

Galactic and Extragalactic Astronomy

AA 472/672

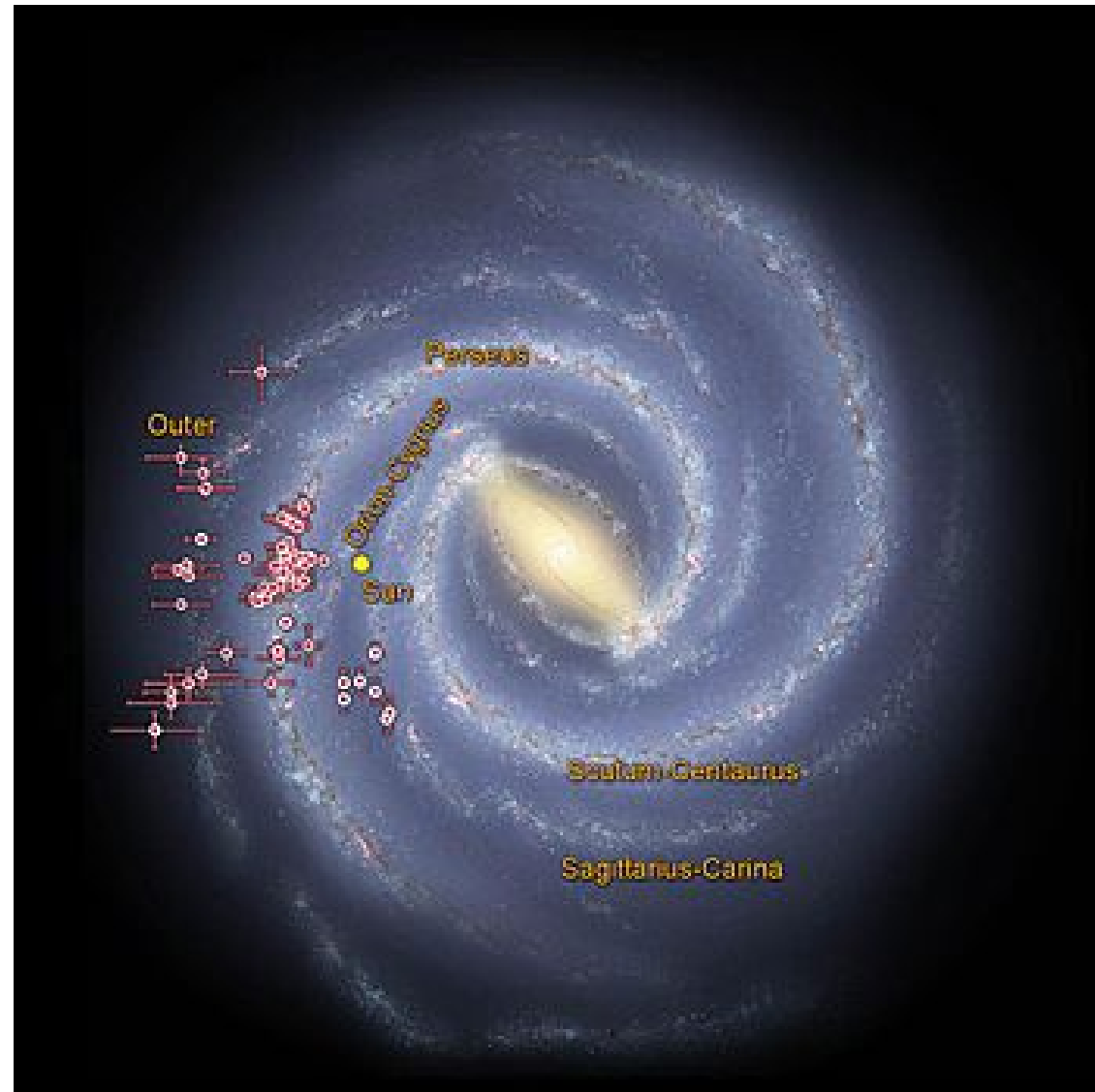
Spring Semester

Instructor: Manoneeta Chakraborty

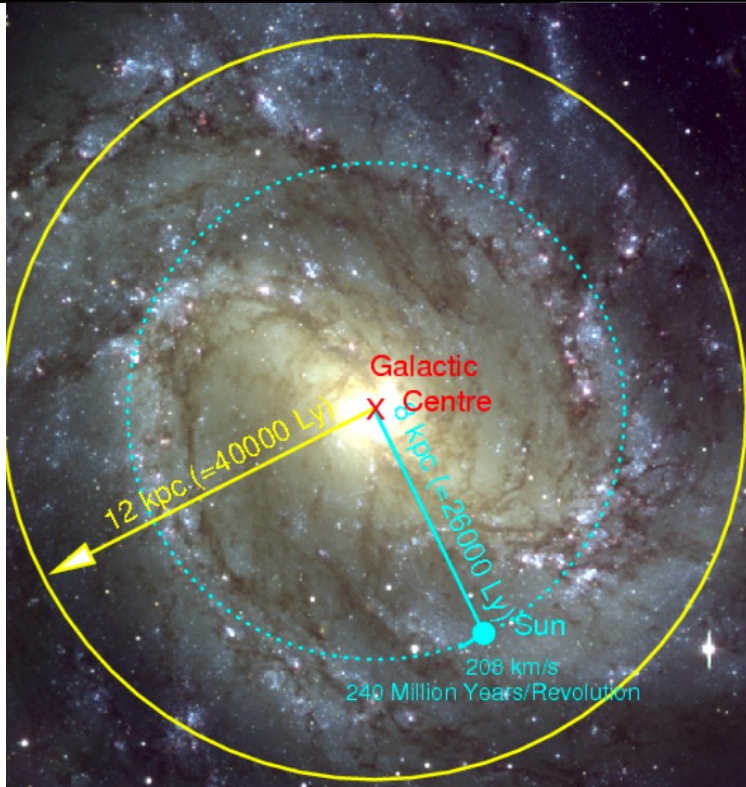
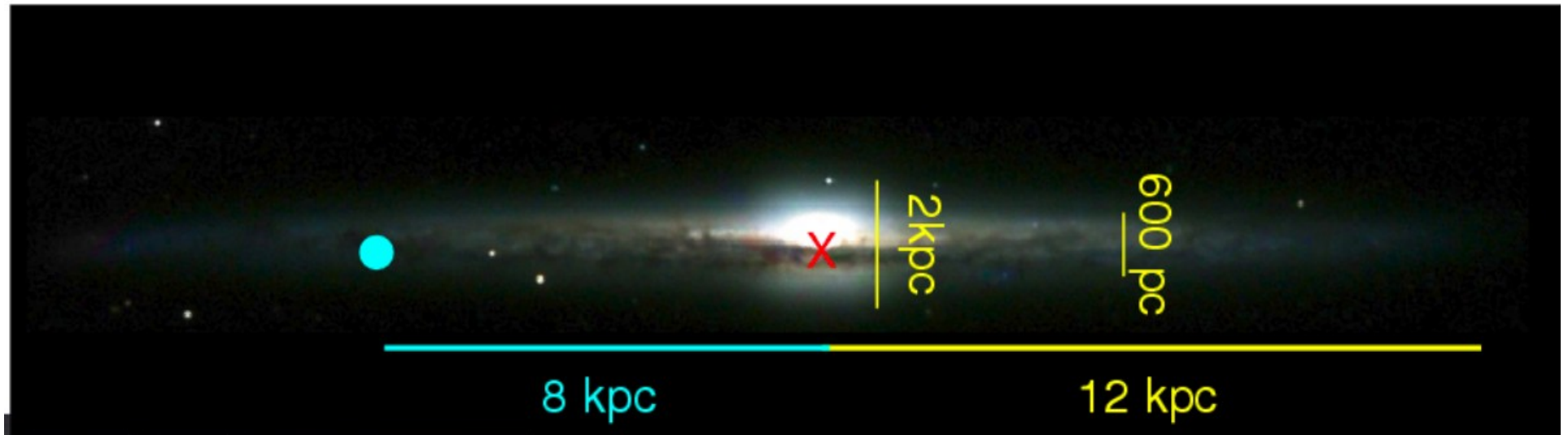
Email: manoneeta@iiti.ac.in

Centre of Astronomy
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India
Asia
Earth
Solar System
Milkyway
Local Group
Virgo Supercluster
Laniakea galaxy supercluster
Observable Universe
Universe

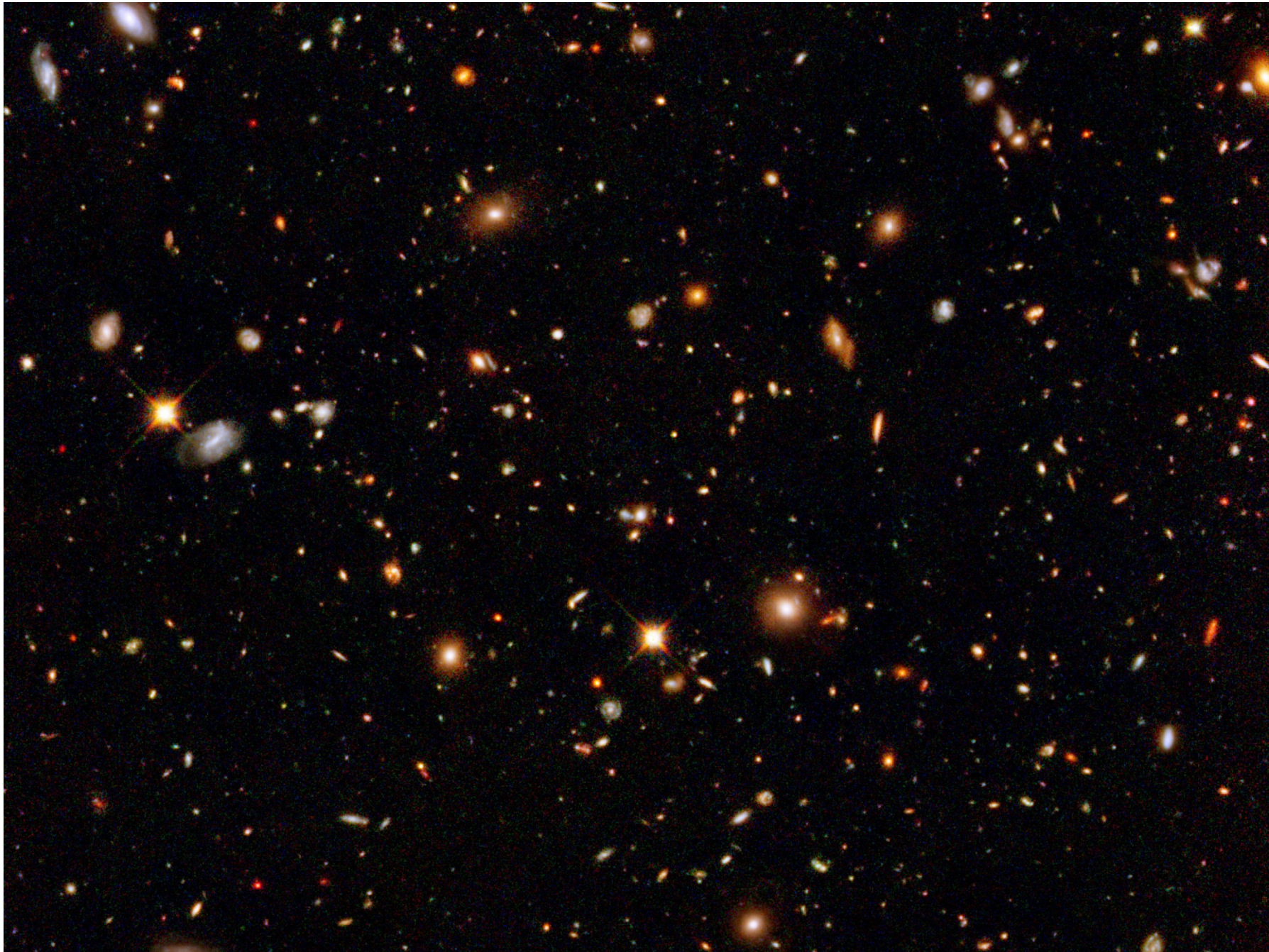
Galaxies: Milkyway



Galaxies: Milkyway

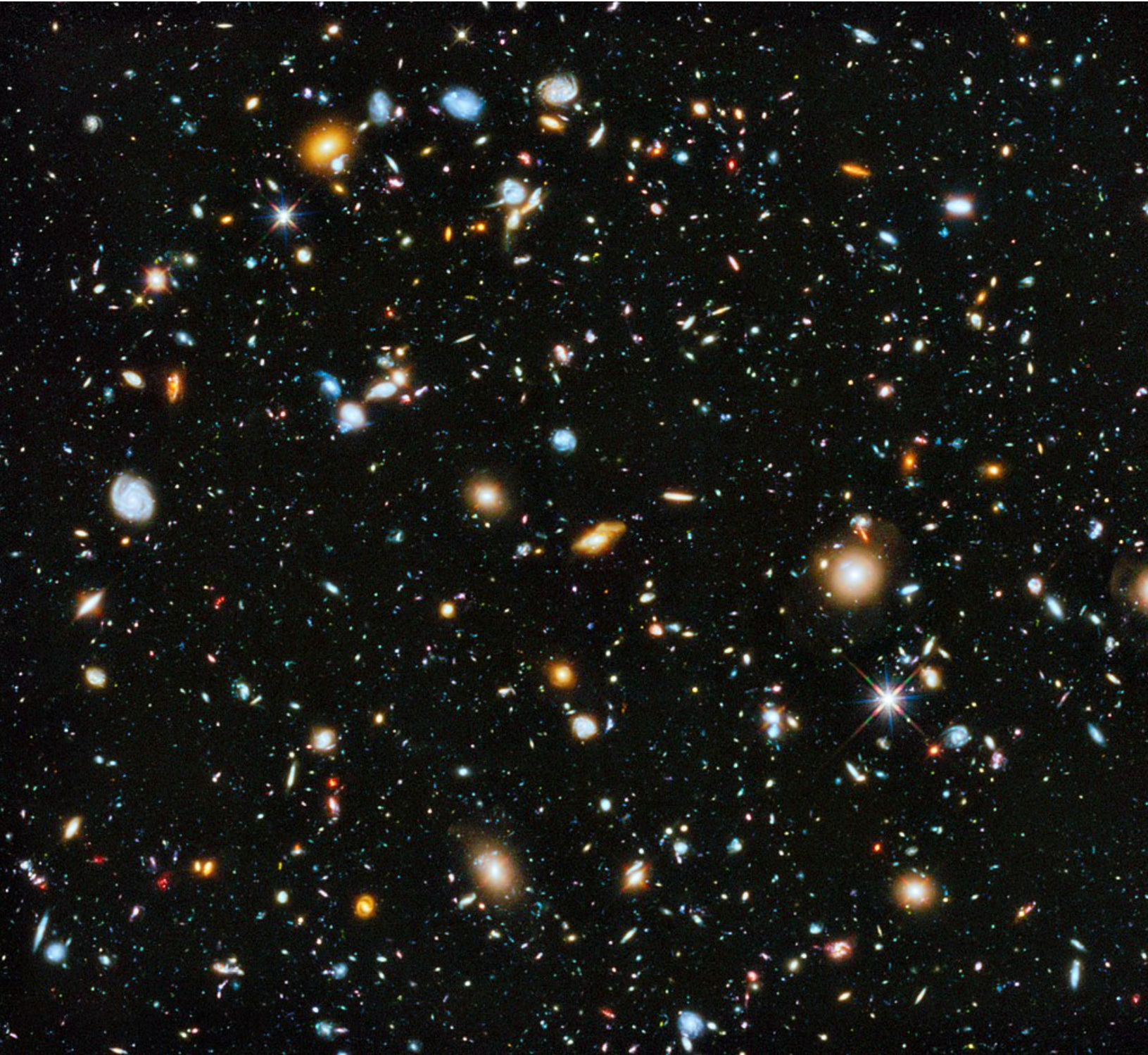


Luminosity: $\sim 2 \times 10^{10} L_{\odot}$
 Mass: $\sim 10^{11} M_{\odot}$ (radiating)
 $\sim 10^{12} M_{\odot}$ (total)
 Stellar density:
 $\sim 0.3 M_{\odot} \text{ pc}^{-3}$



Hubble
deep
field

Hubble Ultra-
deep field



Galaxies: Elliptical

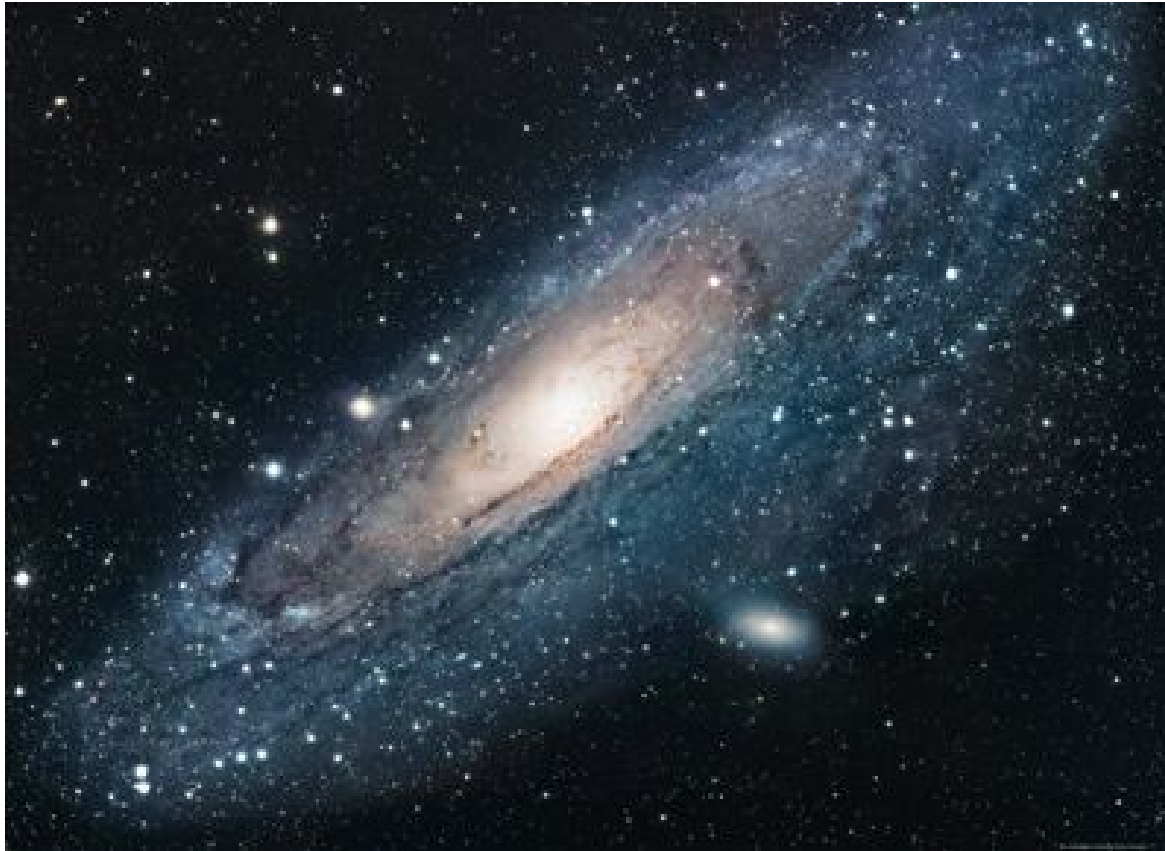


Ellipticals are low on dust and gas, reddish color (=old stars!), typically low luminosity and low mass ($10^6 M_{\odot}$)

Low rotation

M87

Galaxies: Spiral



Spiral Galaxies: Elliptical nucleus plus spiral arms, designated **Sa**, **Sb**, **Sc** depending on opening angle of spiral (Sa: $\sim 10^\circ$, Sc: $\sim 20^\circ$) and dominance of nucleus.

Bluer than ellipticals.

Mass content $\sim 3 \times 10^{11} M_\odot$, with $M/L \sim 20$,

Andromeda

Galaxies: Irregular



LMC

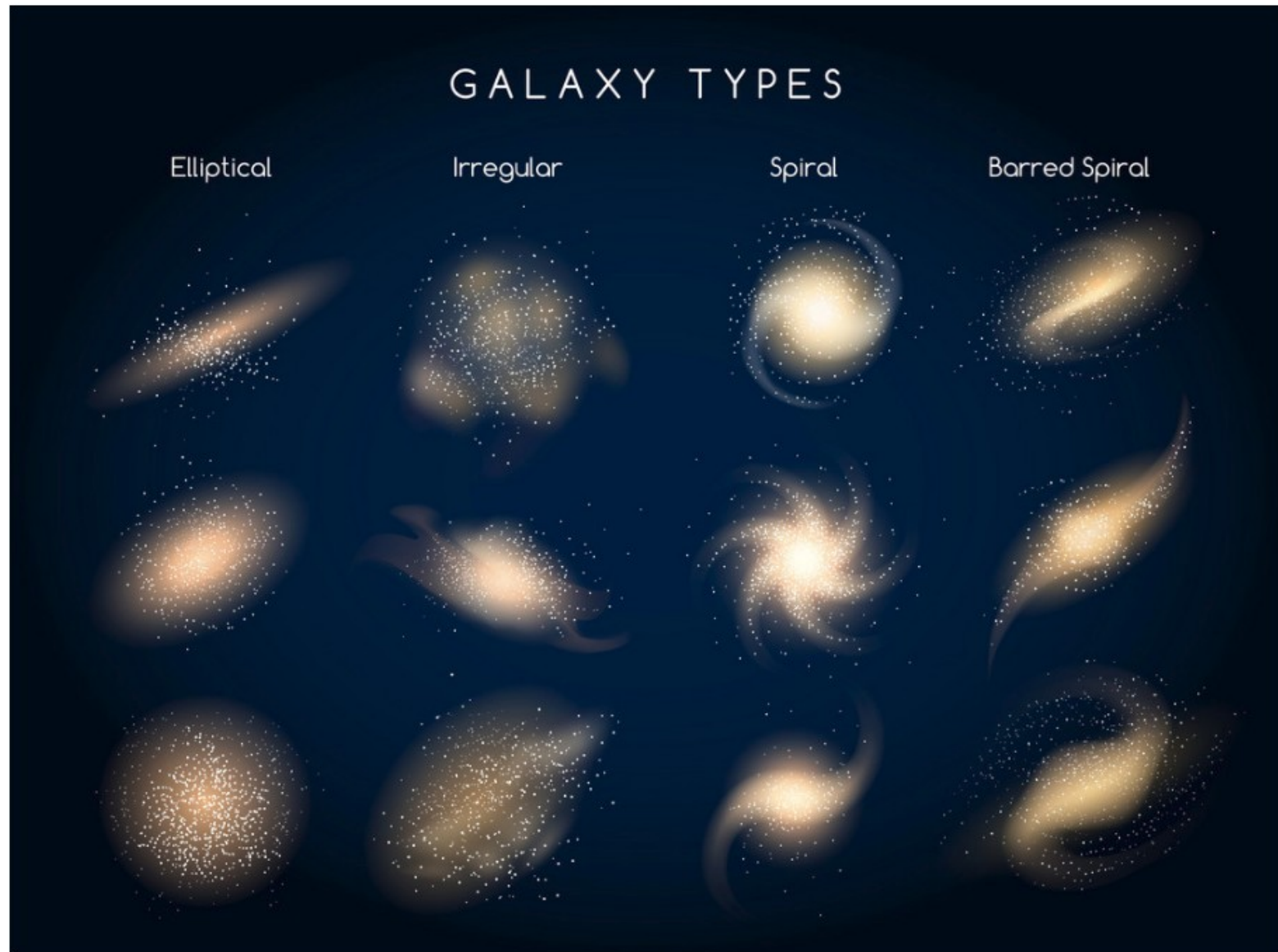
<http://zoo1.galaxyzoo.org/Tutorial.aspx>

irr I: no symmetry or spiral arms, bright knots of O- and B-type stars, very blue ($B - V \sim 0.5$), high dust content ($\sim 16\%$),

$M/L \sim 3$, masses vary appreciably from 10^6 to $10^{10} M_{\odot}$.

Examples: SMC, LMC
 $\Rightarrow$ “Magellanic type irregulars”.

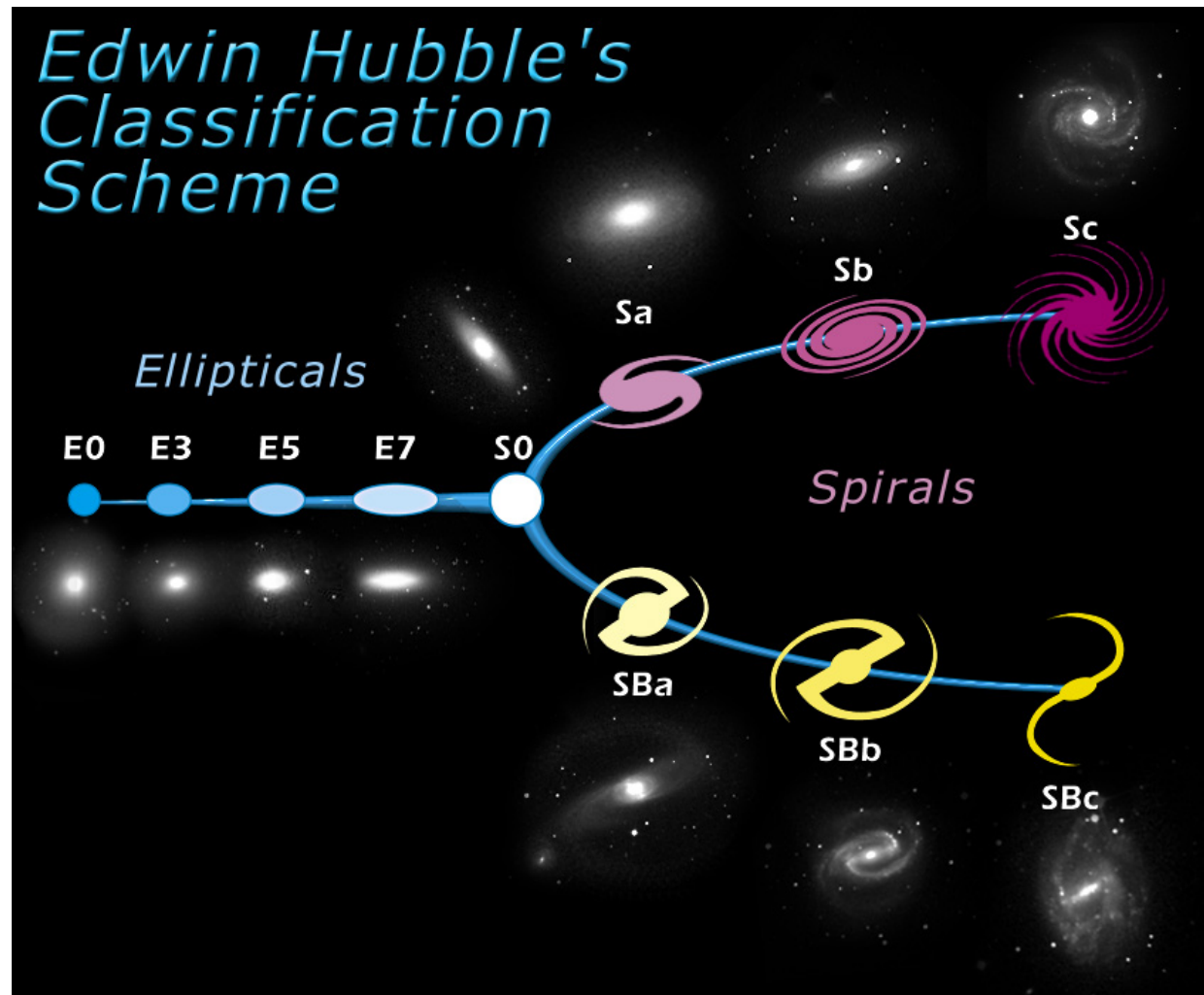
Galaxies: Not so simple



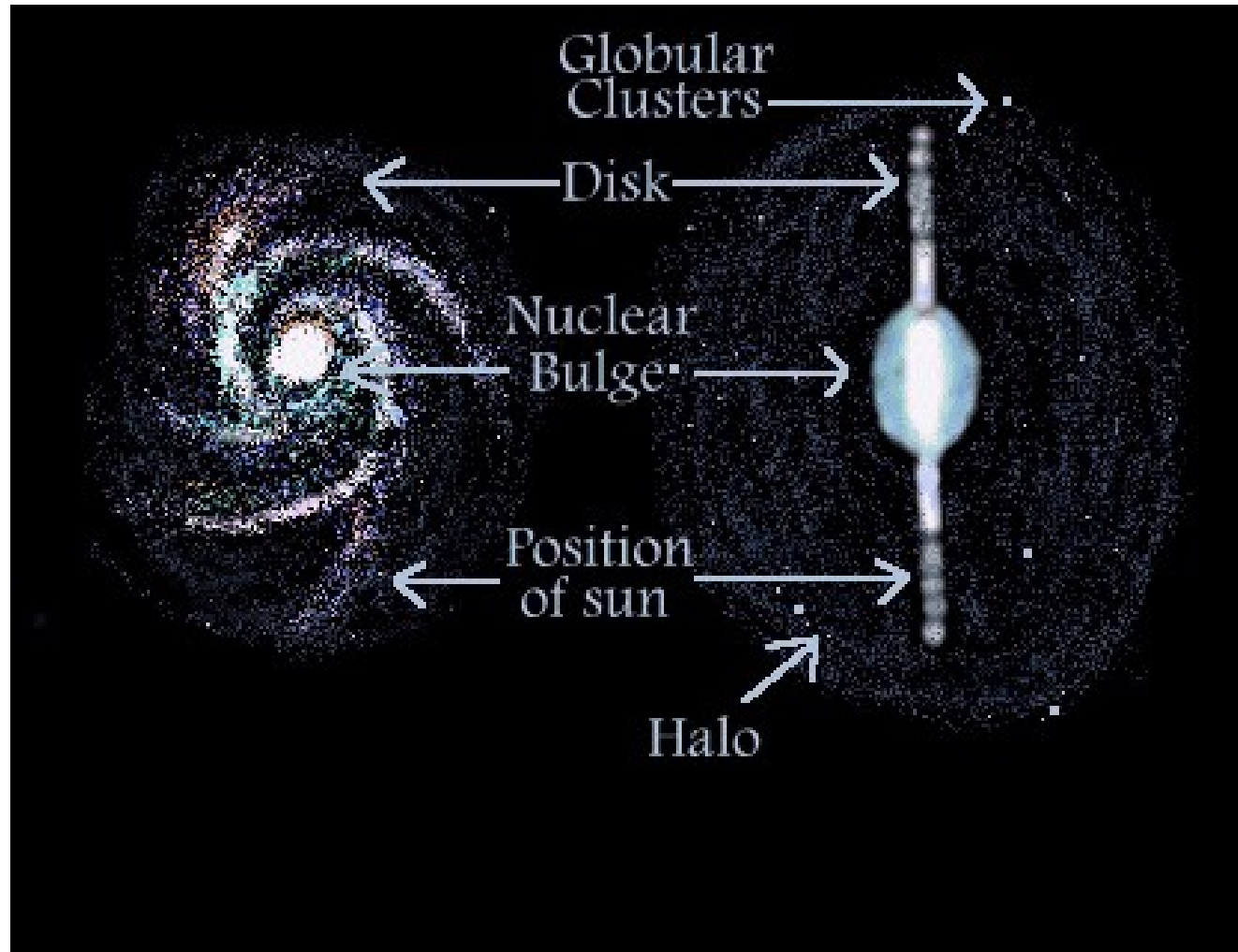




Galaxy classification: Hubble's Tuning fork



Spiral Galaxy components



Galaxies : rotation



This is a **clockwise**, face-on spiral galaxy



This is an **anti-clockwise**, face-on spiral galaxy

Galaxies : rotation



This is a **clockwise**, on-edge spiral galaxy



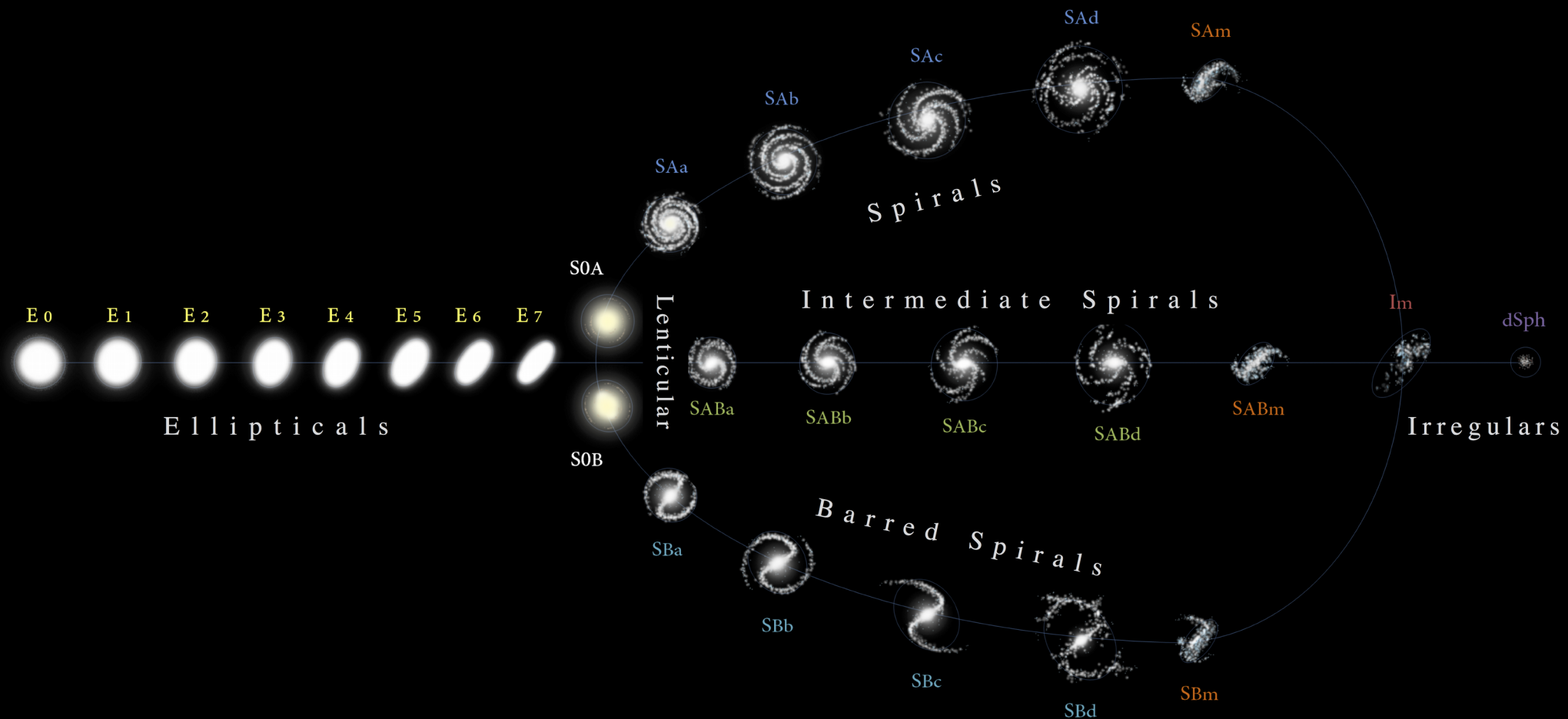
This is an **anti-clockwise**, on-edge spiral galaxy

Merging Galaxies



Galaxy classification: Updated Tuning fork

HUBBLE-DE VAUCOULEURS DIAGRAM



Rotation curve of Galaxy

