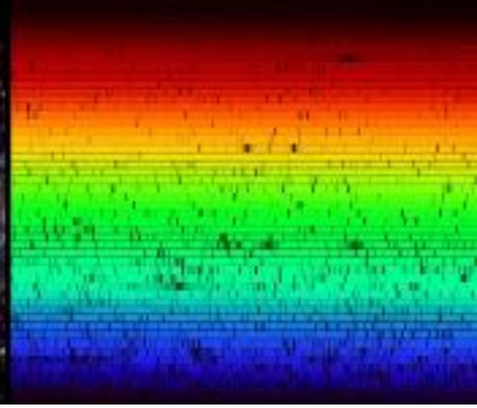
Foundations (of?) Astronomy

ASTR/PHYS 2500

Professor Daniel R. Wik

ASTR/PHYS 2500: Foundations Astronomy



Week 1

Each class will begin with this informational slide
(what we will cover, what's due soon, what to read, etc.)

<u>Today:</u>
Syllabus
Student Info and Pre-course Asssessment
Course Material Overview
Group Discussions / Problem Solving Exercises

Who / When / Where

Prof Wik (Dan)

Office Hours

Tues 2-4pm
(as needed)

Wed 3-5pm

TA: Samir Suthar

Office Hours

Wed 9:45-11:45am

Former student in ASTR 1060 (with me) & ASTR 2500 (with Dr. Z)

Office Hours conducted over Zoom
Zoom info is provided on Canvas

A little about your tour guide…

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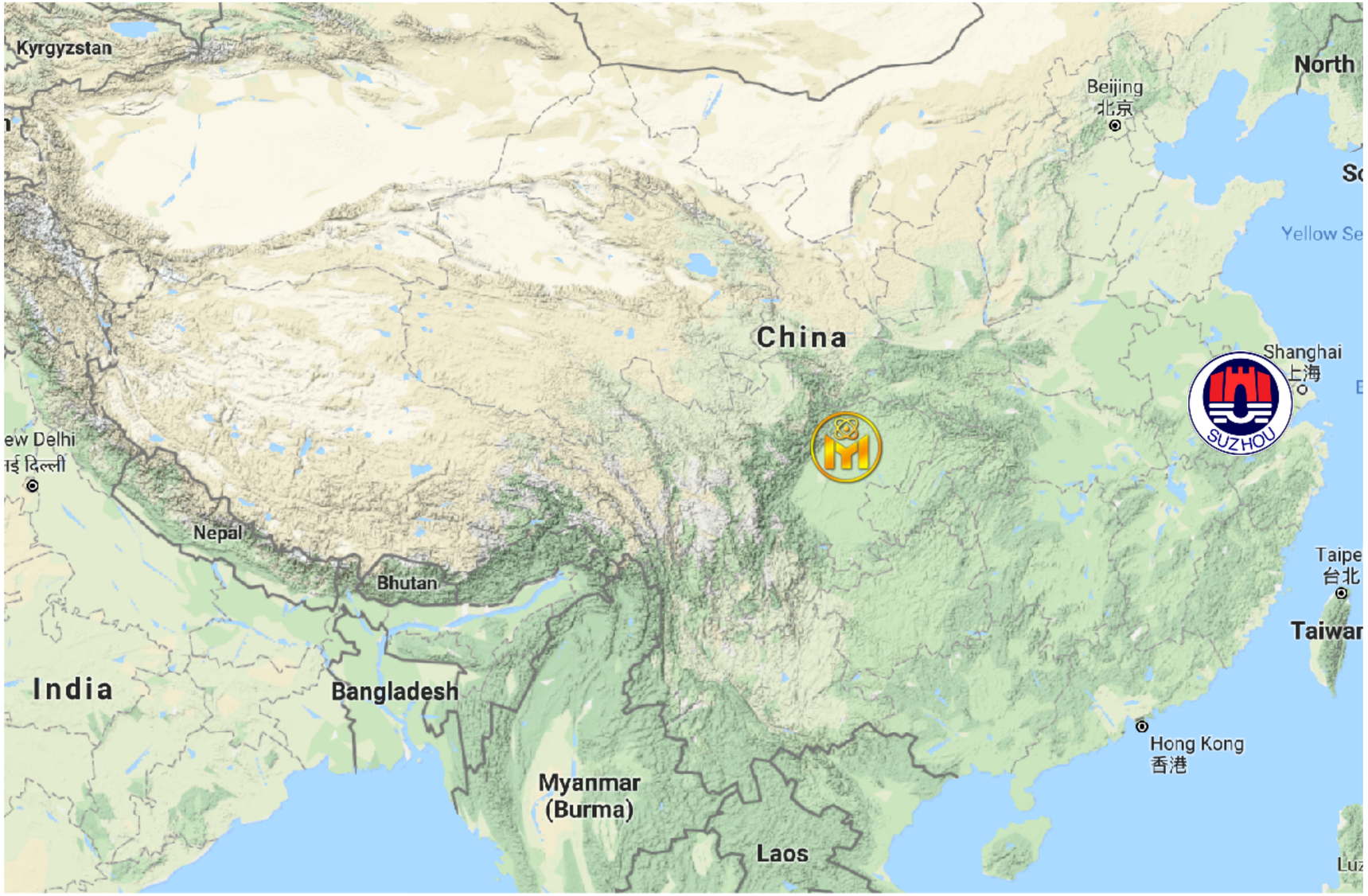
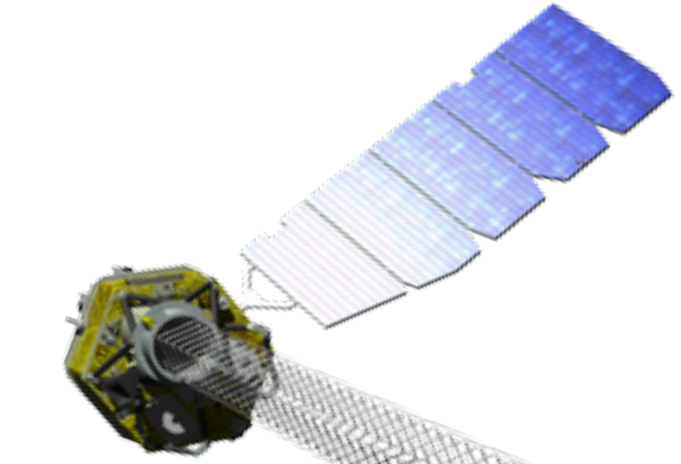
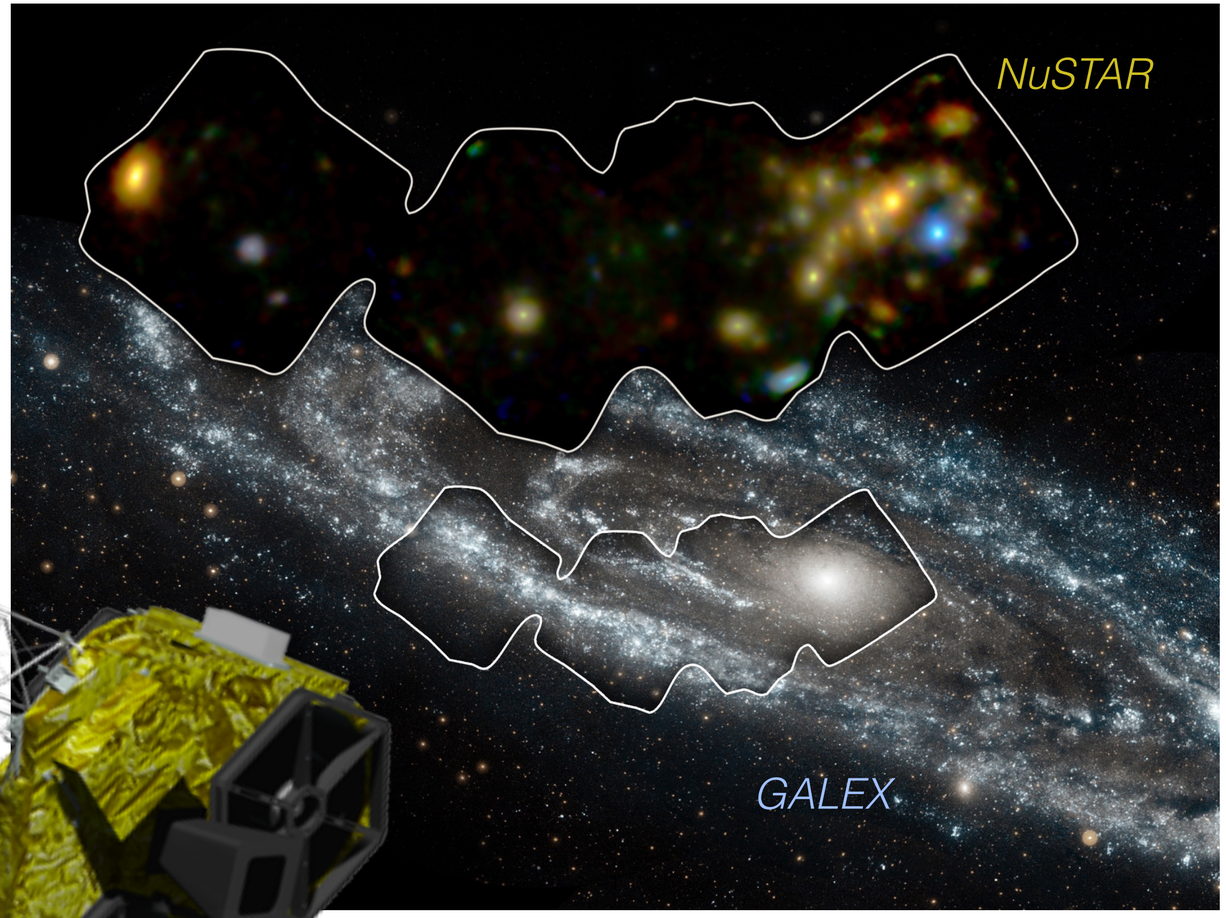


A little about your tour guide…

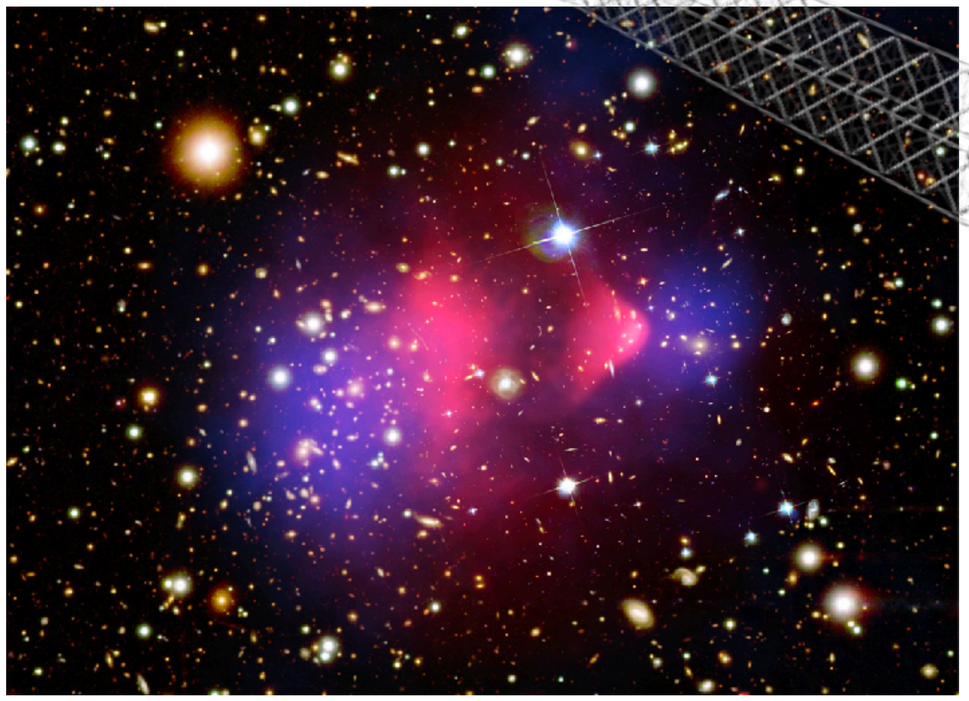
I’m an X-ray Astronomer





Andromeda Galaxy

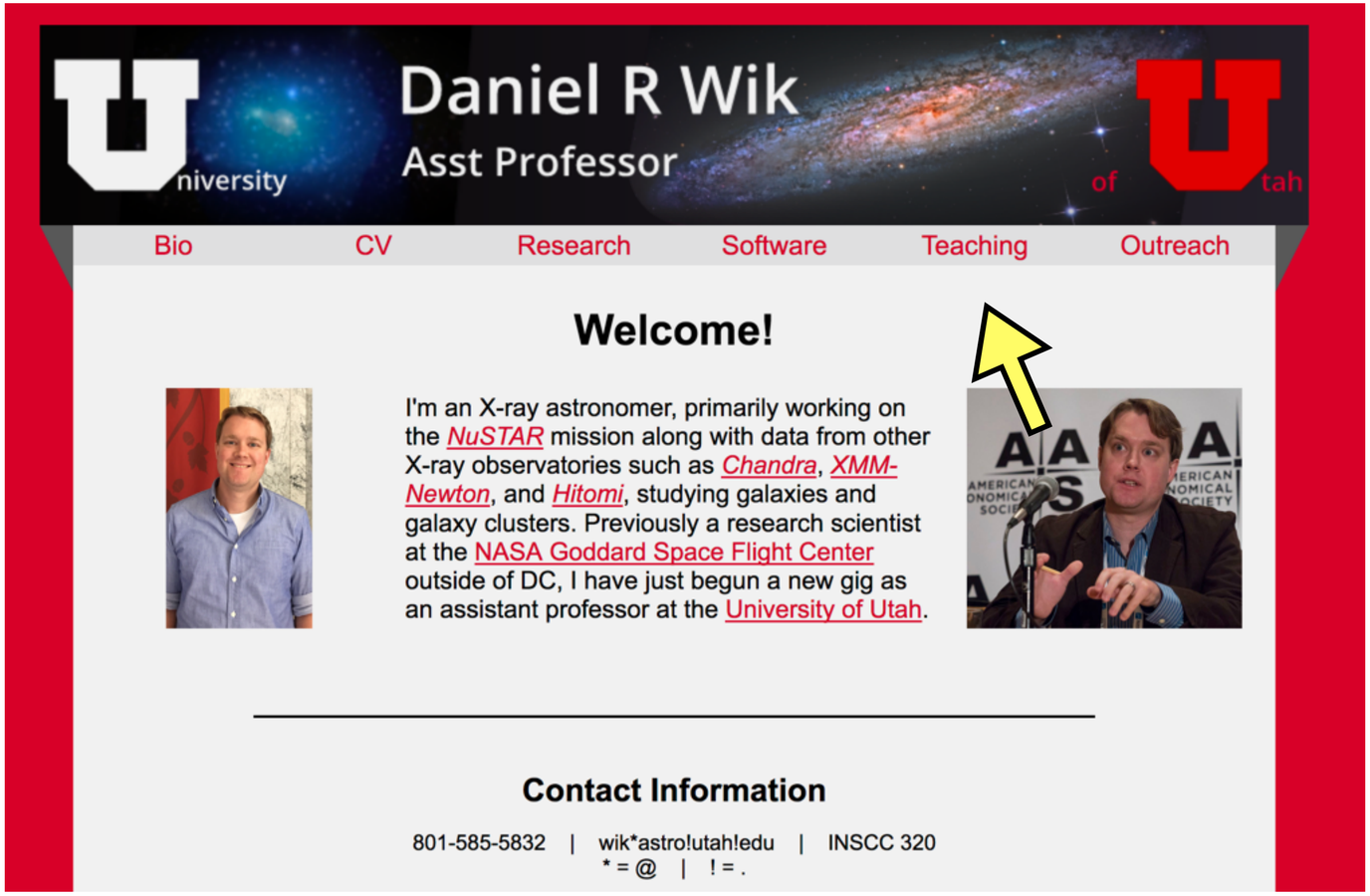
Bullet Cluster



https://the-nightly-news.com/blog/blog-87-secrets-of-the-high-energy-x-ray-unverse

How this course will work

http://www.astro.utah.edu/~wik



Syllabus & Website

http://www.astro.utah.edu/~wik/courses/astr2500fall2020/

Student Info & Pre-Course Assessment

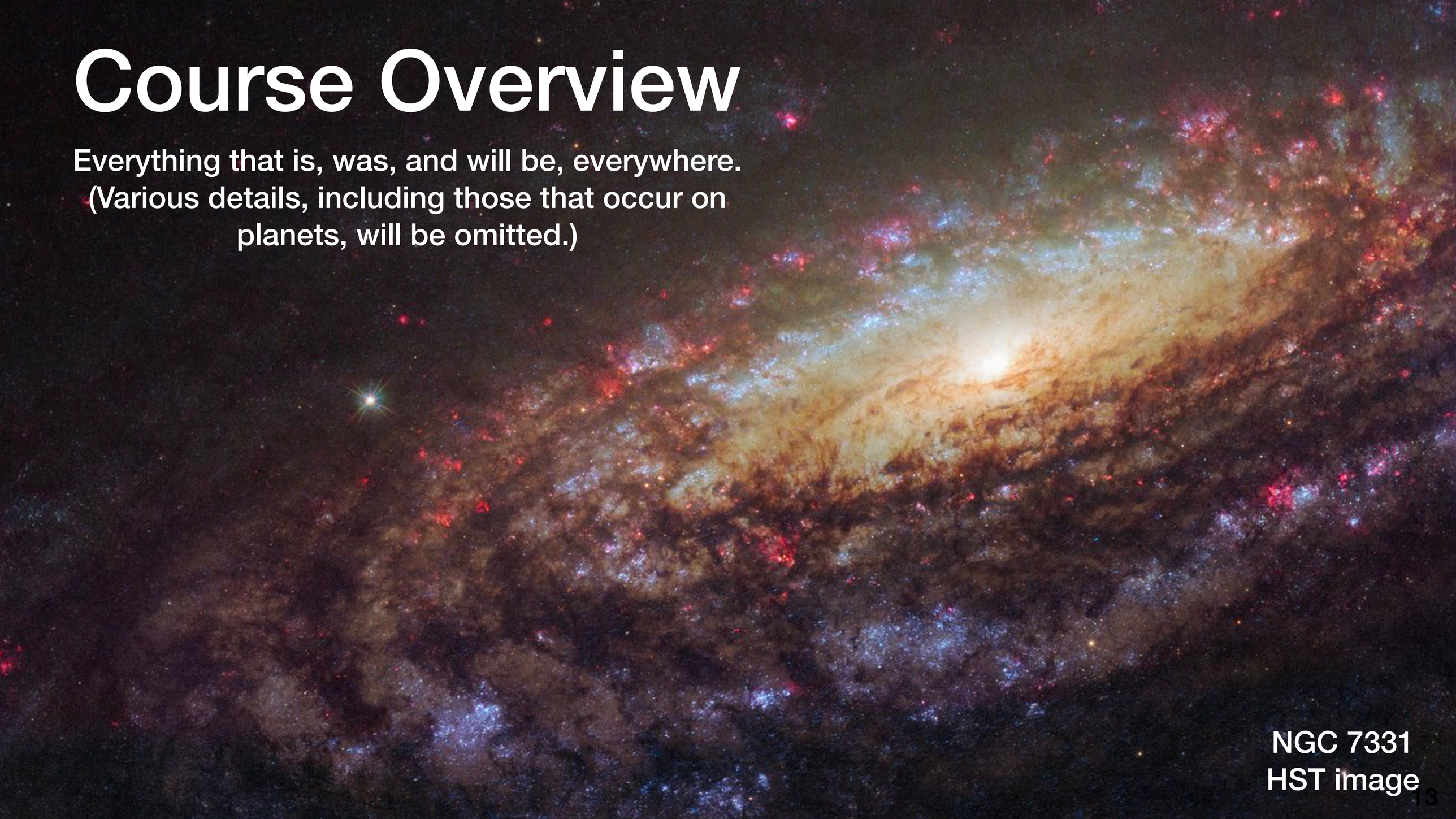
http://www.astro.utah.edu/~wik/courses/astr2500fall2020/hw/day1assessment.pdf

Exams: open note/textbook, no internet

Student-made gif after my first exam last semester

Course Overview

Everything that is, was, and will be, everywhere.
(Various details, including those that occur on planets, will be omitted.)



NGC 7331
HST image

History of Astronomy

Until Galileo, all astronomy "naked eye"

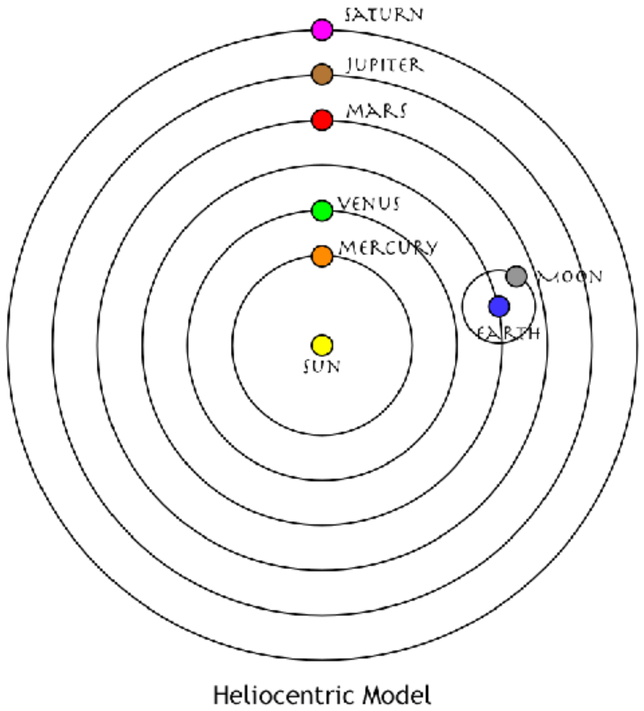
Tycho Brahe (late 1500s)

<u>Birth of Agriculture</u> ~10,000 years ago
Determine Planting/Harvest Times
(weather can be unreliable)

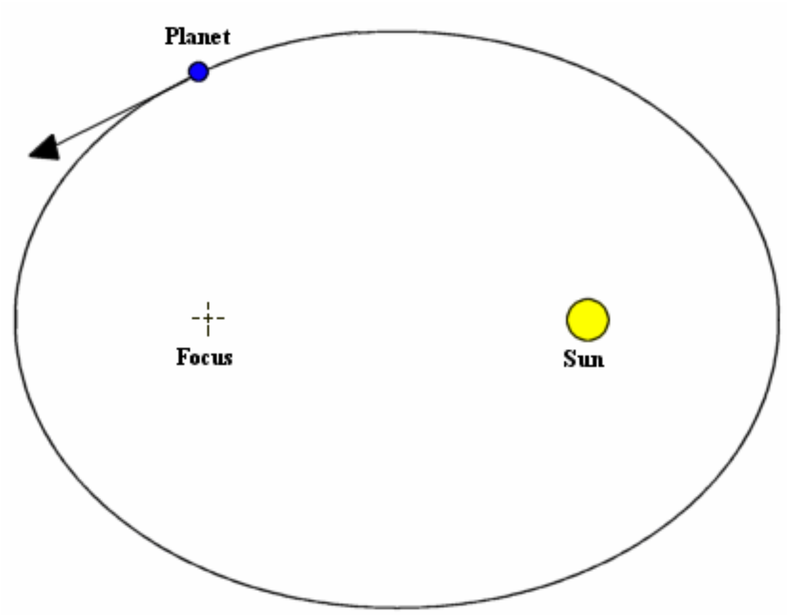
Therefore astronomy often called the oldest "science"
(observations led to predictions)

Measurements essentially all positional, attempting to predict the paths of planets in the sky for astrological and cosmological reasons

History of Astronomy



Heliocentric Model



Copernicus → **Kepler** → **Newton**

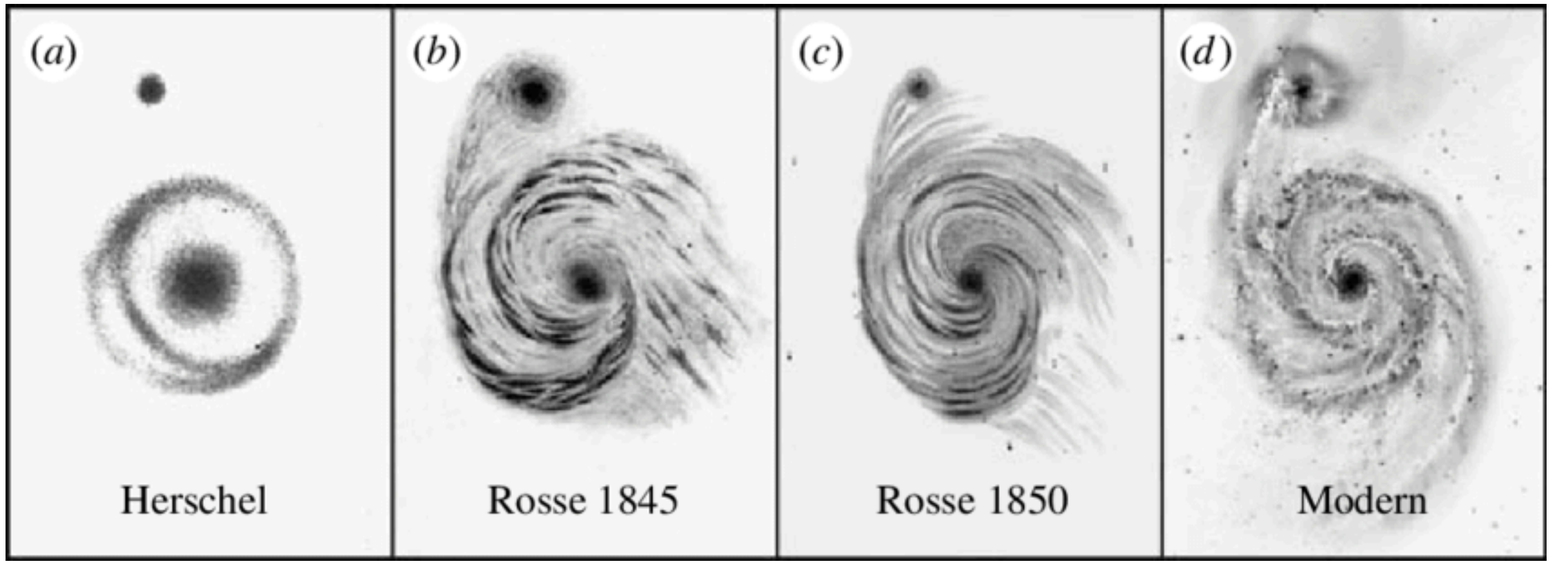
Sun in the right place

Planetary paths mapped out correctly

Reason for paths explained theoretically

Astronomy leads to the development of physics

History of Astronomy

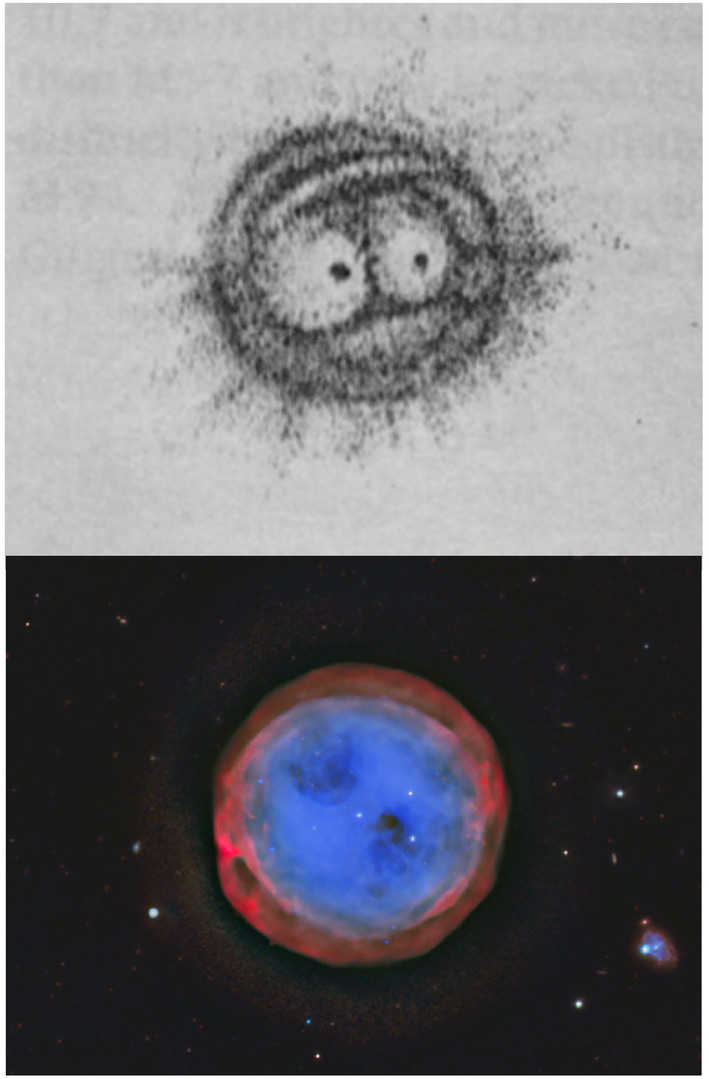


Until astronomical photography pioneered in the mid 1800s, difficult to perform precision measurements

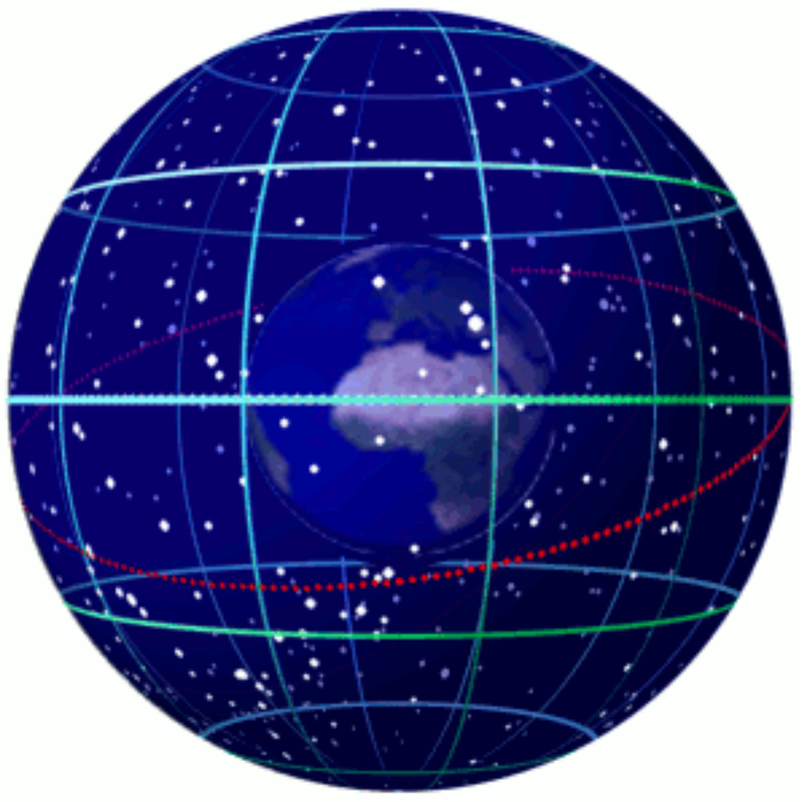
After this development, the sky can be studied in much greater detail

Astronomy —> Astrophysics

M97, the Owl Nebula

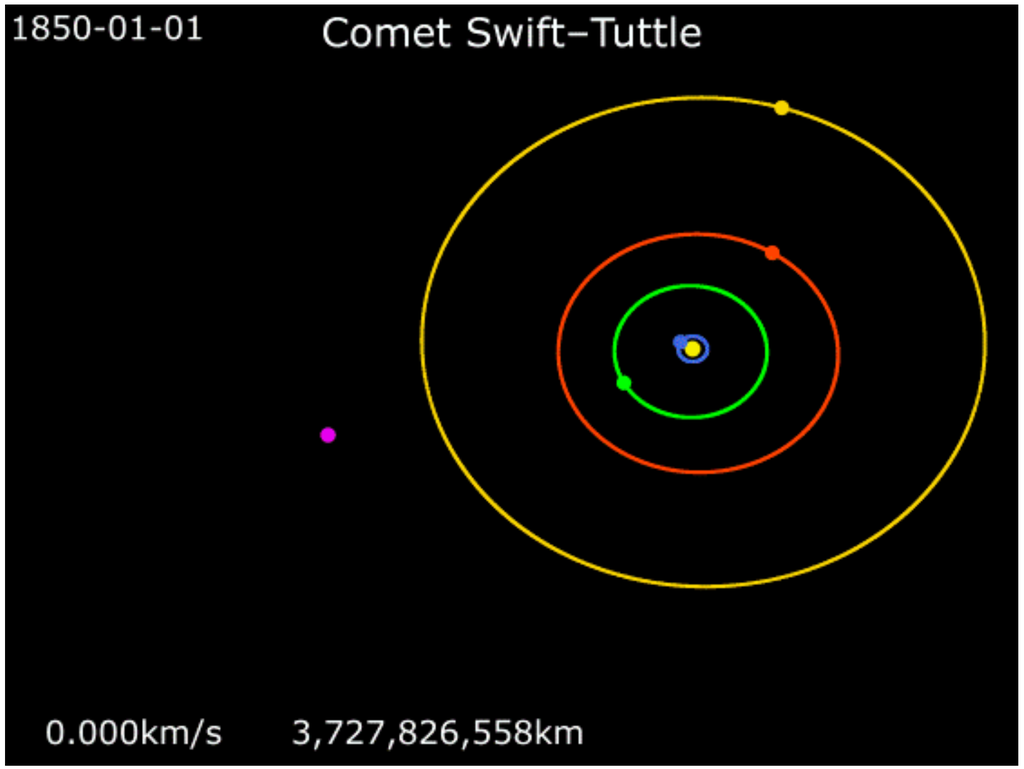


The Night Sky & Astronomical Coordinates

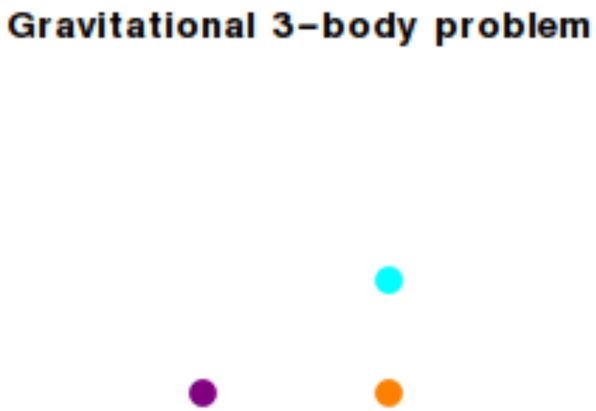


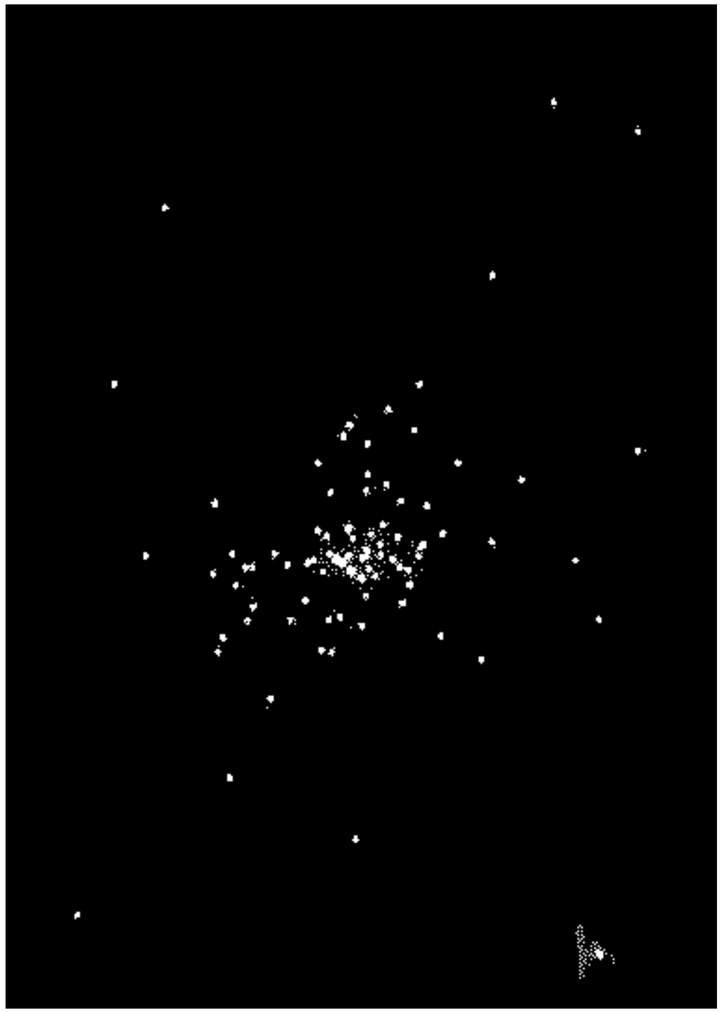
Star trails over the Gemini South telescope

Gravitational Forces / Orbits



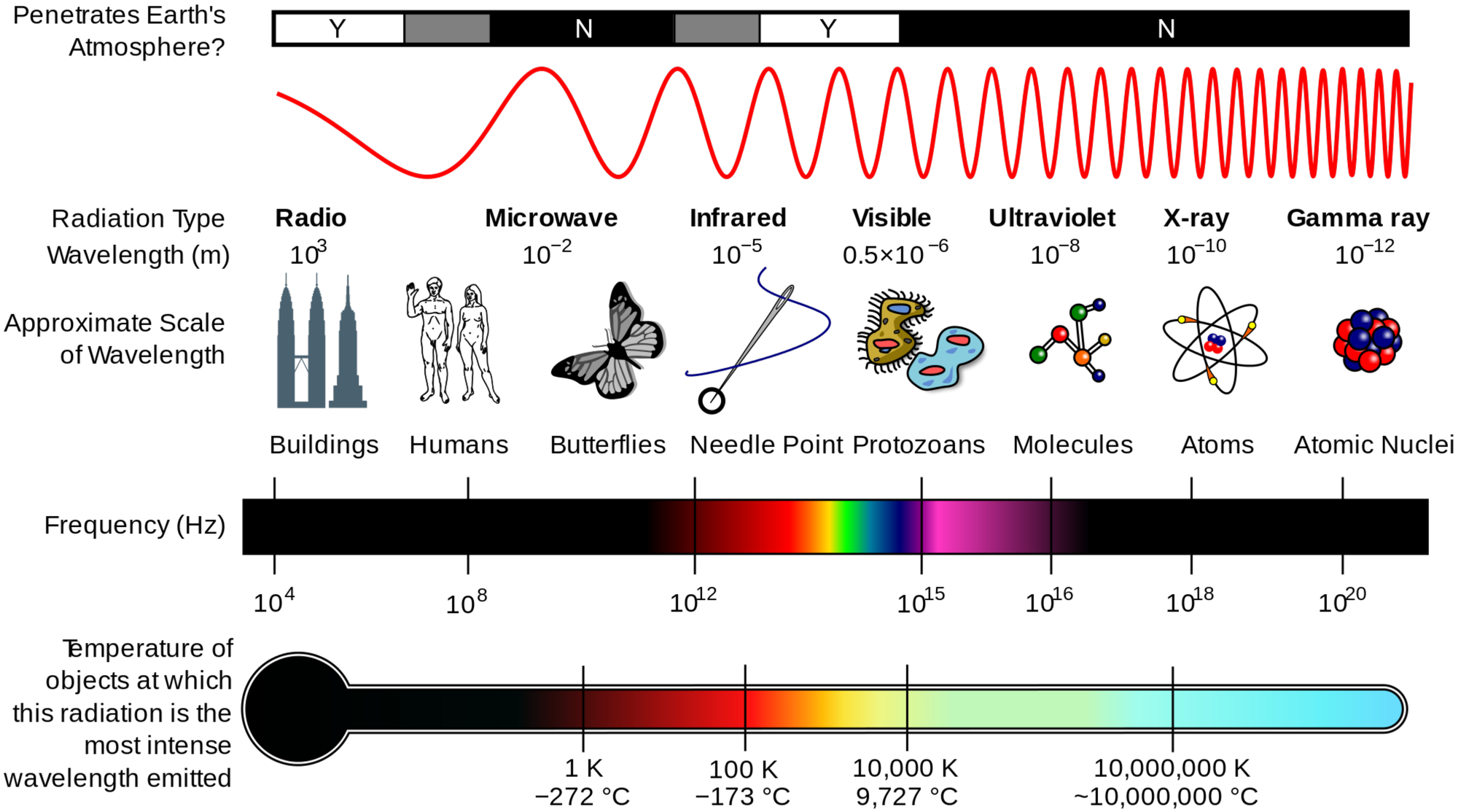
Effective 2-body orbits



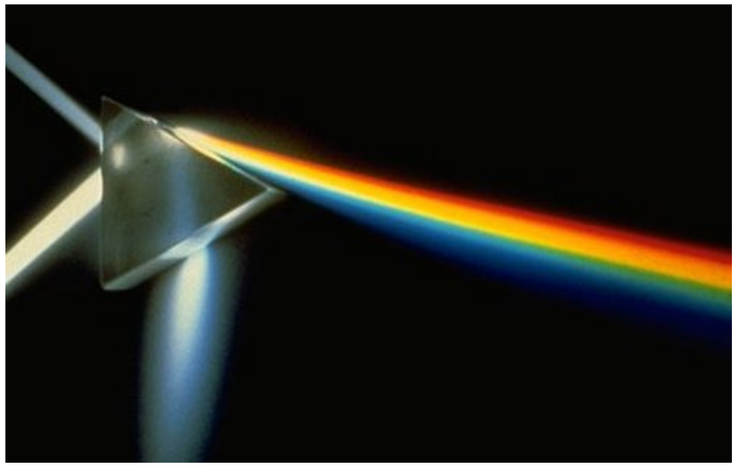


N-body system

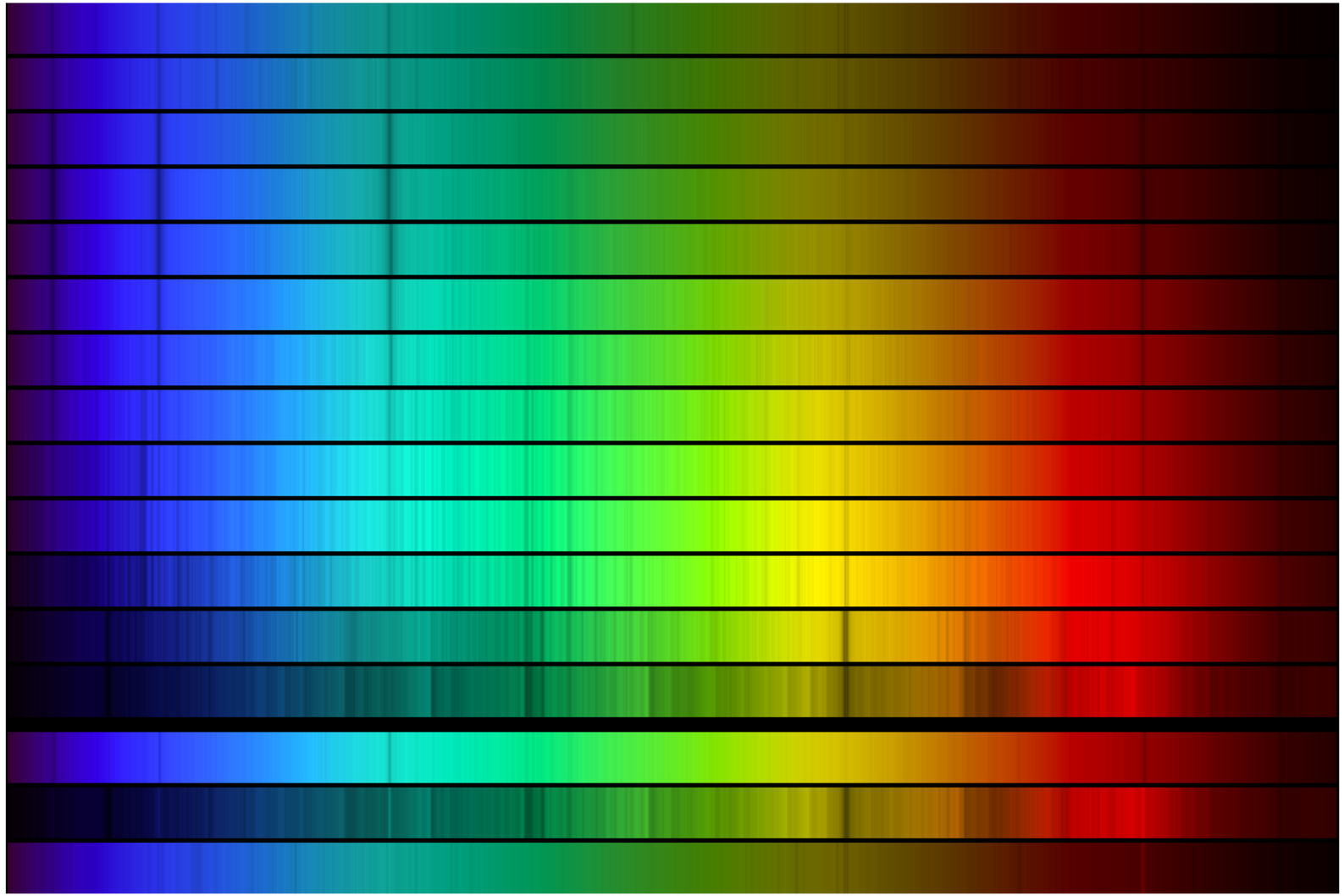
Electromagnetic Radiation (I mean, light!)



Starlight

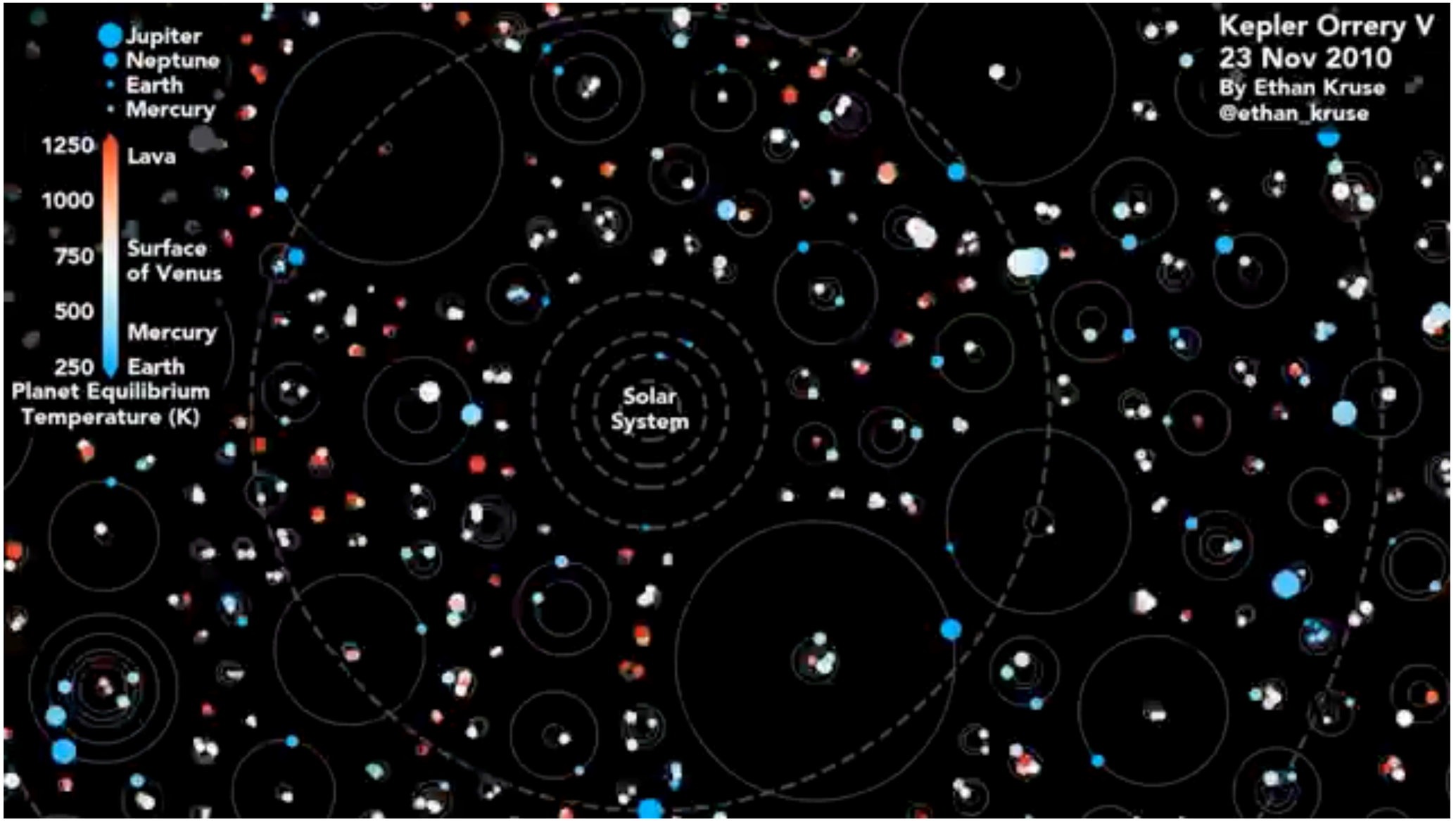


Spectroscopy



Planetary Systems

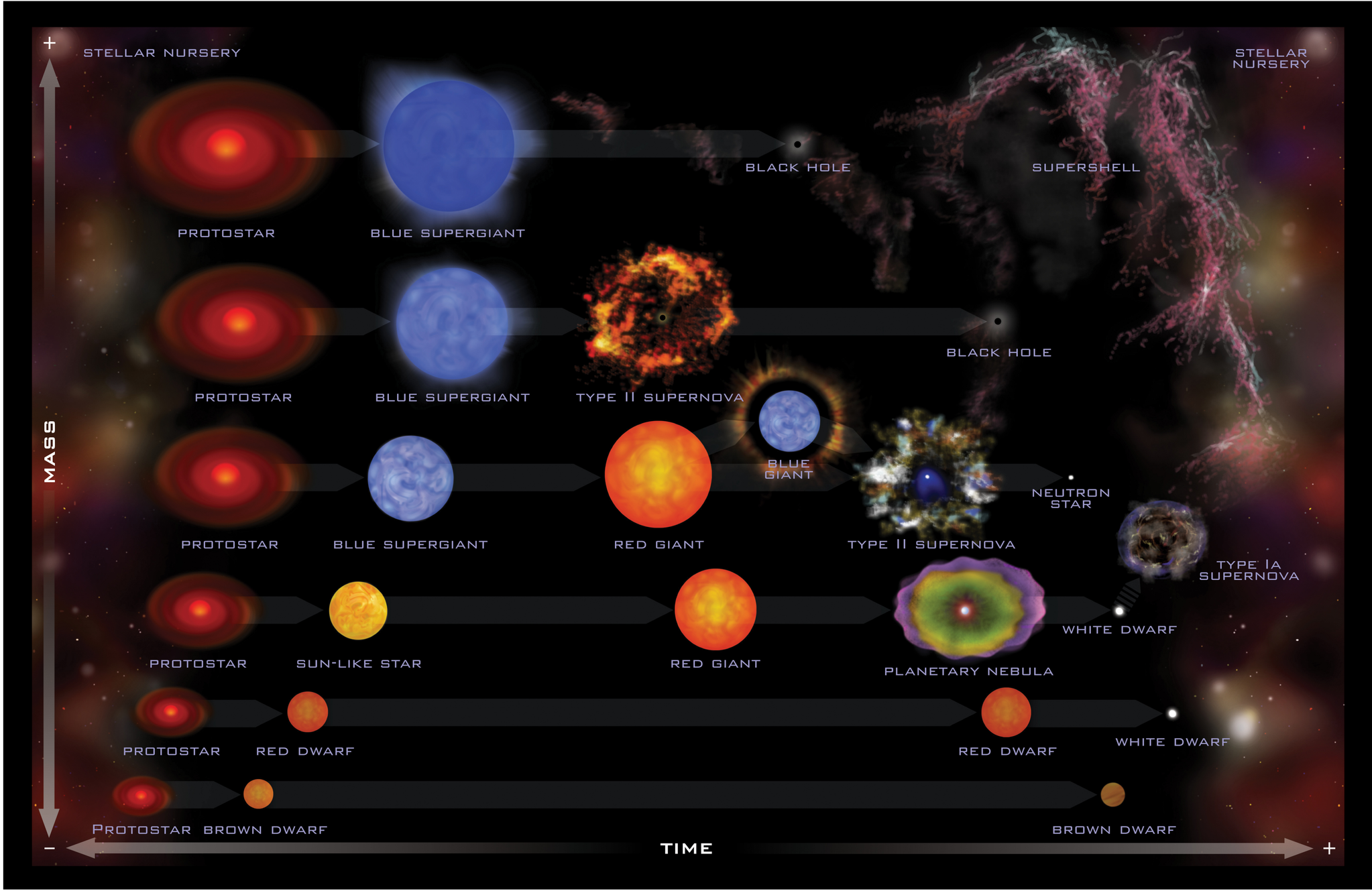
https://www.youtube.com/watch?v=Td_YeAdygJE



Stars

Evolutionary paths of stars with different initial masses

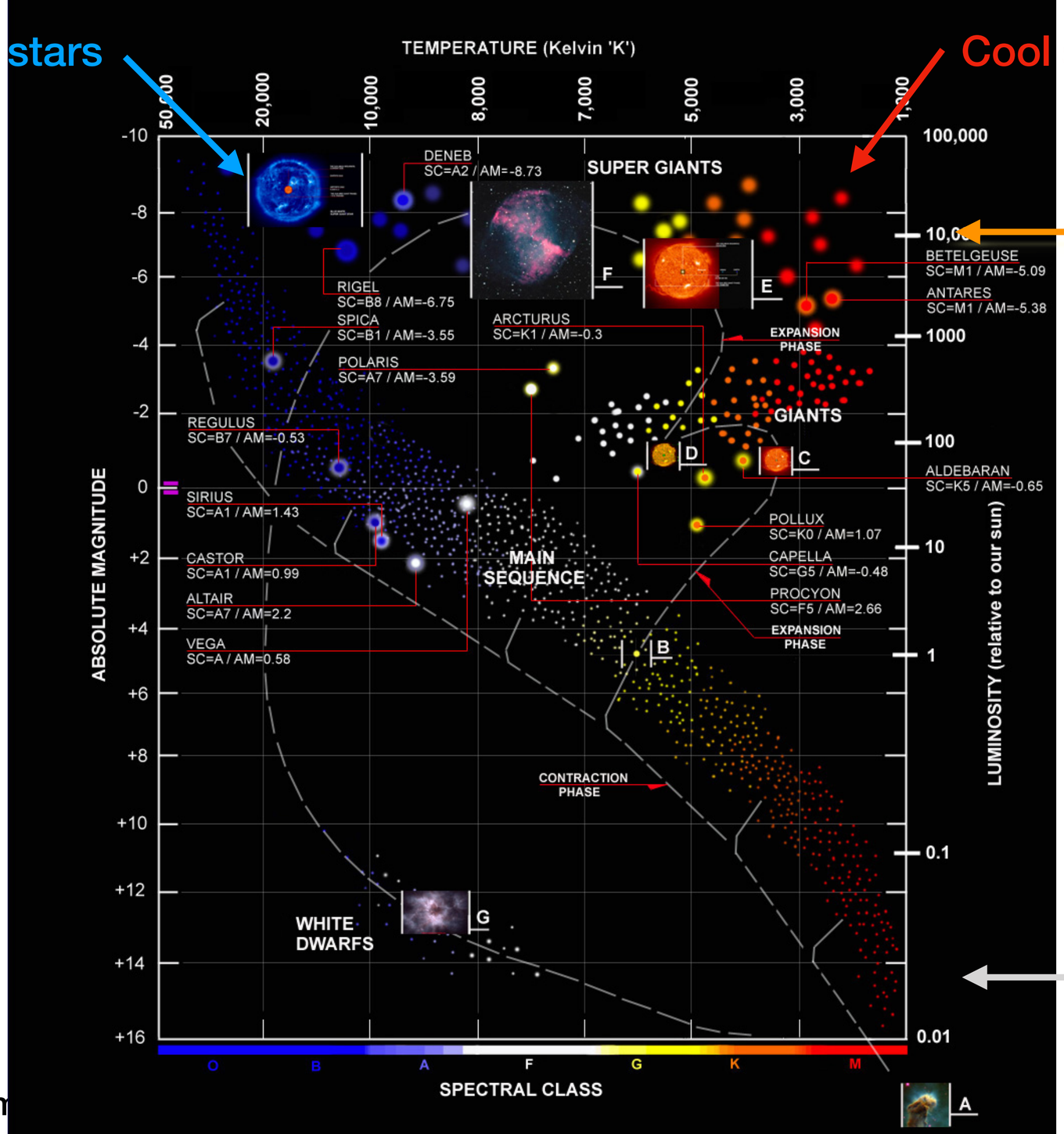
Mass vs. Time



Stars

Evolutionary paths of stars with different initial masses

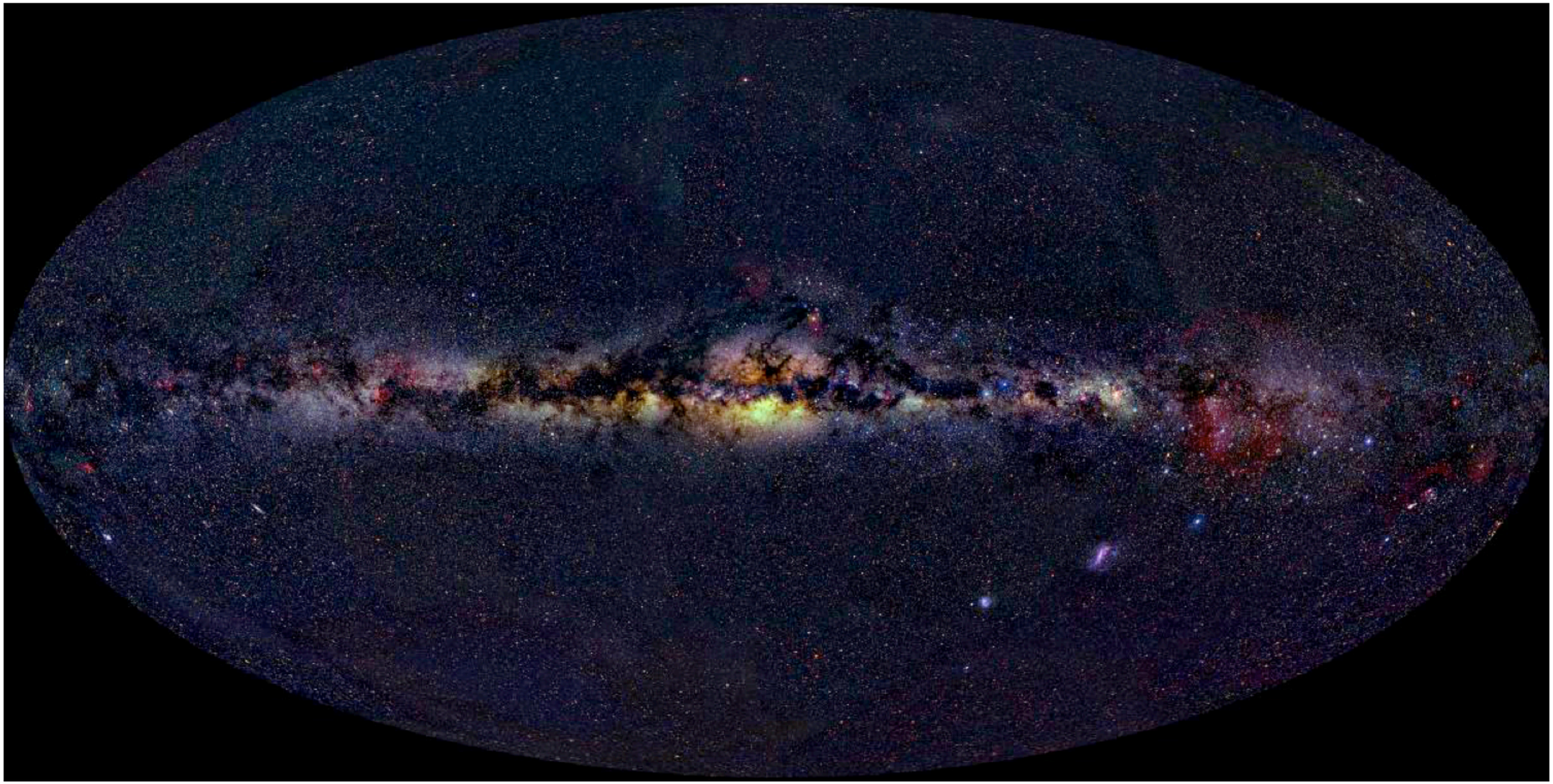
Intrinsic Brightness vs. Color



Bright stars

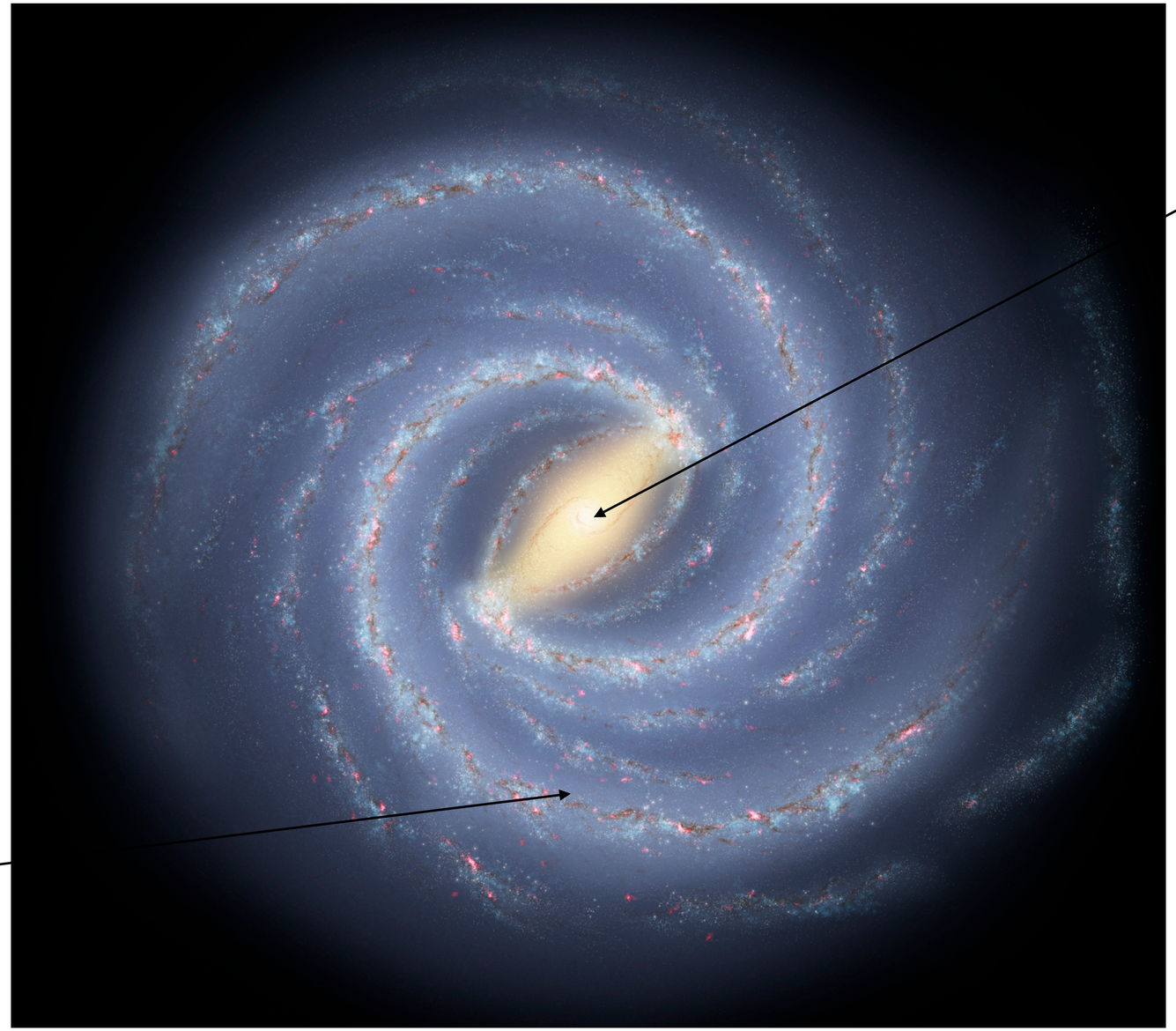
Faint stars

(Our) Milky Way Galaxy



(Our) Milky Way Galaxy

Artist conception of our Galaxy from "above"

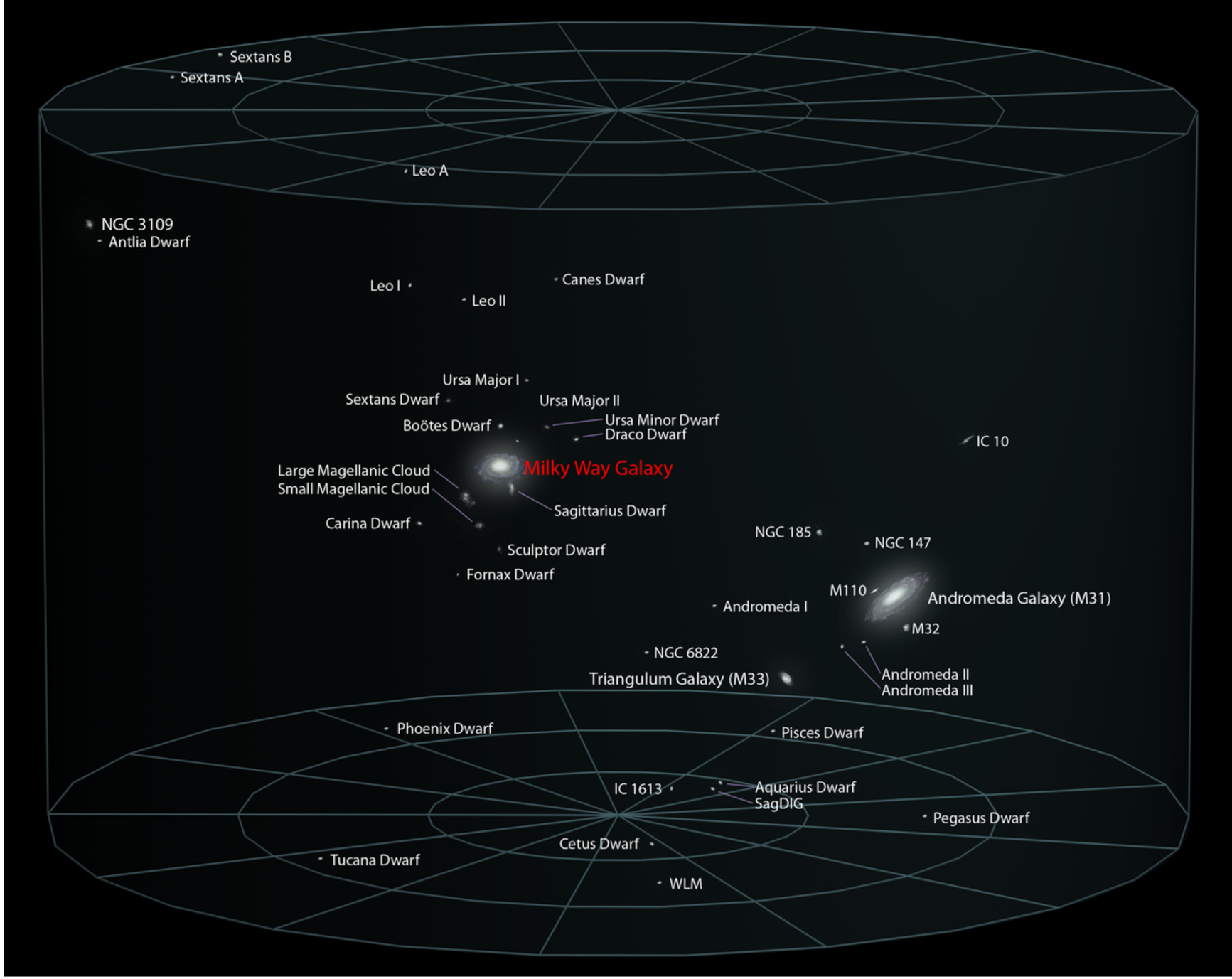


Supermassive (millions of times more massive than the Sun) Black Hole

Our Sun (more or less)

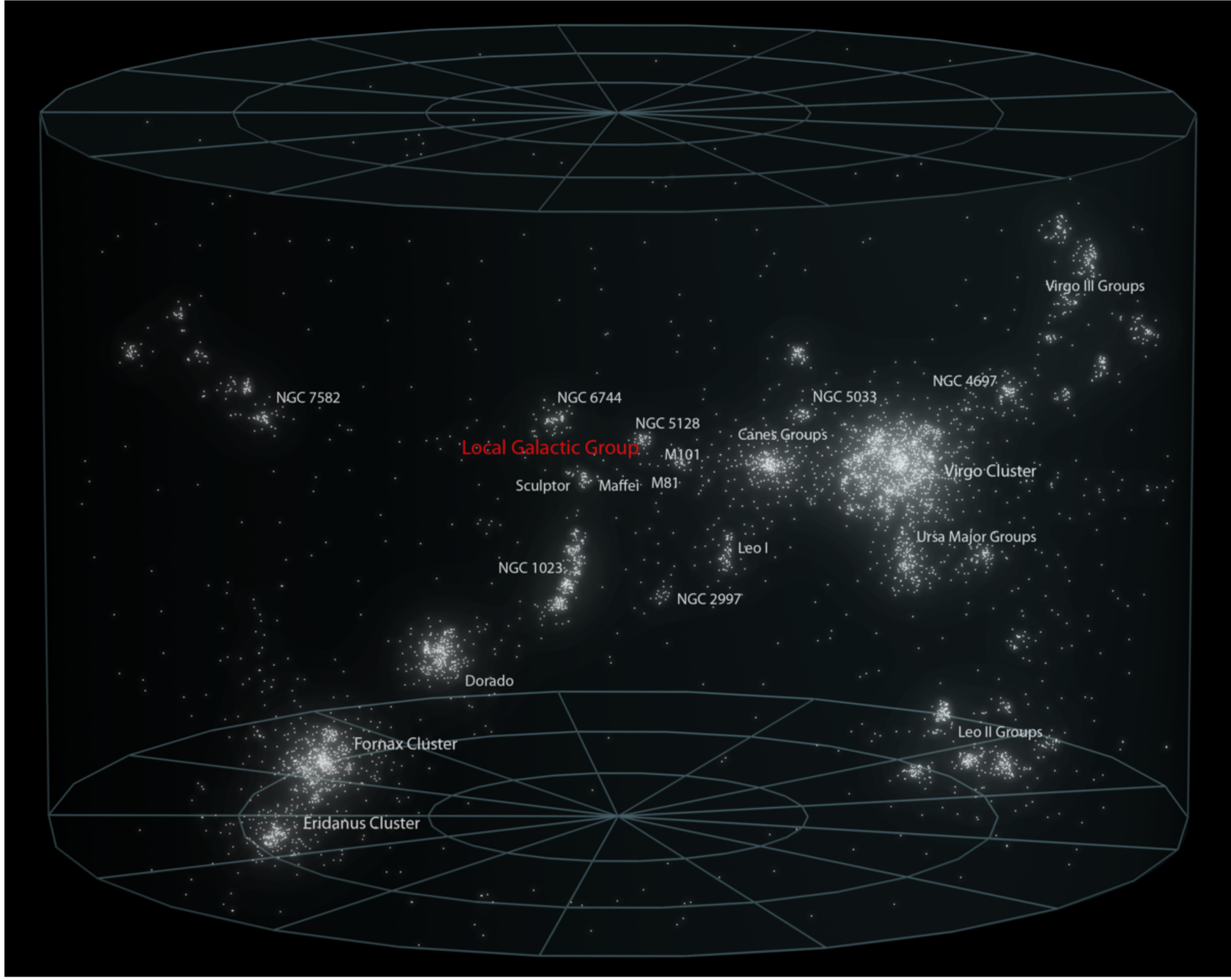
Galaxies

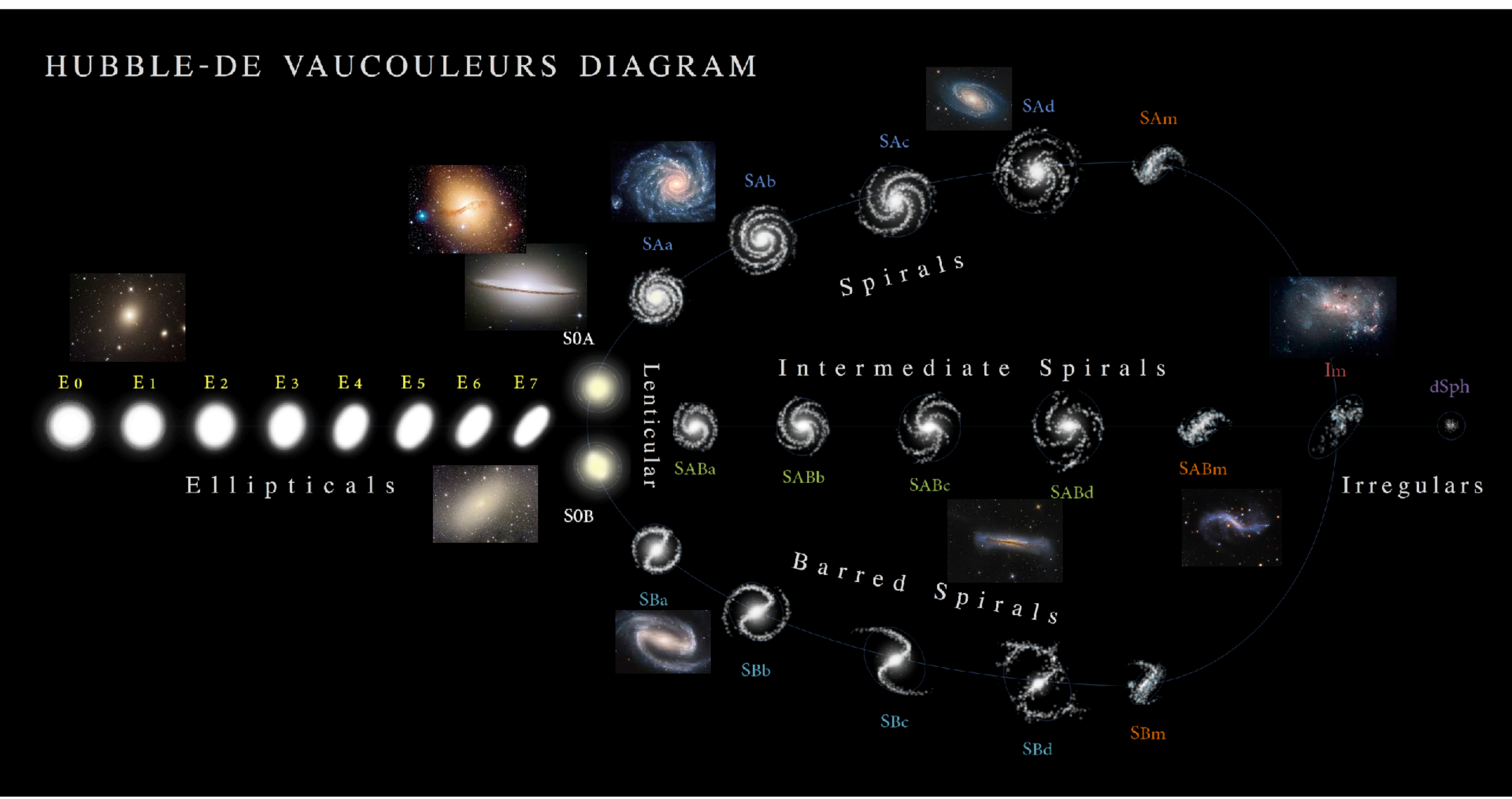
our Local Group



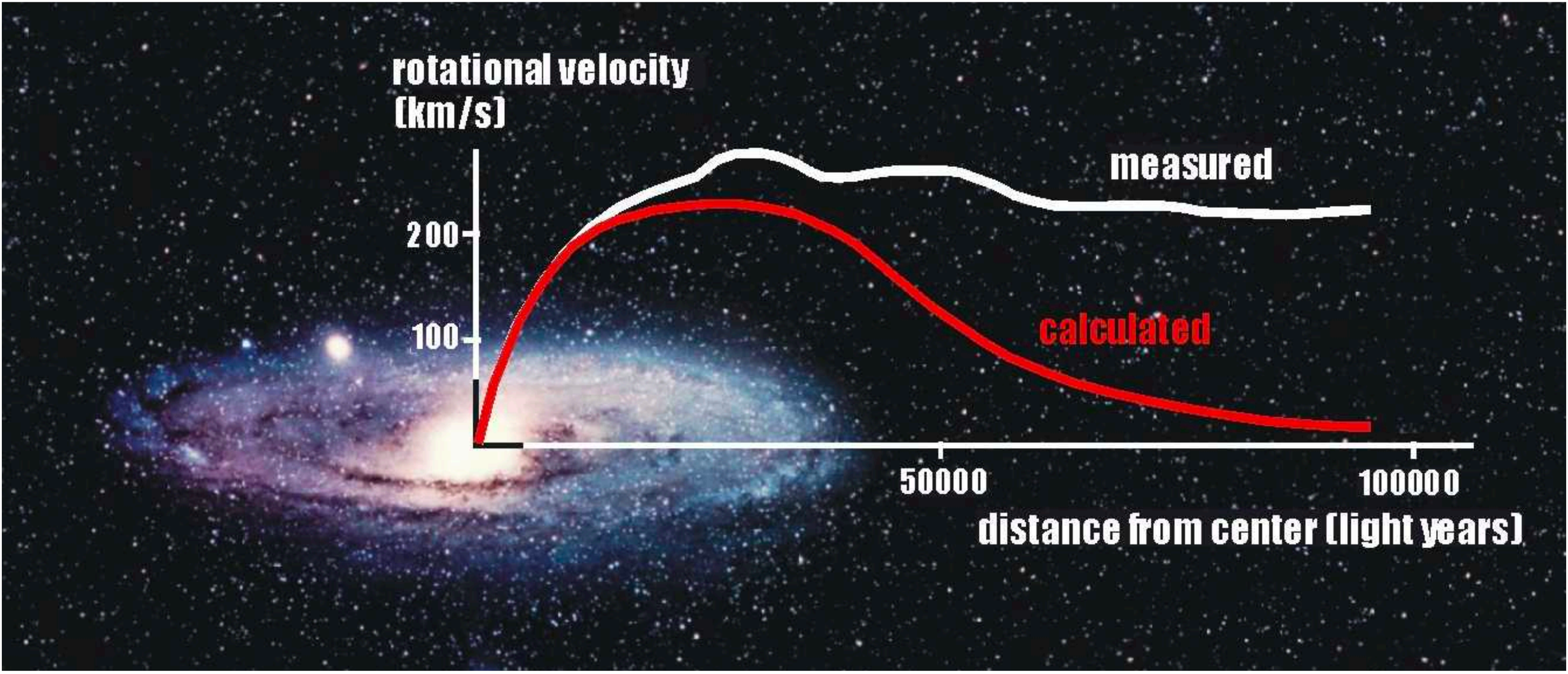
Galaxies

Clustering of galaxies

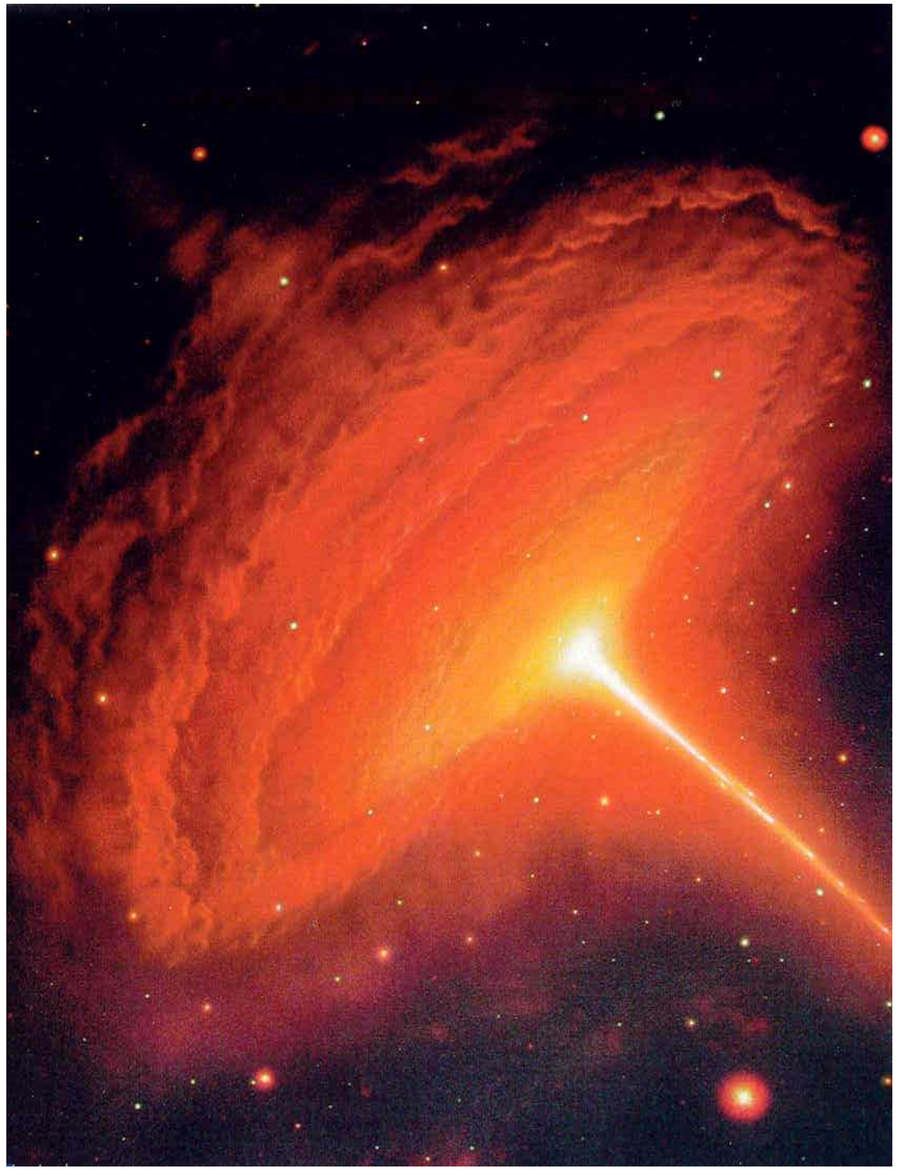



HUBBLE-DE VAUCOULEURS DIAGRAM
E0
E1
E2
E3
E4
E5
E6
E7
Ellipticals
S0A
S0B
Lenticular
SAa
SAb
SAc
SAd
SAm
Spirals
Intermediate Spirals
Im
dSph
Irregulars
SABa
SABb
SABc
SABd
SABm
Barred Spirals
SBa
SBb
SBc
SBd
SBm

Dark Matter

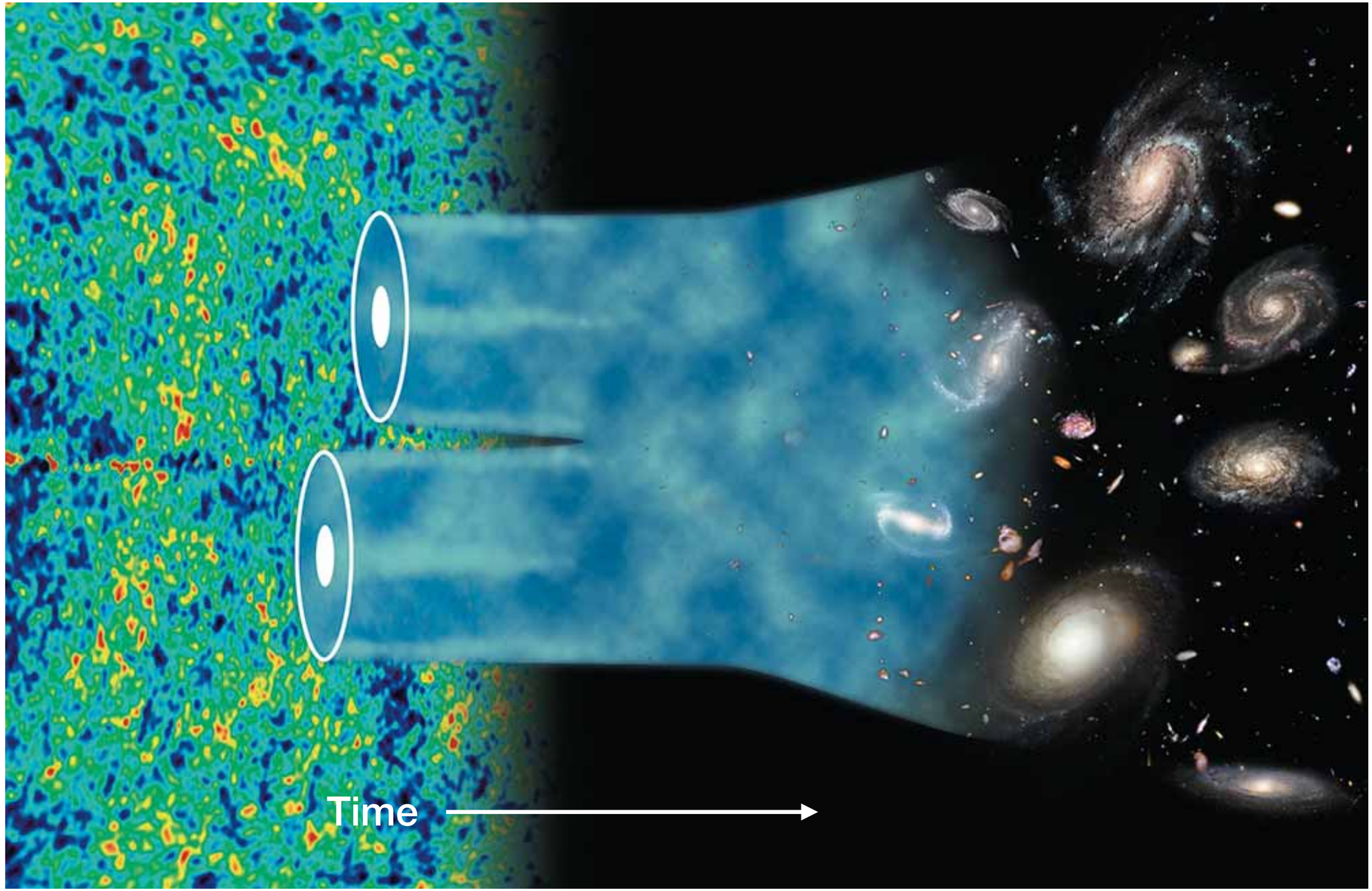

rotational velocity
(km/s)
200
100
measured
calculated
50000
100000
distance from center (light years)

Black Holes & Quasars



Artist Conceptions

Cosmology and the Early Universe



Aliens

$$N = R_* \times f_p \times n_e \times f_e \times f_i \times f_c \times L$$

- N: The number of technologically advanced civilizations in the Milky Way galaxy
- R_*: The rate of formation of stars in the galaxy
- f_p: The fraction of those stars with planetary systems
- n_e: The number of planets, per solar system, with an environment suitable for life
- f_e: The fraction of suitable planets on which life actually appears
- f_i: The fraction of life-bearing planets on which intelligent life emerges
- f_c: The fraction of civilizations that develop a technology that releases detectable signs of their existence into space
- L: The length of time such civilizations release detectable signals into space

$$A = N_{ast}$$

- A: The number of technological species that have formed over the history of the observable universe
- N_{ast}: The number of habitable planets in a given volume of the universe

Discussion Time!