HURTIGRUTEN

Astronomy Voyage

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Lecture Programme

- Tonight's Night Sky
- Astrophotography
- The Aurora
- Our Solar System
- Our Galaxy
- **Our Universe**
- **Modern Astronomy: Life as a Astronomer & Tools of the Trade**
- **Why We Are Here: A 13.8-billion year-old story**


Milky way
< Andromeda
nebula


Large Magellanic Cloud

Spiral Nebulae

Are they small & nearby, or large & far away?

Galaxy M51

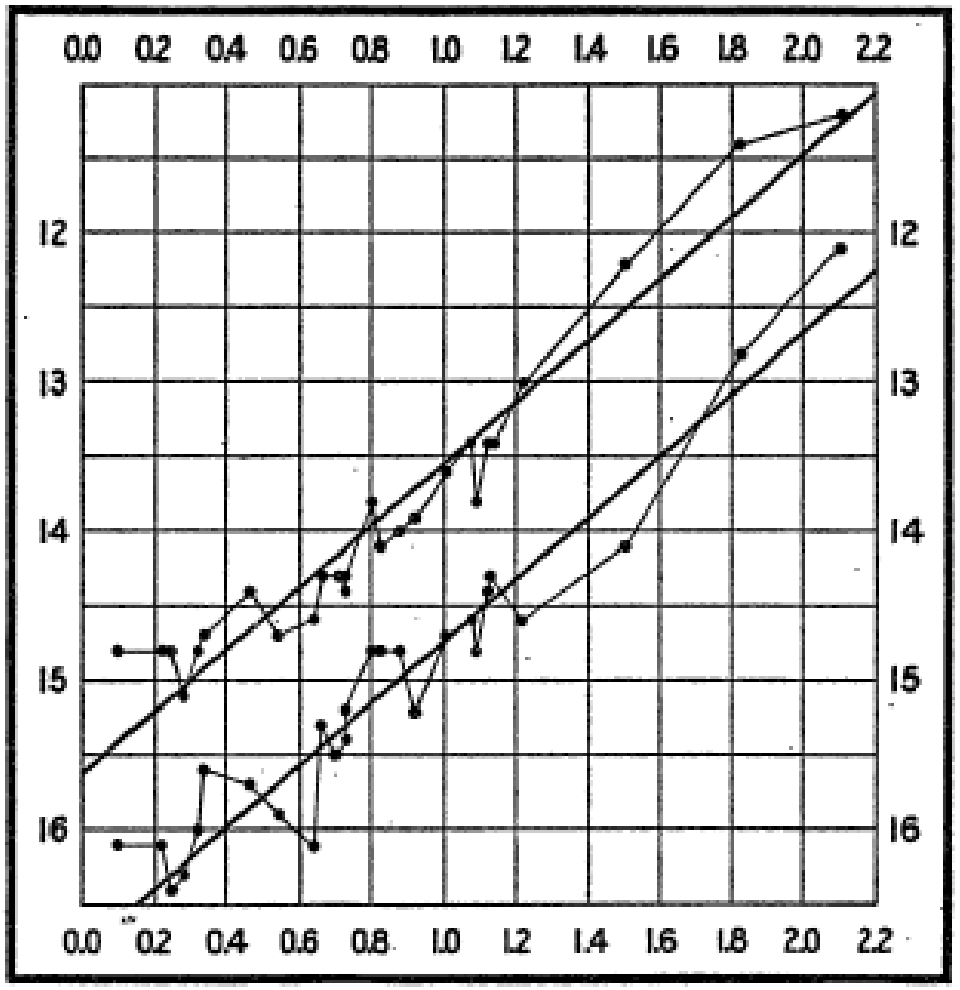
Young star & disk MWC 758

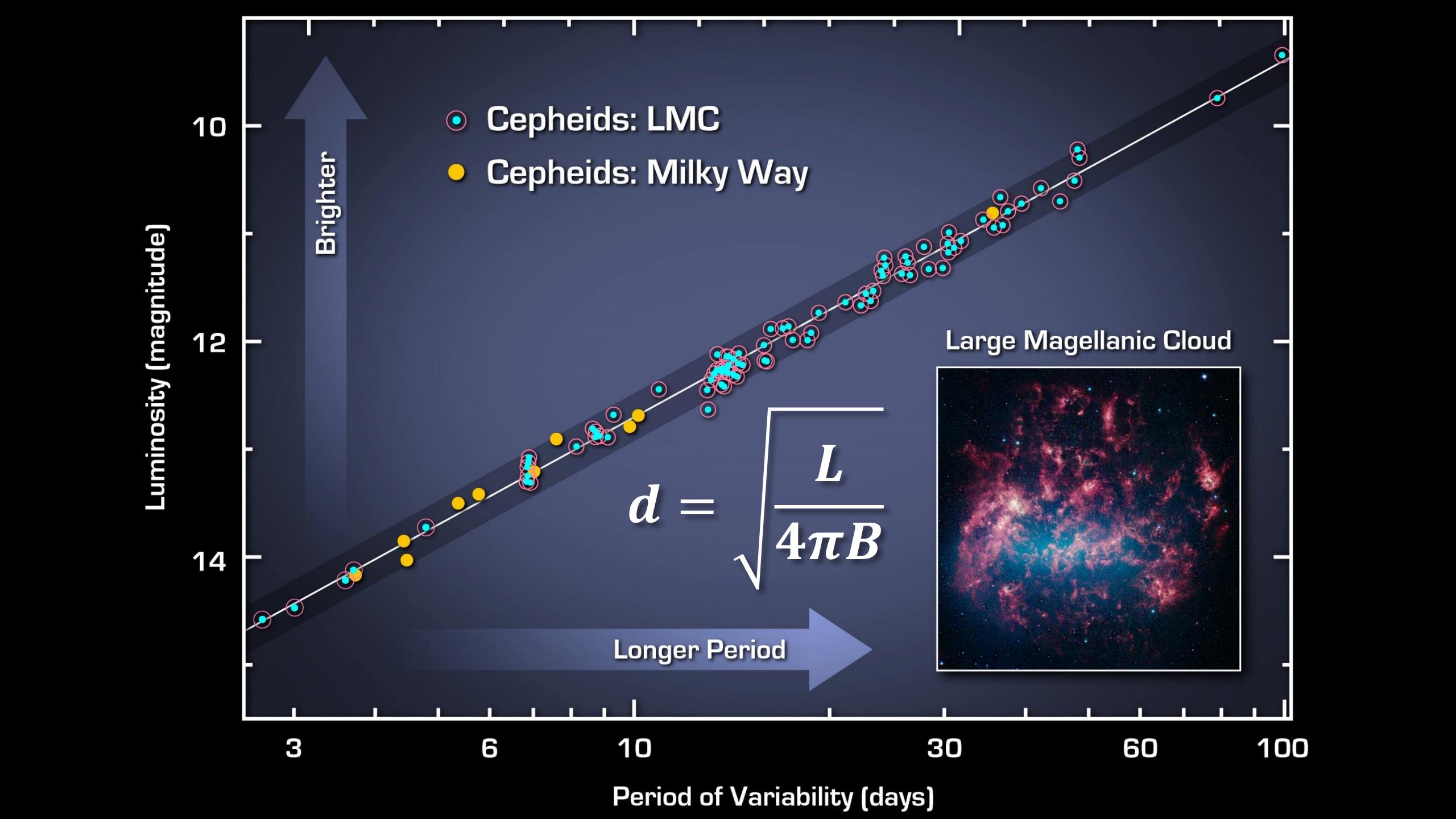
MWC 758
ESO/VLT

Distances to Nebulae

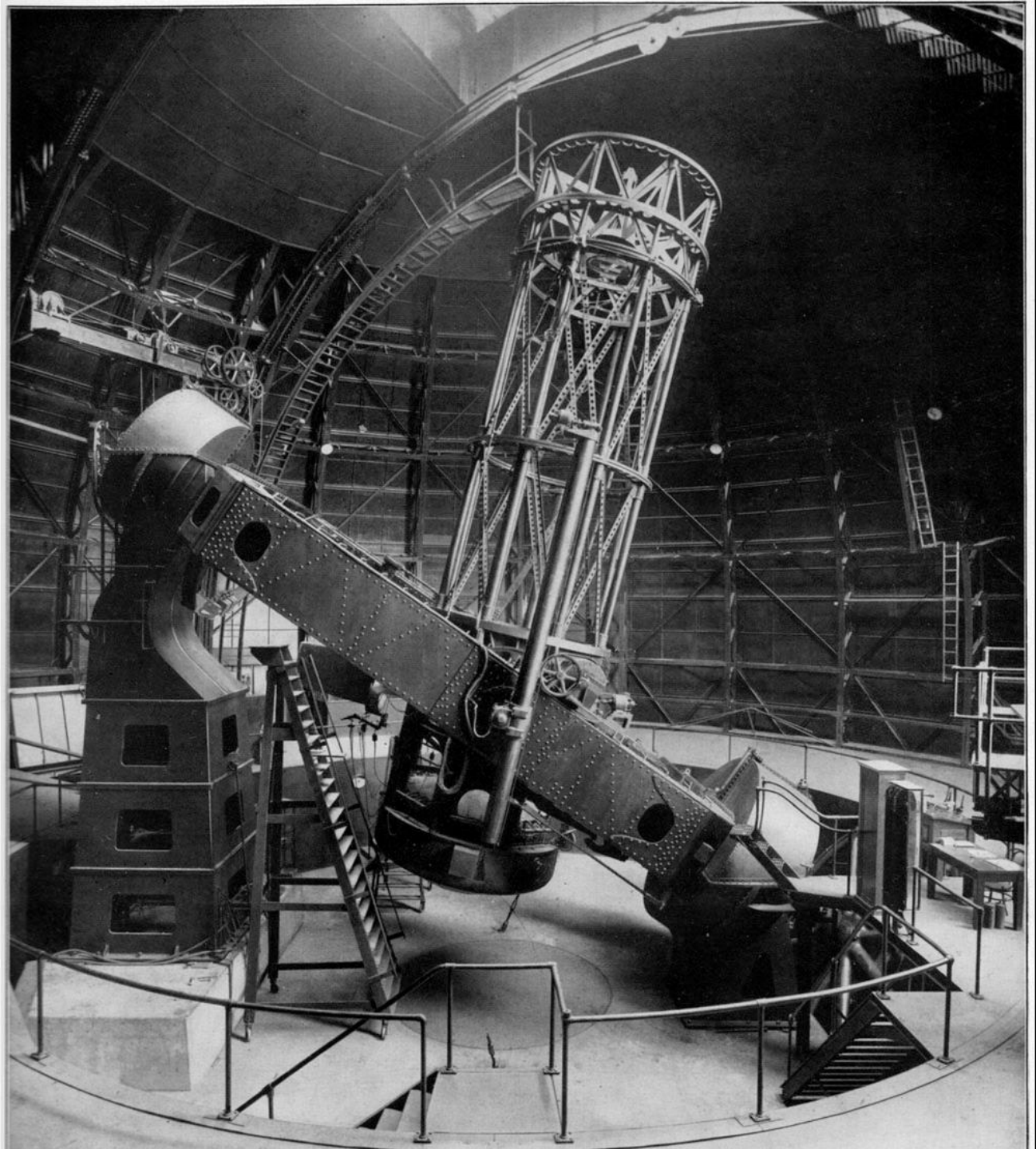
Henrietta Swan Leavitt

& Cepheid Variable pulsating stars




Cepheids: LMC
Cepheids: Milky Way
Brighter
Longer Period
Luminosity (magnitude)
10
12
14
3
6
10
30
60
100
Period of Variability (days)
$d = \sqrt{\frac{L}{4\pi B}}$
Large Magellanic Cloud

Hubble



Orion Nebula, M42

25,000x bigger than our solar system

Andromeda Galaxy, M31

250 million x bigger than our solar system


Our Solar System
50AU = 7 light hrs
Our Galaxy
~100,000ly


The Andromeda Galaxy
2.5 million light years away


Hubble Space Telescope Ultra-Deep Field
FOV:
0.2% Moon
1 Ms
(12 day)
exposure
10,000 galaxies


James Webb
Space
Telescope
Deep Field
FOV: 10% Moon
12.5 hour
(45ks) exposure
45,000 galaxies


Most distant object ever imaged
13.4 G ly distant


500 years out of a star's ~10bn year life
≡
2 minutes out of our lifetime

Galaxy types

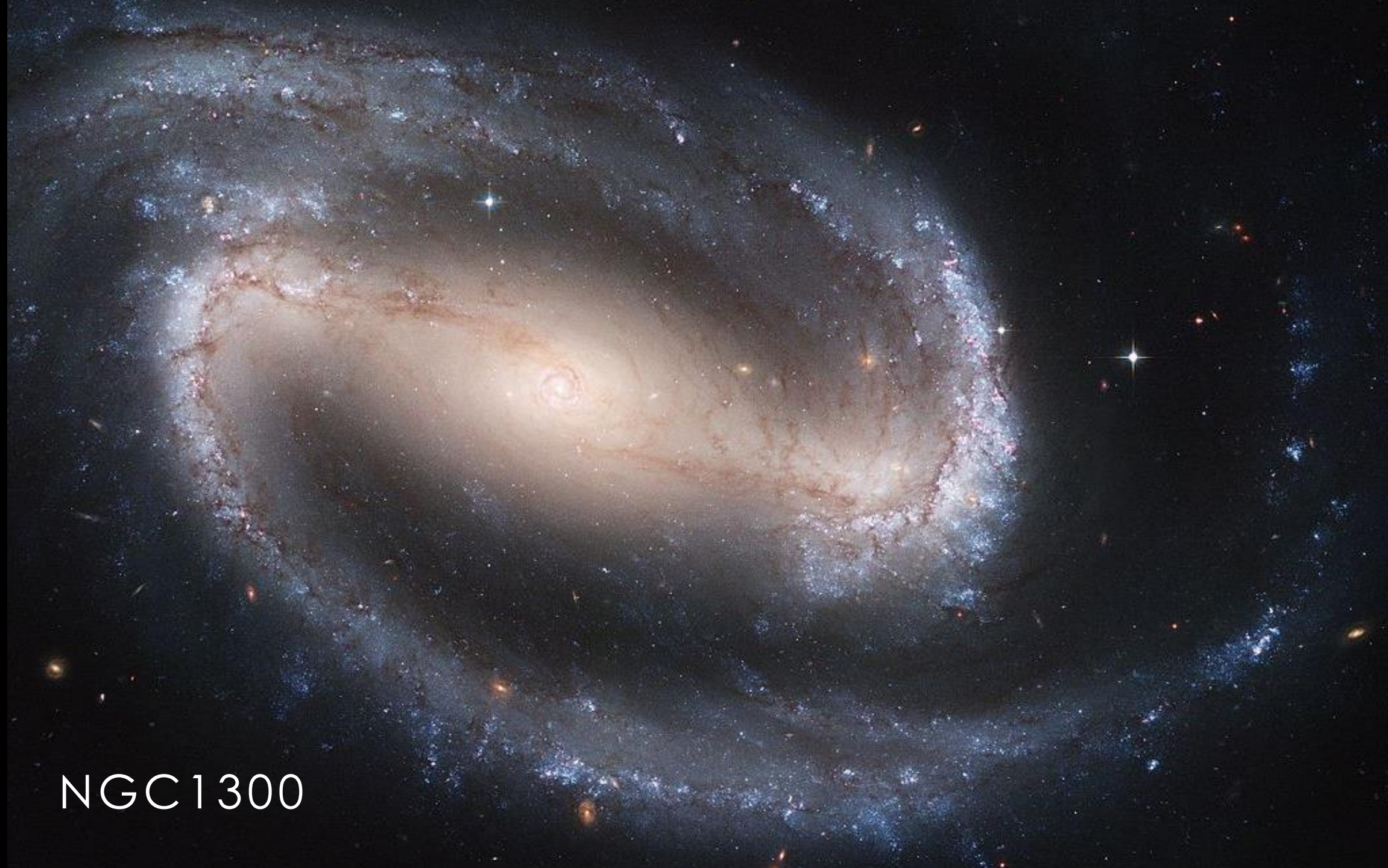
Elliptical Galaxies

M87

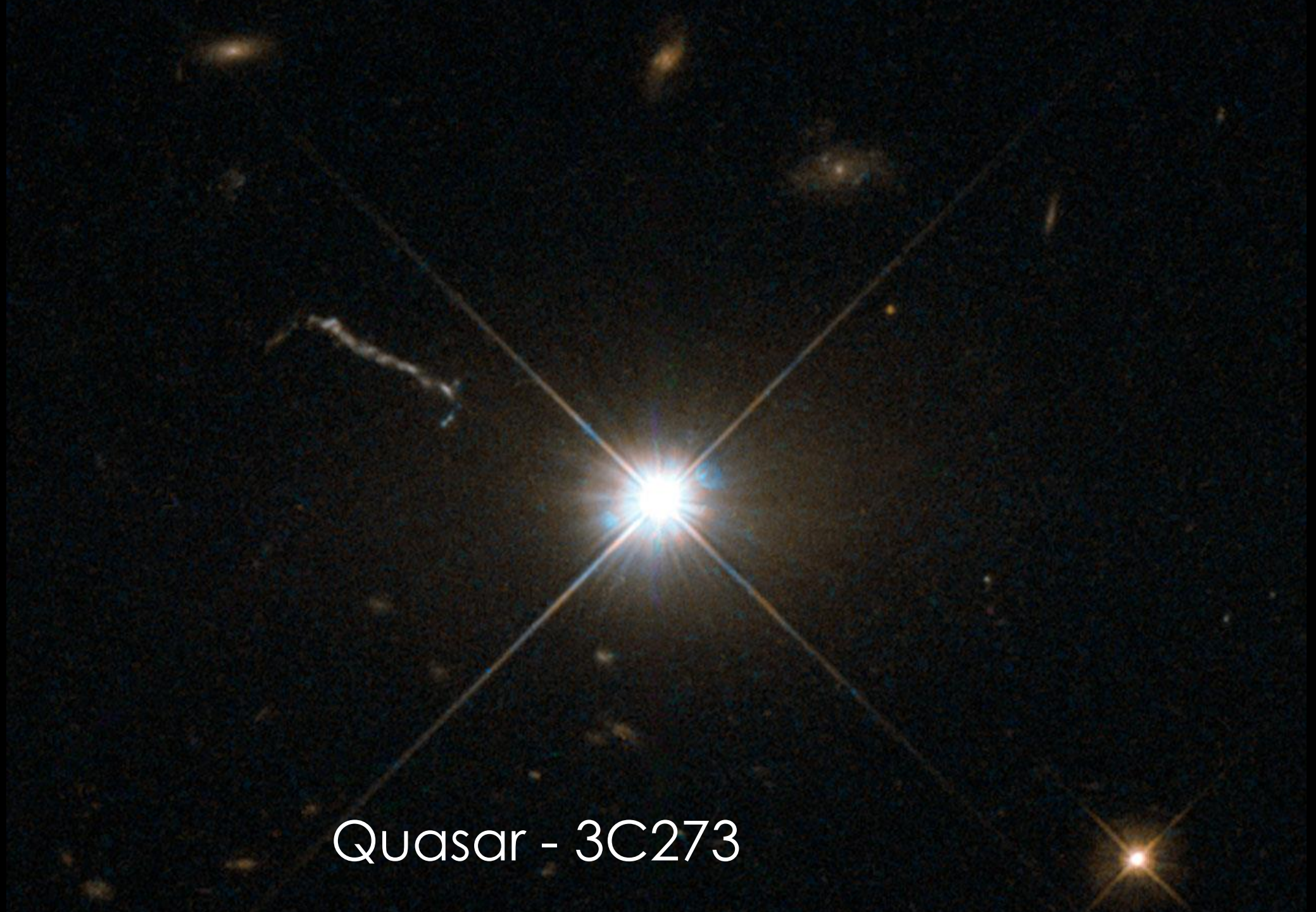
Spiral Galaxies

Pinwheel Galaxy, M101

Barred Spiral Galaxies

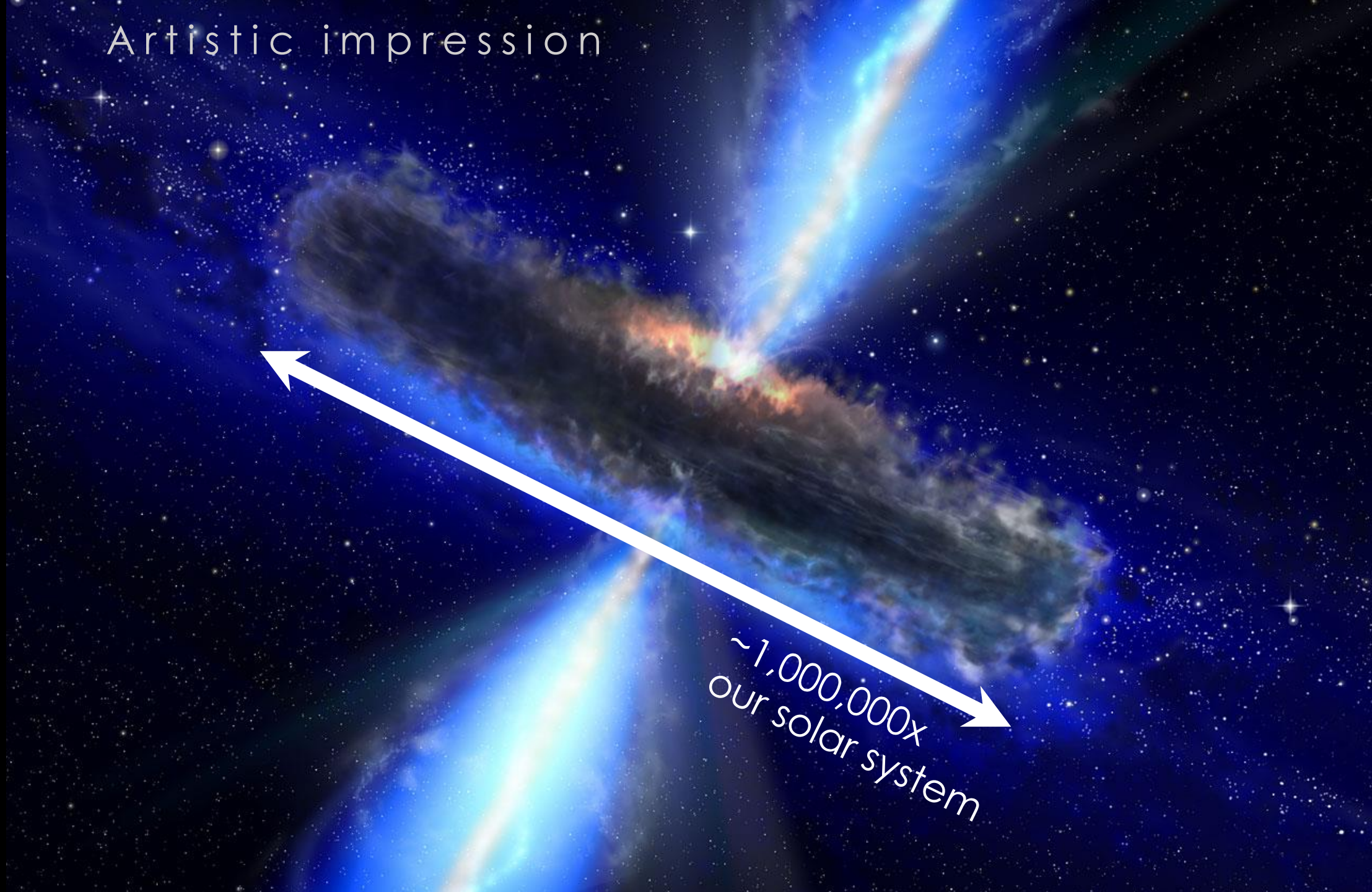


Quasars



Quasar - 3C273

Quasars

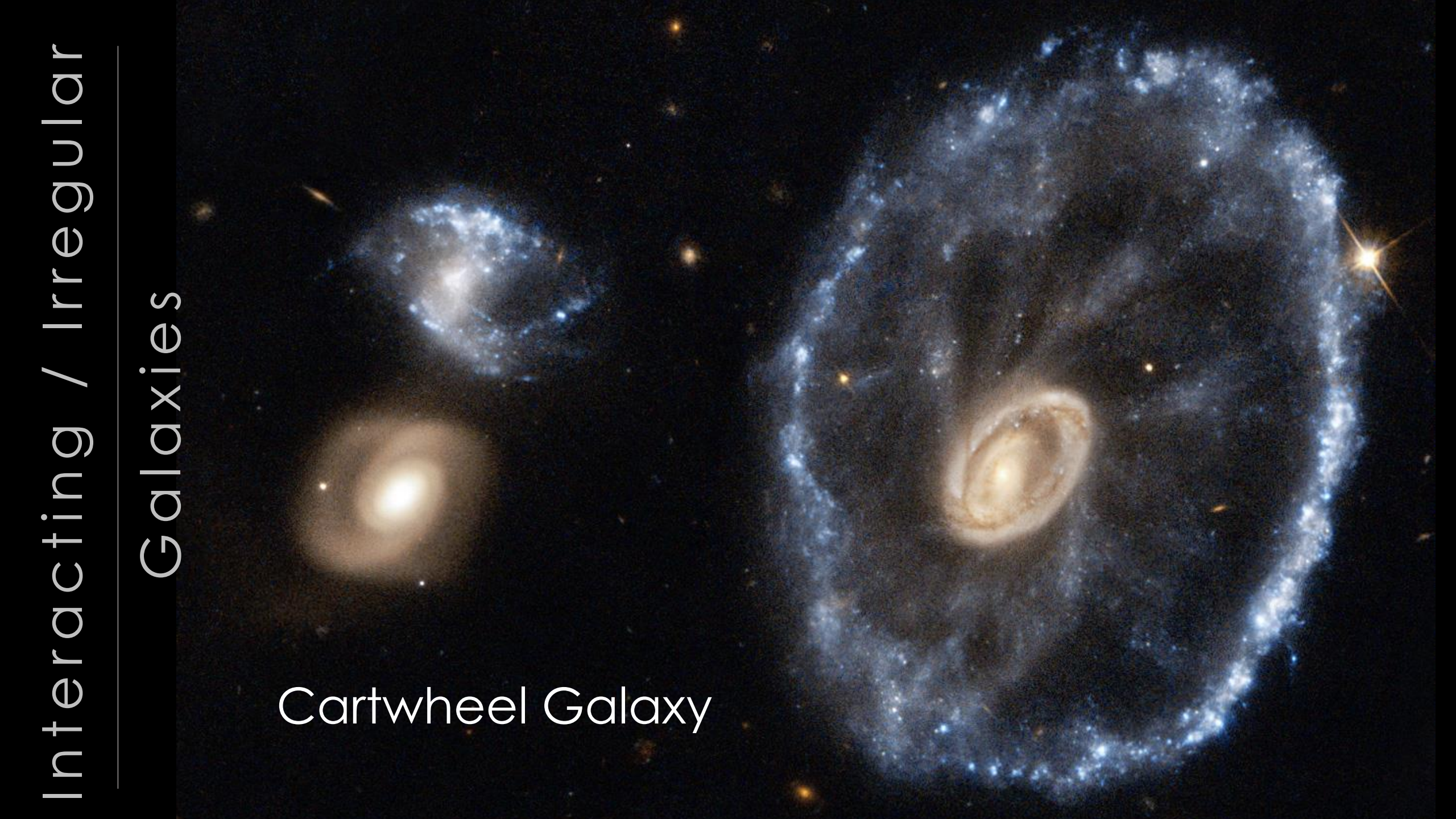


Interacting / Irregular Galaxies

The Antennae Galaxies

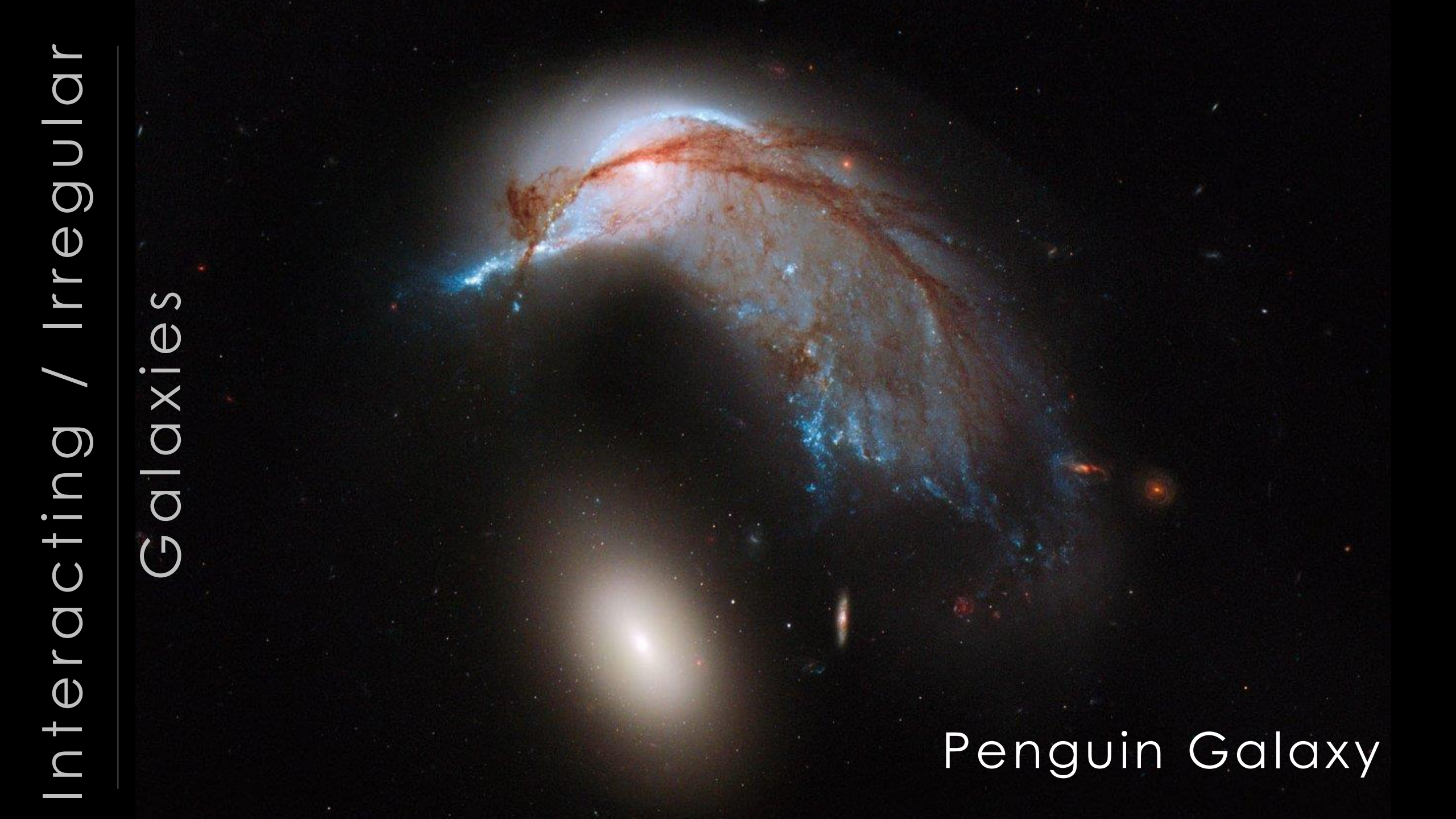

0.000 billion years

Interacting / Irregular Galaxies



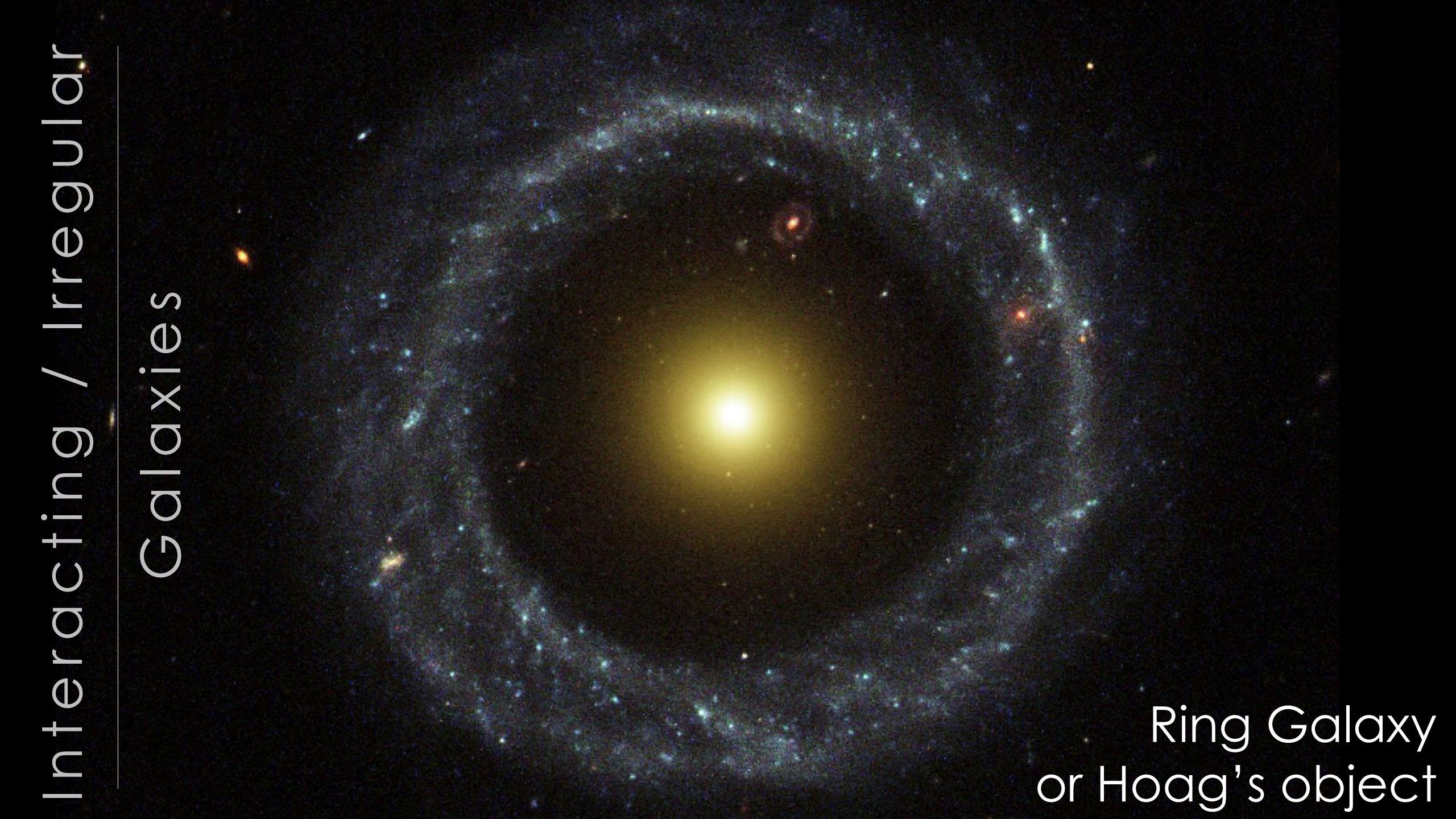
Cartwheel Galaxy

Interacting / Irregular Galaxies



Penguin Galaxy

Interacting / Irregular Galaxies

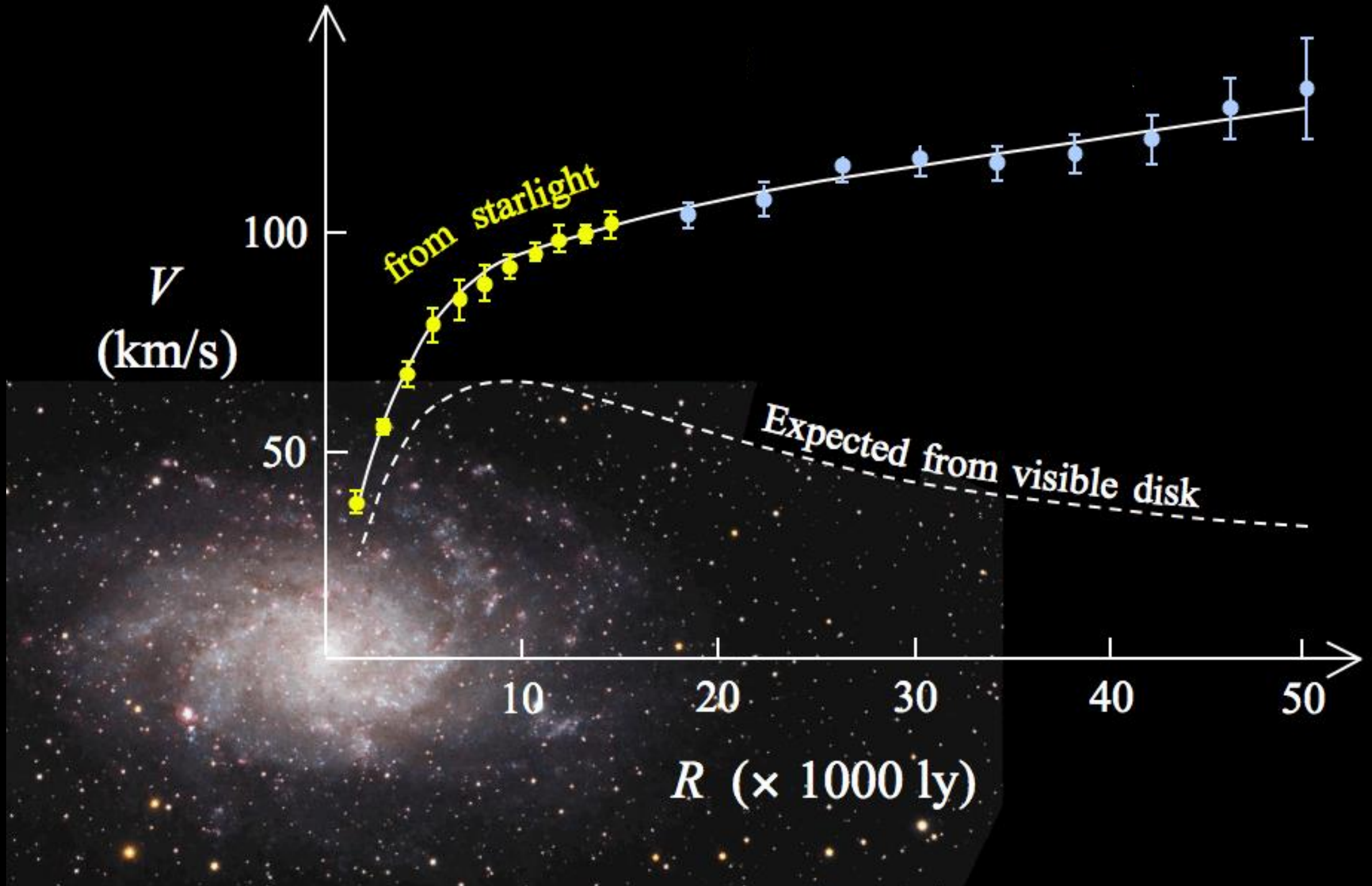


Ring Galaxy
or Hoag's object

Galaxy Clusters

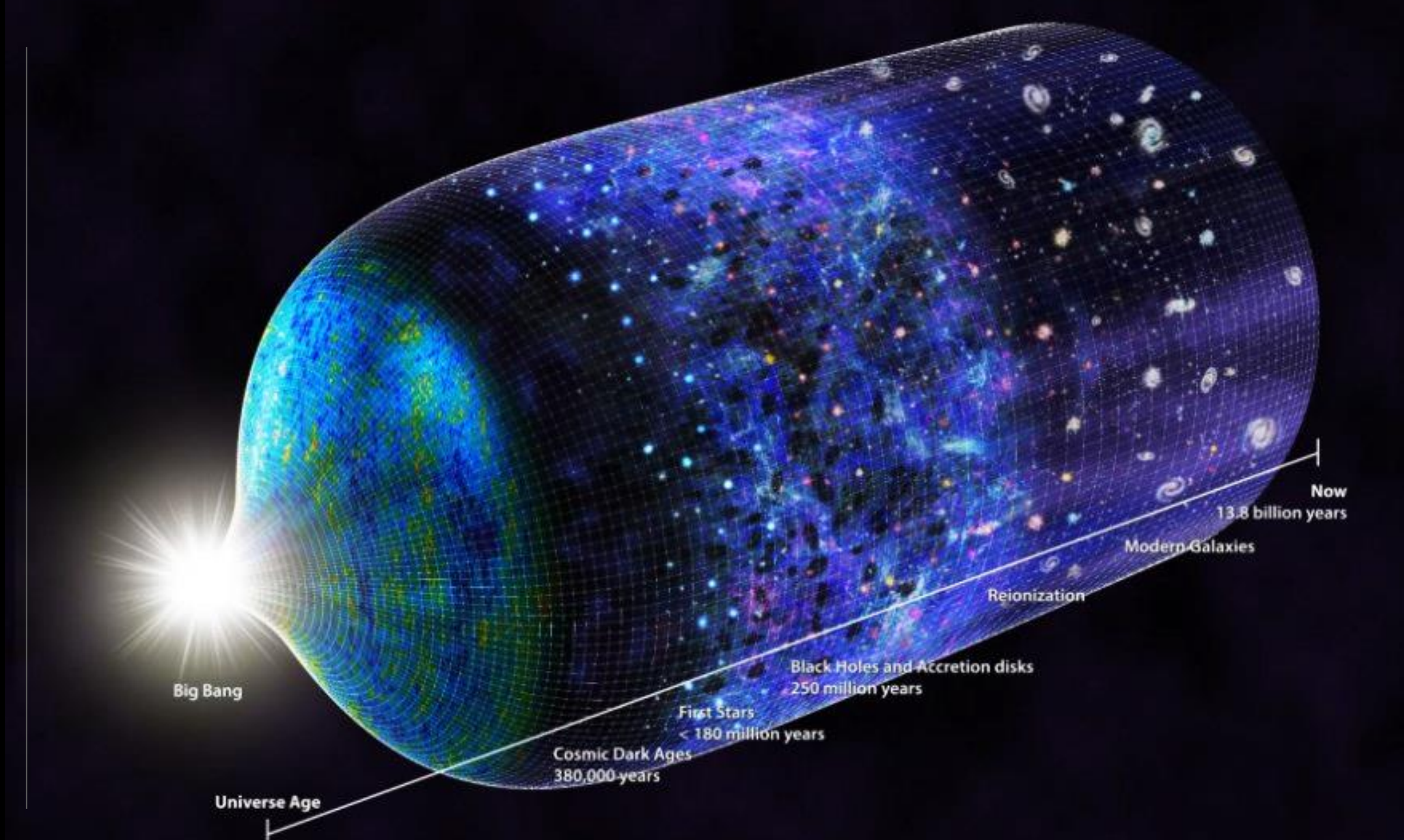
Dark Matter

Vera Rubin



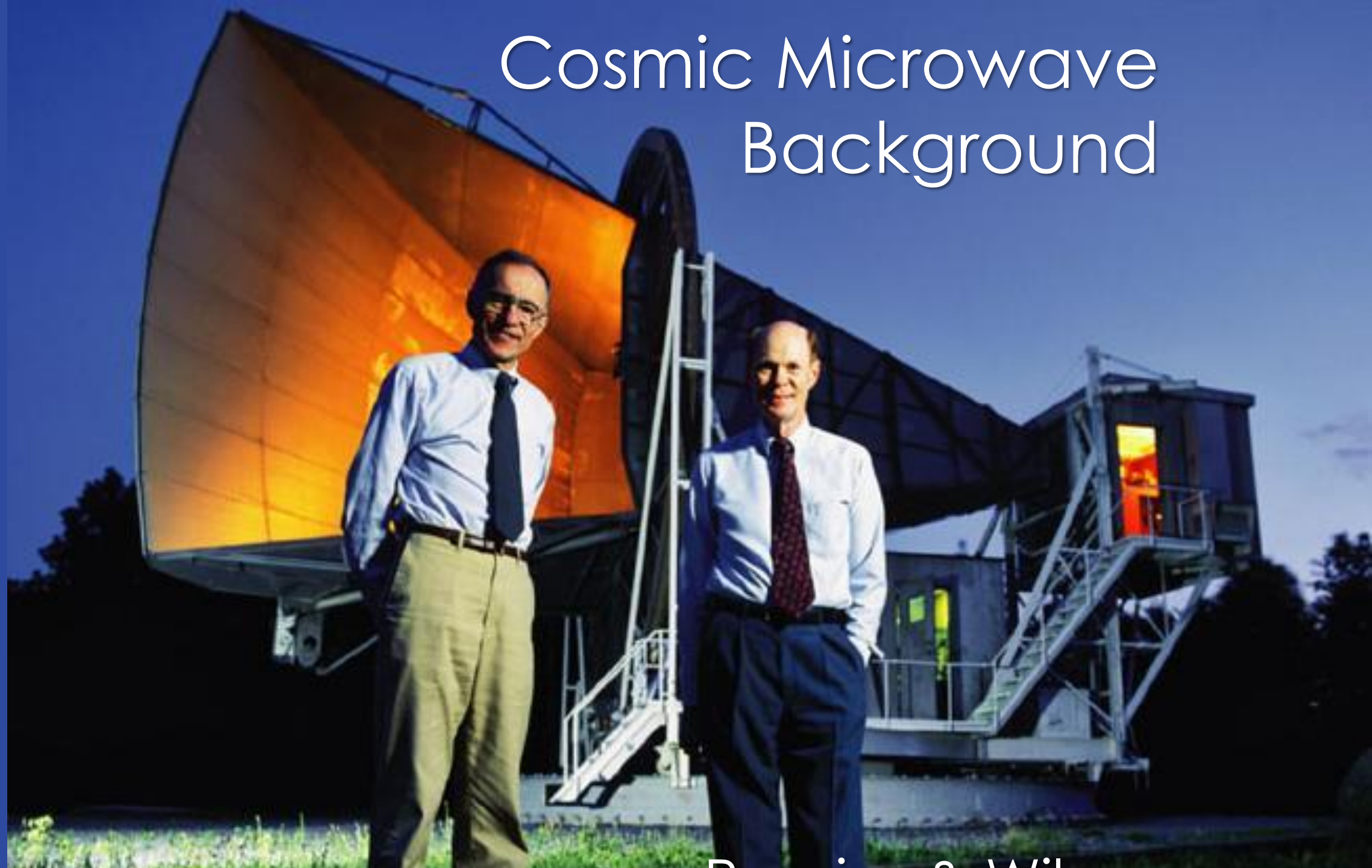
By Stefania.deluca via Wikipedia

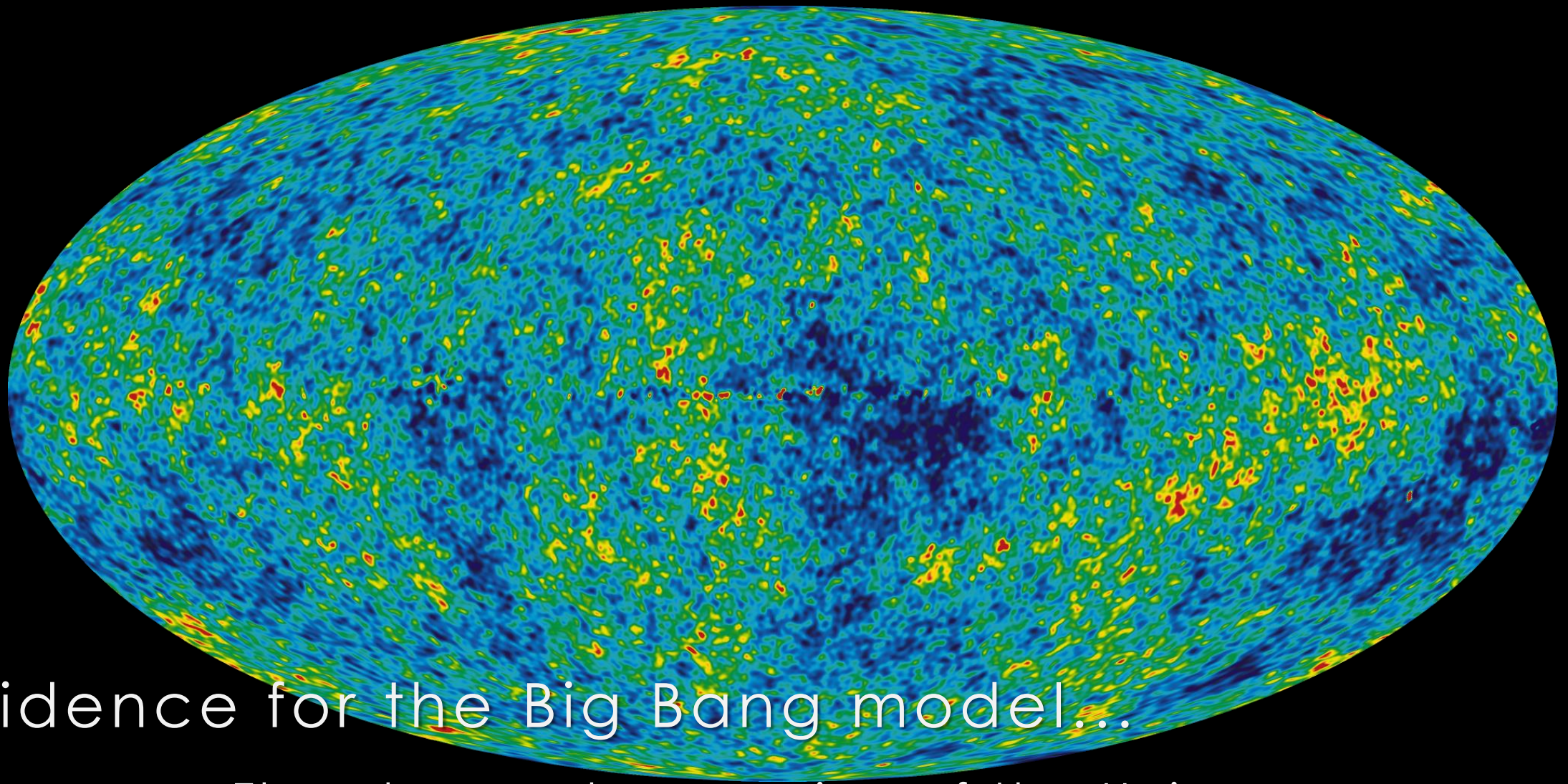
The Big Bang


Big Bang
Cosmic Dark Ages
380,000 years
First Stars
< 180 million years
Black Holes and Accretion disks
250 million years
Reionization
Modern Galaxies
Now
13.8 billion years
Universe Age

Big Bang

Cosmic Microwave Background





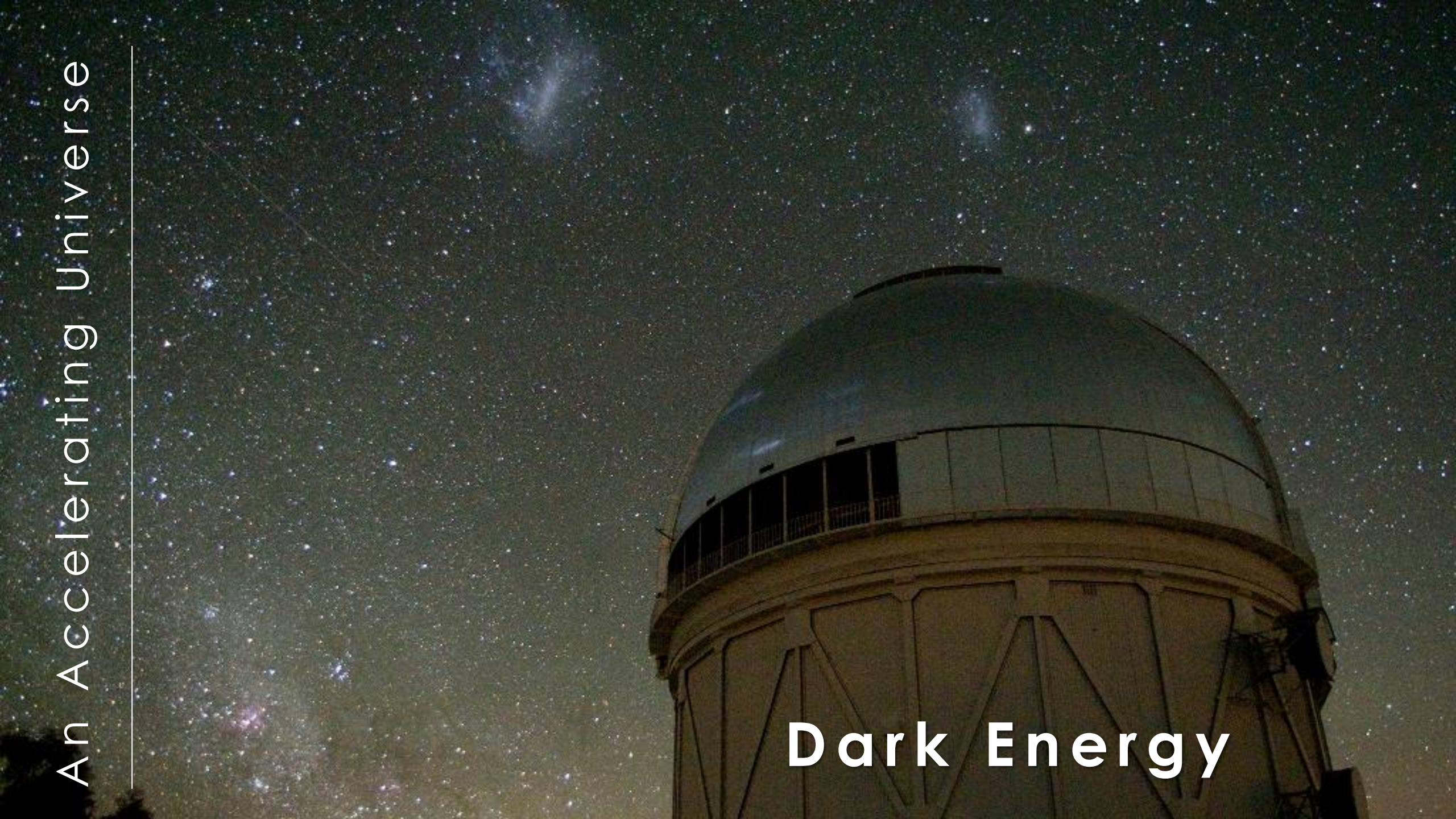
Evidence for the Big Bang model...

The observed expansion of the Universe

The wavelength of the CBR

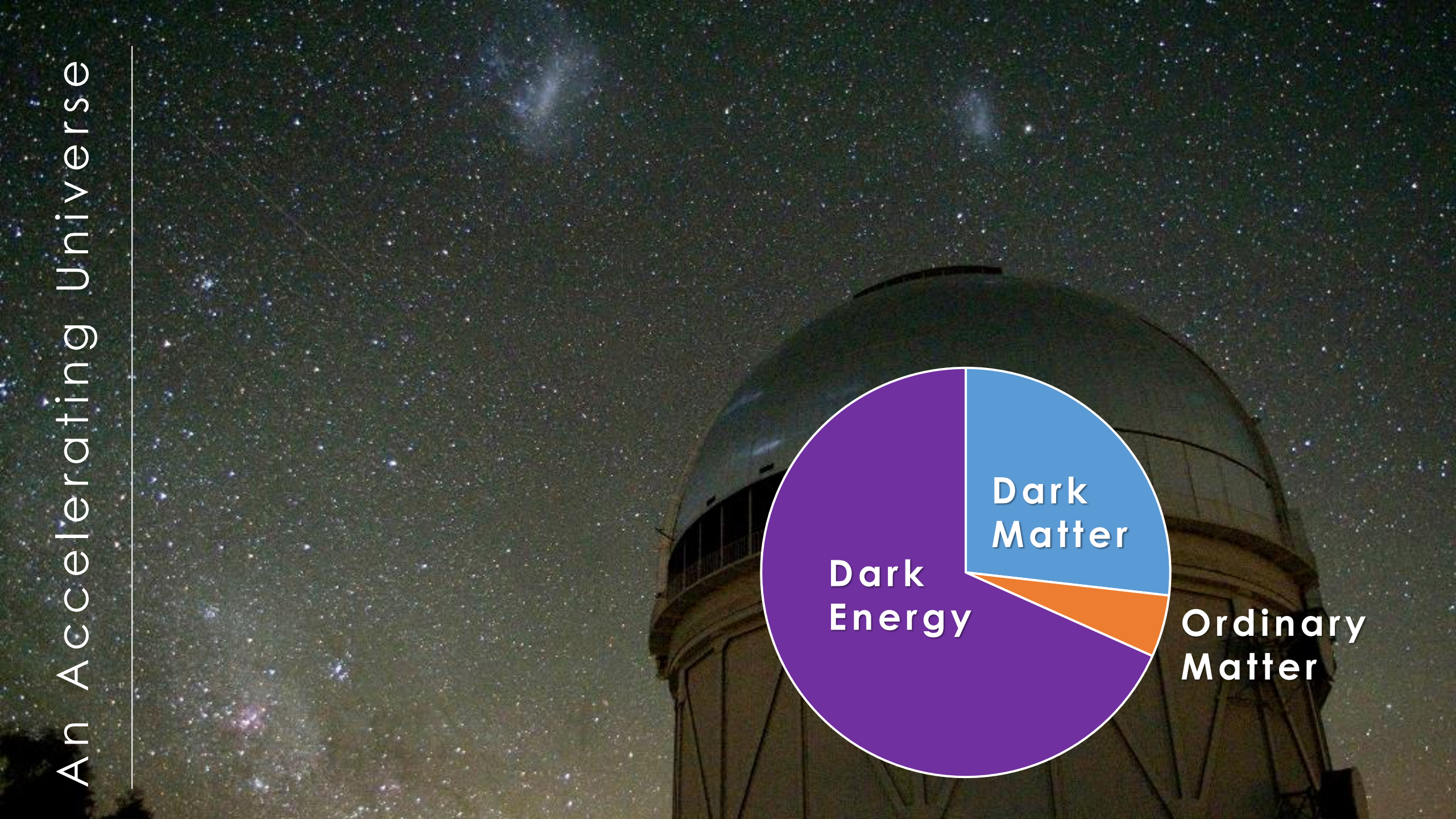
The observed abundances of the light elements

Artistic Impression of a type 1a Supernova



Dark Energy

An Accelerating Universe



Multiverse theory

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