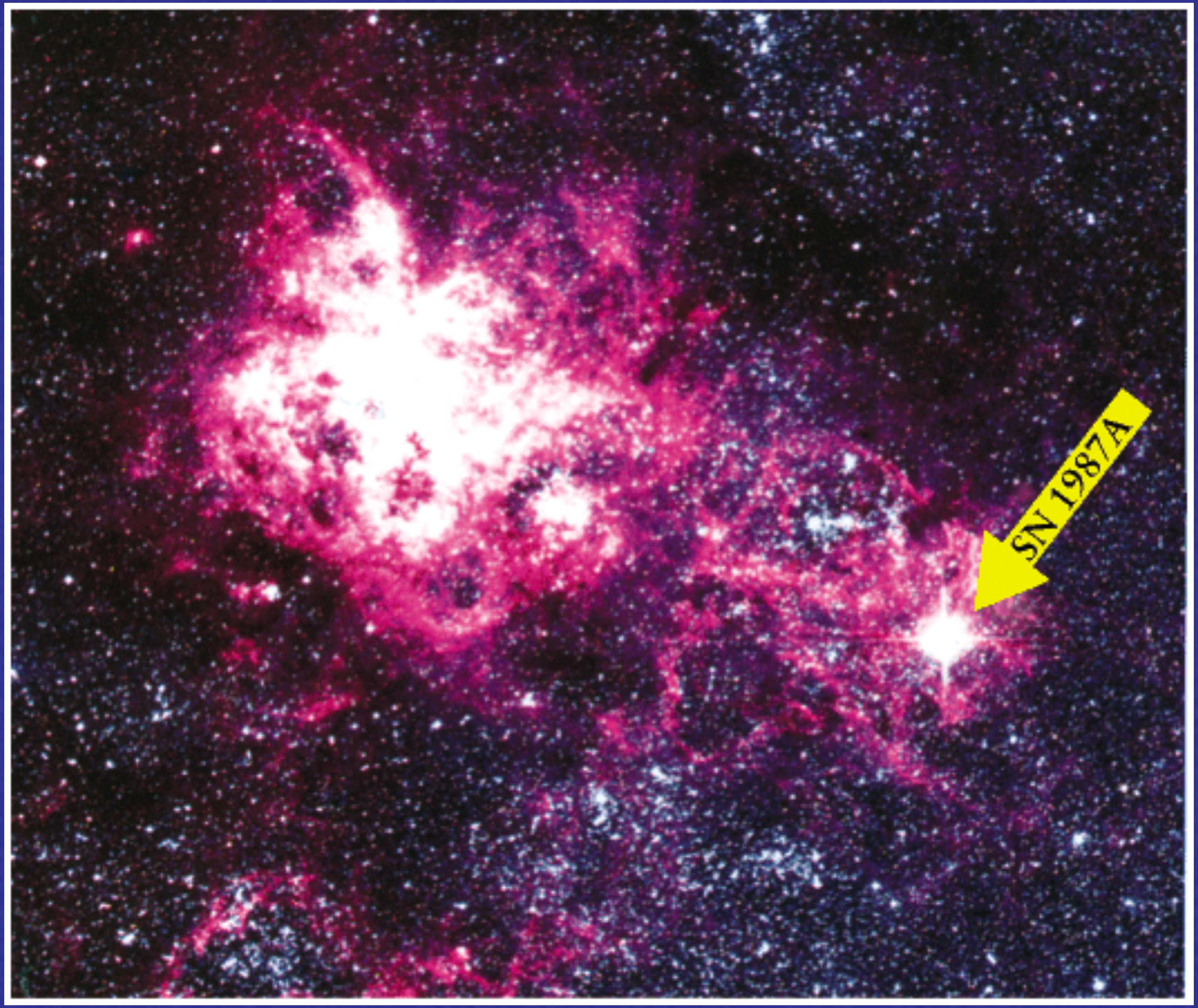




Optical telescope

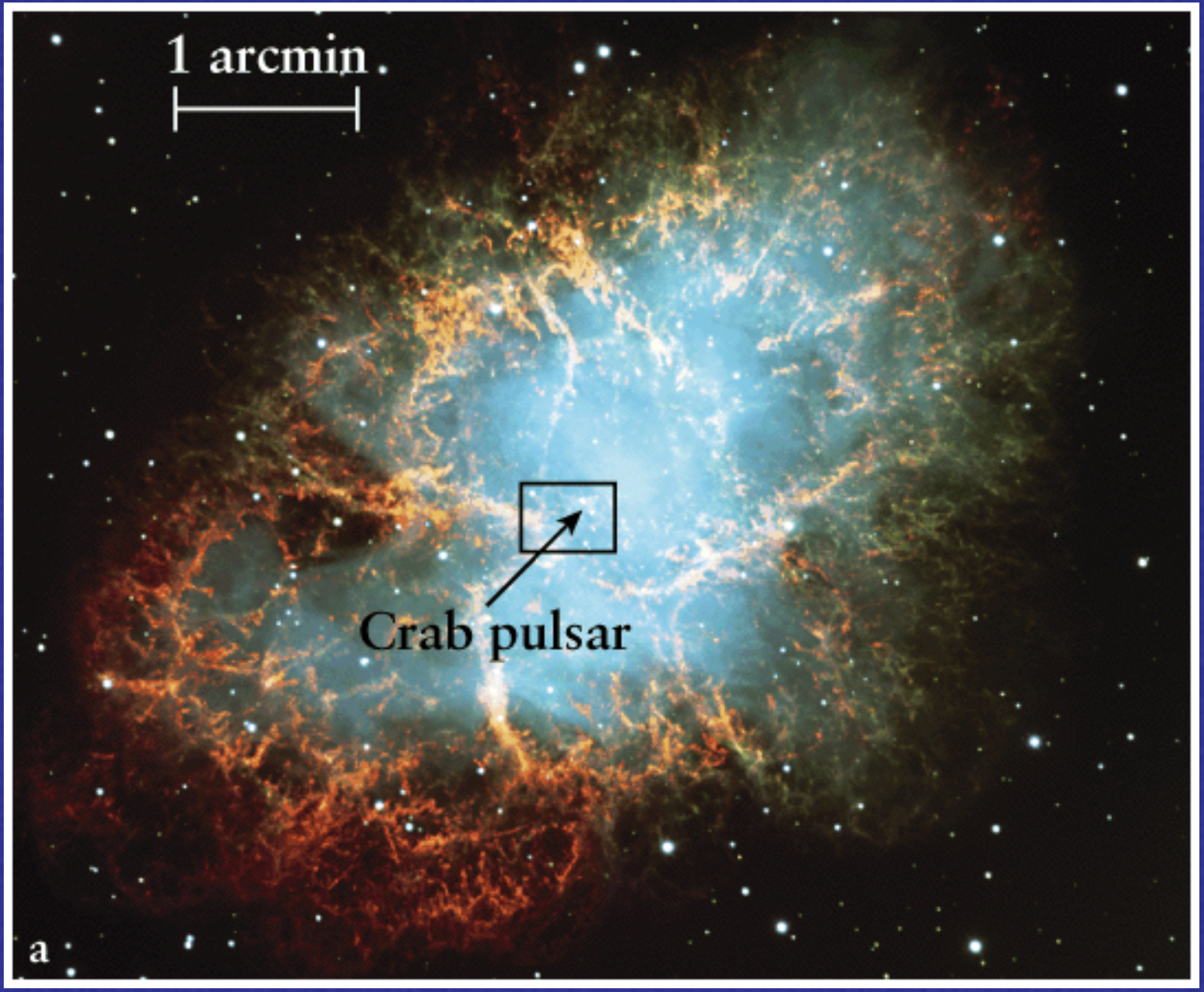

"Belt"
Alnitak
"Sword"
Orion Nebula
a

Optical telescope


SN 1987A

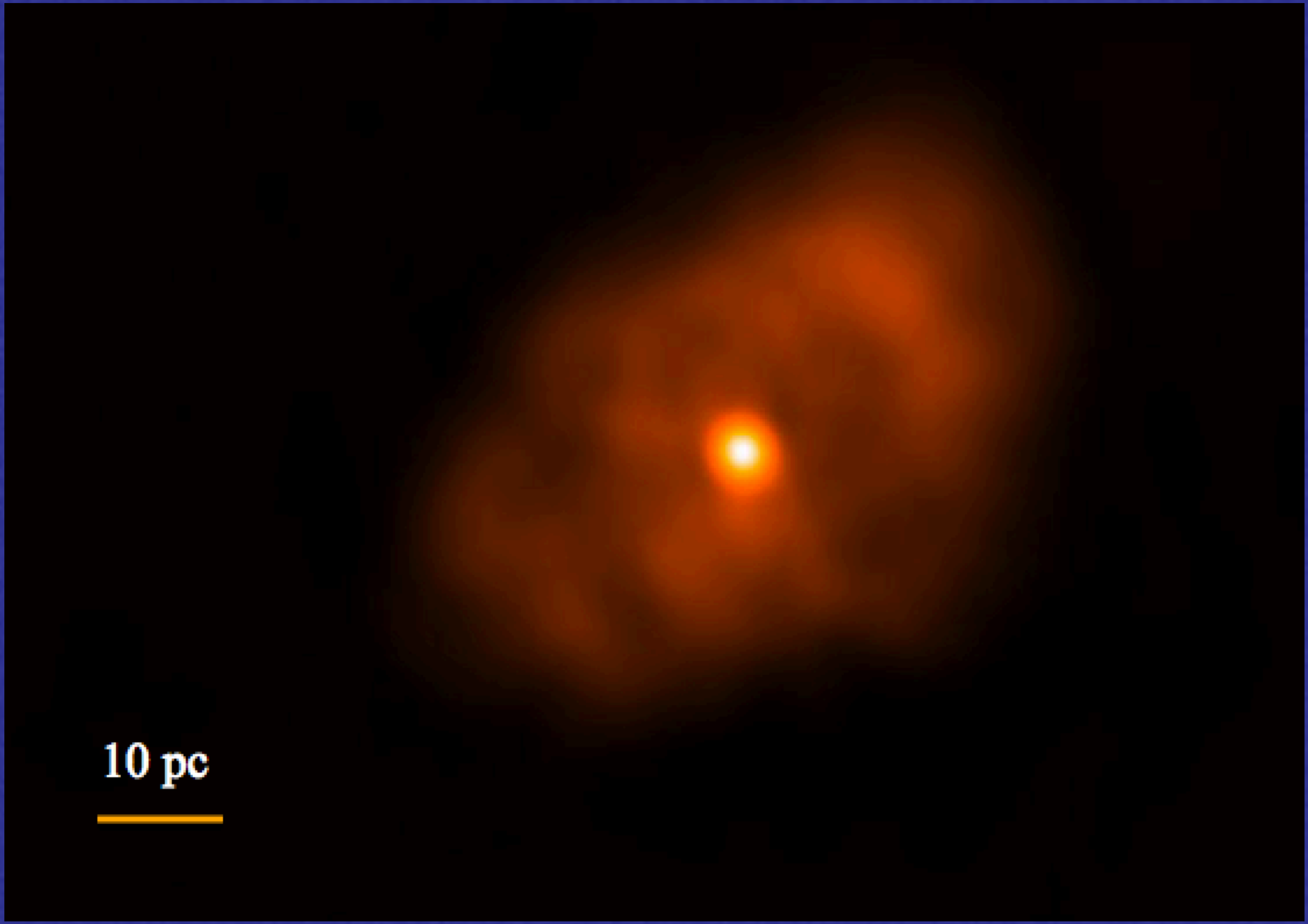
Gum Nebula - a supernova remnant

Central object: neutron star



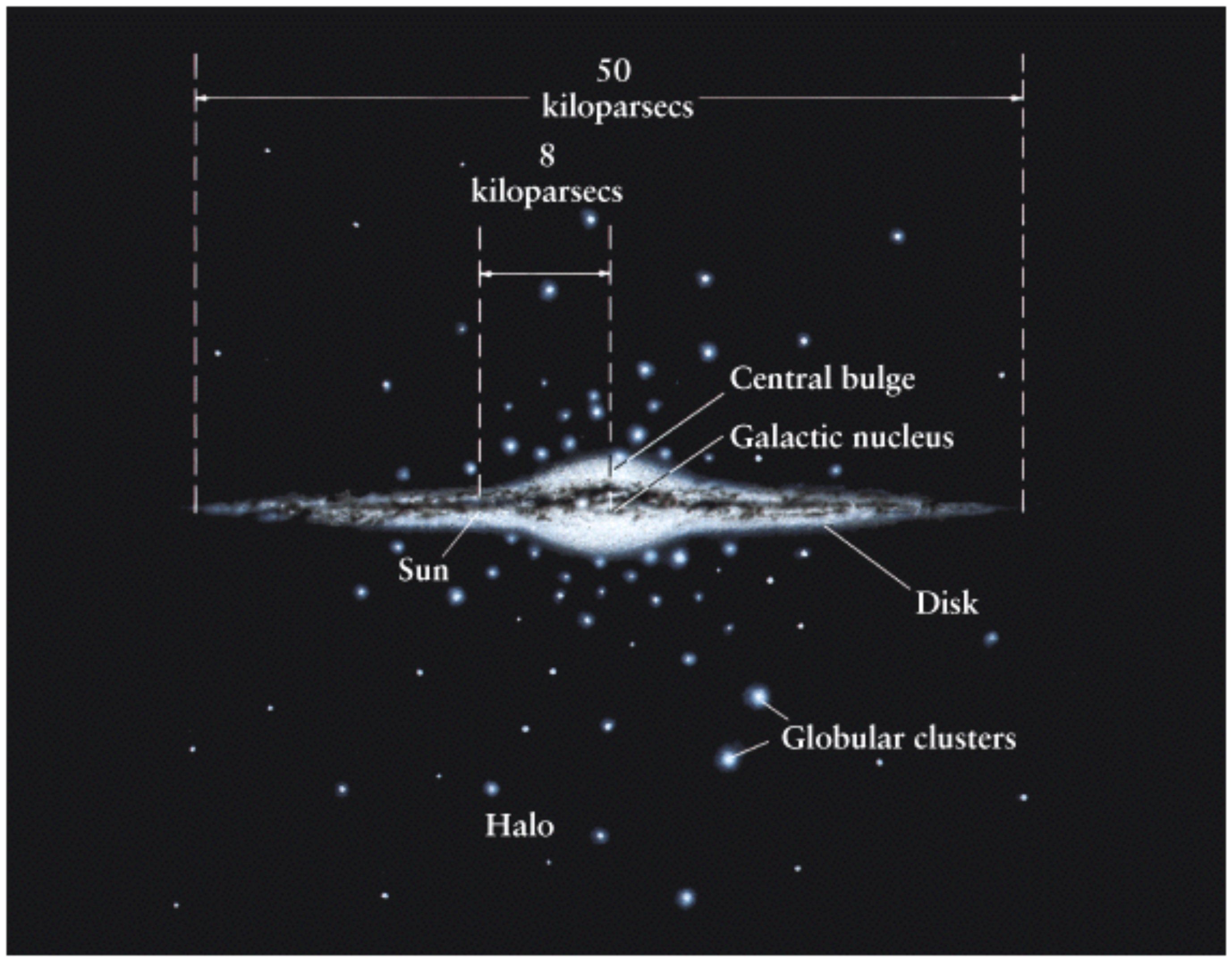
Central object: neutron star

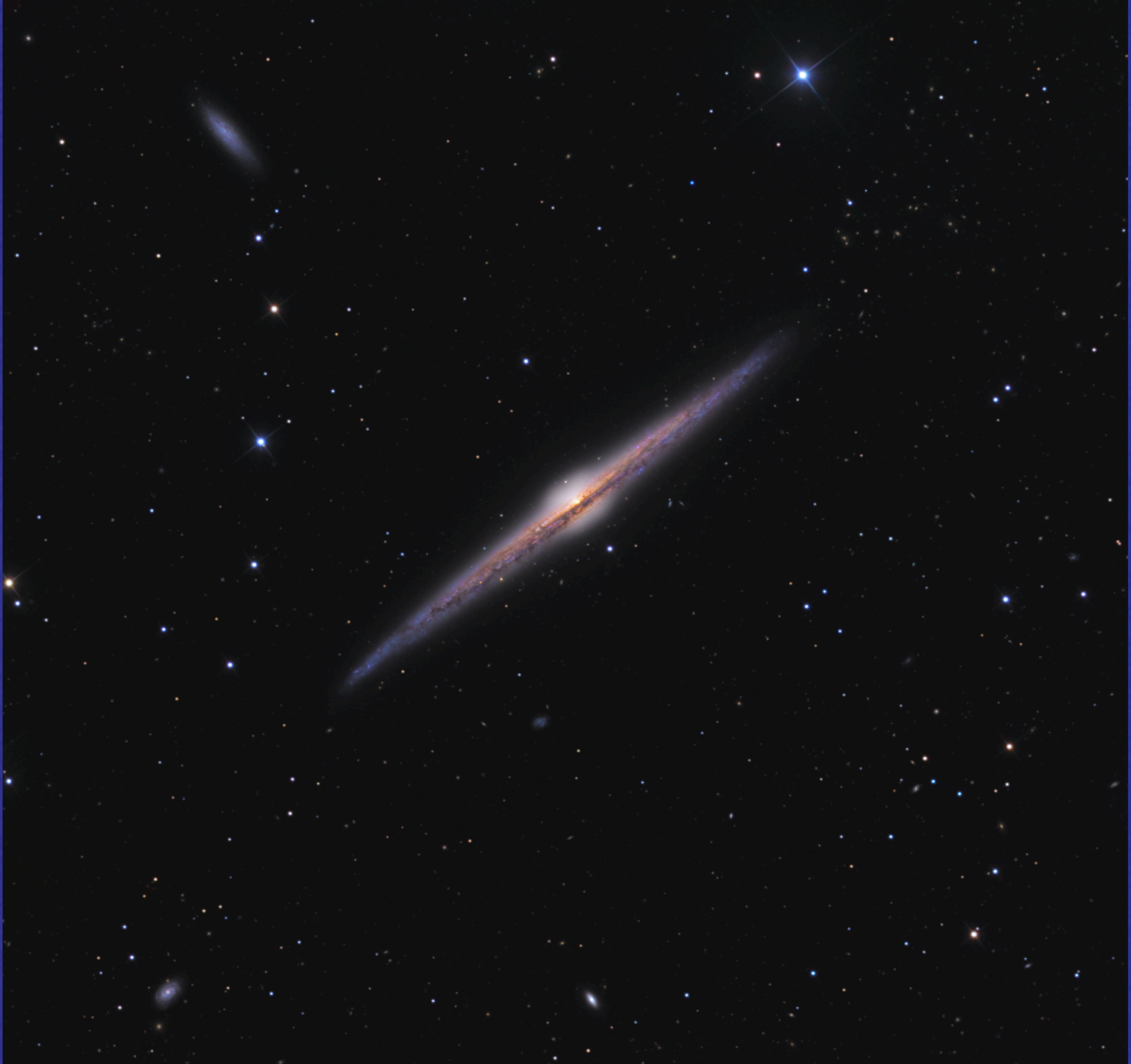
Crab pulsar imaged with LWA



The Sun

Artist's conception


50
kiloparsecs
8
kiloparsecs
Central bulge
Galactic nucleus
Sun
Disk
Globular clusters
Halo

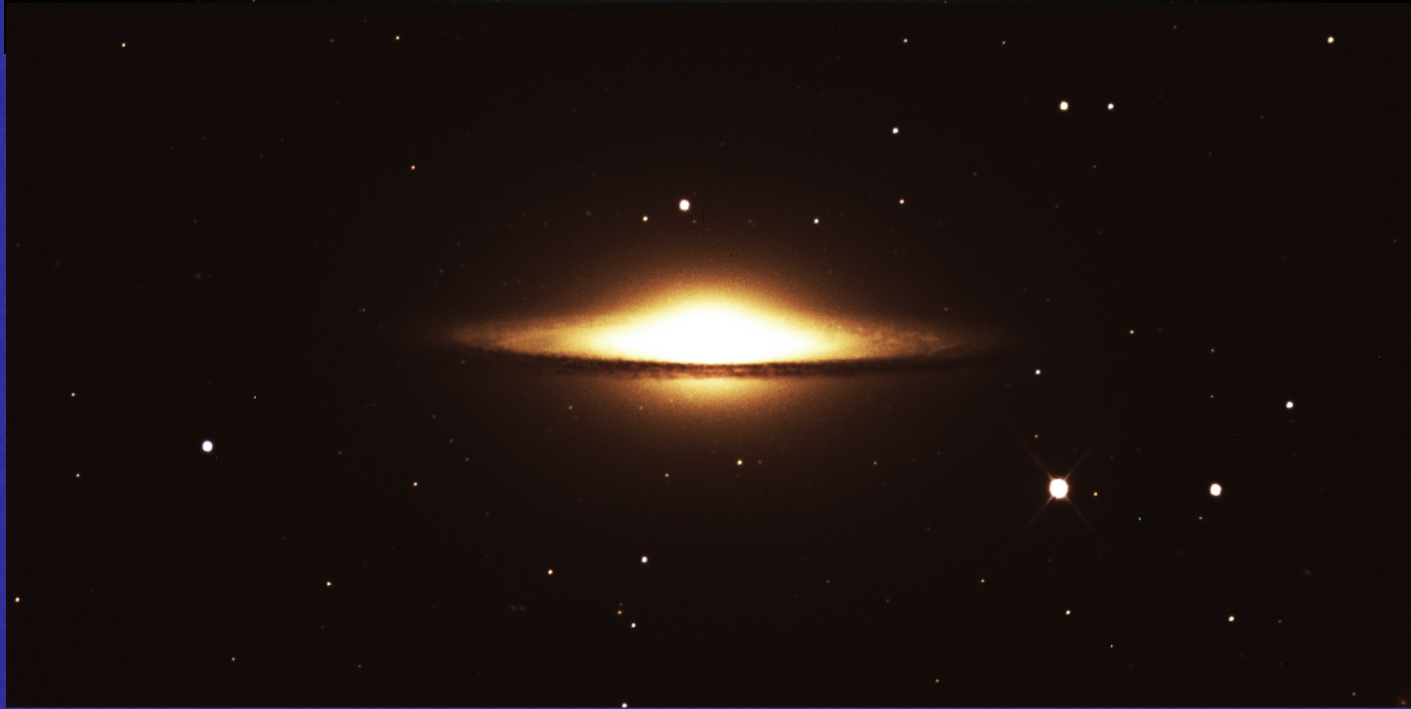


Hubble Space Telescope

Sombrero Galaxy

Me

(with a 1.0m telescope in Chile)

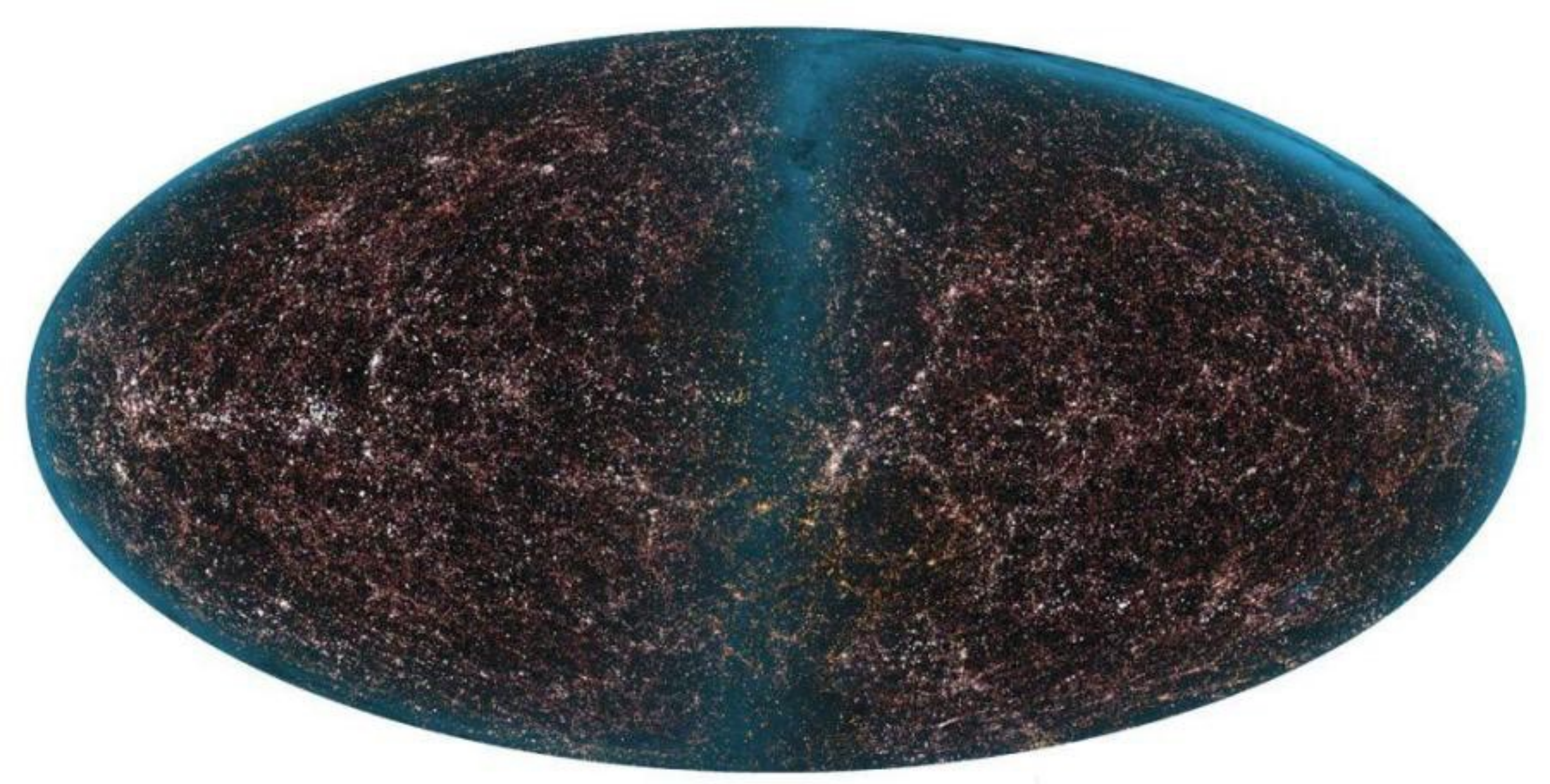


NGC3377

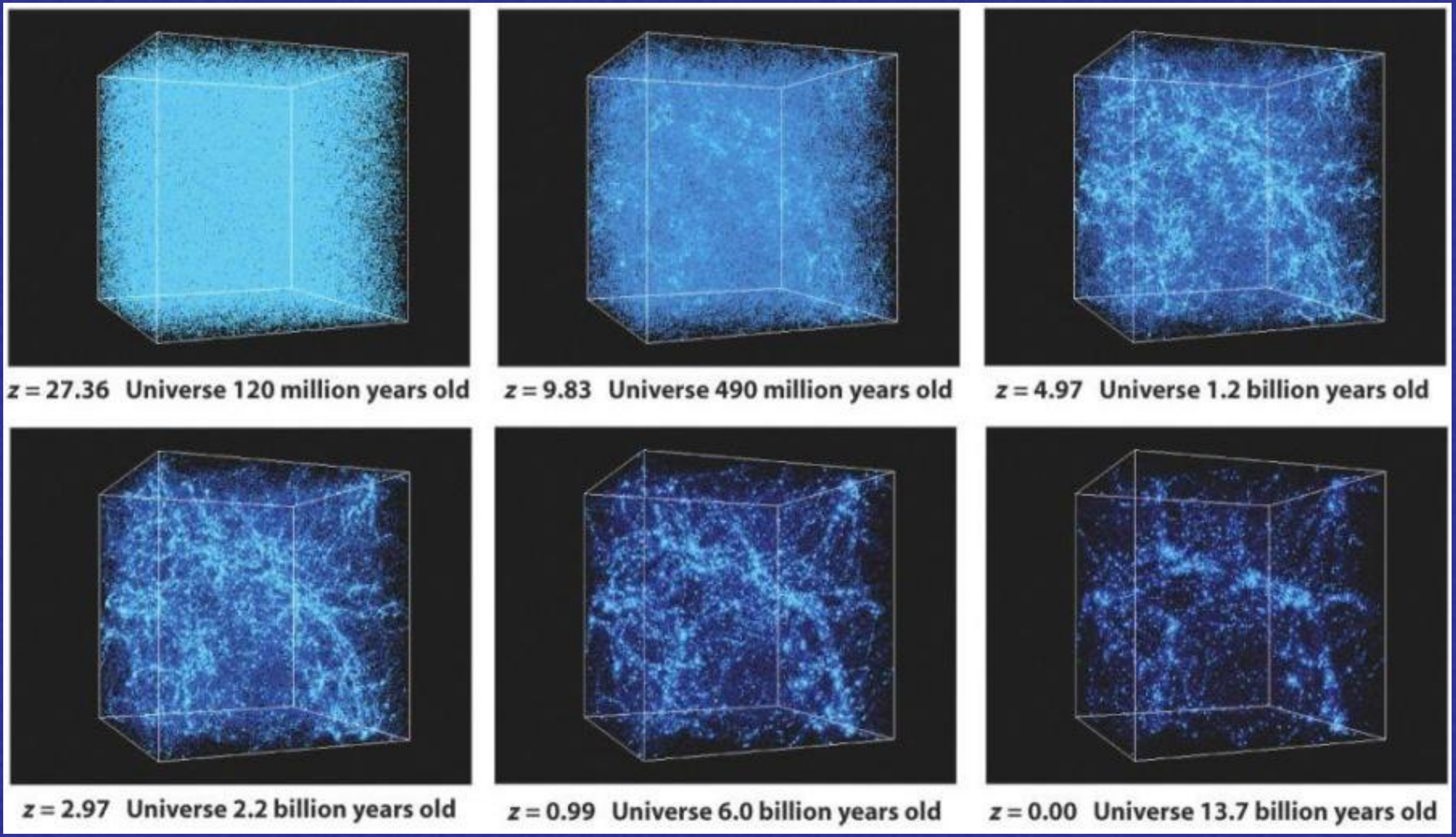
Centaurus A

The Hercules Cluster

Large Scale Structure

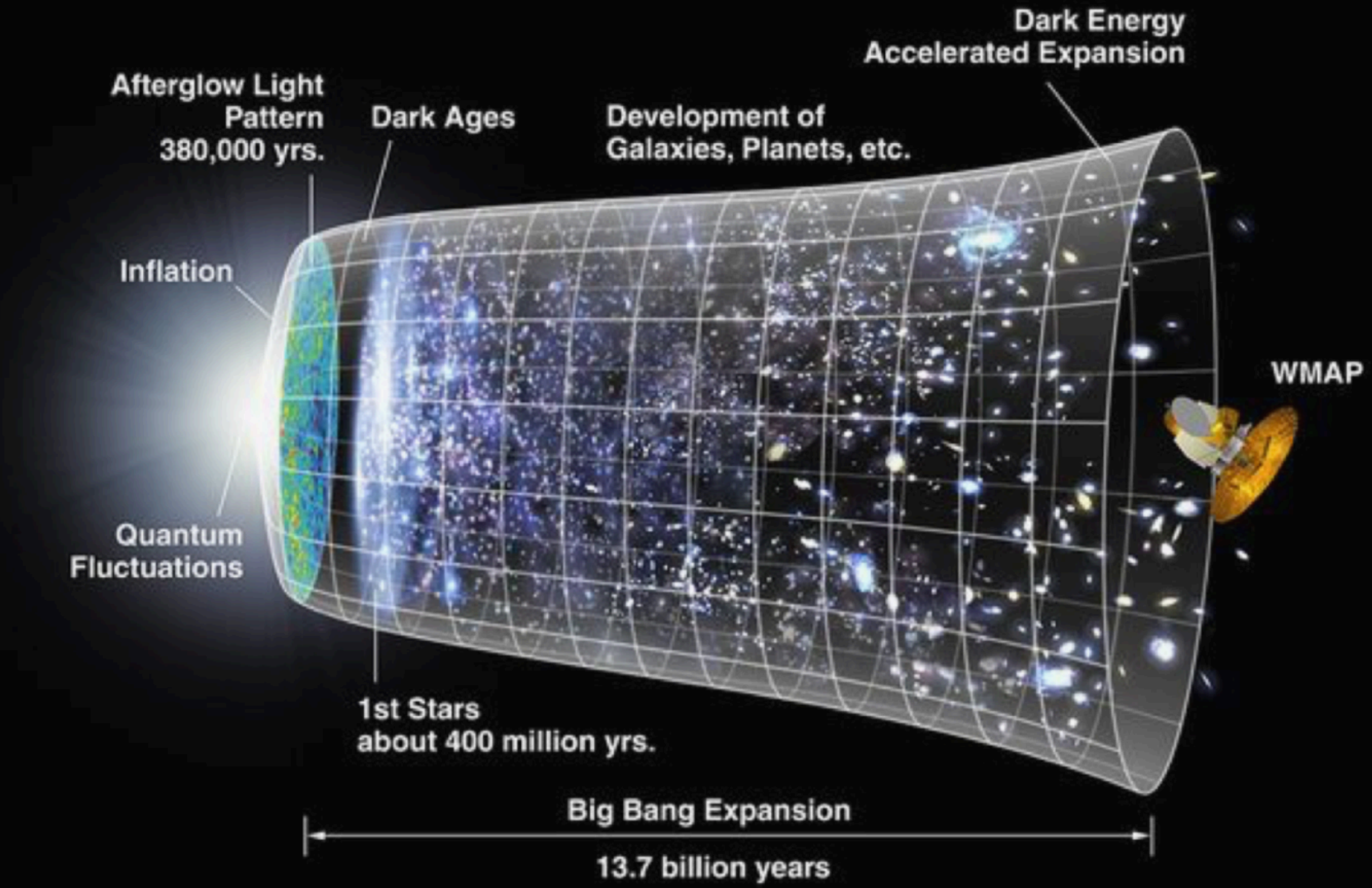


How did this structure form?



computer simulations

Cosmology



Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
380,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years

The Process of Astronomy Research

- What is it that we see? (observing)
- How does it work? (analysis)
- How was it formed, and how will it evolve? (theory & predictions)

What we need in order to explore

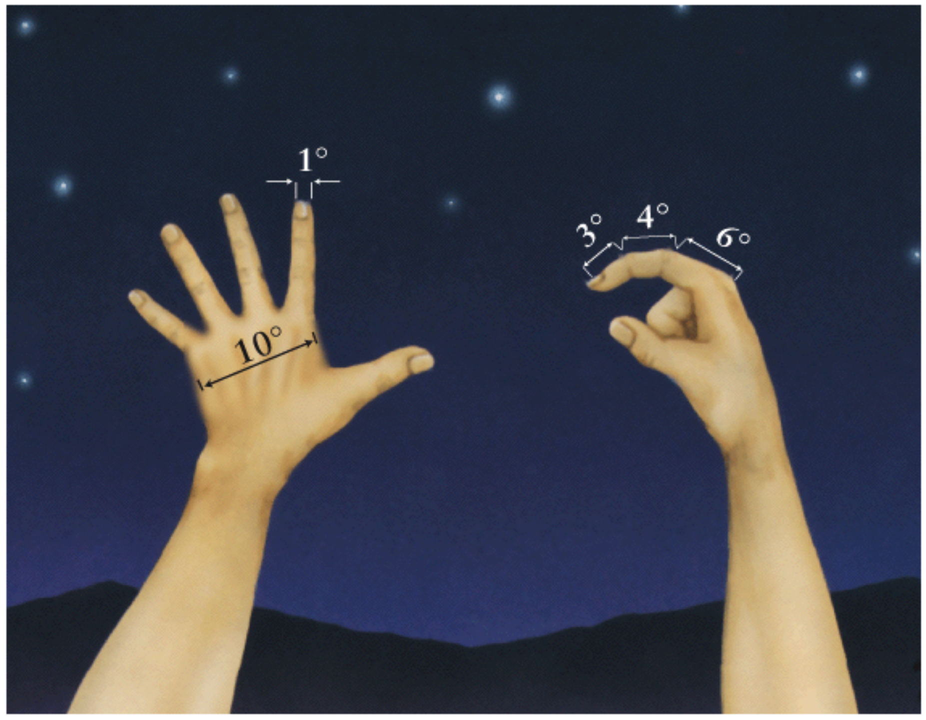
- To describe: angular measure
  coordinate system
  phases, apparent motion etc.

- To explain: orbital motion
  atoms and molecules
  EM radiation

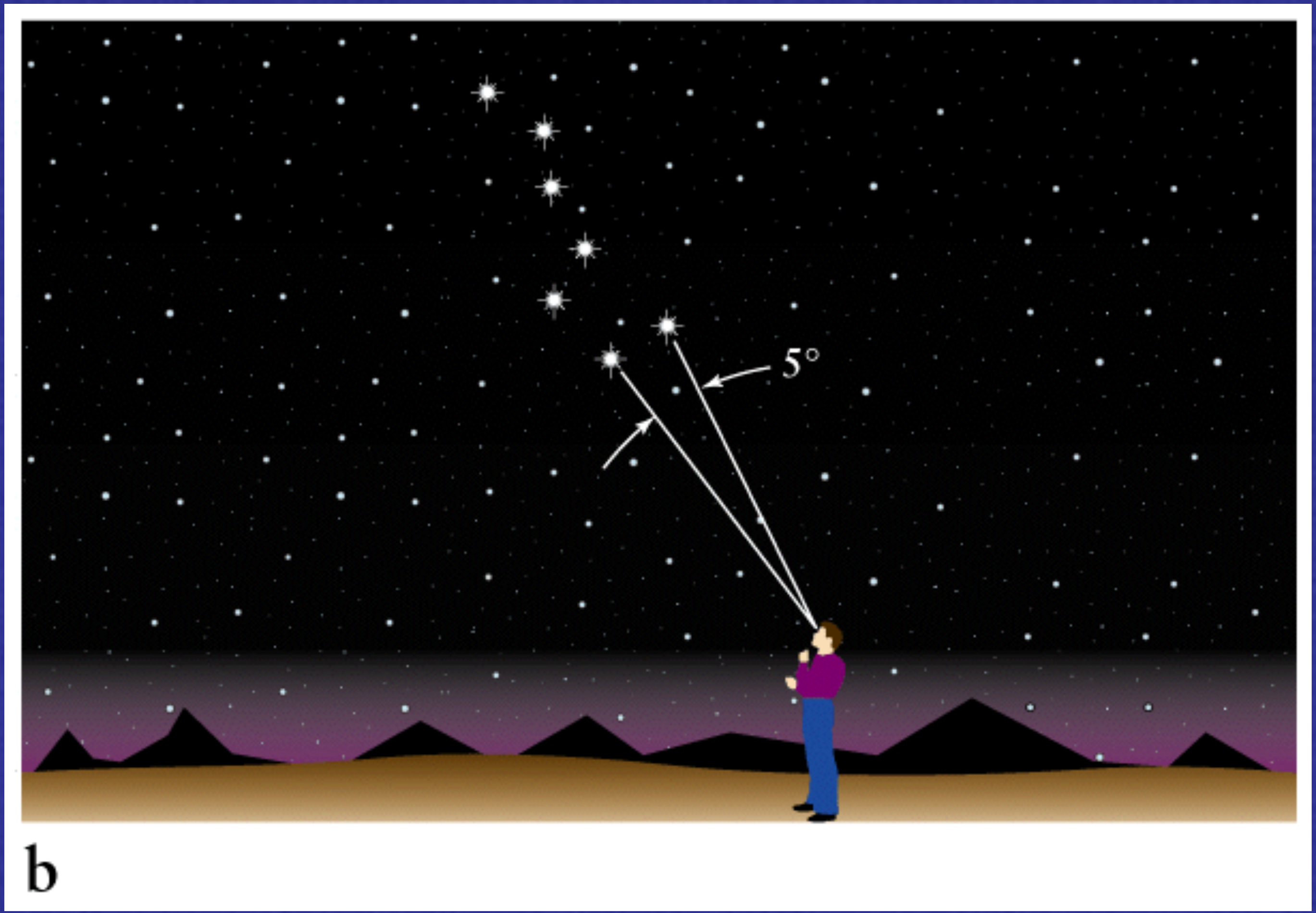
Angles

- We lack depth perception, therefore we use the angular measure to describe:
  - The apparent size of a celestial object
  - The separation between objects
  - The movement of an object across the sky

- To estimate angles, extend your arm and use your hands and fingers like this =>



Example of angular distance: the “pointer stars” in the big dipper



The Moon subtends about one-half a degree

How do we express smaller angles?

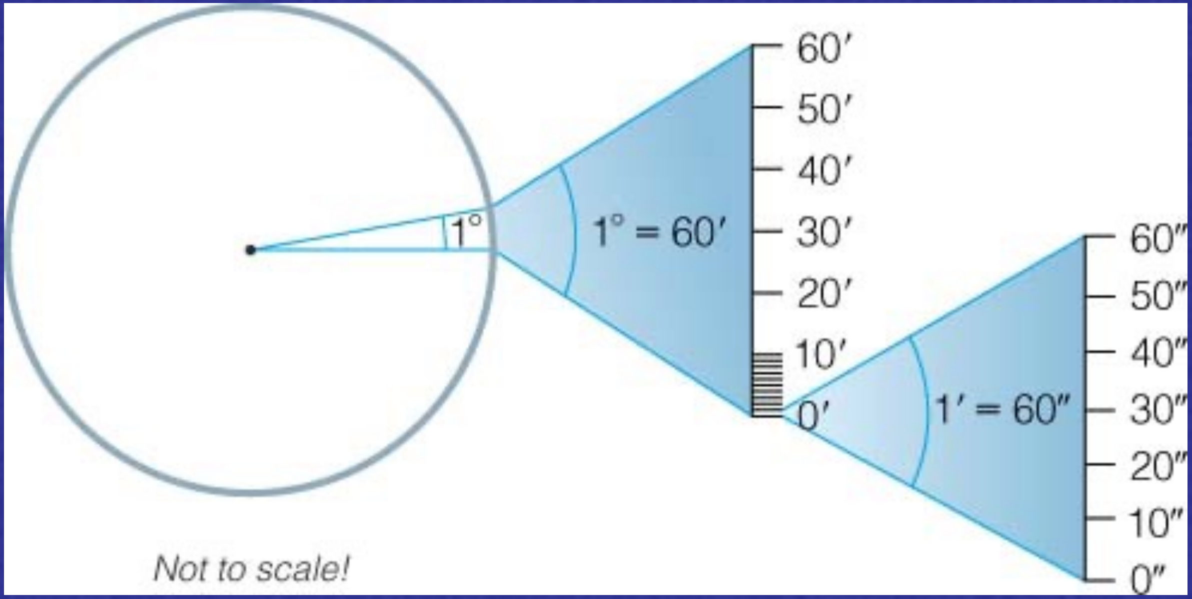
One circle has 2π radians = 360°

We subdivide the degree into 60 arcminutes (a.k.a. minutes of arc):

1° = 60 arcmin = 60'

An arcminute is split into 60 arcseconds (a.k.a. seconds of arc):

1' = 60 arcsec = 60"



Powers-of-ten notation

- Astronomy deals with very big and very small numbers – we talk about galaxies AND atoms.
- Example: distance to the Sun is about 150,000,000,000 meters. Hard to handle!
- Use “powers-of-ten”, or “exponential notation”. All the zeros are consolidated into one term consisting of 10 followed by an exponent, written as a superscript.

Note some familiar numbers in powers-of-ten notation (ch. 1.6):

One hundred	$= 100 = 10^2$	hecto
One thousand	$= 1000 = 10^3$	kilo
One million	$= 1{,}000{,}000 = 10^6$	mega
One billion	$= 1{,}000{,}000{,}000 = 10^9$	giga

One one-hundredth	$= 0.01 = 10^{-2}$	centi
One one-thousandth	$= 0.001 = 10^{-3}$	milli
One one-millionth	$= 0.000001 = 10^{-6}$	micro
One one-billionth	$= 0.000000001 = 10^{-9}$	nano

Examples of powers-of-ten notation

$150 = 1.5 \times 10^{2}$

$84,500,000 = 8.45 \times 10^{7}$

$0.032 = 3.2 \times 10^{-2}$

$0.0000045 = 4.5 \times 10^{-6}$

The exponent (power of ten) is just the number of places past the decimal point.

- Example: distance to the Sun is about 150,000,000,000 meters.

  How do we write this in exponential notation?

e.g. distance to the sun is 1.5×10^{11} m

We can write the size of just about anything on this chart! (Sizes given in meters):

An atom

Cell is about 10^{-4}m

Taj Mahal is about 60 meters high

Earth diameter is about 10^{7} m