

Foundations (of?) Astronomy

ASTR/PHYS 3070

Professor Daniel R. Wik



Classroom Climate

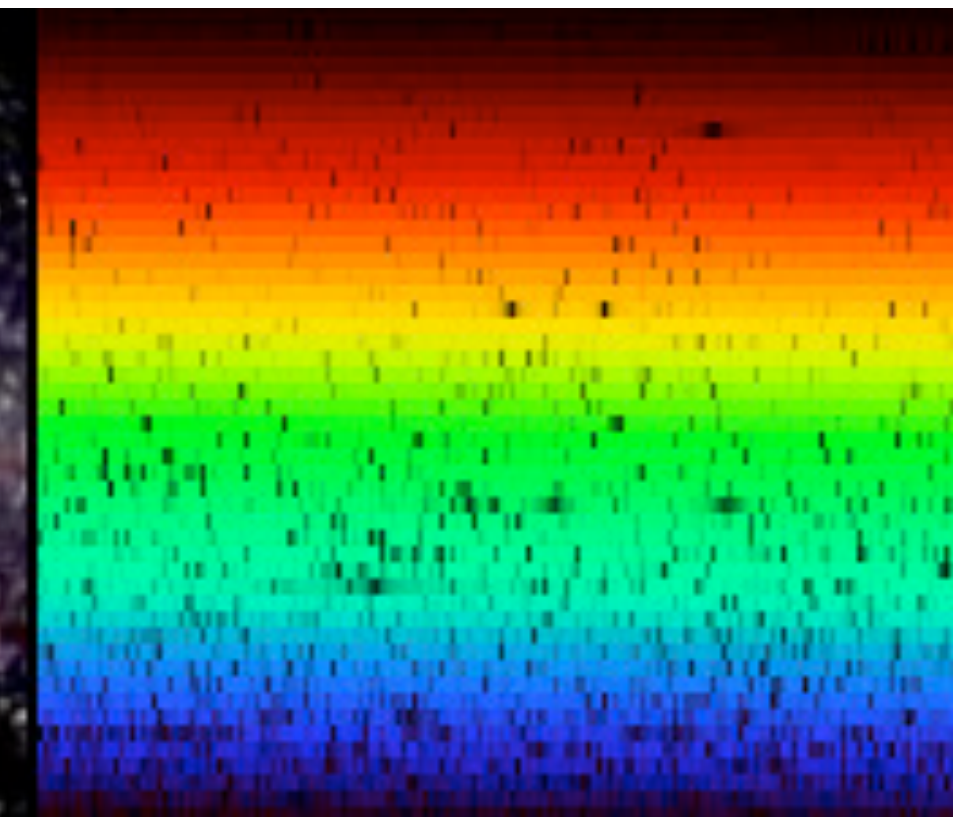
In this course, I strive to provide an inclusive climate in which each student feels welcome and free to question, contributes to the discussion, thrives, and learns, independent of gender identification, race, sexual orientation, ethnicity, disability, economic background, national origin, or religious affiliation. I expect students to contribute actively to this learning environment through open and respectful verbal and written communication. Discrimination or harassment of any form will not be tolerated. I also welcome any suggestions for improving the learning environment.

Welcome to the Community of Astronomers

In addition to conveying course material, a goal of this class is to introduce and welcome you to the astronomical community, either professionally or casually. Astronomy has its own culture and traditions and is open to all – if you are taking this class, you belong!



ASTR/PHYS 3070: Foundations Astronomy



Week 1

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

Today's Agenda

- Course Logistics
- Group & Class Discussion
- Interactive Tour of the Universe
- Student Info and Pre-course Assessment & Parting words

Announcements / Reminders

- Read Chapter 1 by Thursday
 - Scanned PDF available on website
- HW 1 due September 3rd at 11:59pm via Canvas upload

Who / When / Where

Prof Wik (Dan)



Office Hours

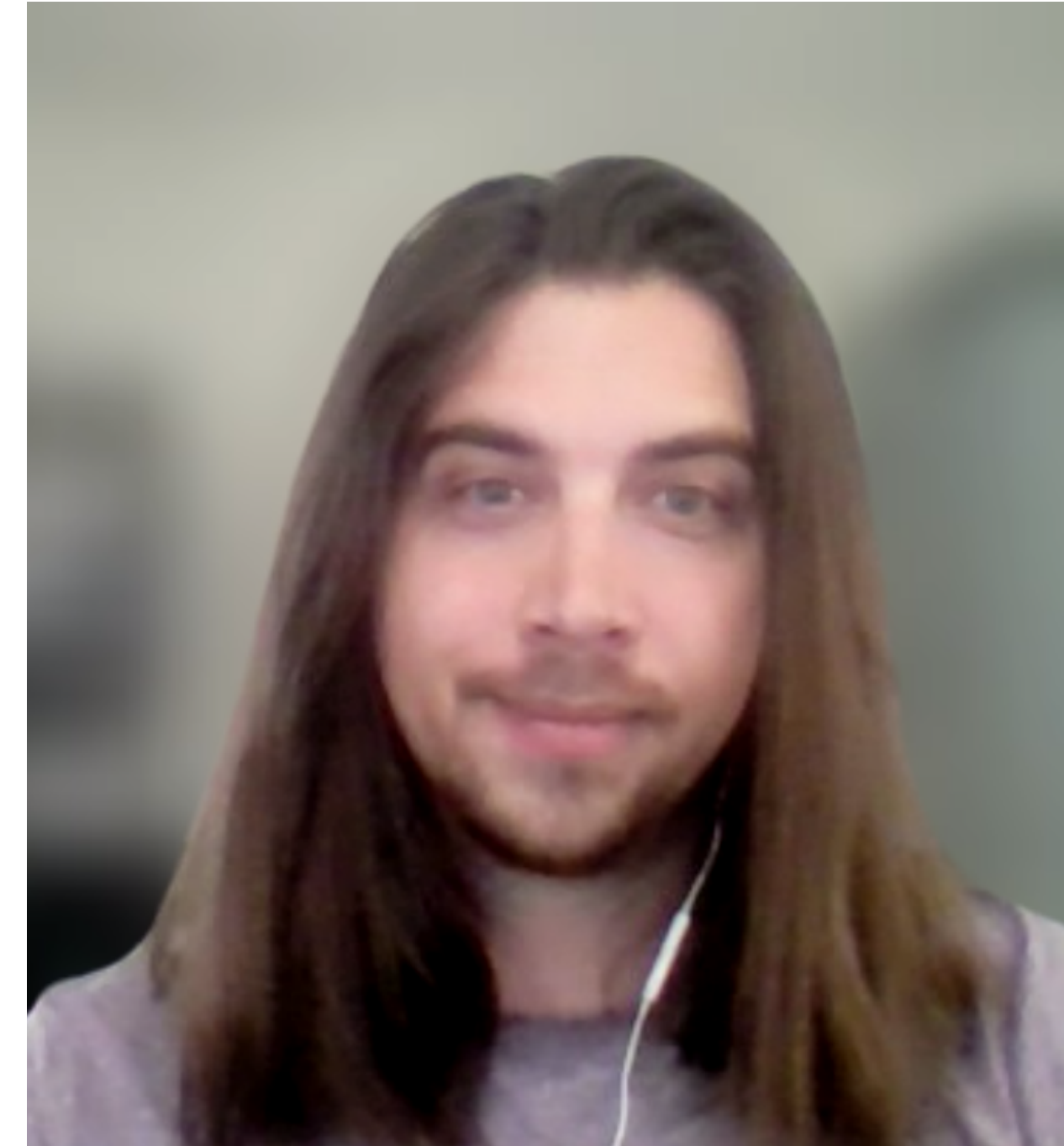
Wed (when?)
Friday 2-3pm

Zoom Info

Meeting ID: 210 492 5342

<https://utah.zoom.us/j/2104925342>

TA: Kameron Goold



Office Hours

Thurs 1-2pm

Zoom Info

<https://utah.zoom.us/j/99083025165>

PW: AstroPhys

Additional Potential Contacts

Hannah Fritze

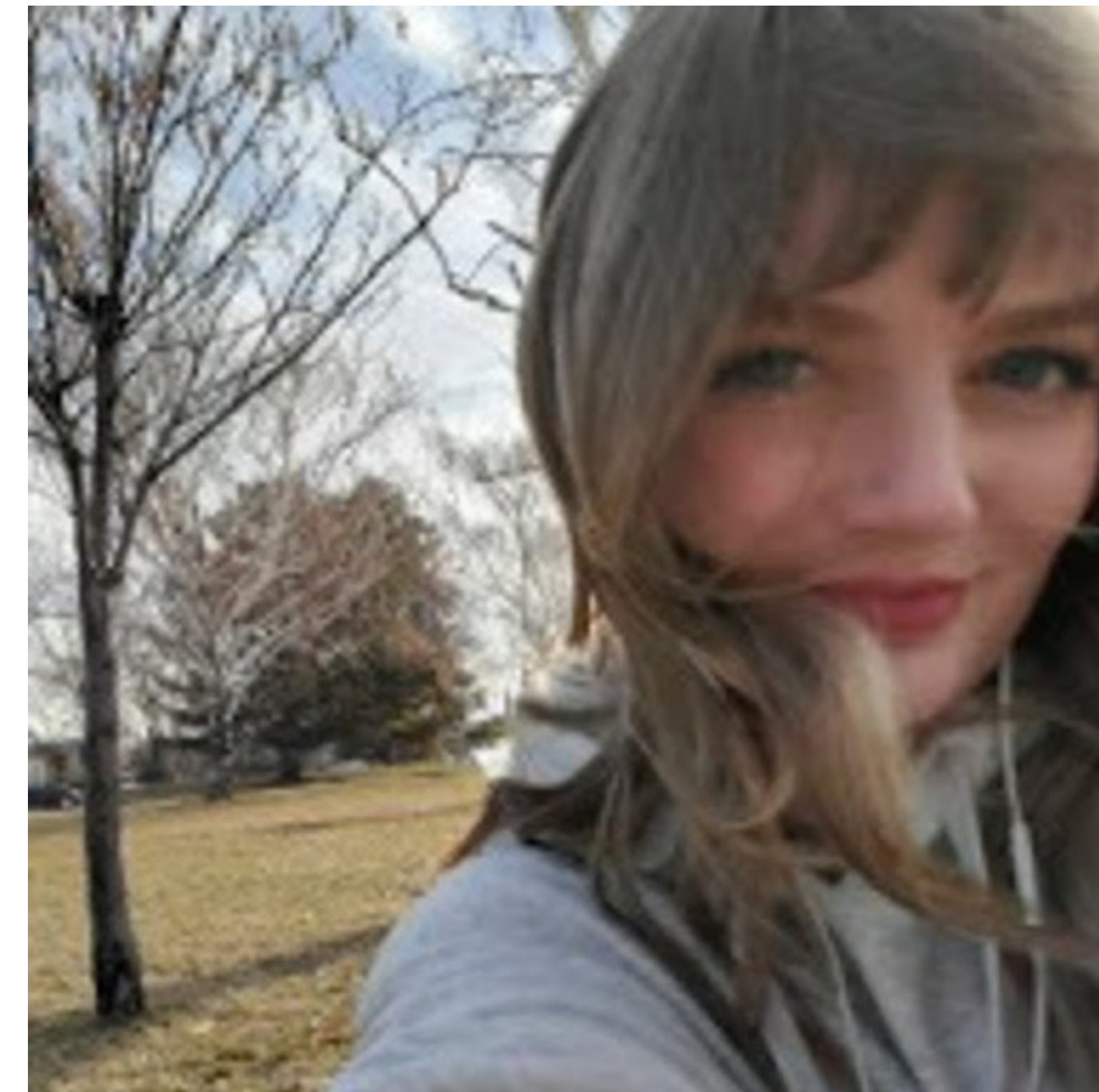
3rd year graduate student
interested in education



hannah.fritze@utah.edu

Ashley Merrell

2nd or 3rd year undergraduate
who took this course last semester



ashleybmerrell@gmail.com

A little about your tour guide...



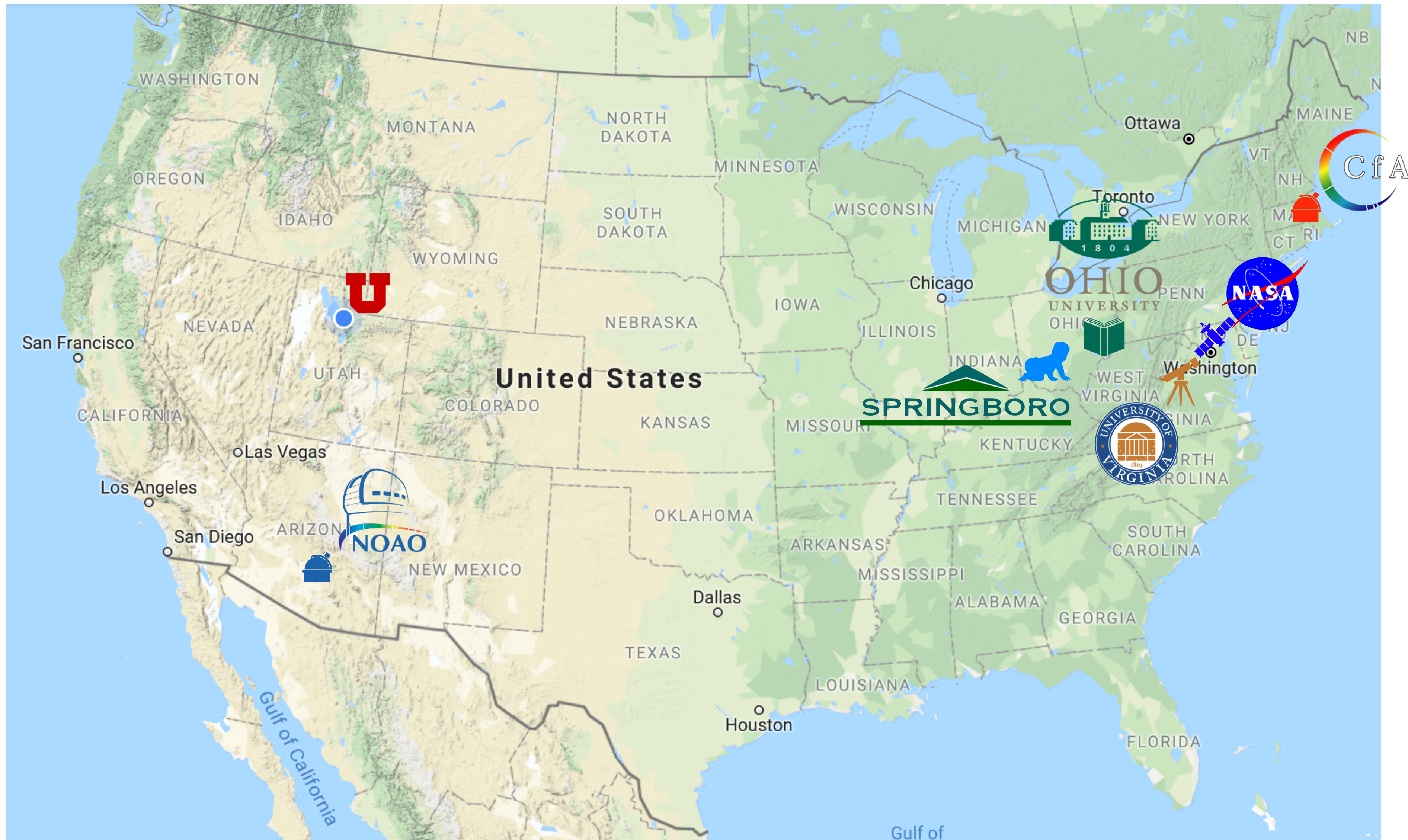
A little about your tour guide...



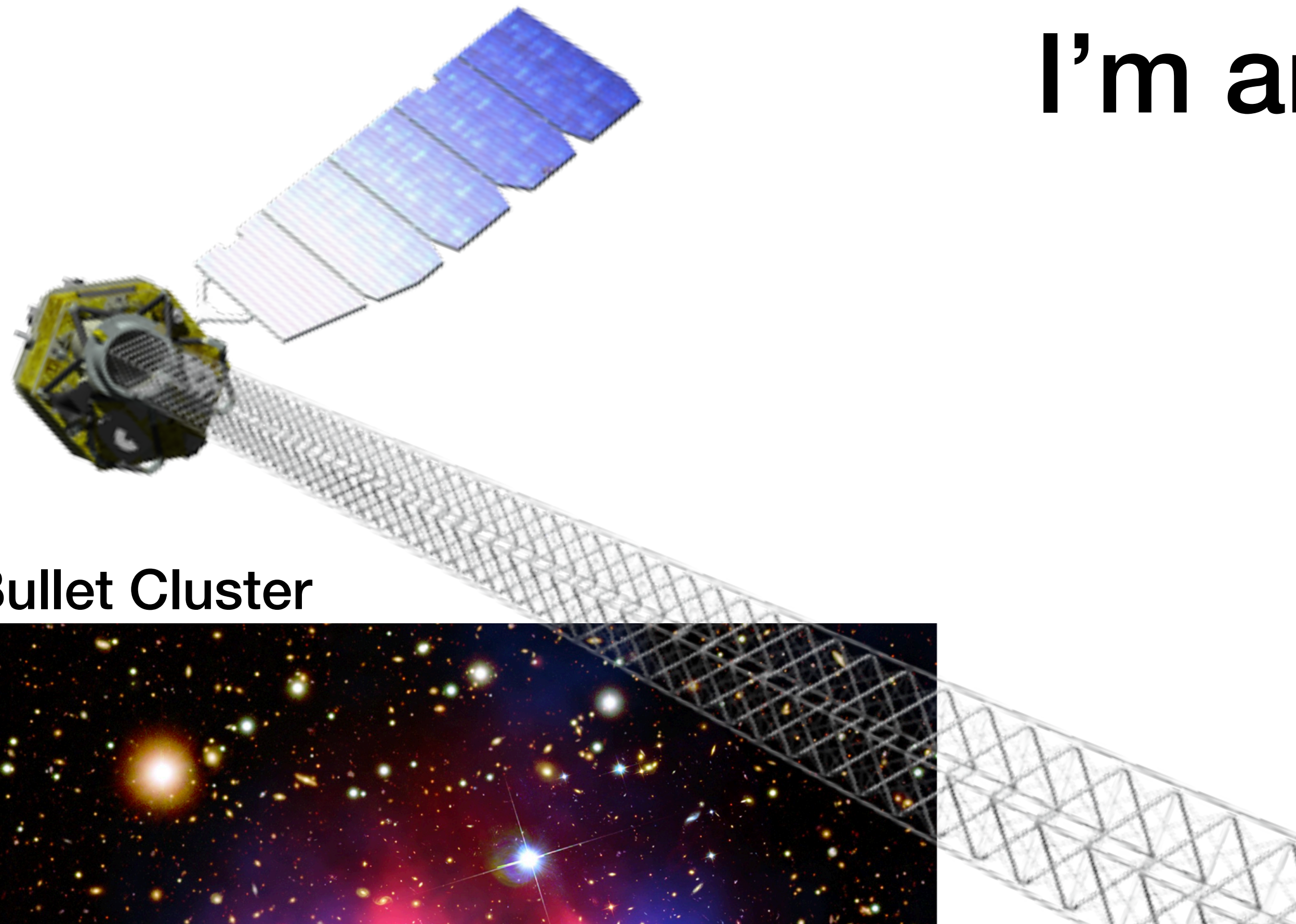
A little about your tour guide...



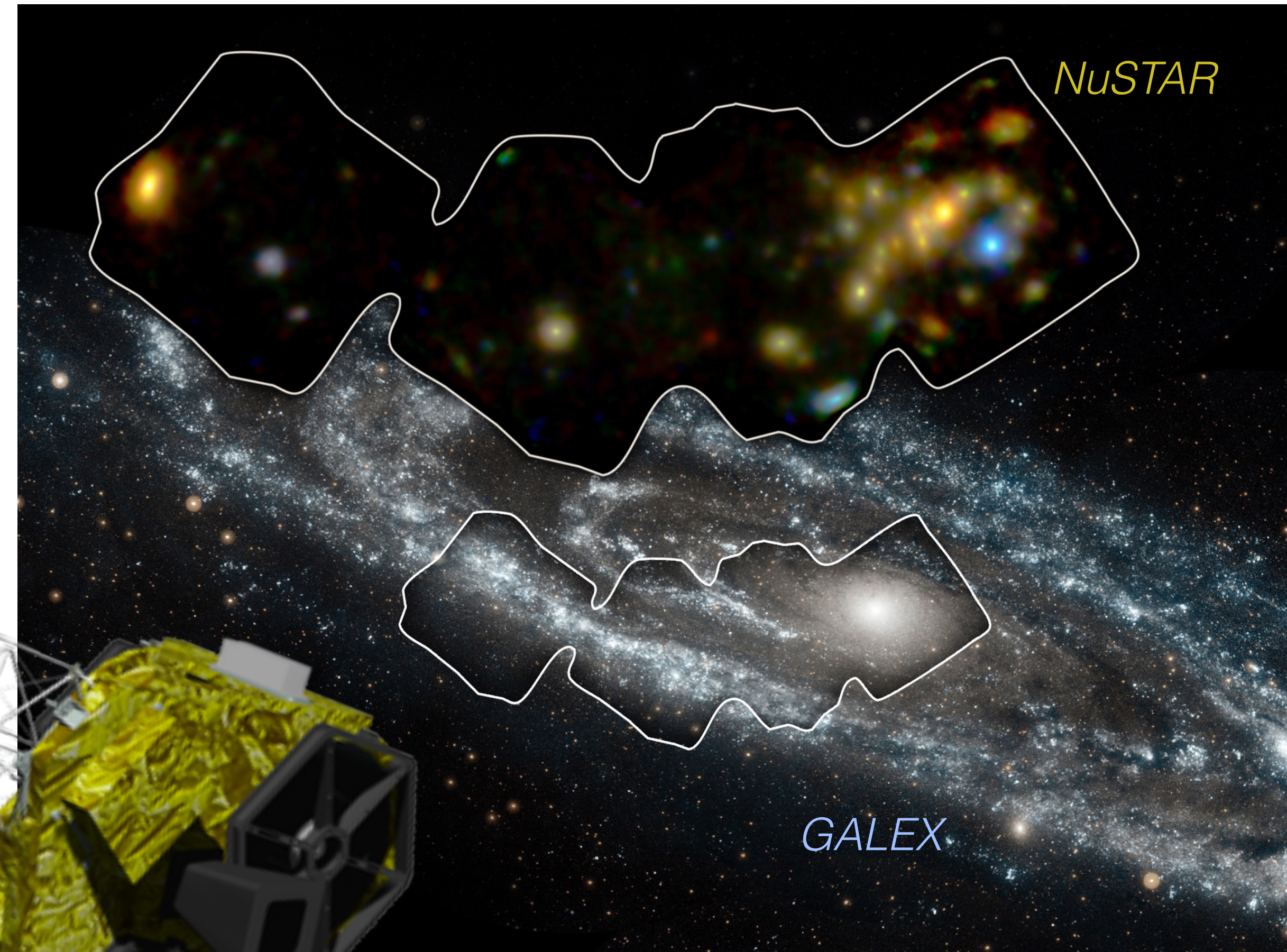
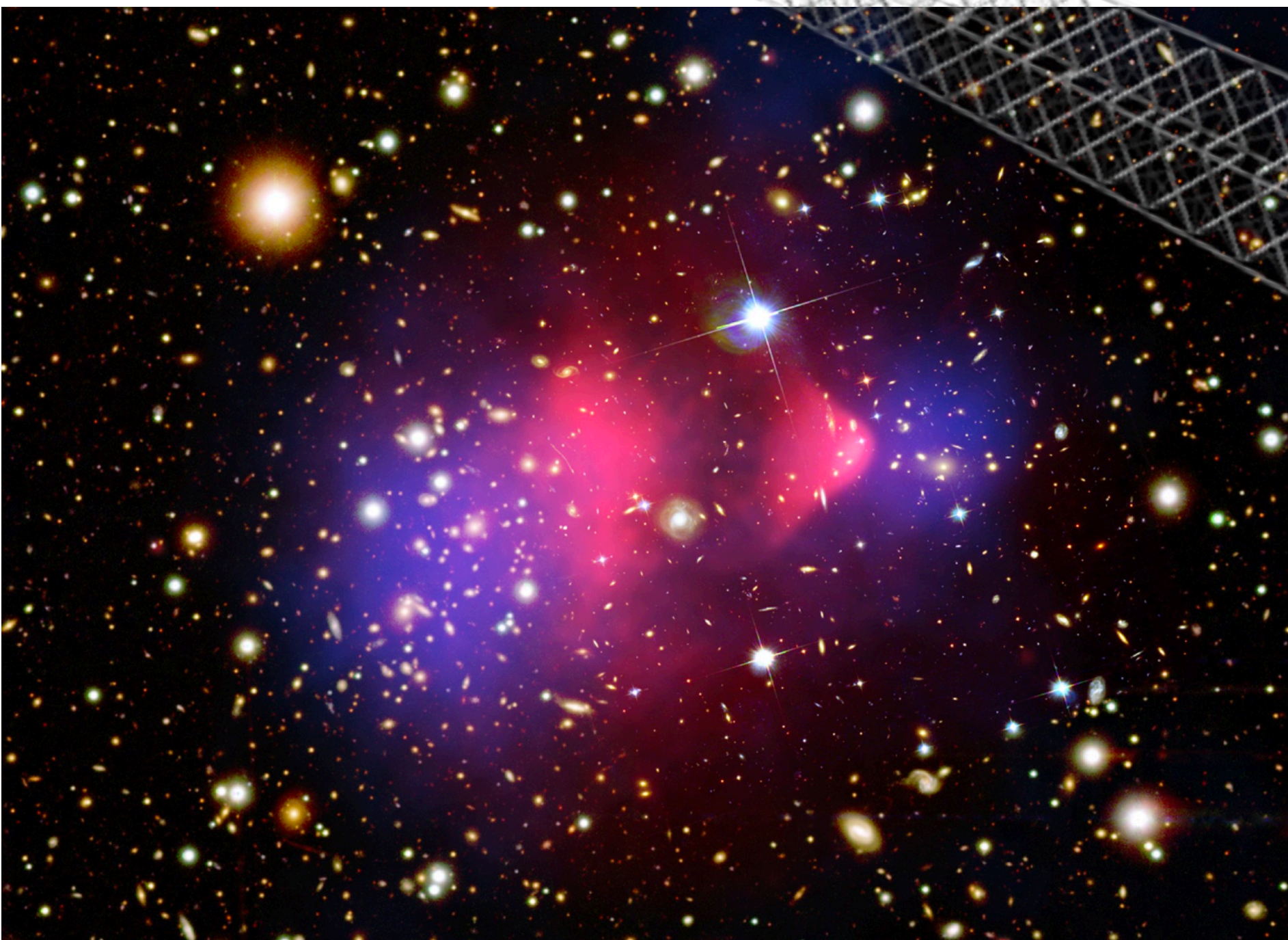
A little about your tour guide...



I'm an X-ray Astronomer



Bullet Cluster

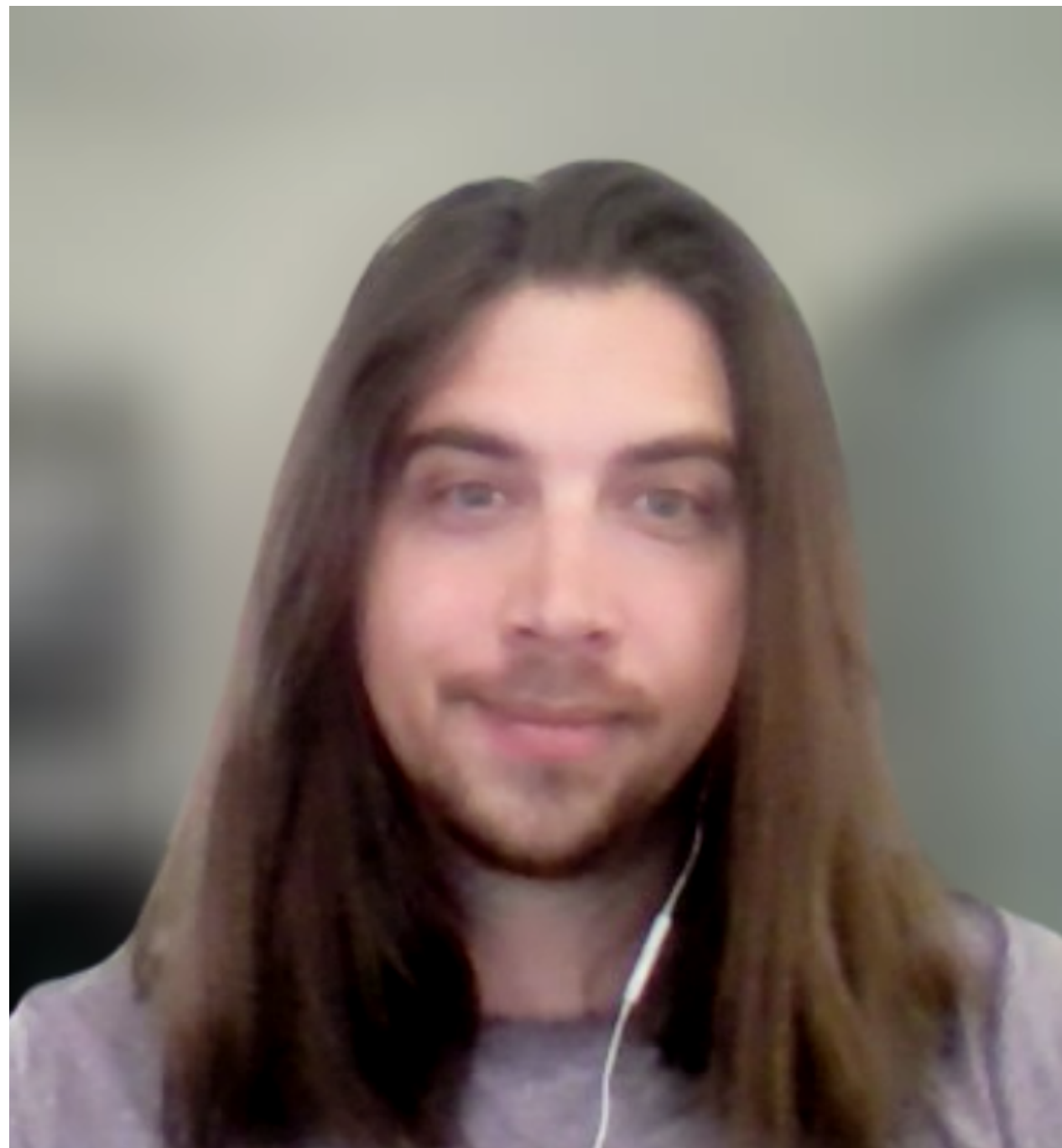


Andromeda Galaxy

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

Your Teaching Assistant

TA: Kameron Goold



Office Hours

Thurs 1-2pm

1st year graduate student

Bachelors degree in physics and
business management

Previous experience as an LA & TA

kameron.goold@utah.edu

Zoom Info

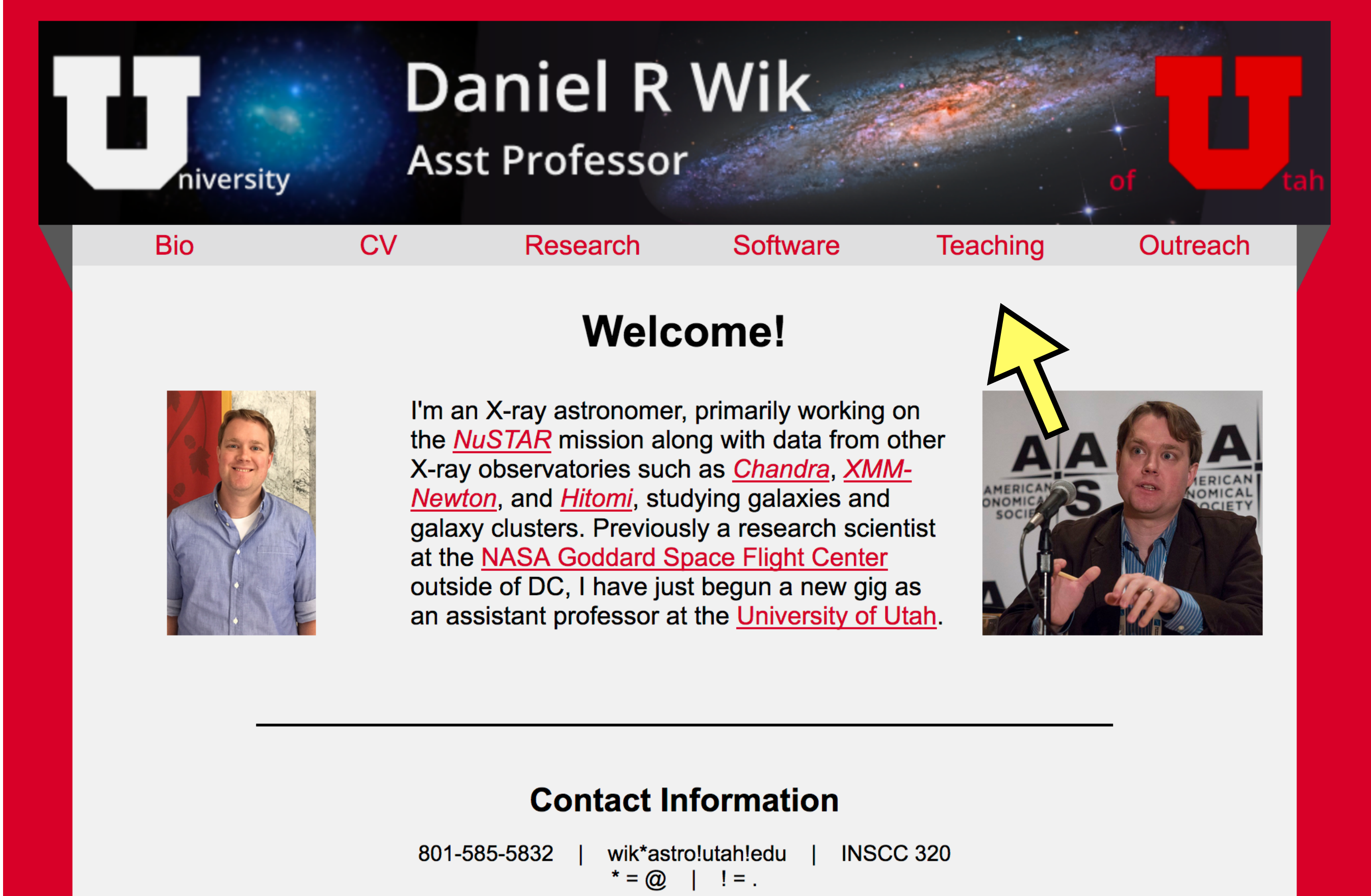
<https://utah.zoom.us/j/99083025165>

PW: AstroPhys

Physics & Astronomy Discord:
<https://discord.gg/ywa2wVCzem>

How this course will work

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



The screenshot shows a website header for Daniel R Wik, an Assistant Professor at the University of Utah. The header features the University of Utah logo on the left and right, and a central banner with a galaxy image. Below the banner is a navigation menu with links for Bio, CV, Research, Software, Teaching, and Outreach. The main content area is titled "Welcome!" and contains a bio paragraph, a portrait photo of Daniel Wik, and a photo of him speaking at a podium. A yellow arrow points to the "Teaching" link in the navigation menu. Below the bio is a "Contact Information" section with contact details.

University of **U**tah

Daniel R Wik
Asst Professor

Bio CV Research Software Teaching Outreach

Welcome!

I'm an X-ray astronomer, primarily working on the [NuSTAR](#) mission along with data from other X-ray observatories such as [Chandra](#), [XMM-Newton](#), and [Hitomi](#), studying galaxies and galaxy clusters. Previously a research scientist at the [NASA Goddard Space Flight Center](#) outside of DC, I have just begun a new gig as an assistant professor at the [University of Utah](#).

Contact Information

801-585-5832 | wik*astro!utah!edu | INSCC 320
* = @ | ! = .

Syllabus & Website

<http://www.astro.utah.edu/~wik/courses/astr3070fall2021/>



SCAN ME

Discussion Time!

Turn to your neighbor and find out:

1. Their name and current major
2. Why they are taking this class
3. What they are excited about learning
4. How knowledgeable they believe themselves to be about astronomy
 - 1 = never really thought about it before, know practically nothing
 - 10 = probably could teach the TA quite a bit
5. Find one (other) unique person whose neighbor gave the same ranking as your neighbor and ask each other the same questions as before

Brief Overview of the Universe

Everything that is, was, and will be, everywhere.
(Almost all details omitted.)

NGC 7331
HST image

Dark Energy

Fusion

Star

Molecular Cloud

Asteroid

Gravity

Neutron Star

Black Hole

Galaxy

Expansion of Space

Dust

Supernova

Planet

Big Bang

Telescope

Cosmic Web

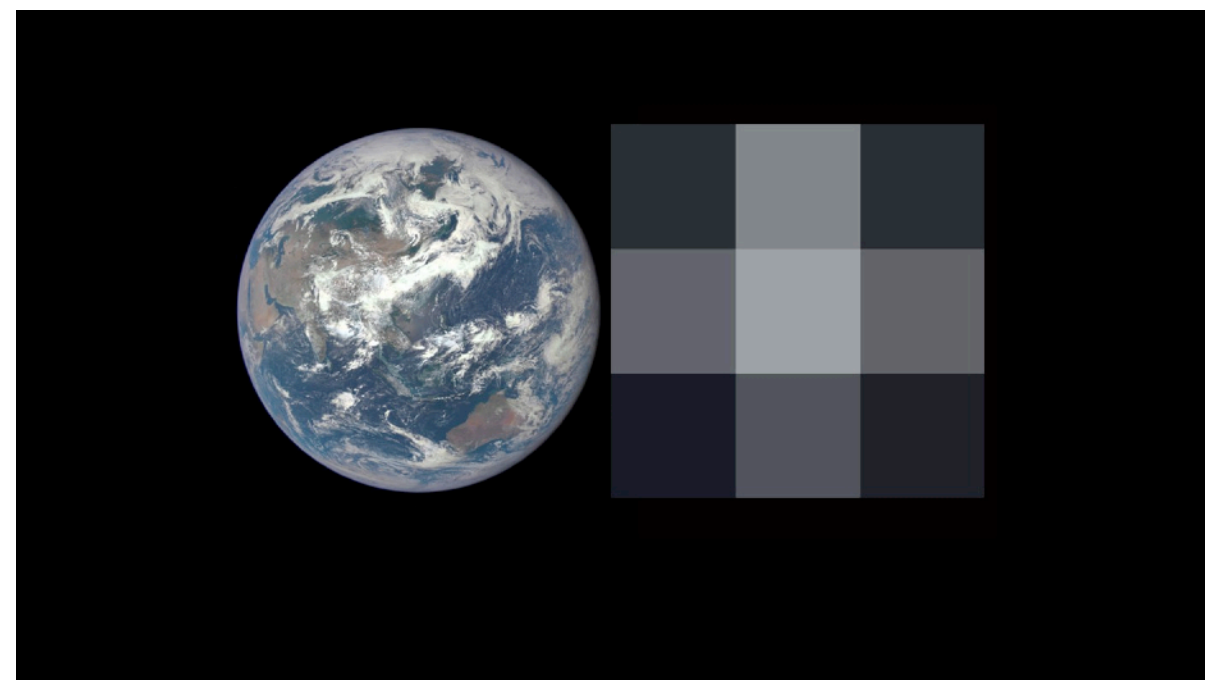
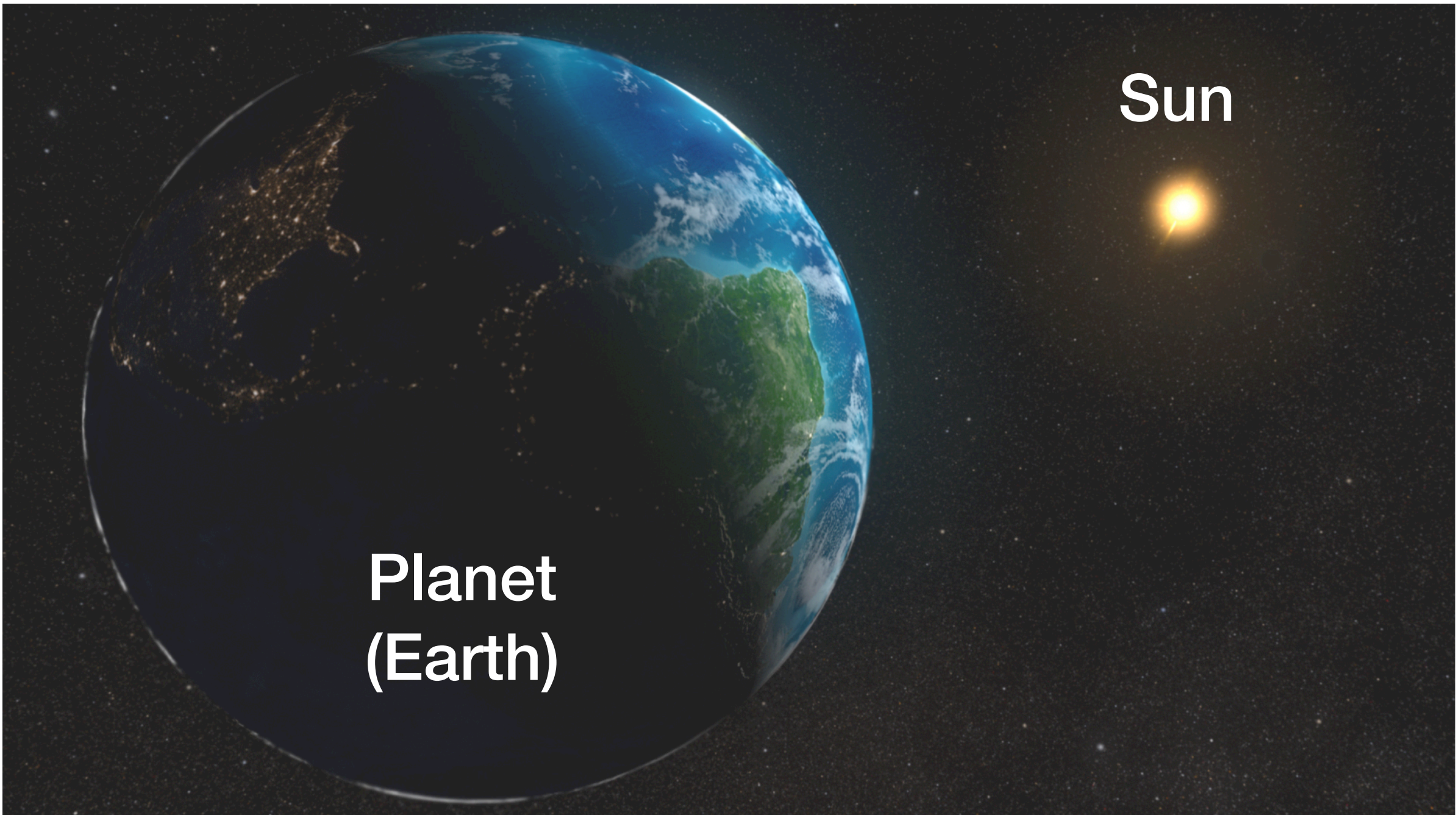
Dark Matter

Planetary Nebula

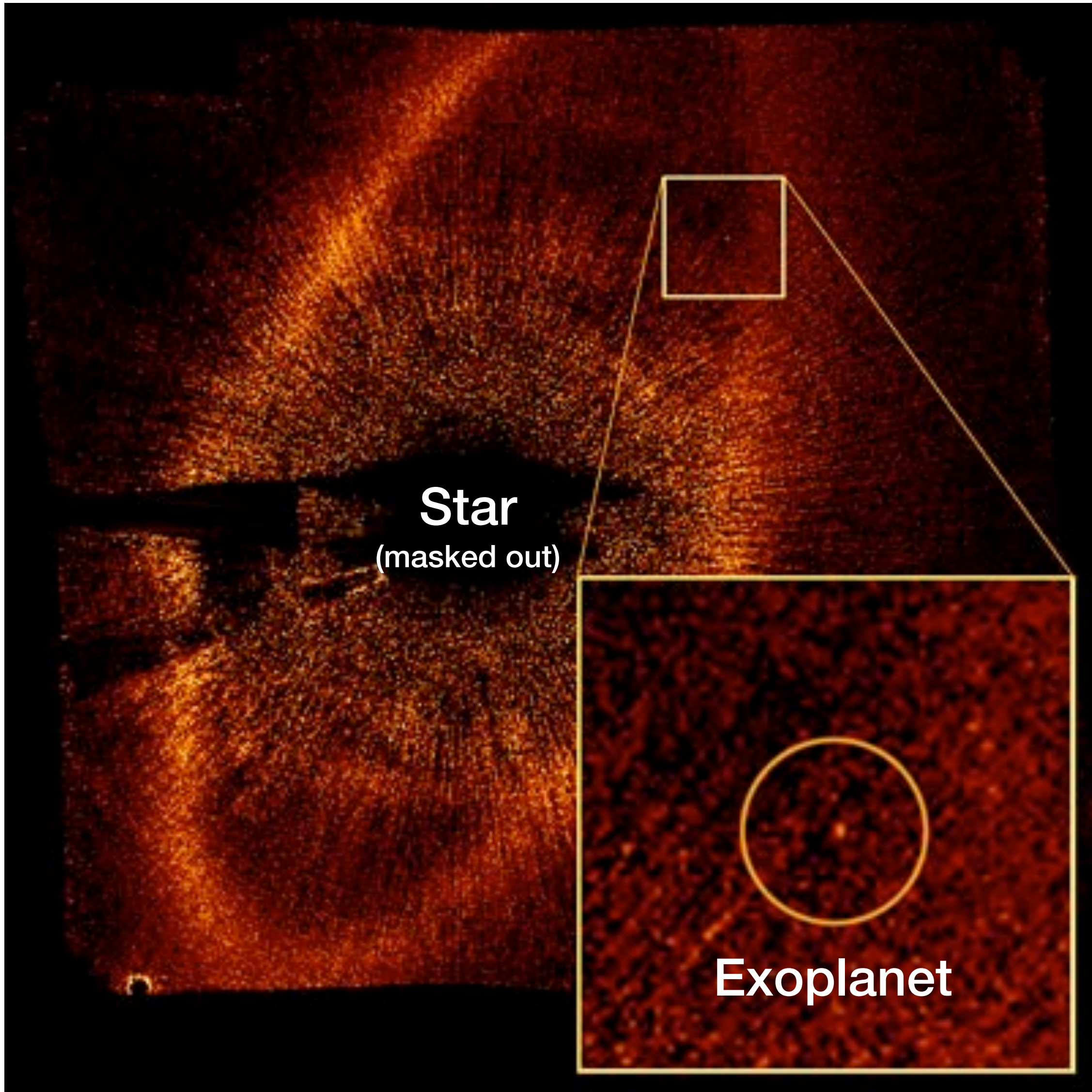
White Dwarf

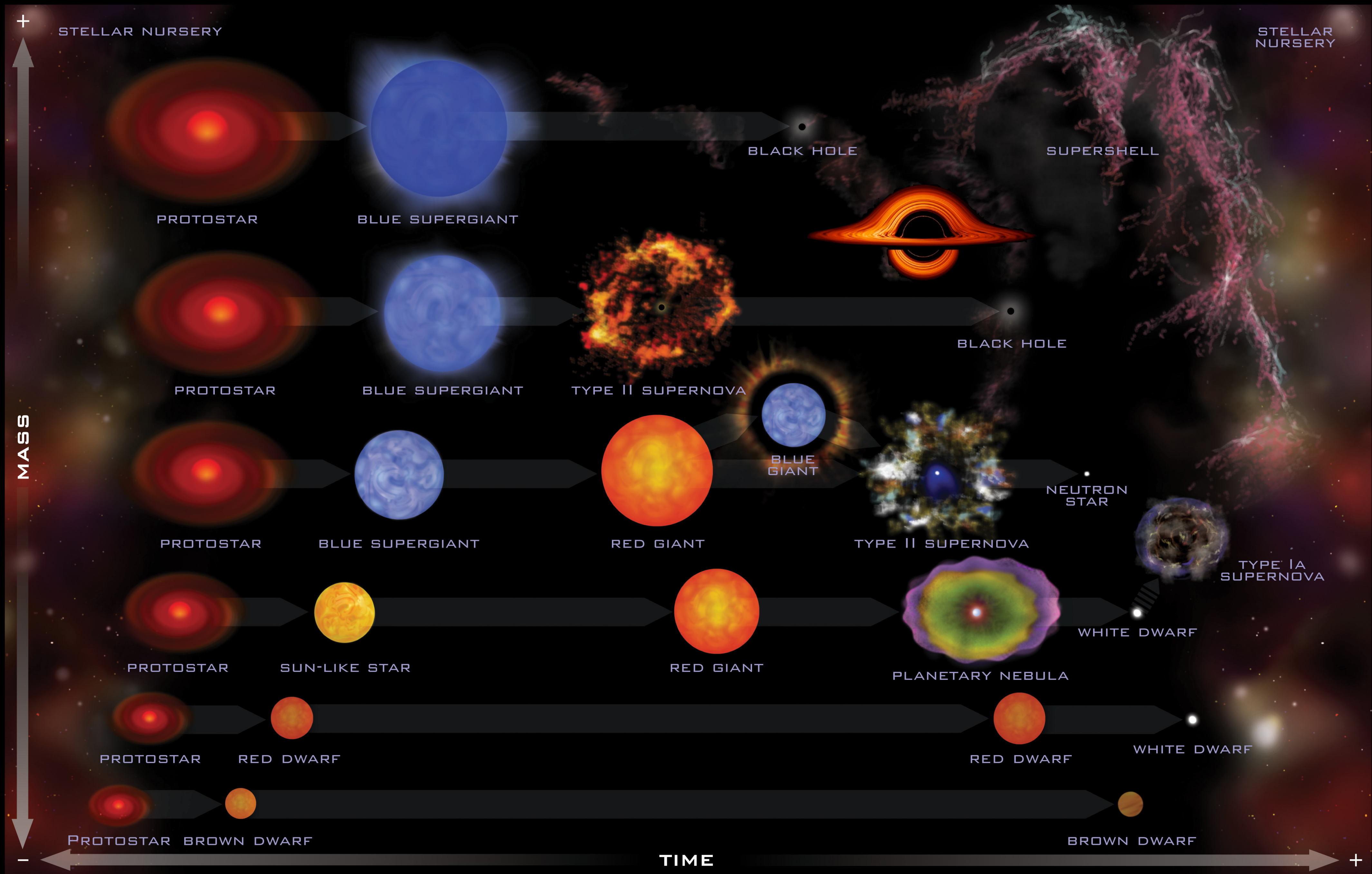
Quantum Mechanics

Spectrum

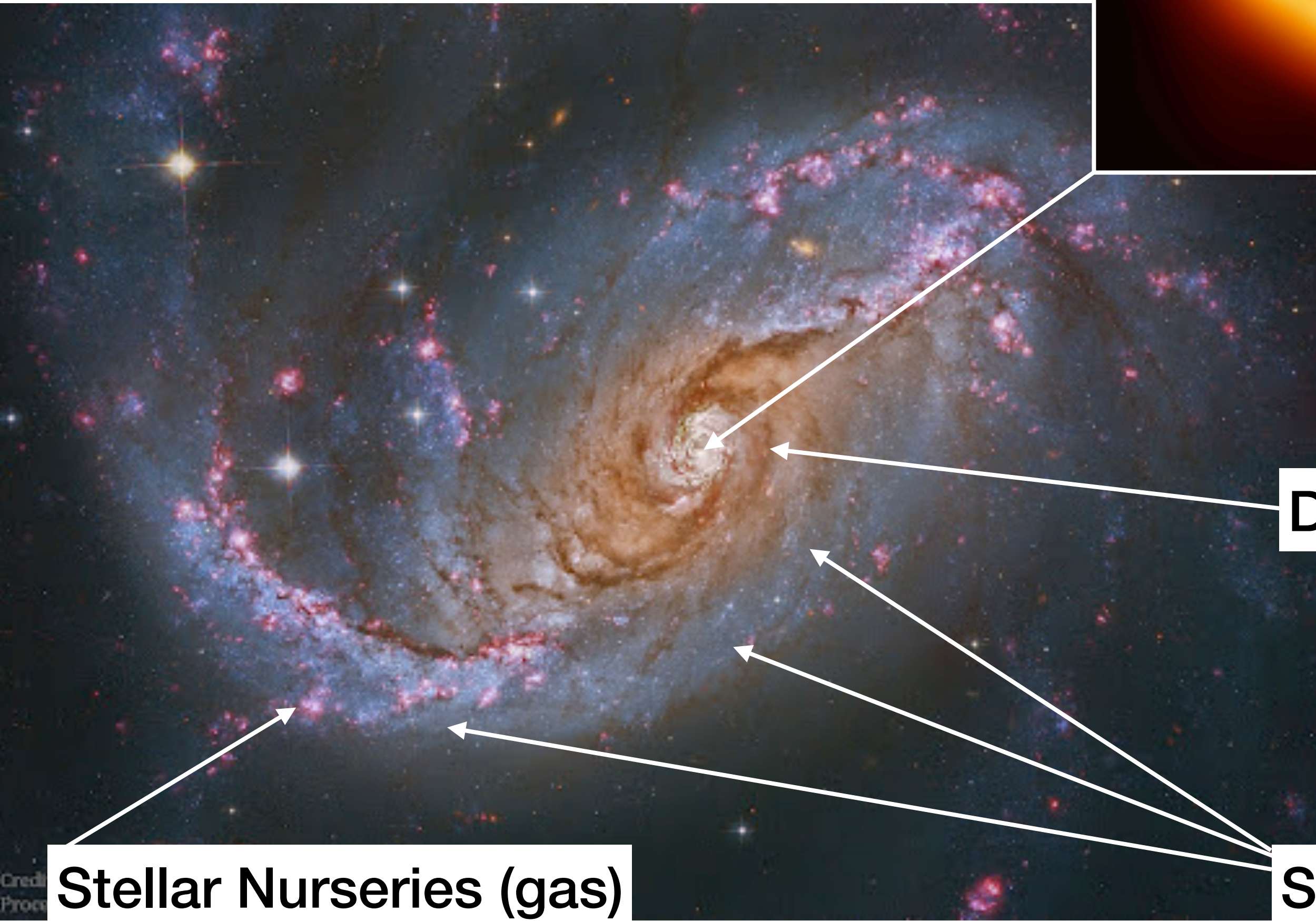


Best first image of an Earth-like planet we will have, one day





Blue (spiral) Galaxy



Stellar Nurseries (gas)



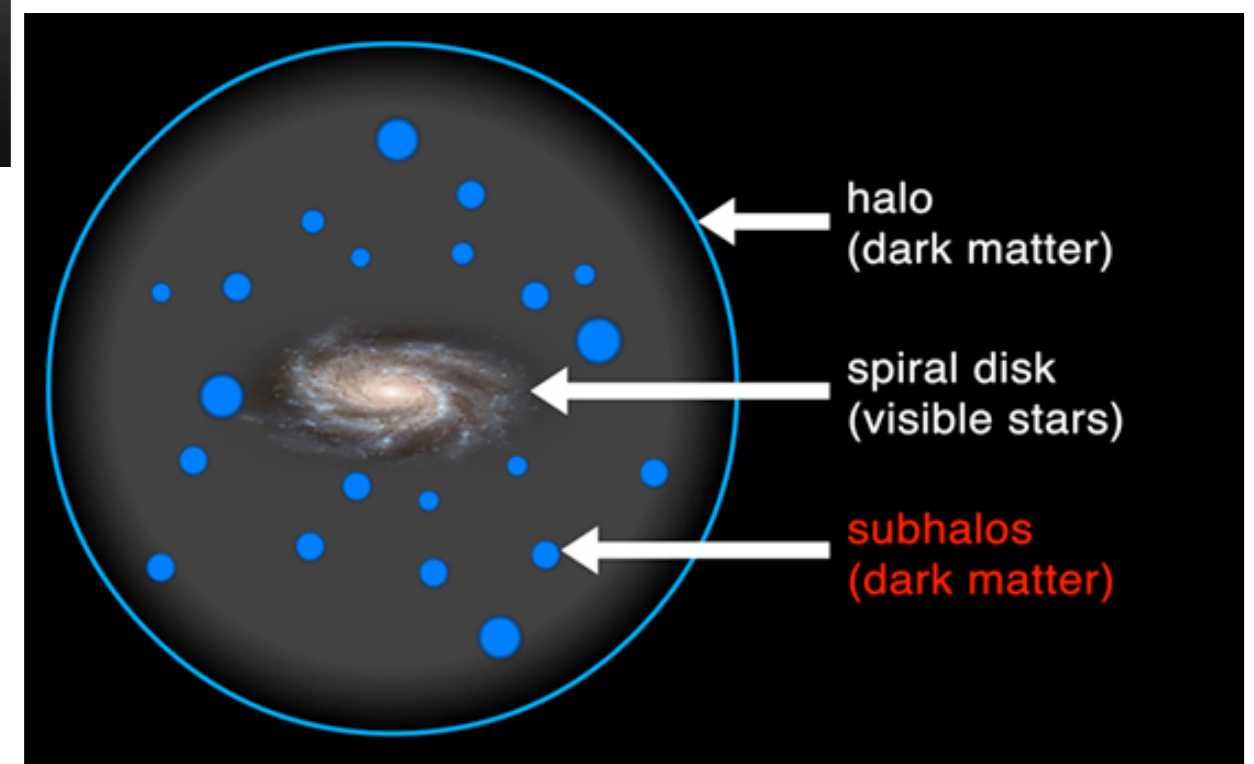
Supermassive Black Hole

Red (elliptical) Galaxy



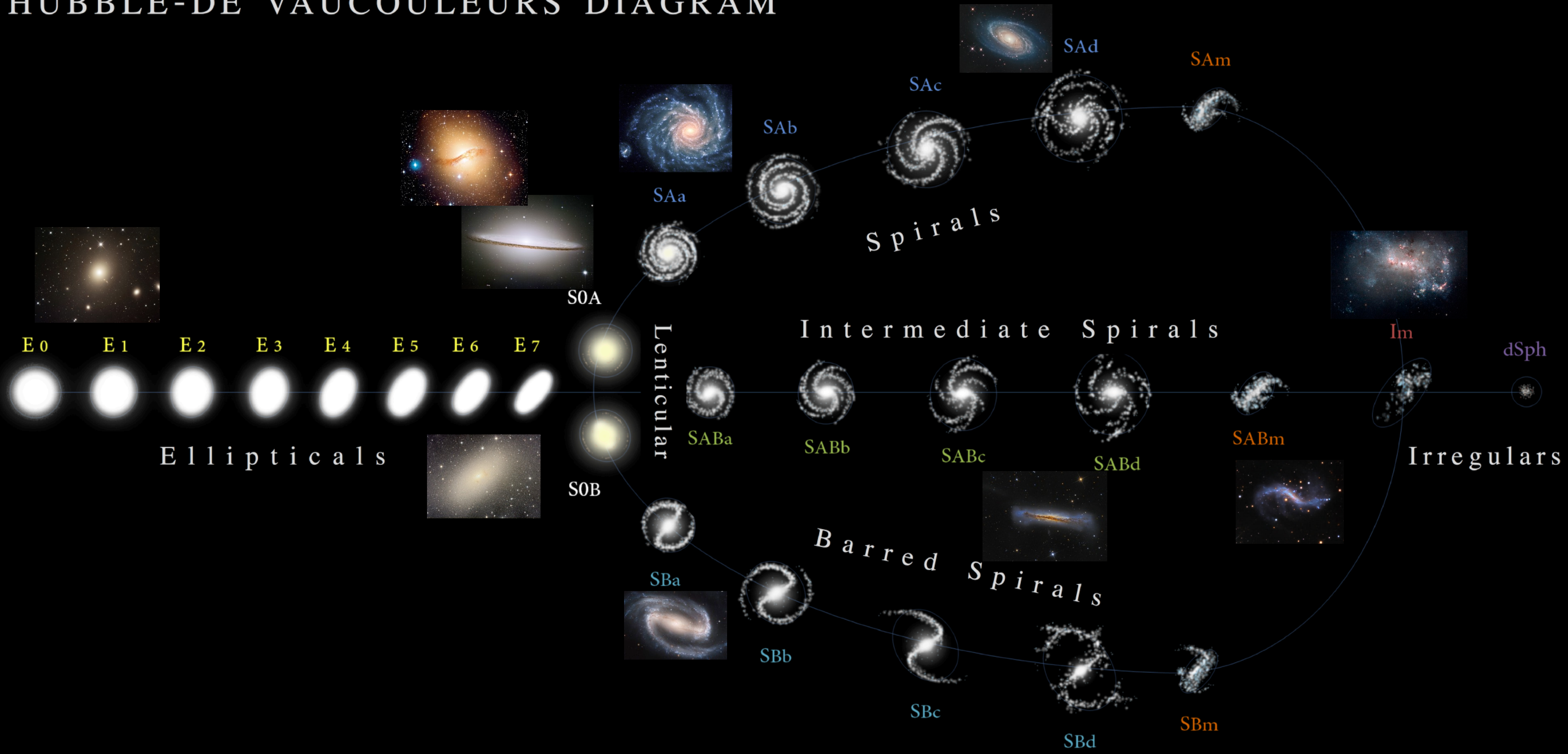
Dust

Stars

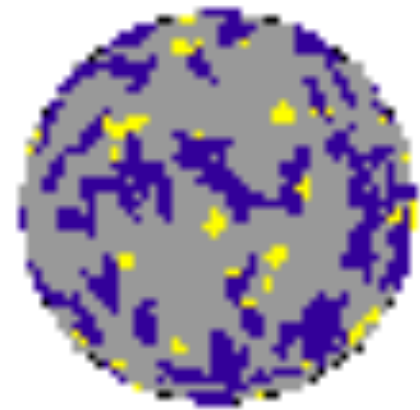


Dark Matter

HUBBLE-DE VAUCOULEURS DIAGRAM

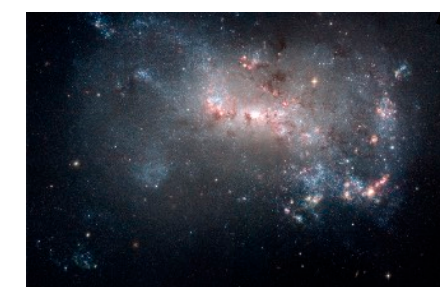
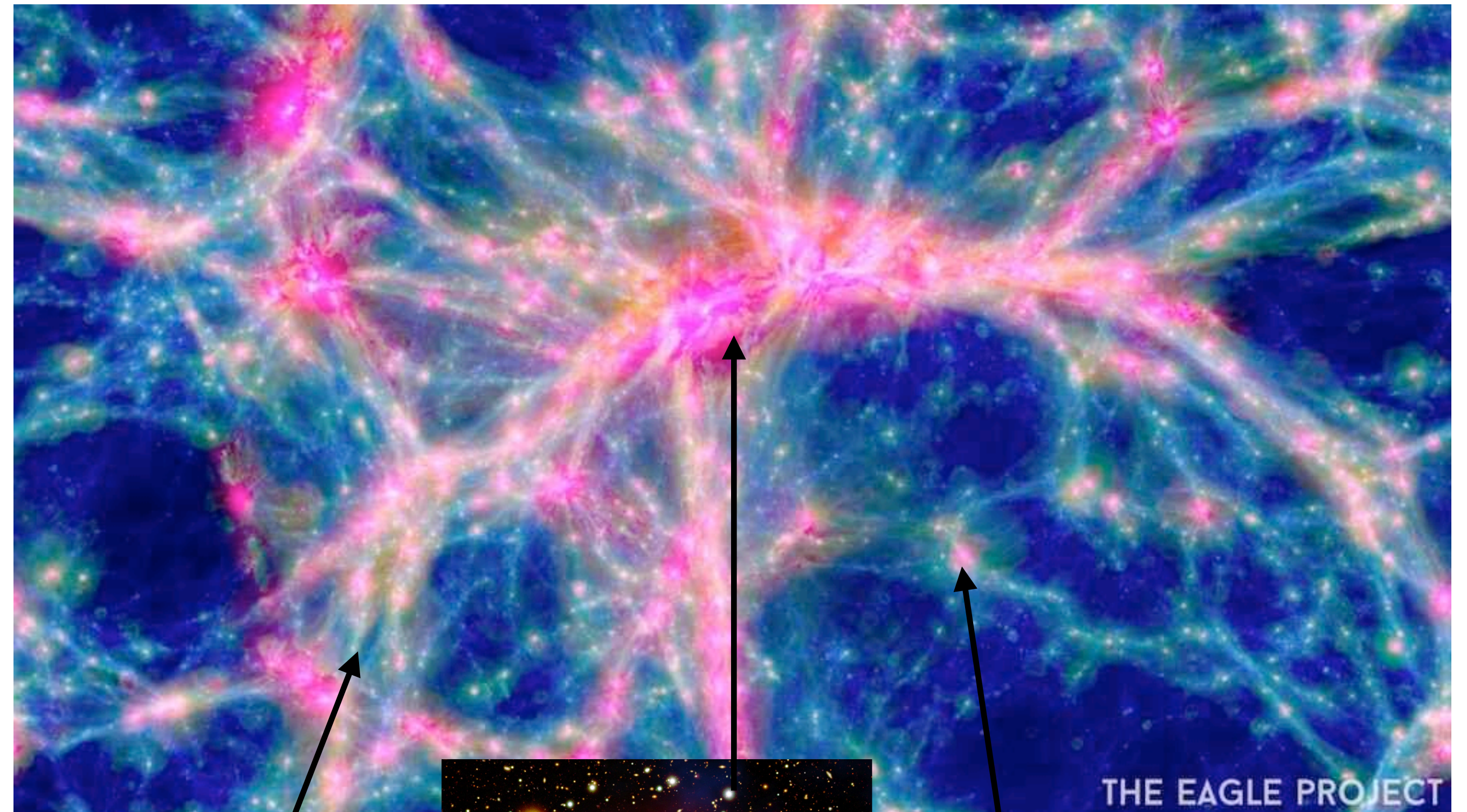


Expansion
of Space

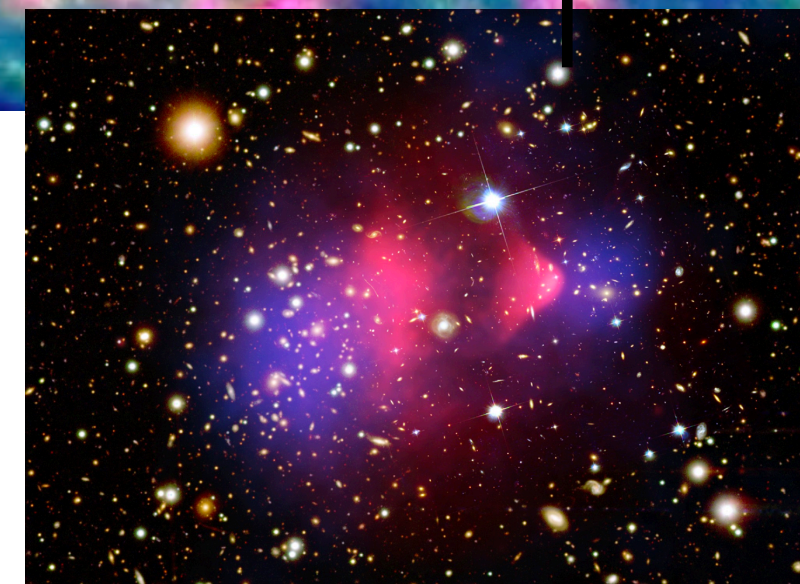


Its acceleration =
dark energy

Cosmic Web



Galaxy



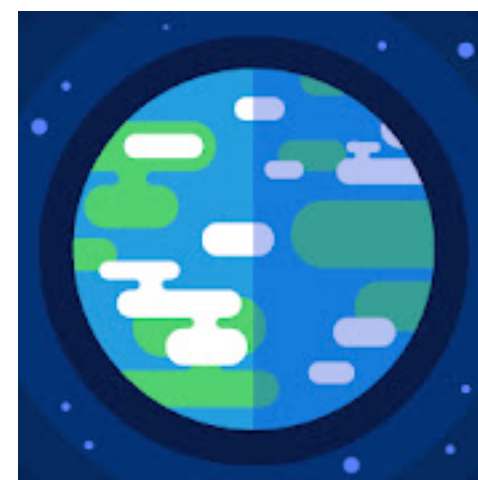
Cluster of
Galaxies



Galaxy

Relative Scales of Things in the Universe

Universe in a Nutshell app
By Kurzgesagt & Wait But Why



<https://www.youtube.com/channel/UCsXVk37bltHxD1rDPwtNM8Q>

Origin of Astronomy



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

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

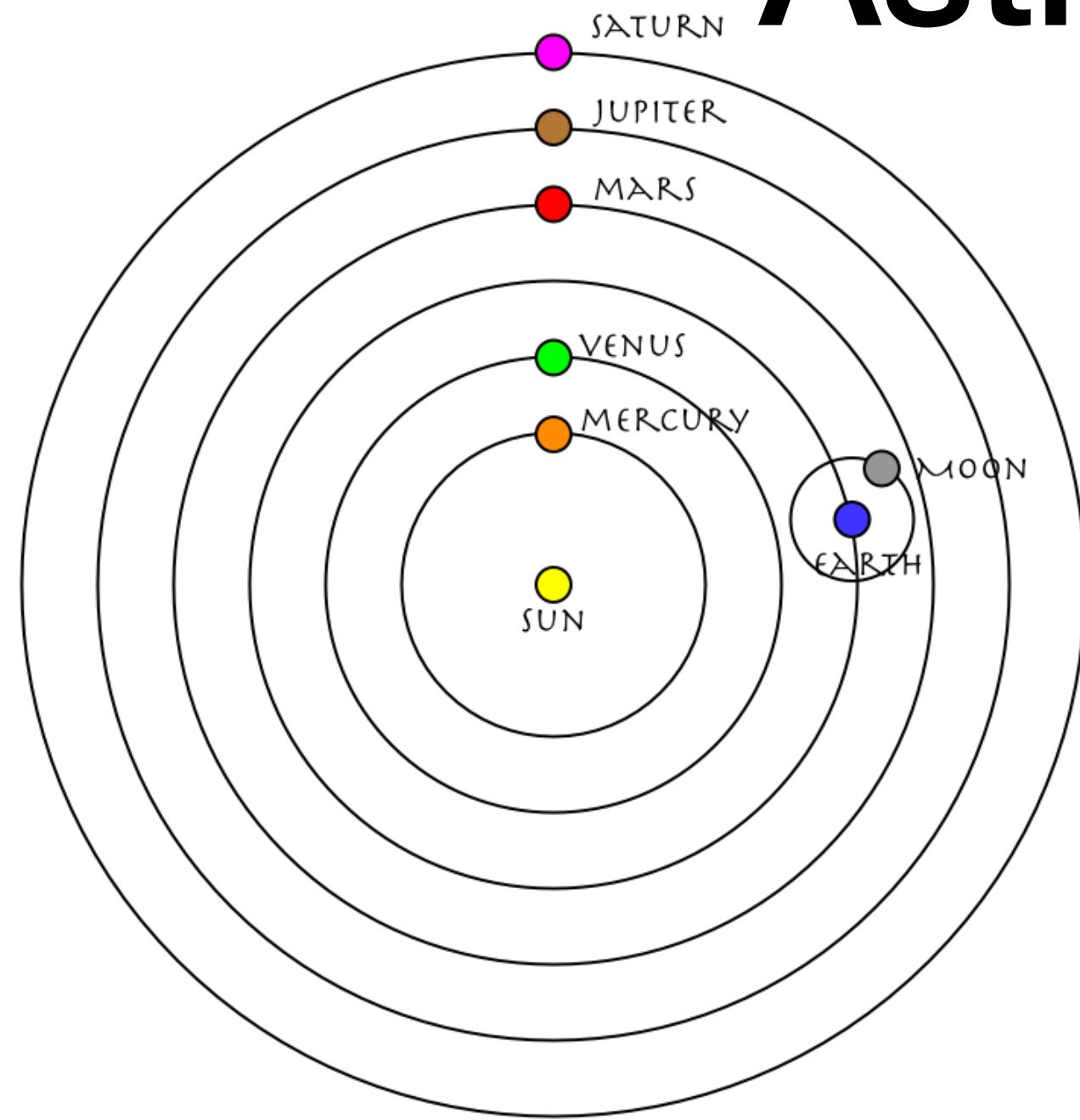
Until Galileo, all astronomy
“naked eye”



Tycho Brahe (late 1500s)

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

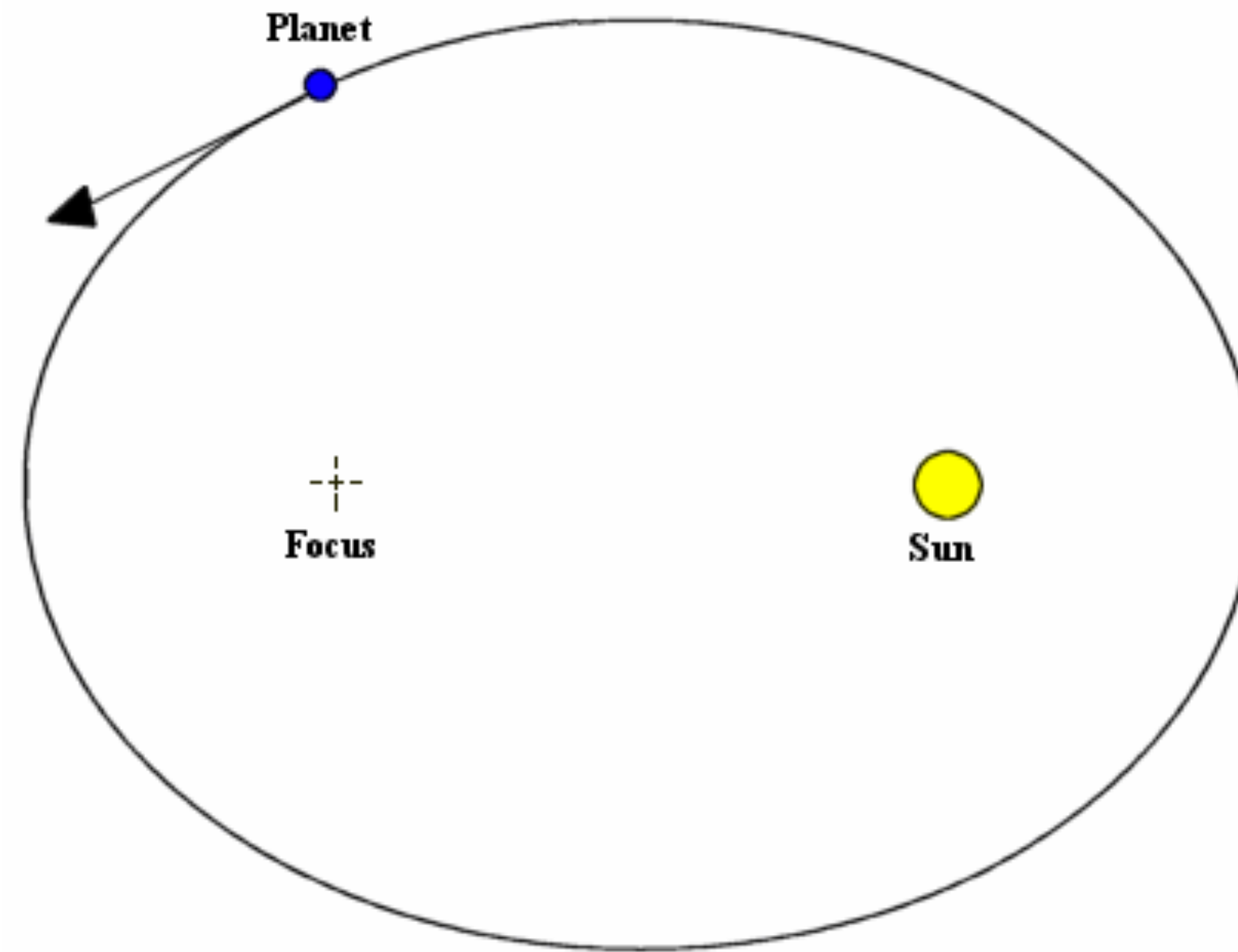
Astronomy becomes a Science



Heliocentric Model

Copernicus

Sun in the right place



Kepler

Planetary paths mapped out correctly



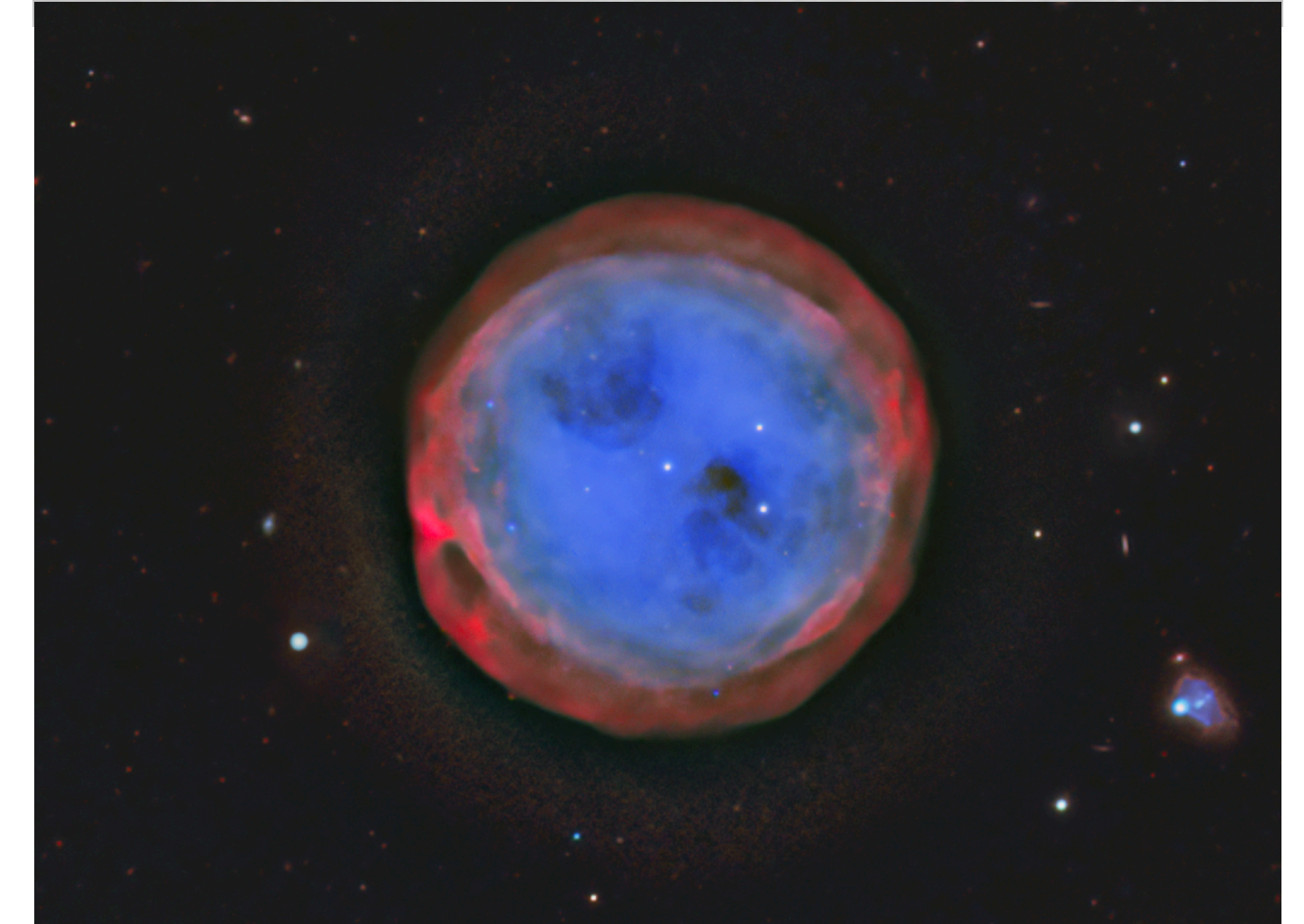
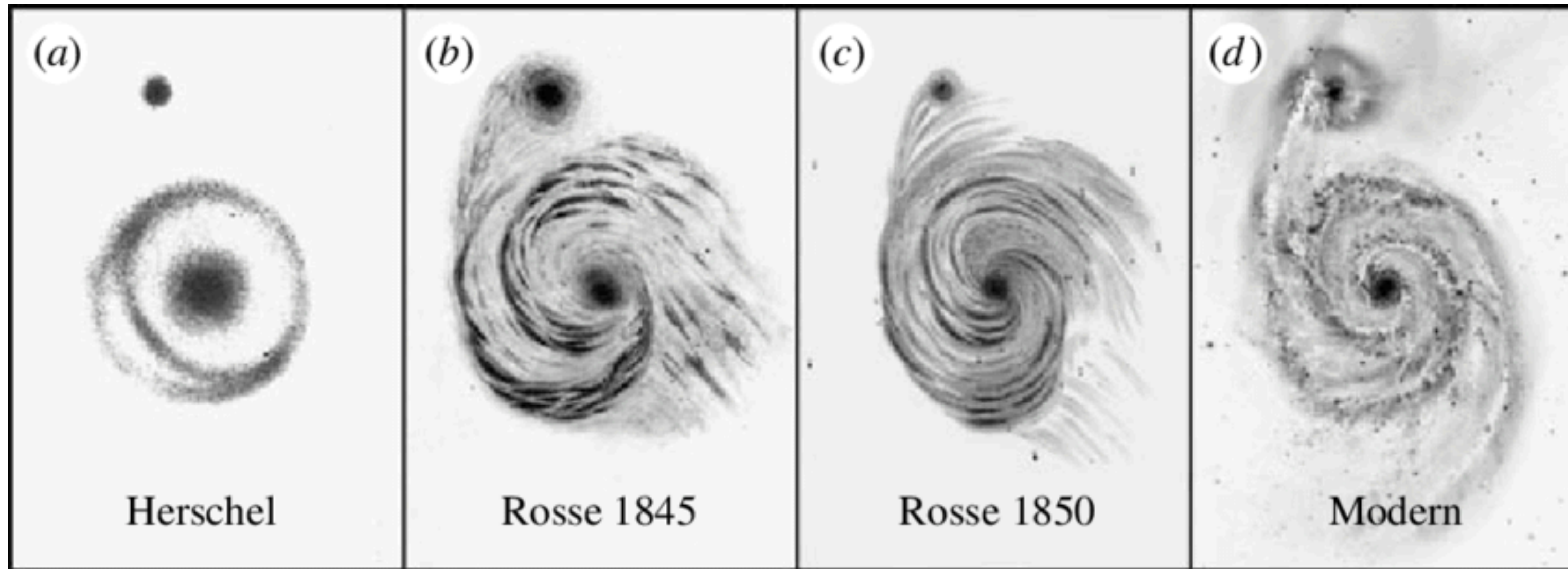
Newton

Reason for paths explained theoretically

Astronomy leads to the development of physics

Modern Astronomy

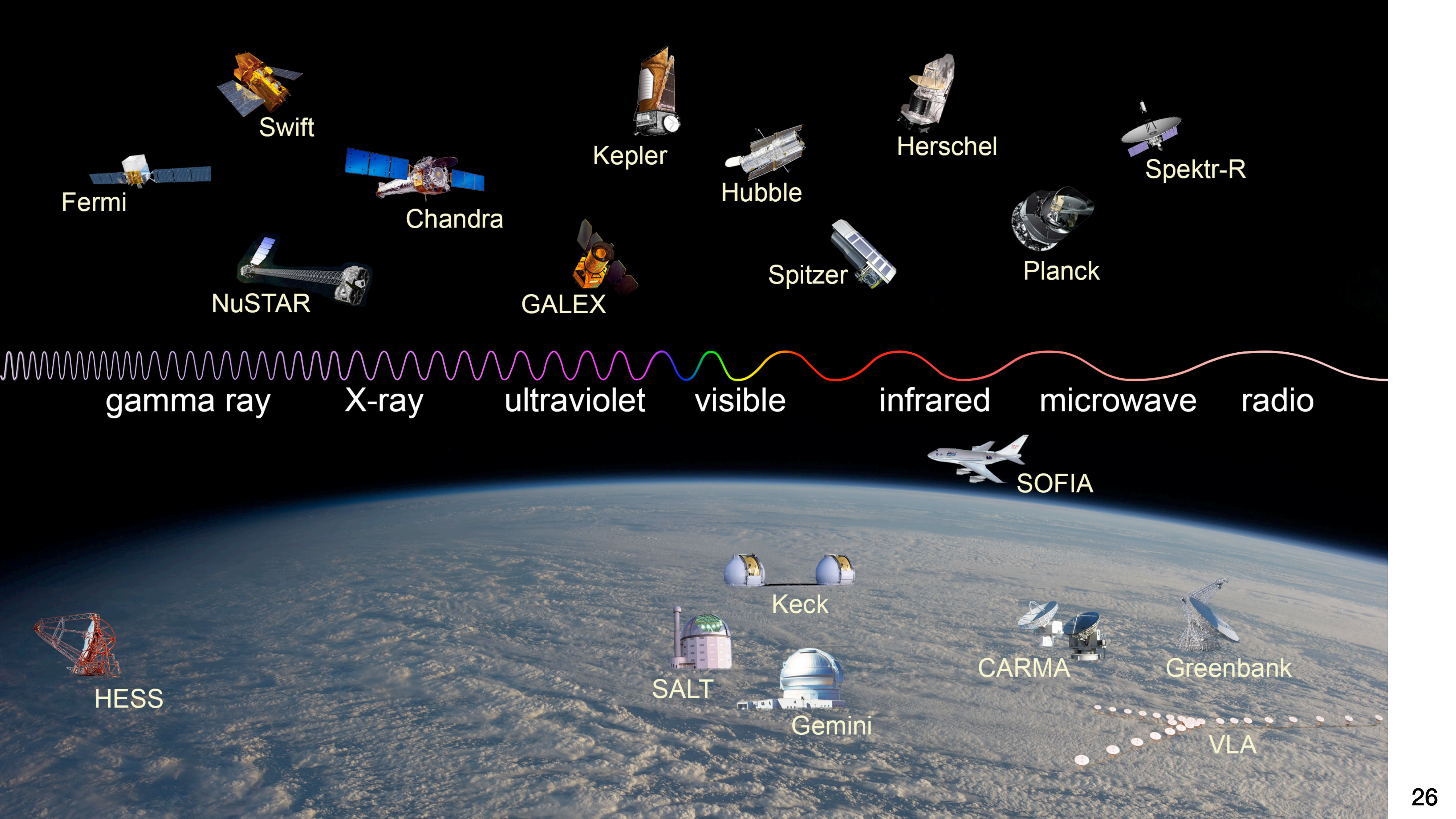
M97, the Owl Nebula



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



Student Info & Pre-Course Assessment

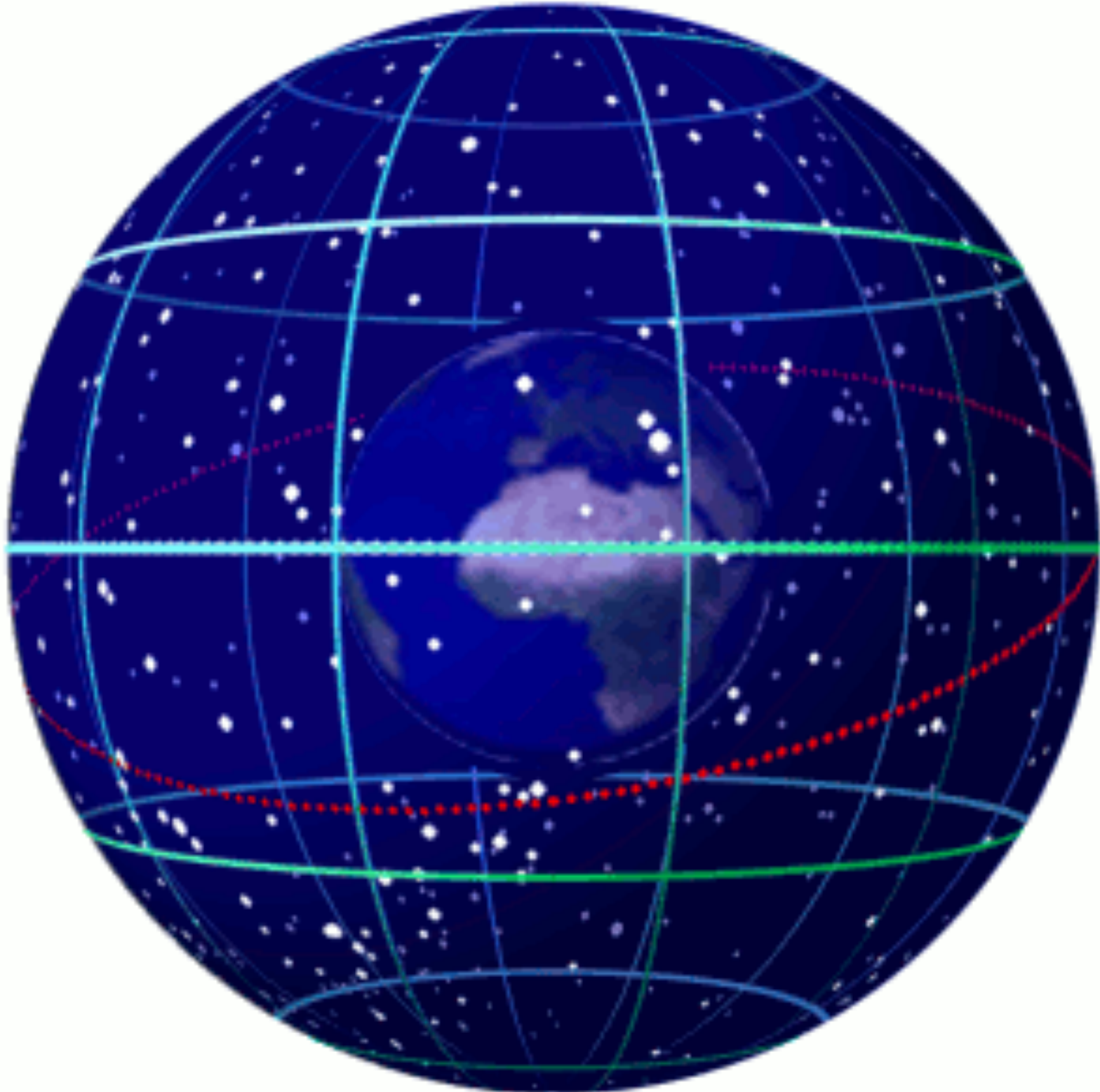
<http://www.astro.utah.edu/~wik/courses/astr3070fall2021/hw/day1assessment.pdf>

Complete and upload via Canvas before midnight TONIGHT to earn 20 bonus points toward the HW portion of your grade

Should only take ~10 minutes

Do NOT look anything up, just do your best and don't be embarrassed (I won't see your answers anyway)

The Night Sky & Astronomical Coordinates



Star trails over the Gemini South telescope

Consider again that **dot**. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar", every "supreme leader", every saint and sinner in the history of our species lived there - on a mote of dust suspended in a sunbeam.

The Earth is a very small stage in a vast cosmic arena. Think of the rivers of blood spilled by all those generals and emperors so that, in glory and triumph, they could become the momentary masters of a fraction of a dot. Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner, how frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds.

Our posturings, our imagined self-importance, the delusion that we have some privileged position in the Universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.

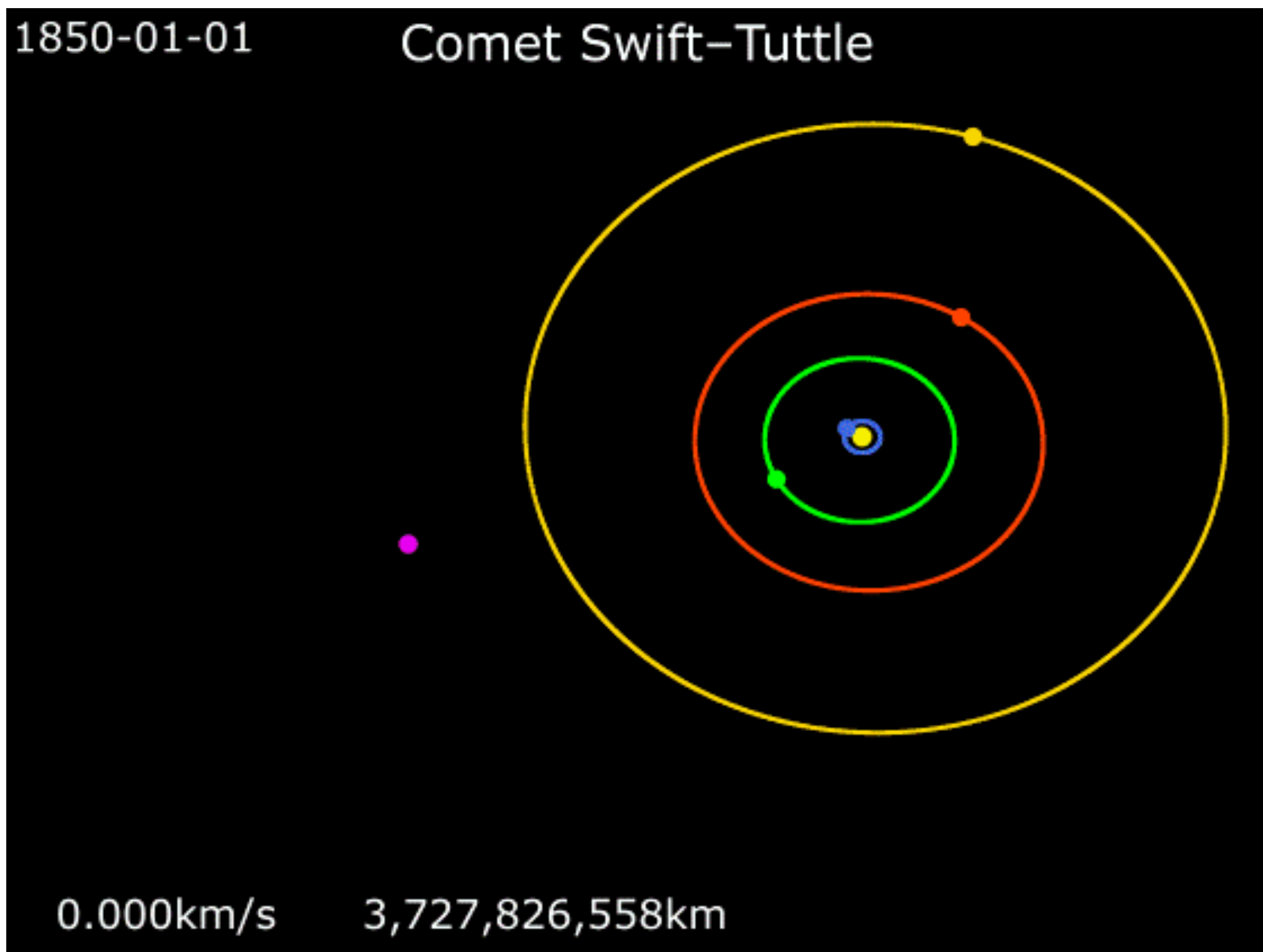
The Earth is the only world known so far to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit, yes. Settle, not yet. Like it or not, for the moment the Earth is where we make our stand.

It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known.

-Carl Sagan (1934-1996)

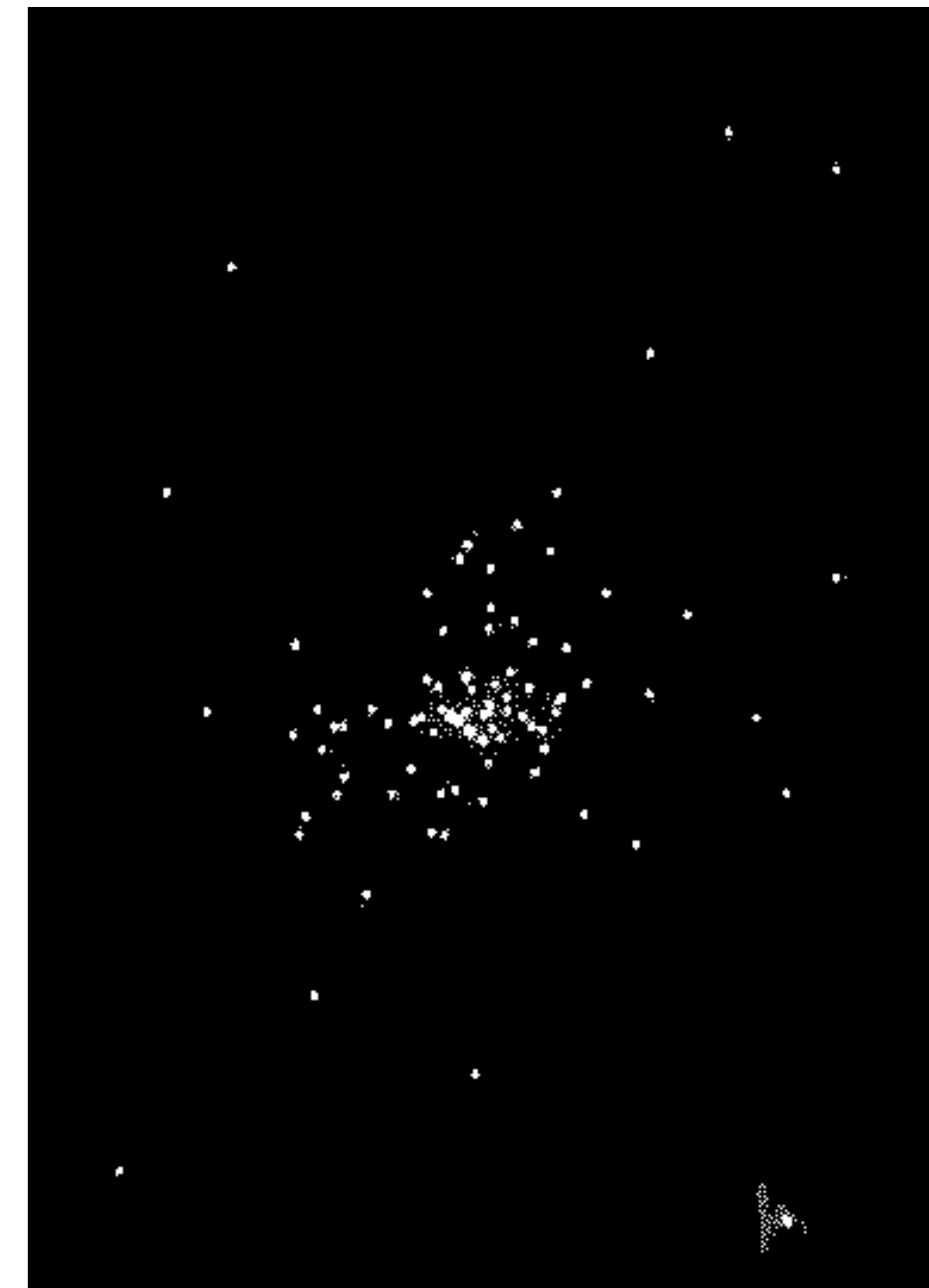
Bonus Slides

Gravitational Forces / Orbits



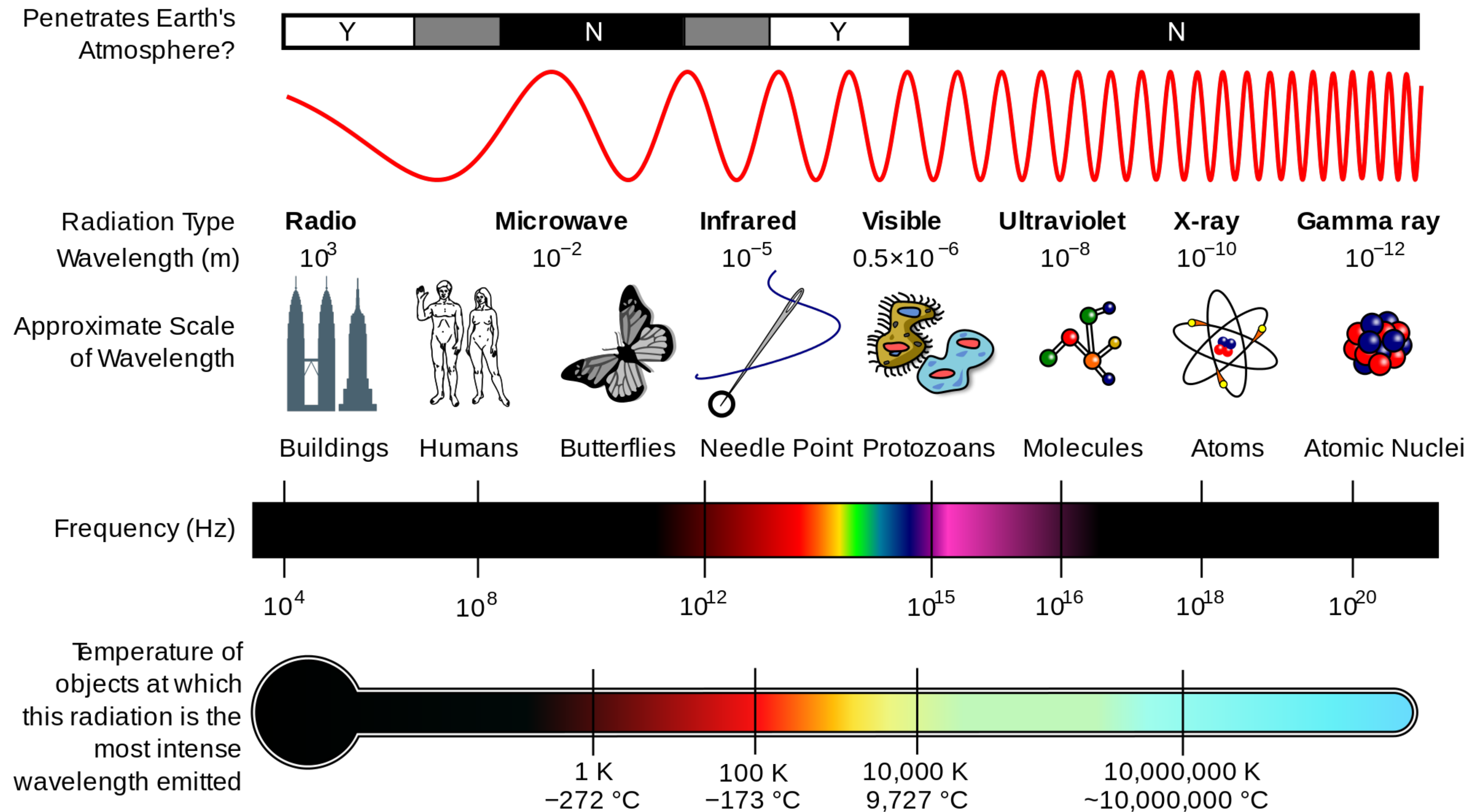
Effective 2-body orbits

Gravitational 3-body problem

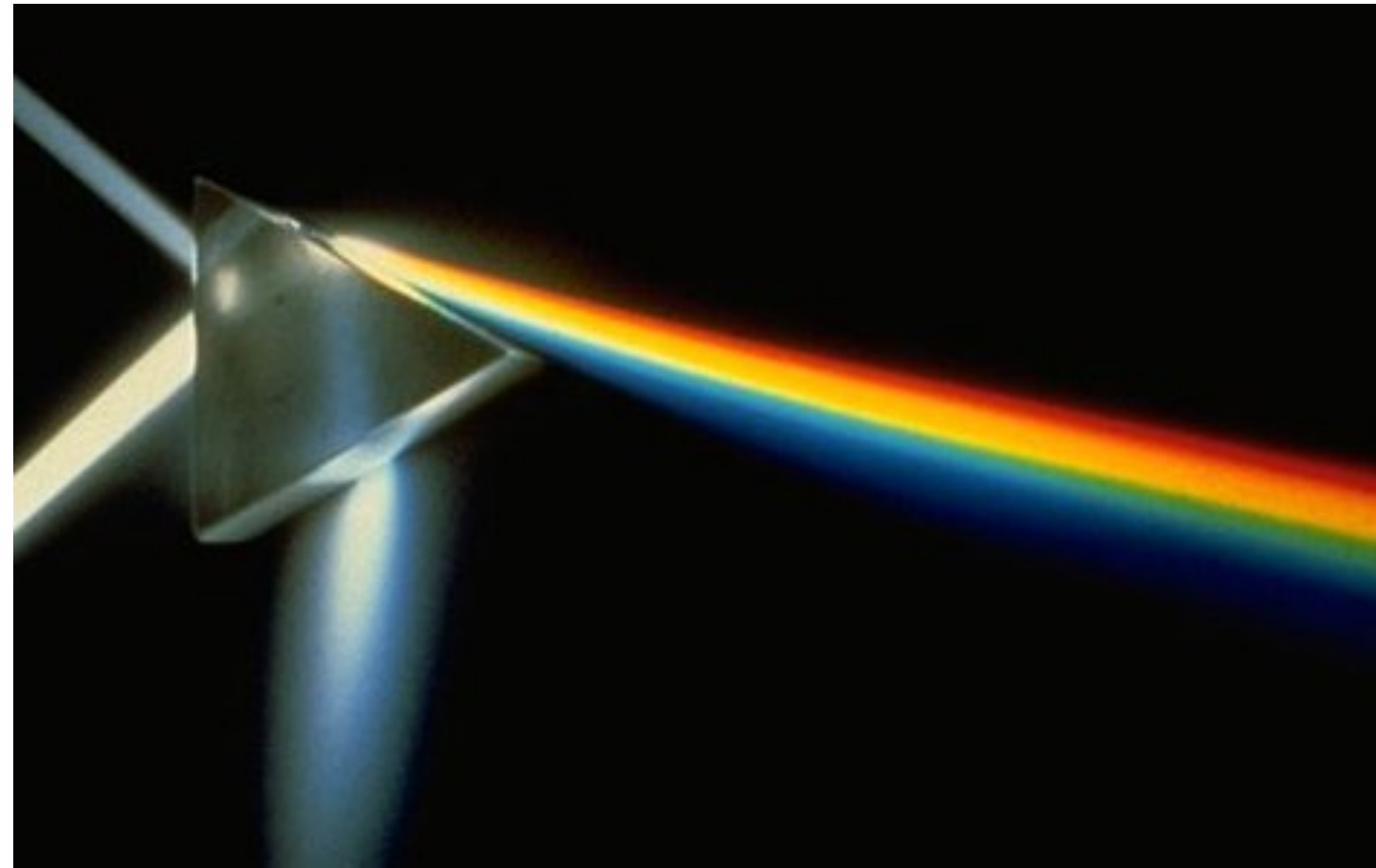


N-body system

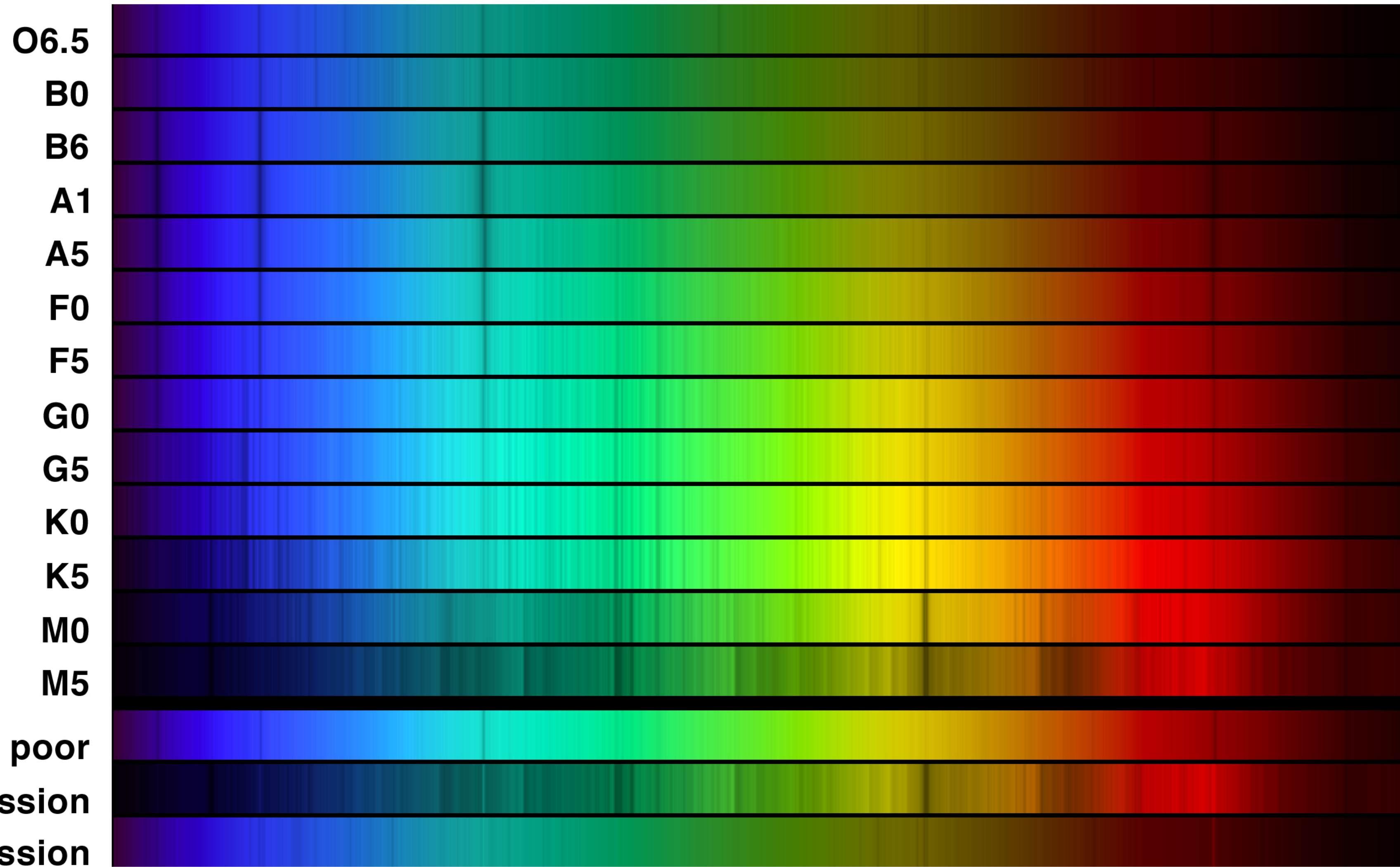
Electromagnetic Radiation (I mean, light!)



Starlight

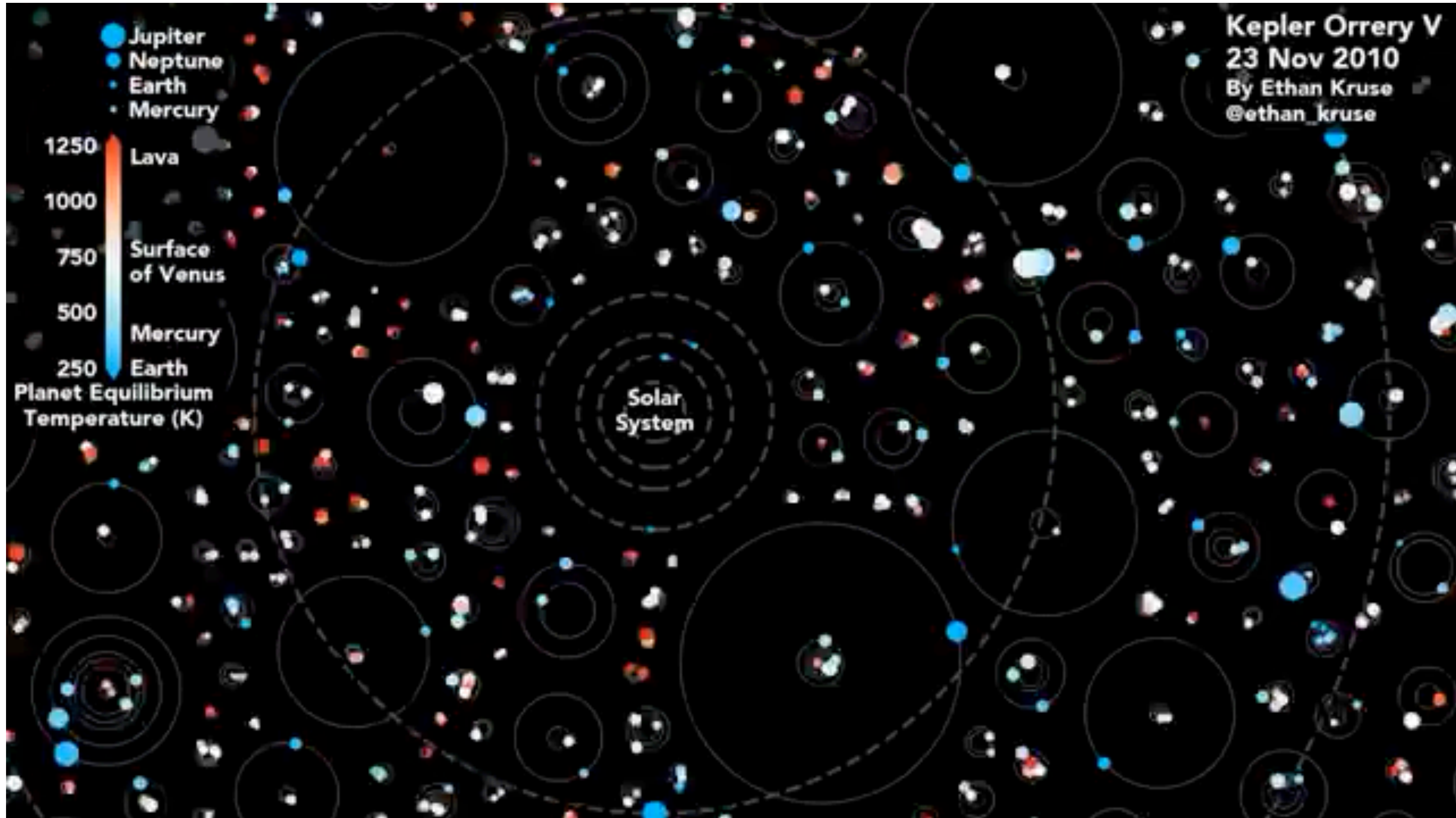


Spectroscopy



Planetary Systems

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



Stars

Evolutionary paths of stars with different initial masses

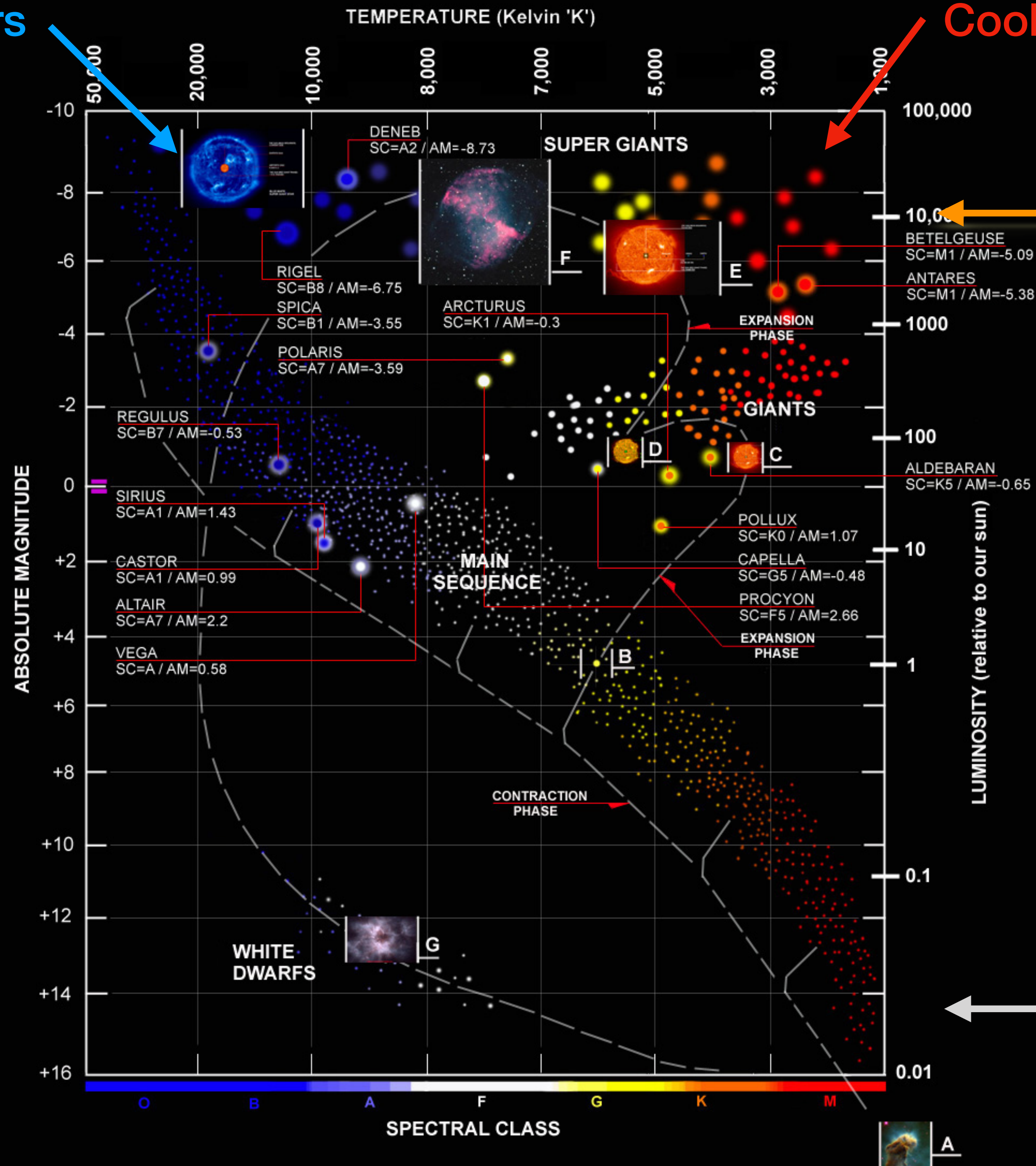
Intrinsic Brightness vs. Color

Hot stars

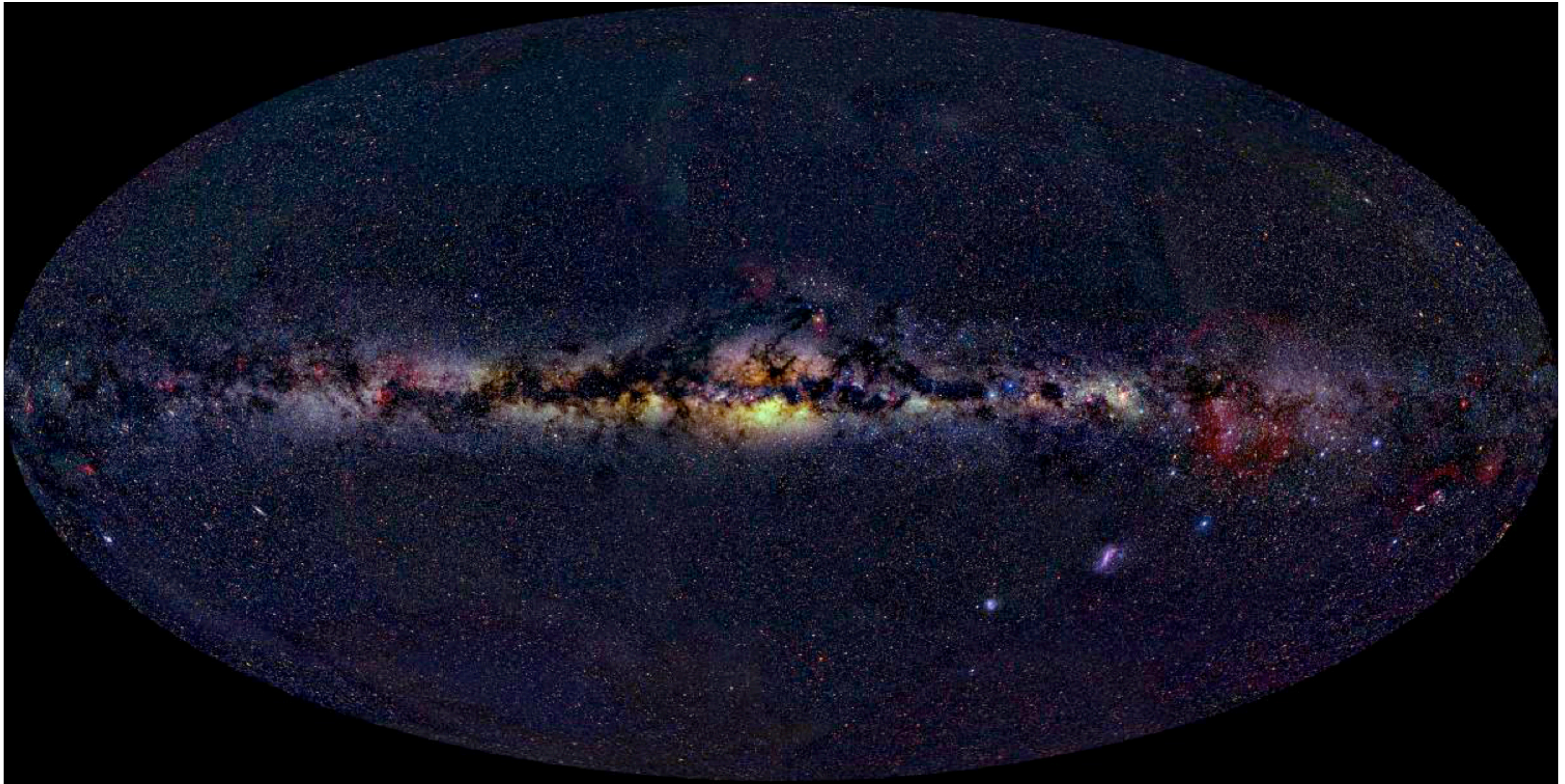
Cool stars

Bright stars

Faint stars

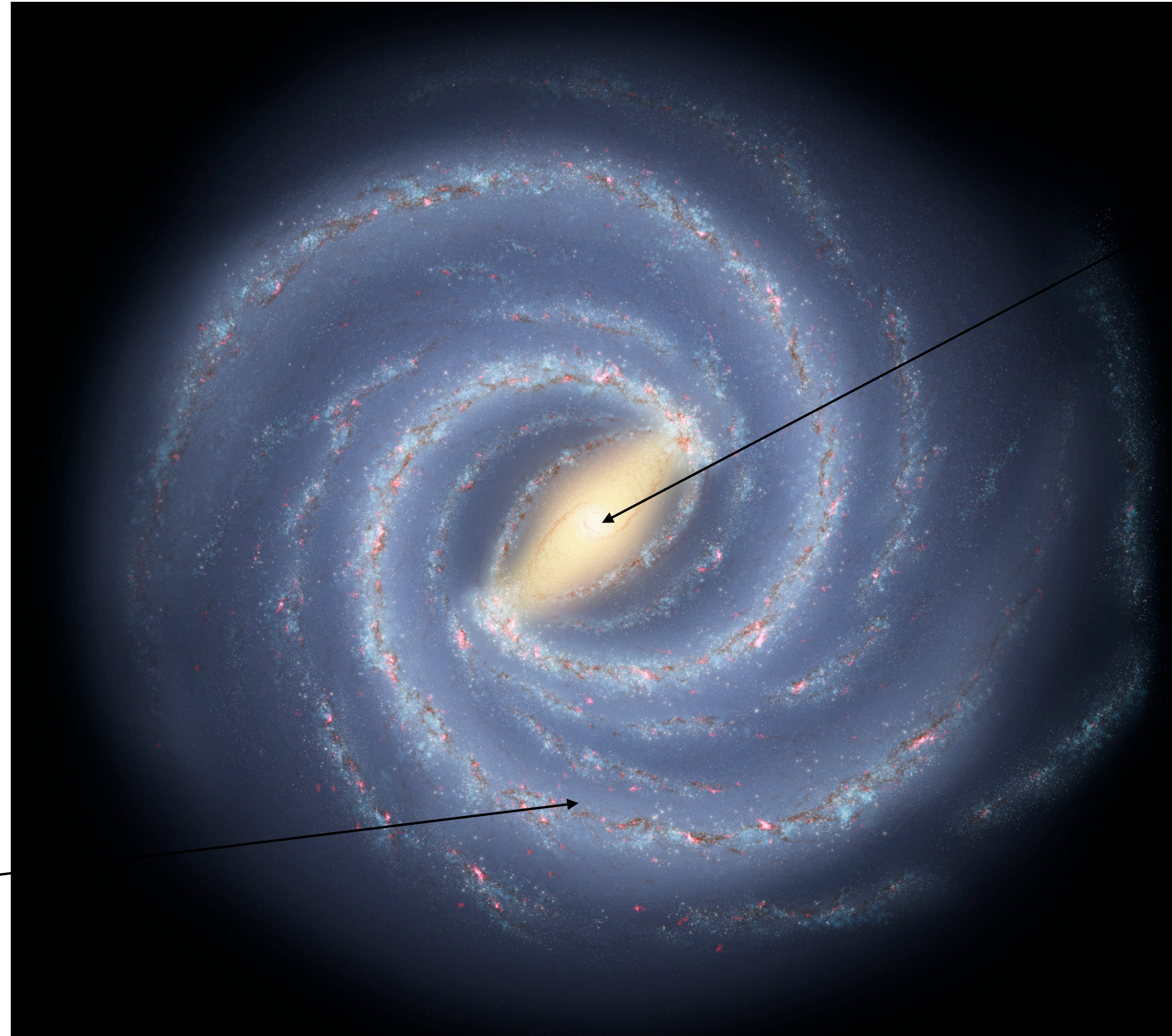


(Our) Milky Way Galaxy



(Our) Milky Way Galaxy

Artist conception of
our Galaxy from
“above”

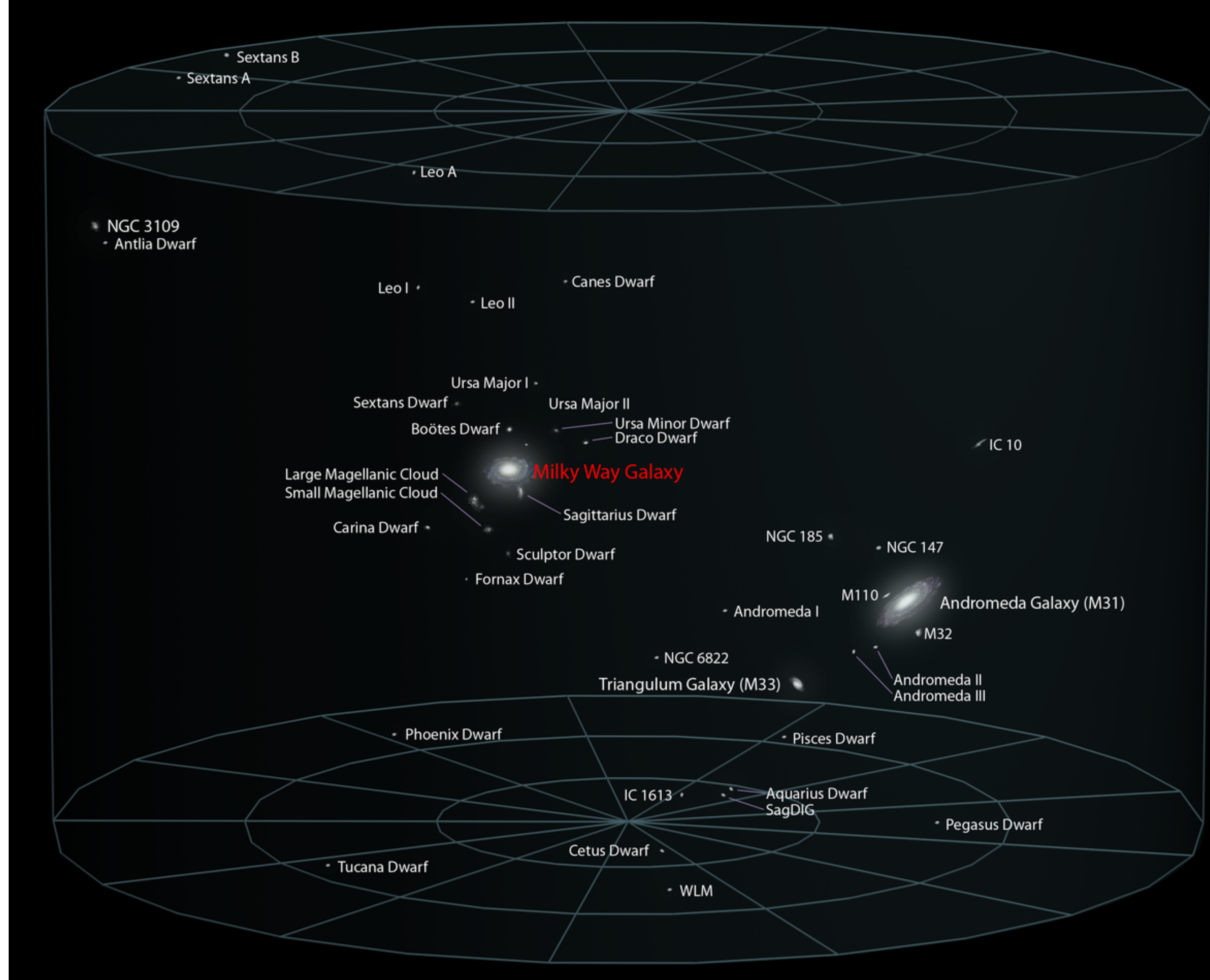


Supermassive
(millions of times
more massive than
the Sun)
Black Hole

Our Sun
(more or less)

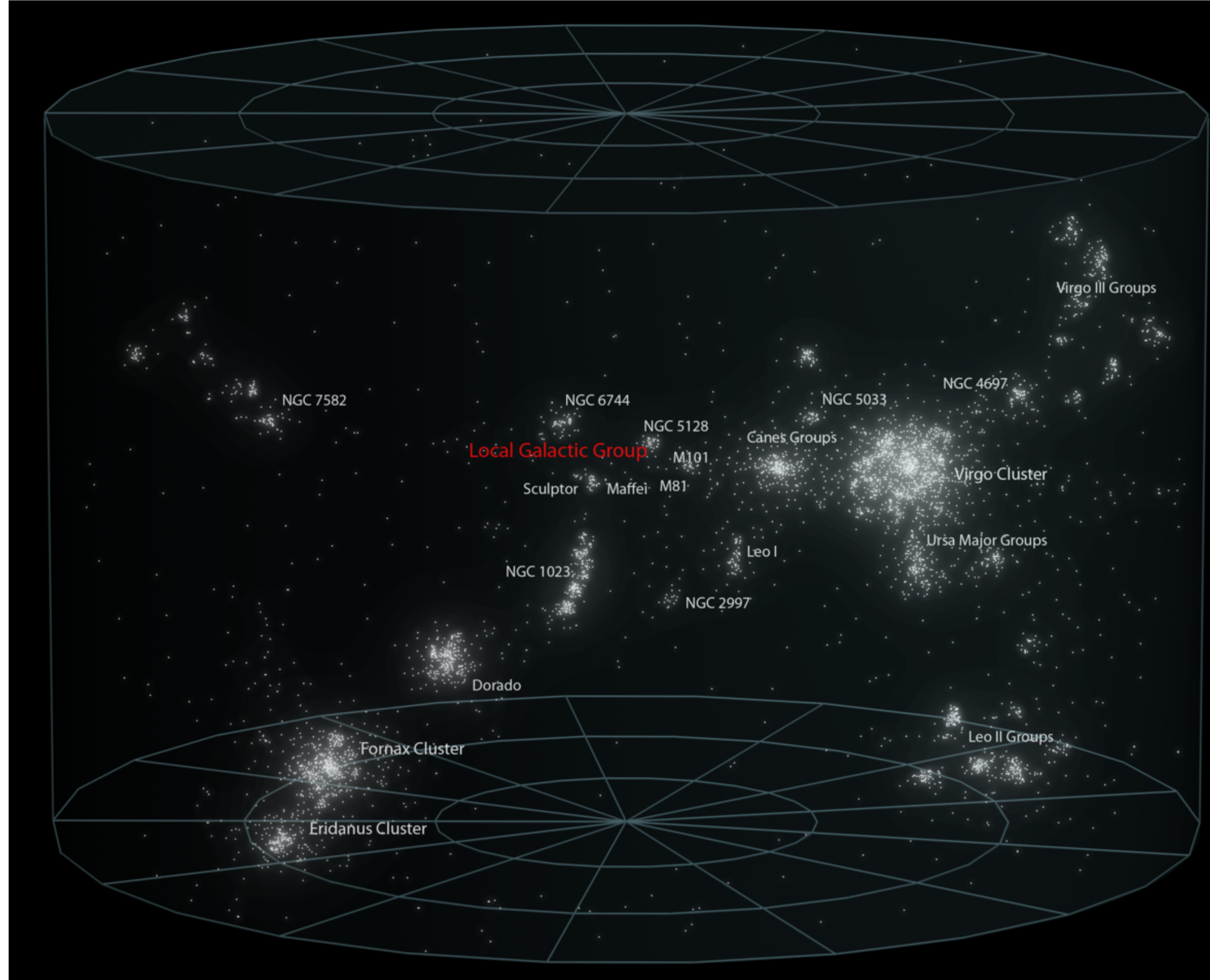
Galaxies

our Local Group



Galaxies

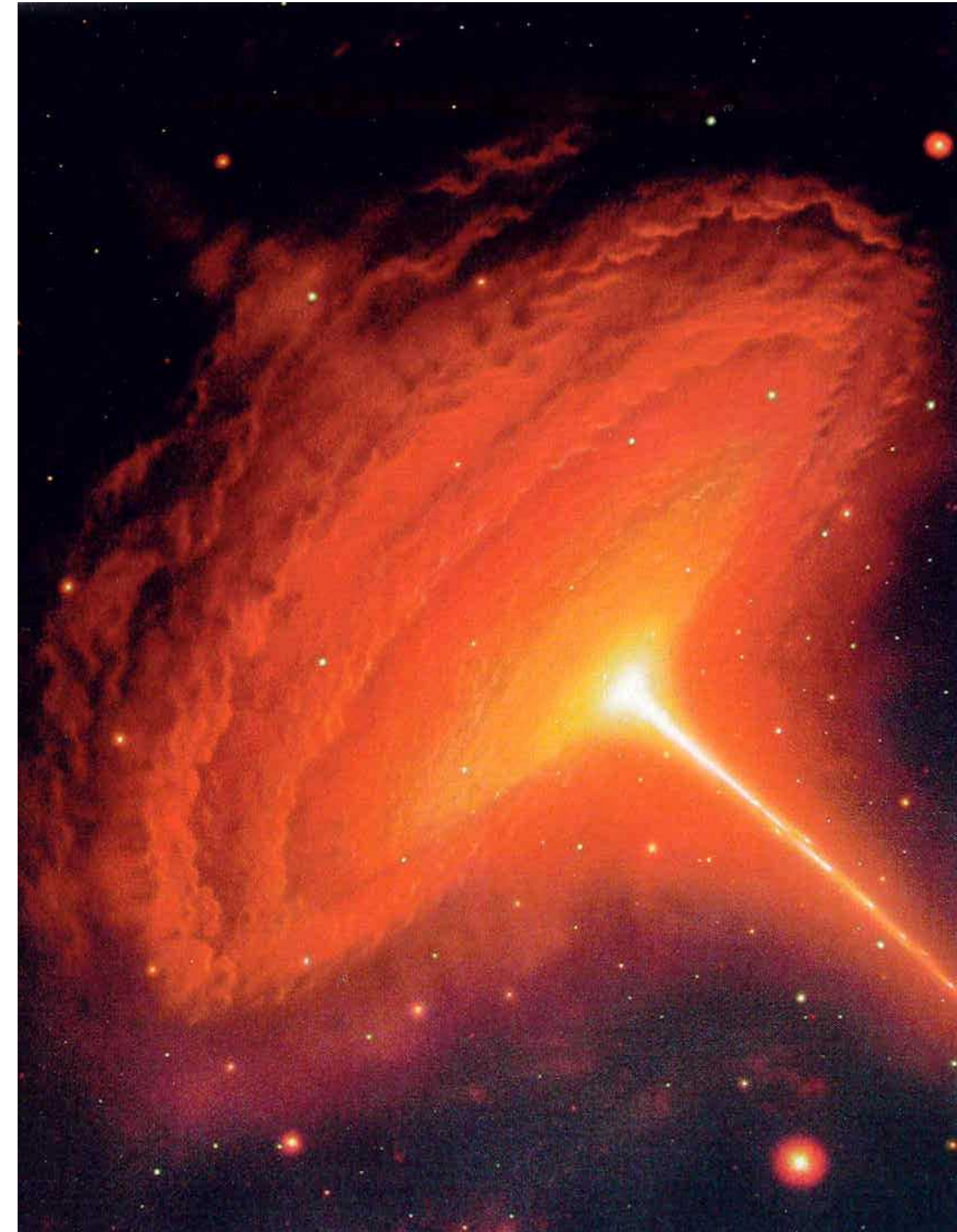
Clustering of galaxies



Dark Matter



Black Holes & Quasars



Artist Conceptions

Aliens

$$N = R_{\star} \times f_p \times n_e \times f_e \times f_i \times f_c \times L$$

The number of technologically advanced civilizations in the Milky Way galaxy

The rate of formation of stars in the galaxy

The fraction of those stars with planetary systems

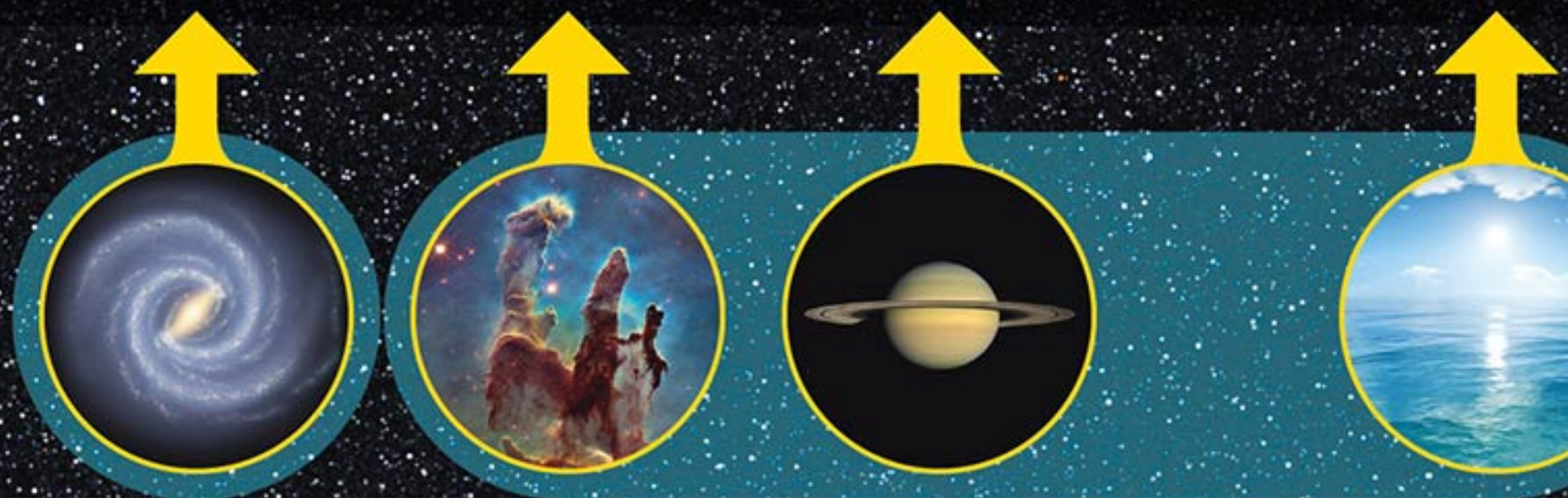
The number of planets, per solar system, with an environment suitable for life

The fraction of suitable planets on which life actually appears

The fraction of life-bearing planets on which intelligent life emerges

The fraction of civilizations that develop a technology that releases detectable signs of their existence into space

The length of time such civilizations release detectable signals into space



A

=

N_{ast}

The number of technological species that have formed over the history of the observable universe

The number of habitable planets in a given volume of the universe

I'M NOT SAYING IT WAS ROMULANS

BUT IT WAS ROMULANS