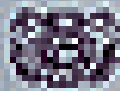
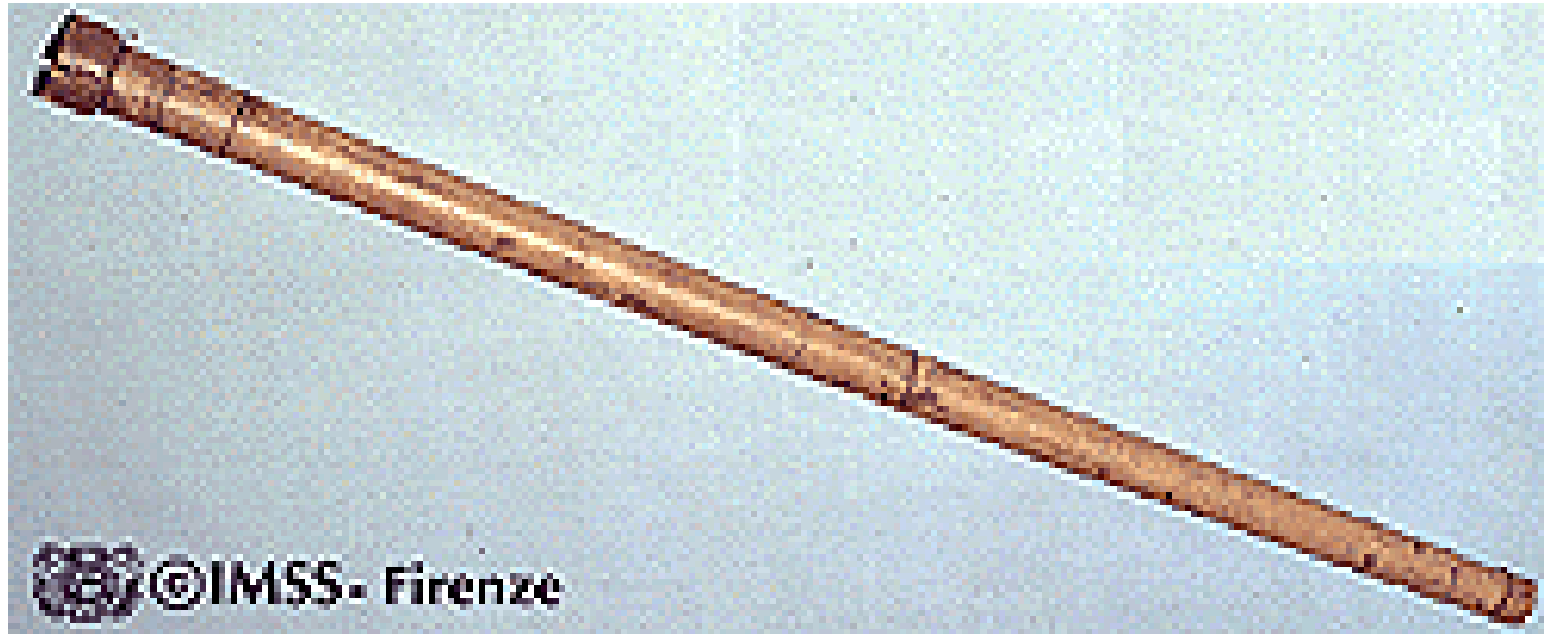
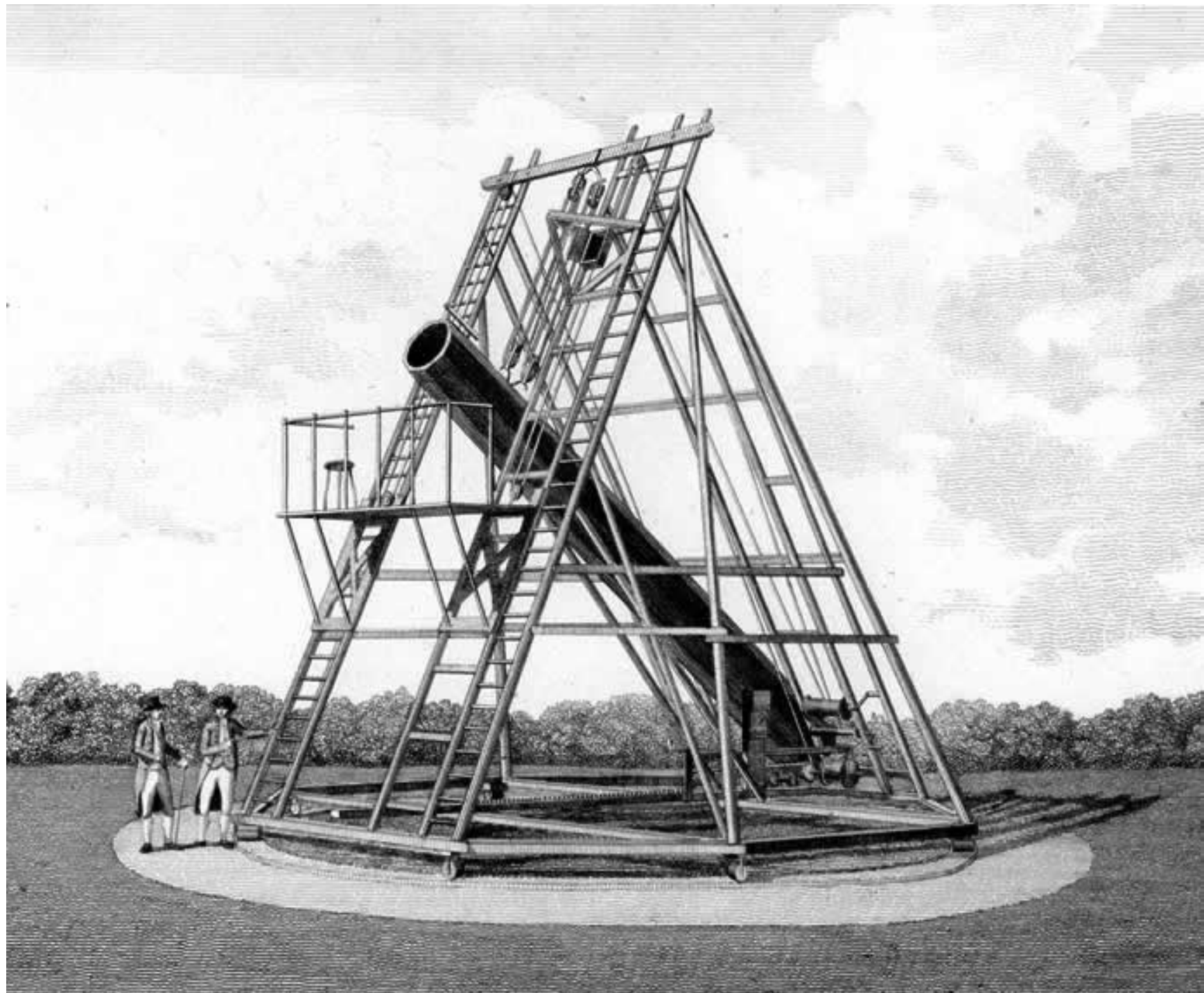


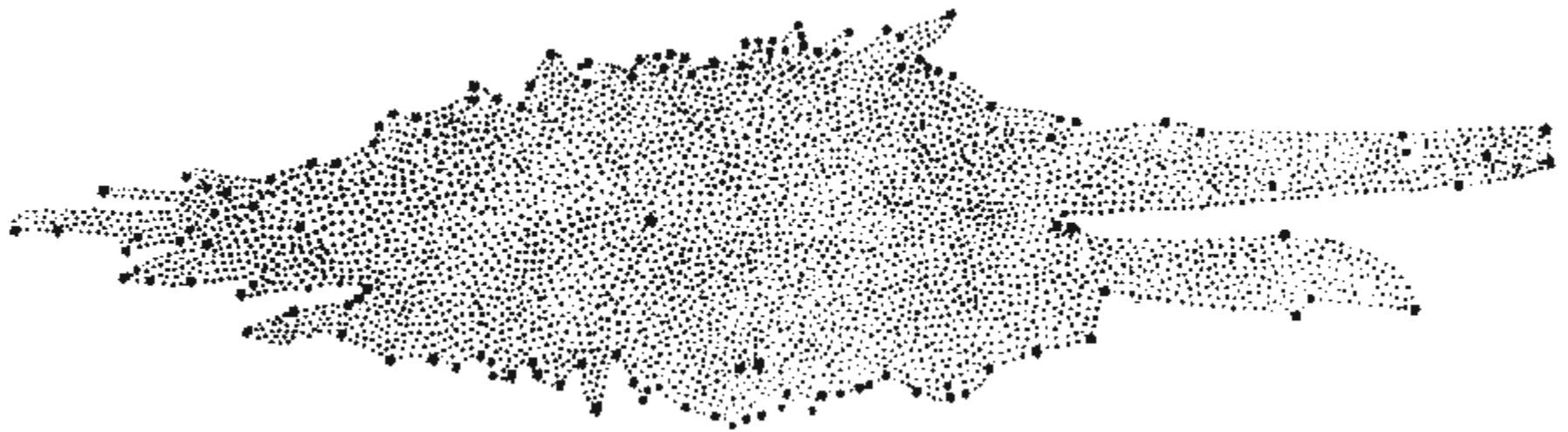
Poznawanie i modelowanie Wszechświata

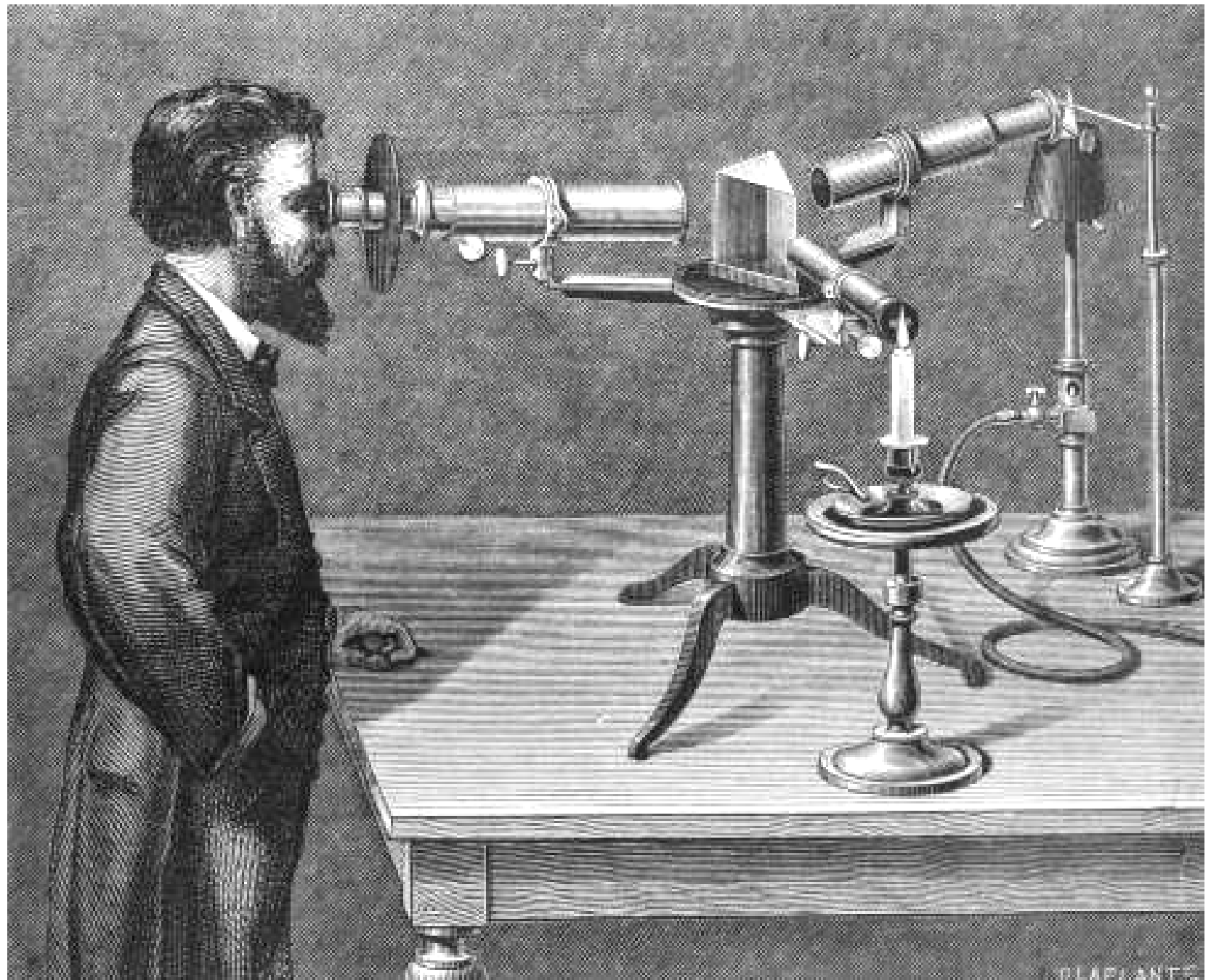
Marek Demiański
Instytut Fizyki Teoretycznej
Uniwersytet Warszawski

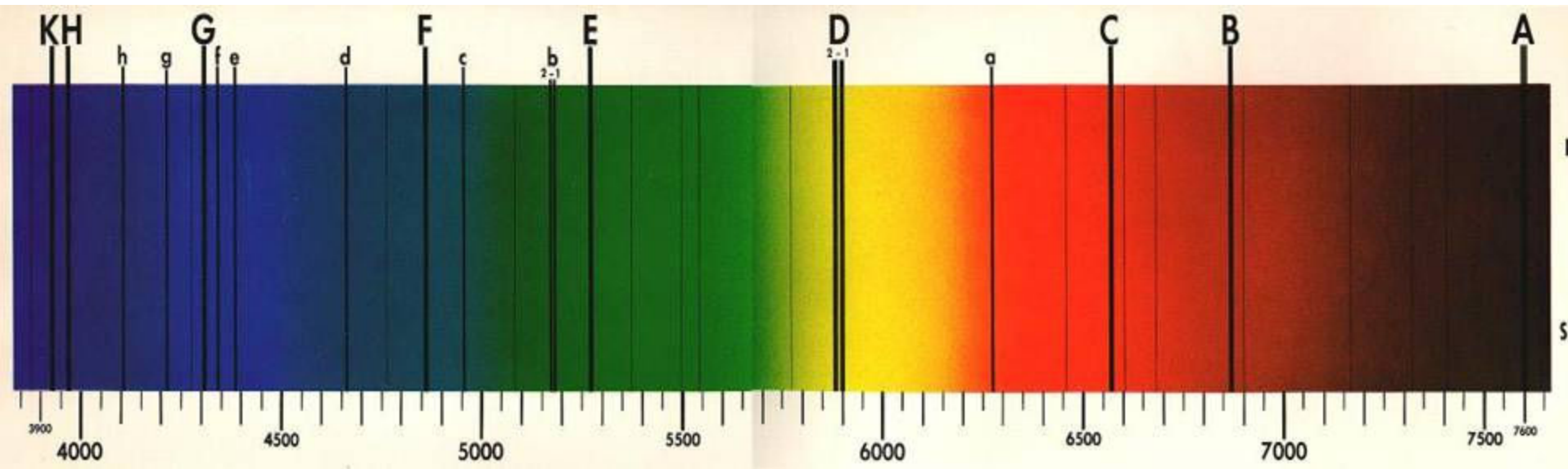


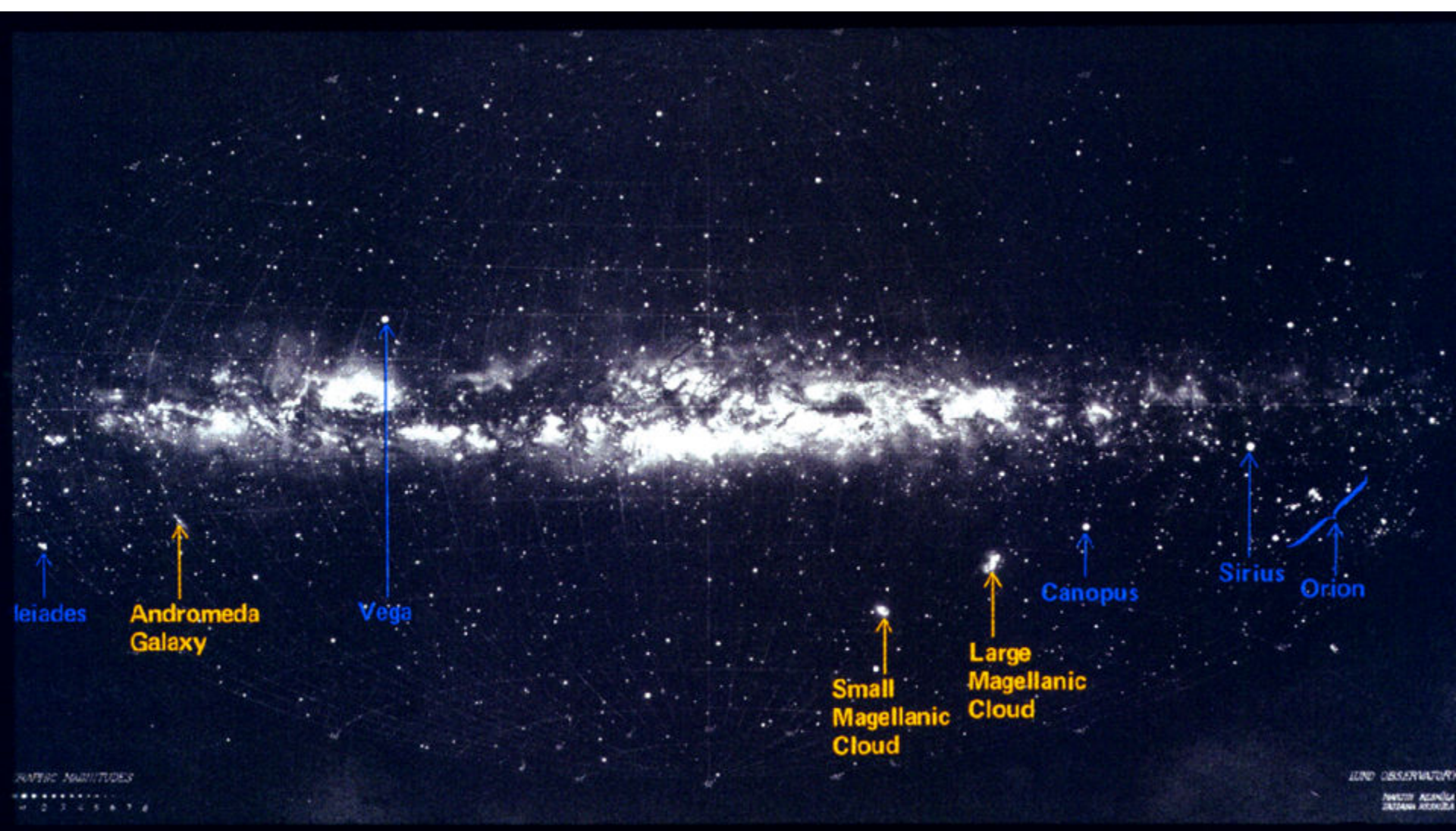
©IMSS - Firenze











Pleiades

Andromeda Galaxy

Vega

Small Magellanic Cloud

Large Magellanic Cloud

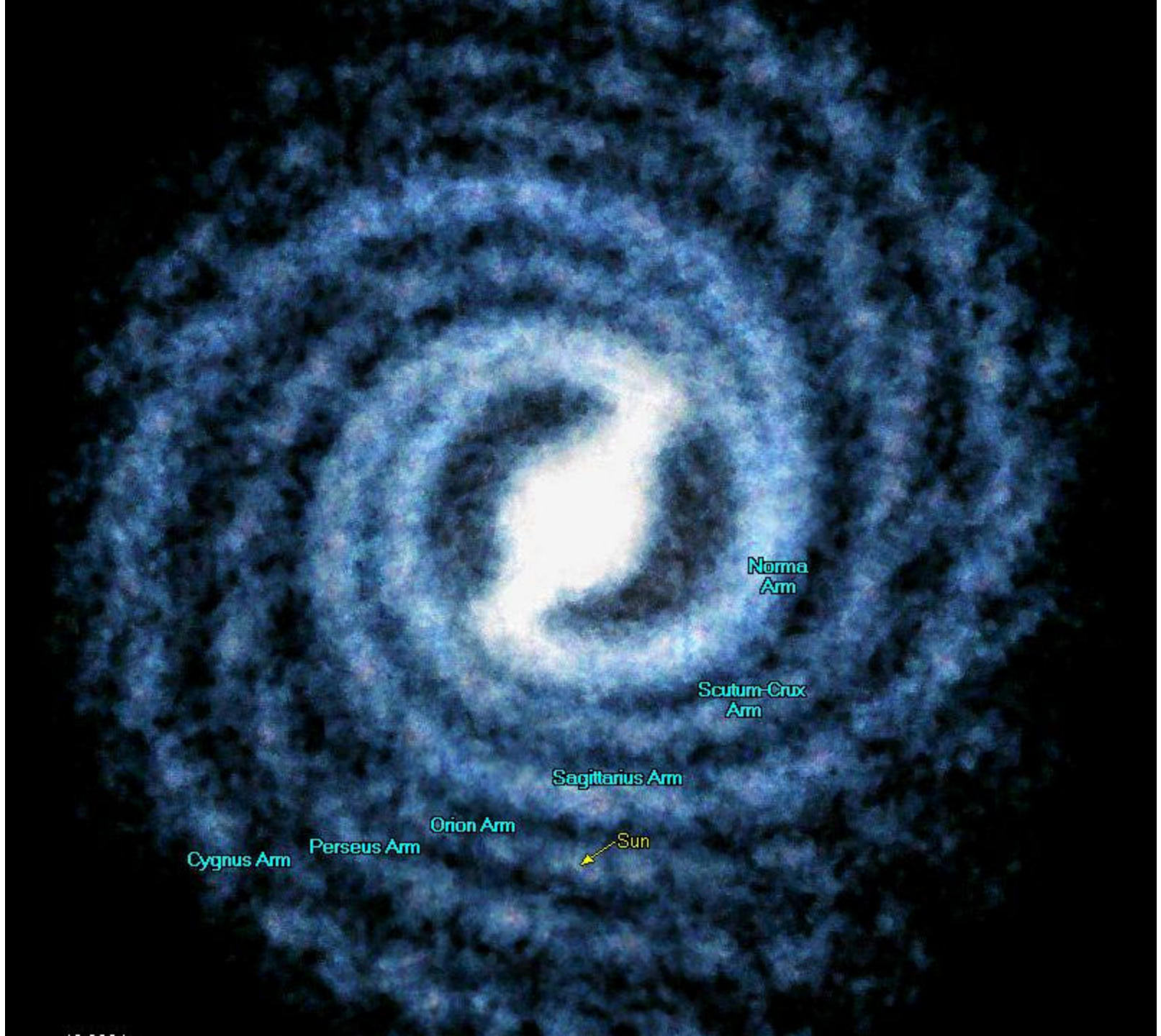
Canopus

Sirius

Orion

MAGNITUDE
.....
4 3 2 1 0

LUND OBSERVATORY
FACULTY AGANOLA
DANSKANA ASTRONOMI



Norma Arm

Scutum-Crux Arm

Sagittarius Arm

Orion Arm

Perseus Arm

Cygnus Arm

Sun

Rozmiary Drogi Mlecznej

- Średnica dysku 120000 lat świetlnych
- Grubość dysku 1000 lat świetlnych
- Średnica galaktycznego halo 300000 lat świetlnych
- Odległość Słońca od centrum Galaktyki 28000 lat świetlnych
- Galaktyka składa się z około 150 miliardów gwiazd

Edwin Hubble









Galaktyka NGC 891





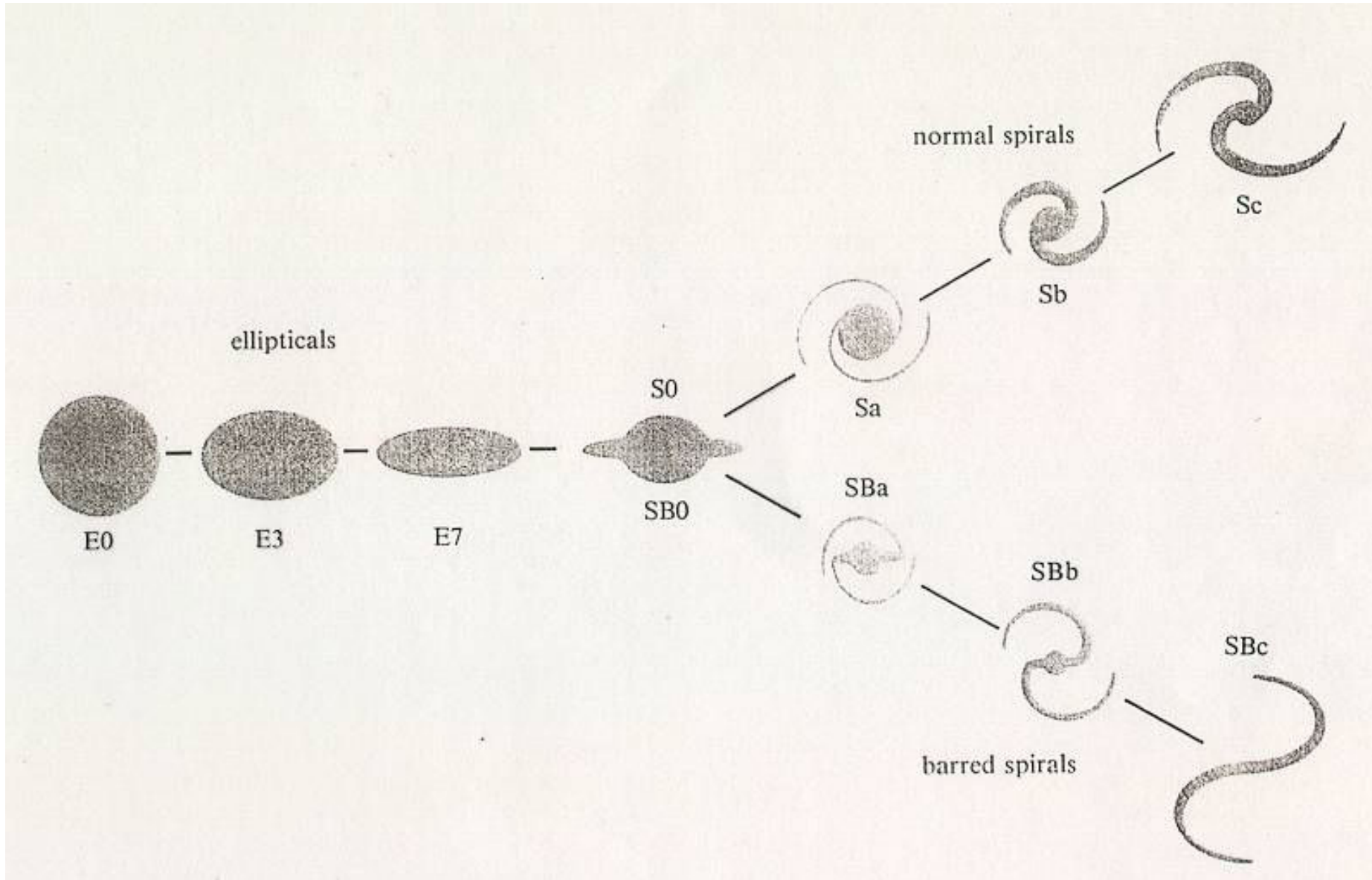










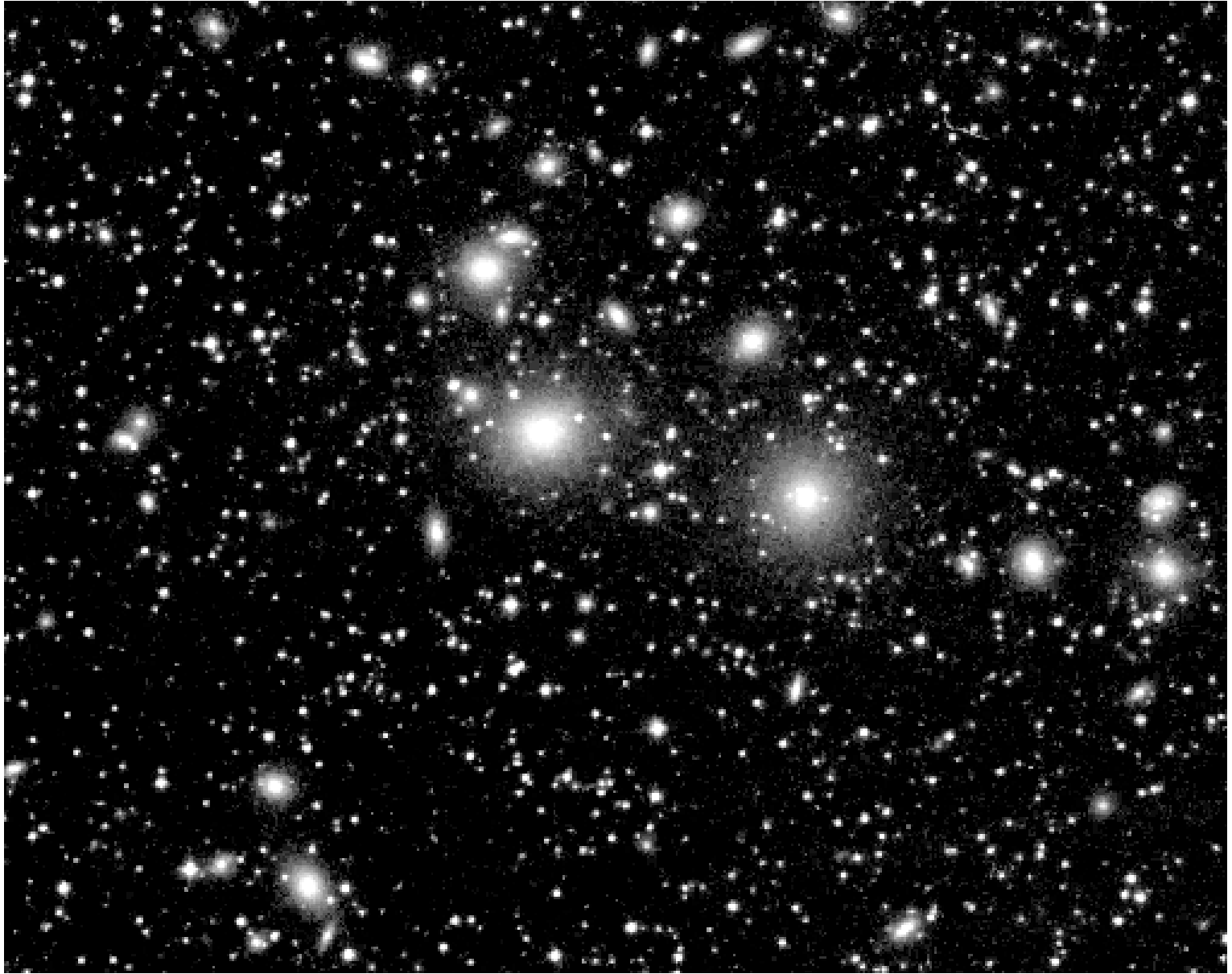


Skład chemiczny Wszechświata

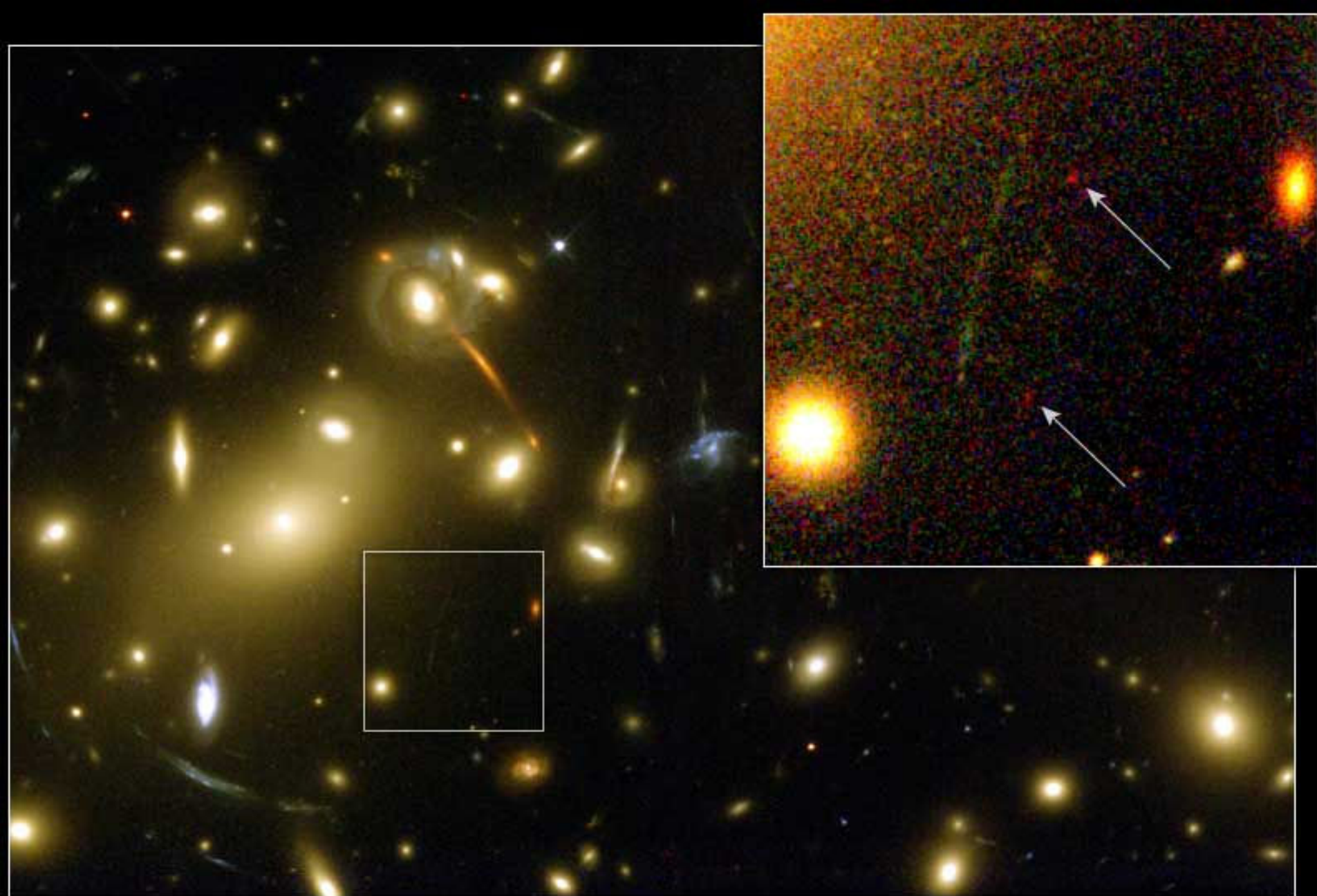
~ 75% H

~ 25% He

Gromada galaktyk

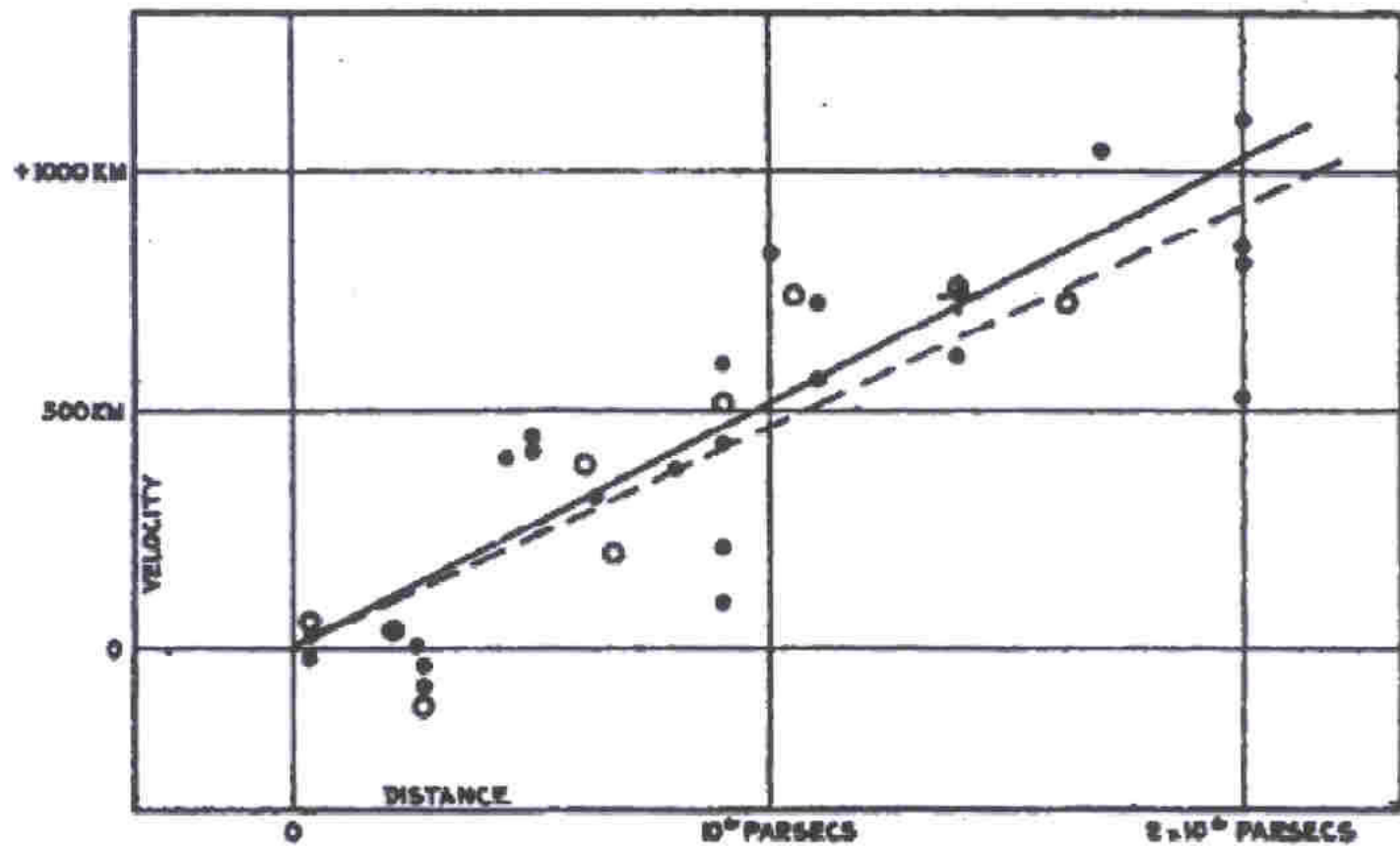


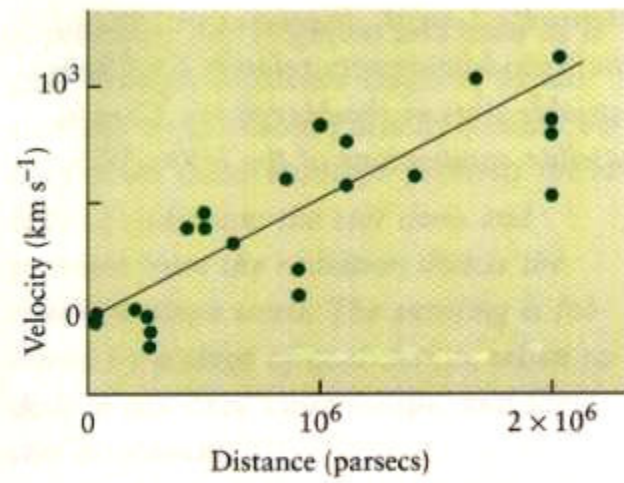




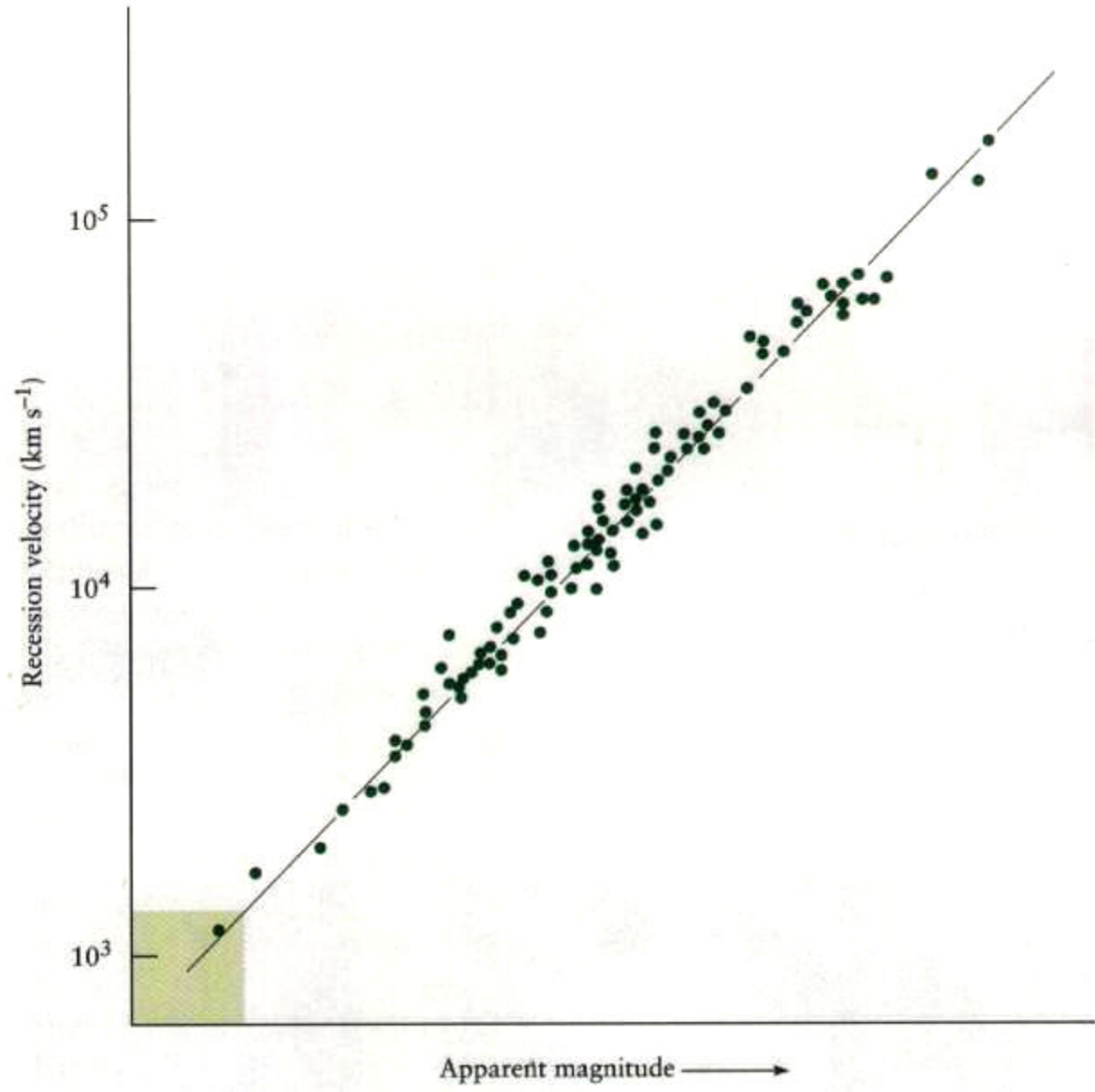
Distant Object Gravitationally Lensed by Galaxy Cluster Abell 2218 HST • WFPC2

NASA, ESA, R. Ellis (Caltech) and J.-P. Kneib (Observatoire Midi-Pyrenees) • STScI-PRC01-32



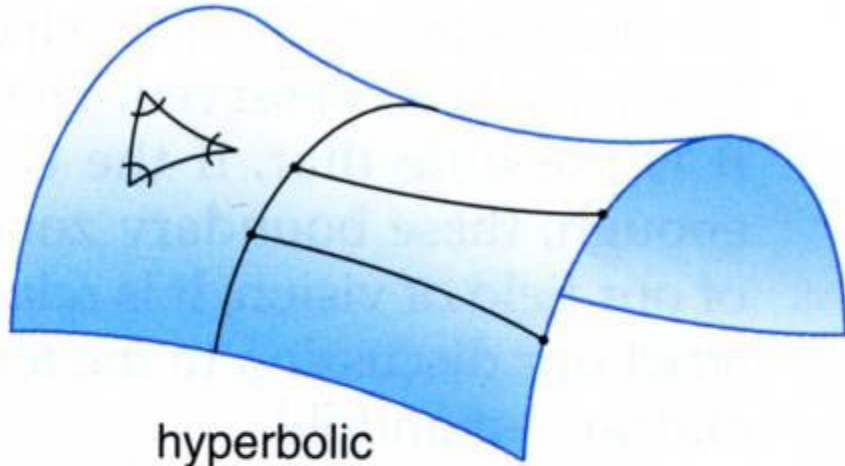


Edwin Hubble made this plot of galaxy velocities versus distances in the 1930s (above left). He only sampled a nearby volume of space, as far as the Virgo cluster. This so-called Hubble diagram was greatly extended by Alan Sandage and his collaborators (right), who compared the recession velocities of the brightest galaxies in galaxy clusters with distances to the clusters as inferred from the apparent magnitudes of these galaxies. A galaxy cluster is so luminous that it can be recognized at a large distance from us. Both plots show that recession velocity increases proportionately to distance.

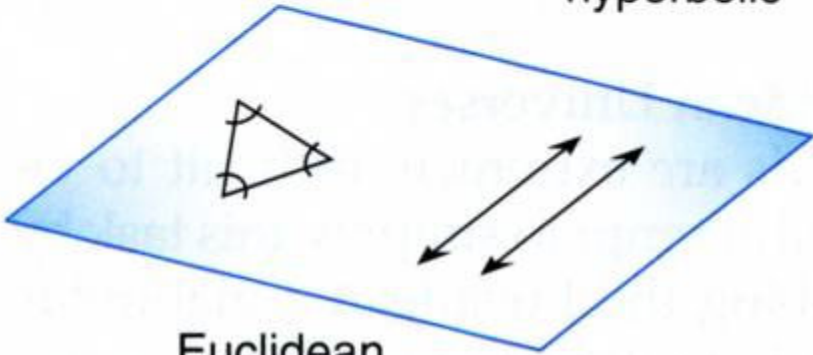




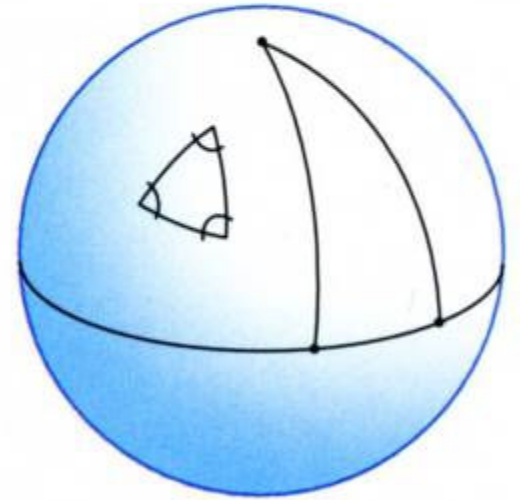




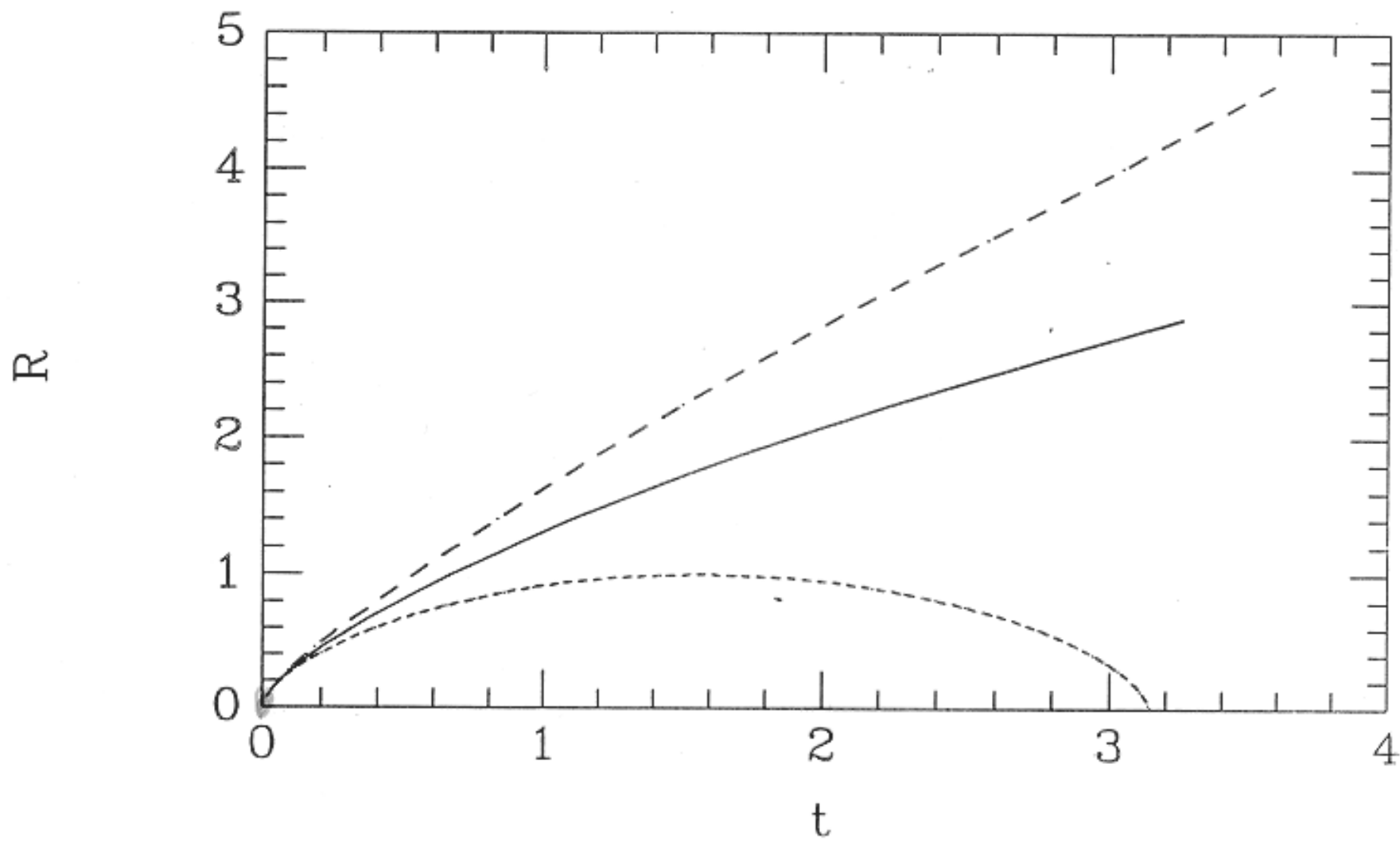
hyperbolic



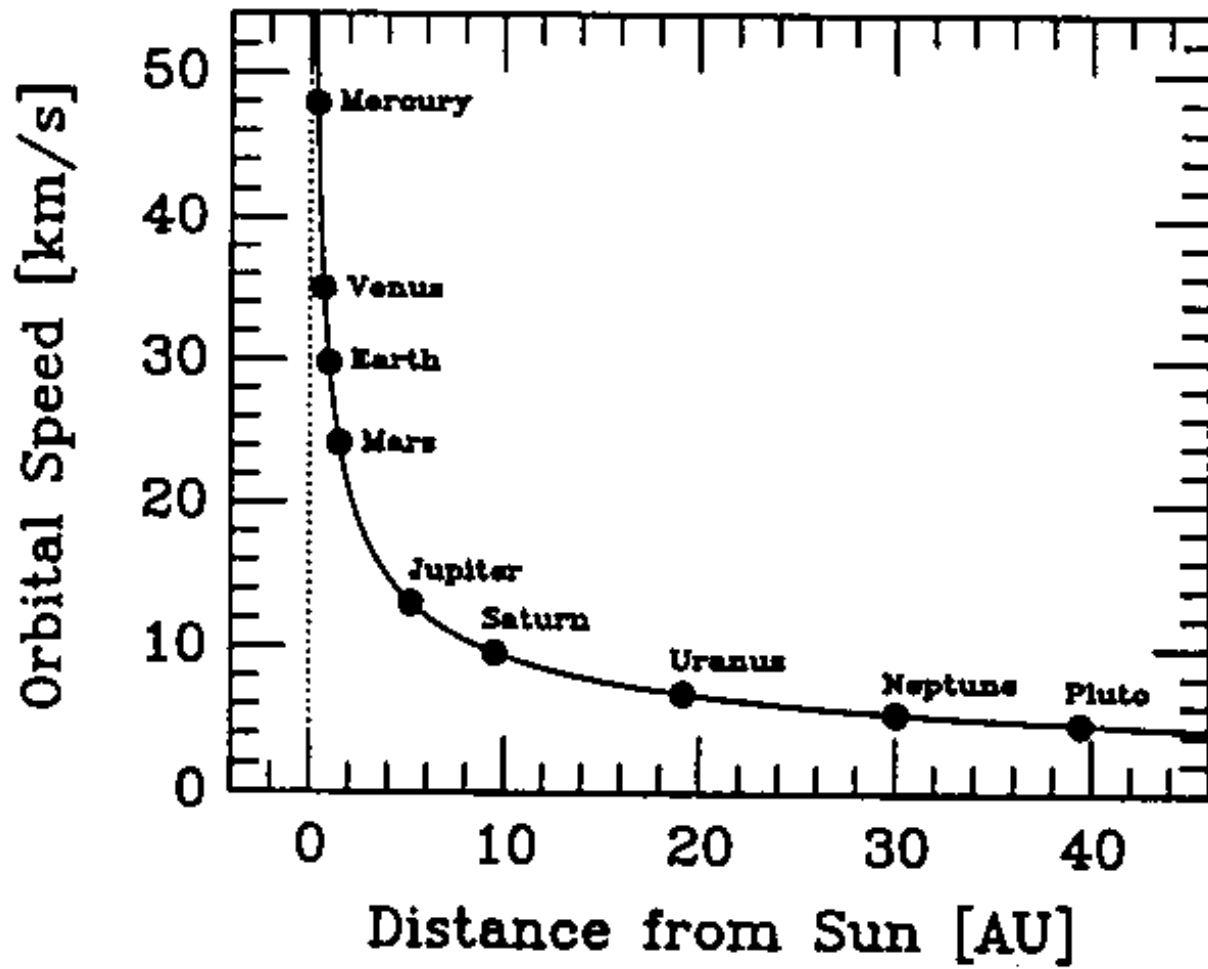
Euclidean

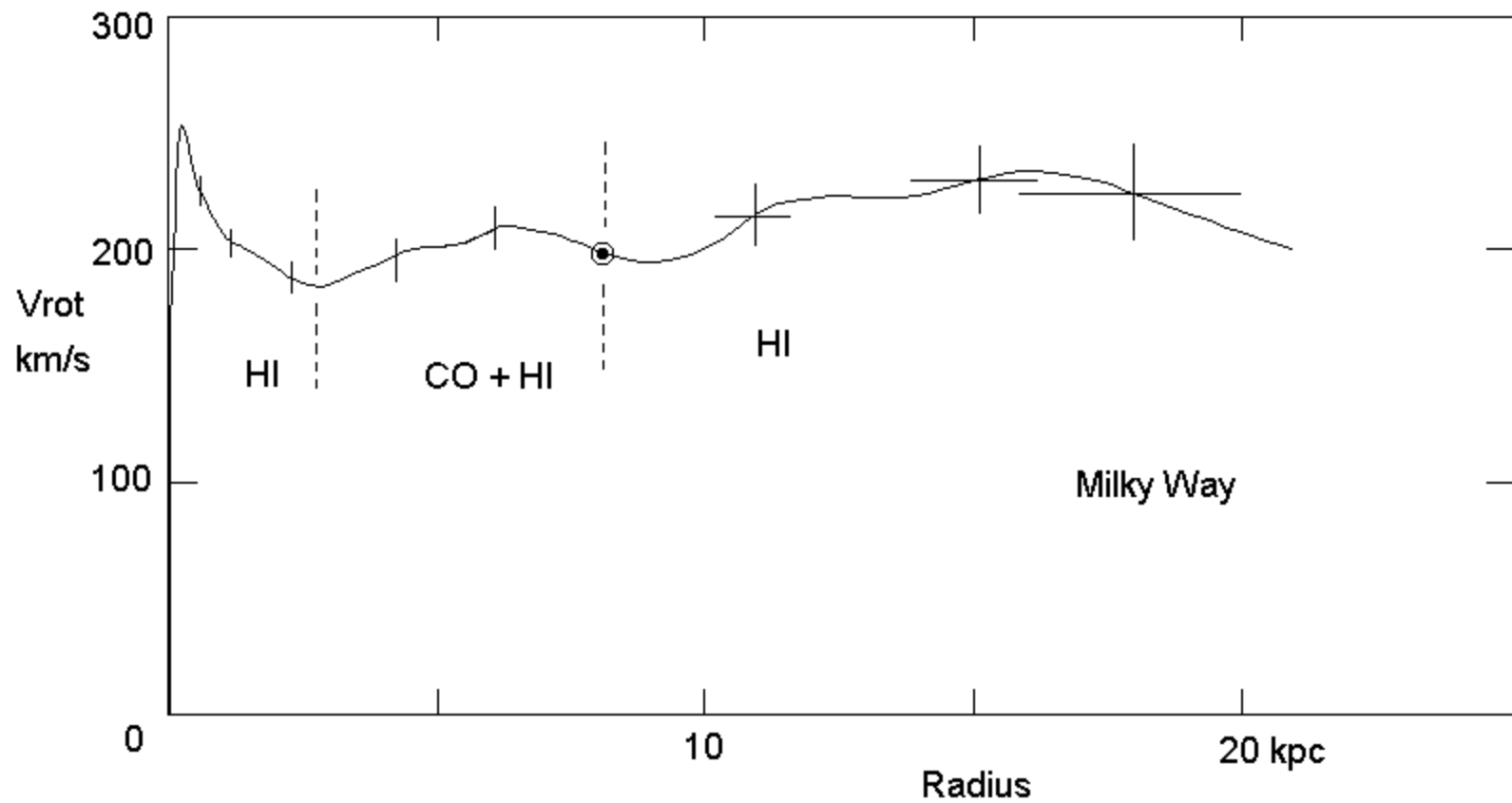


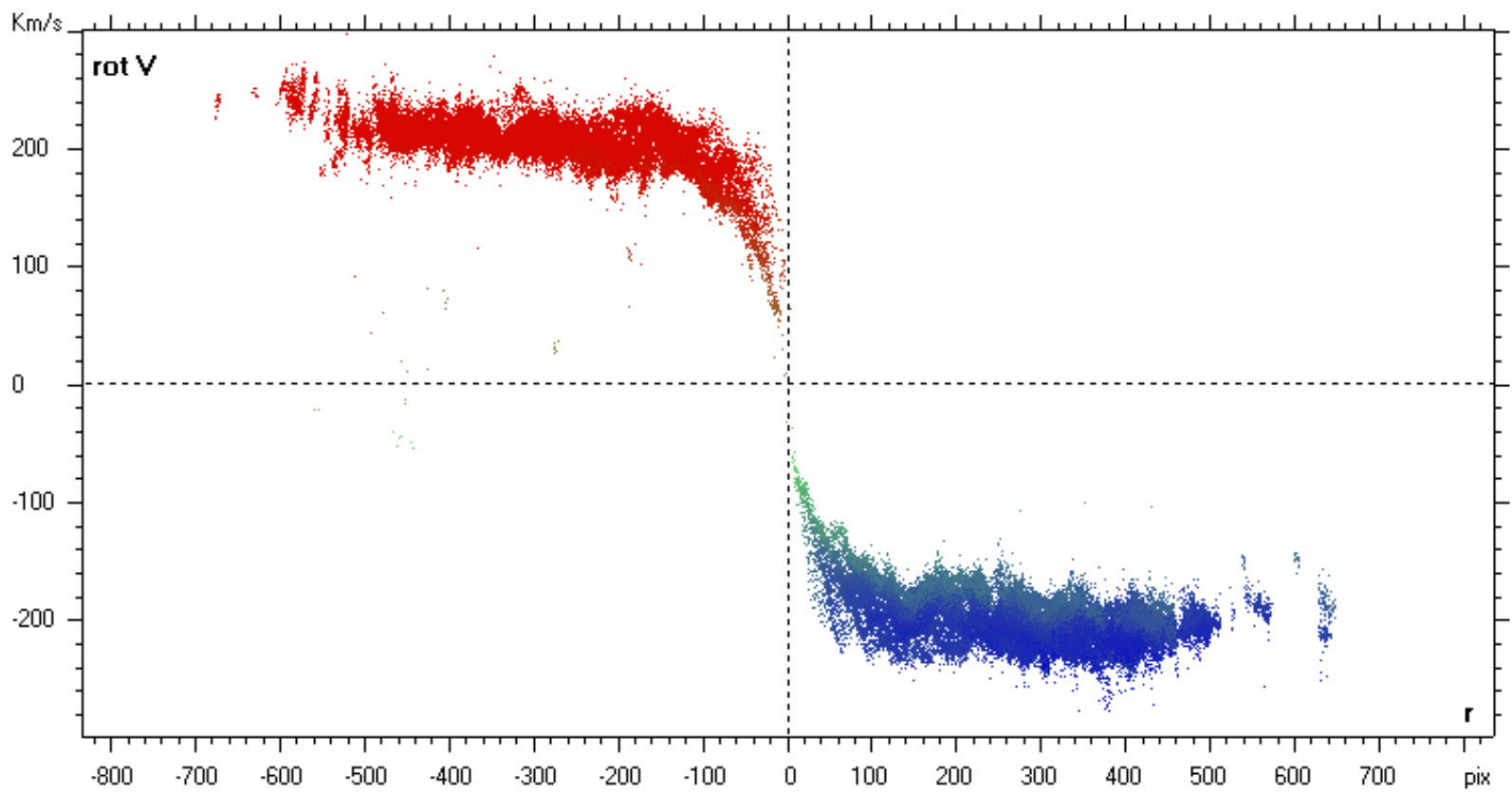
spherical

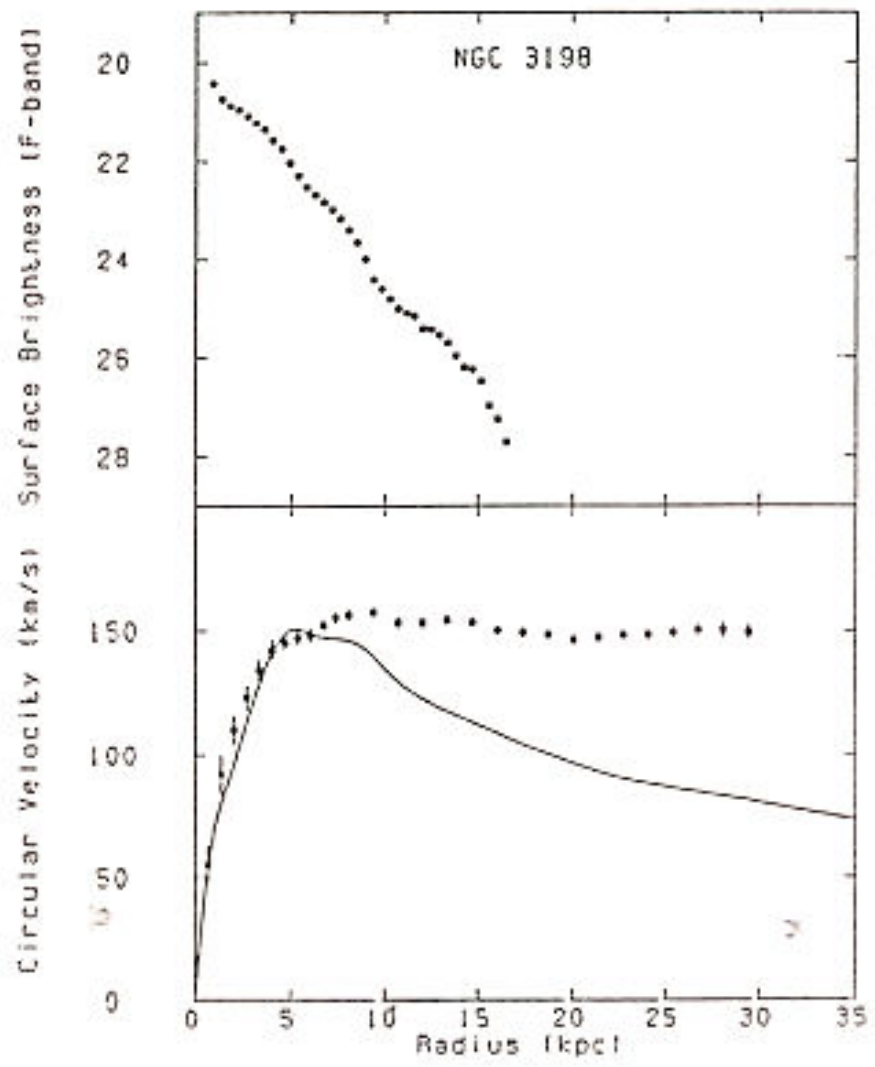










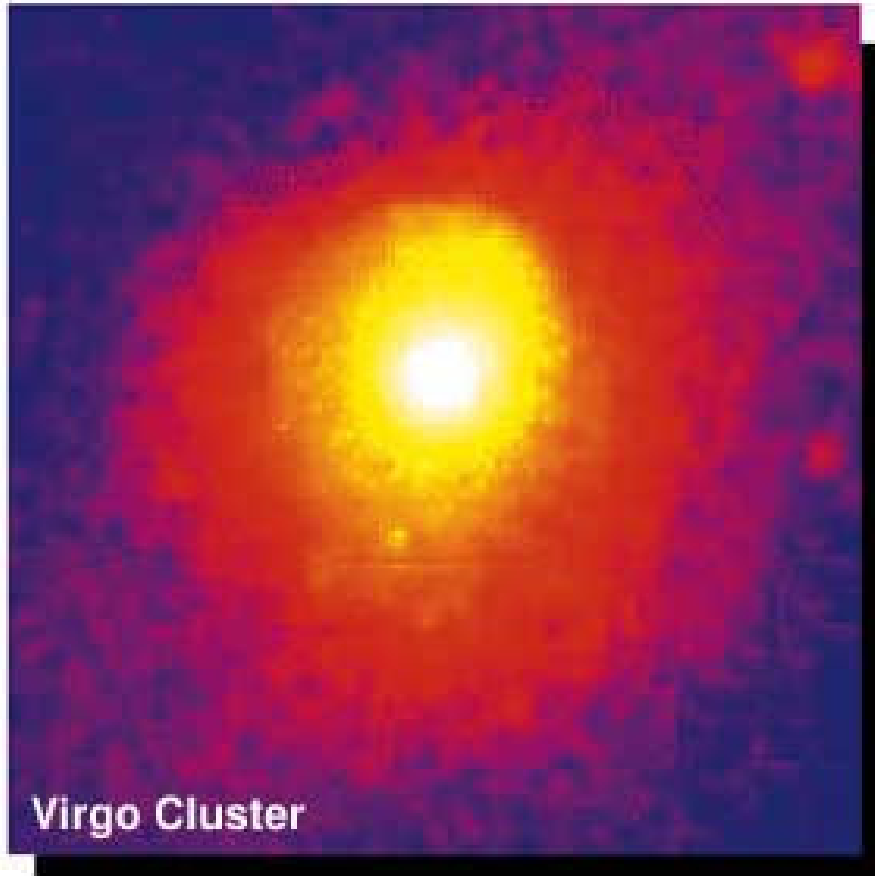


Wnioski z prawa Keplera

$$v(r) = (GM(r)/r)^{1/2} = \text{const}$$

$$M(r) \sim r$$

$$\square \sim 1/r^2$$



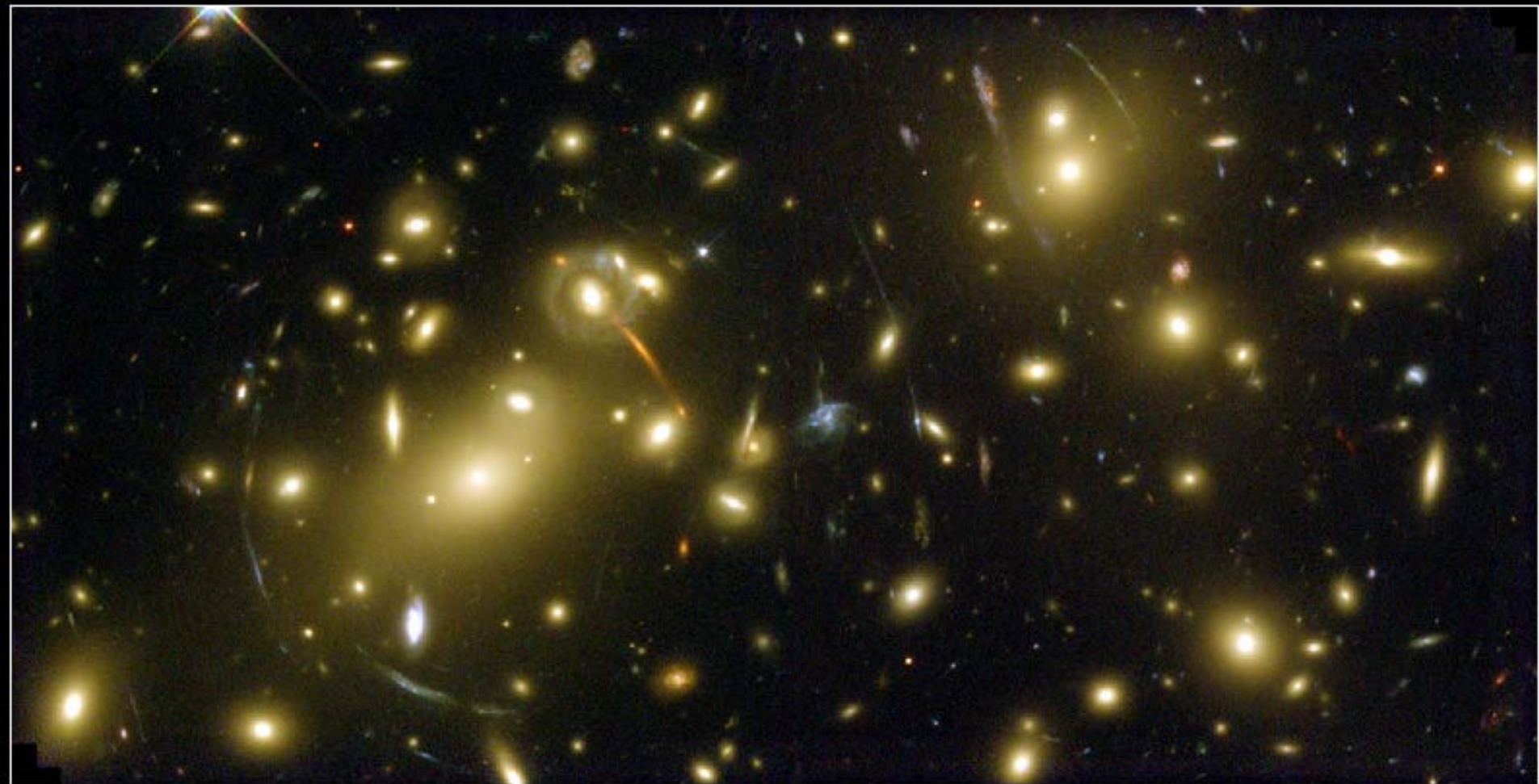
0.5 Mpc



ROSAT PSPC
Abell 2256



MRF 6.00



Galaxy Cluster Abell 2218

HST • WFPC2

NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

Stosunek masy do jasności

galaktyki $M/L \sim 3 - 50$

gromady galaktyk

$M/L \sim 100 - 500$

Potencjalne cząstki tworzące ciemną materię:

aksjony,

neutralino, $m_N \sim 50 \text{ GeV}$,

grawitino,

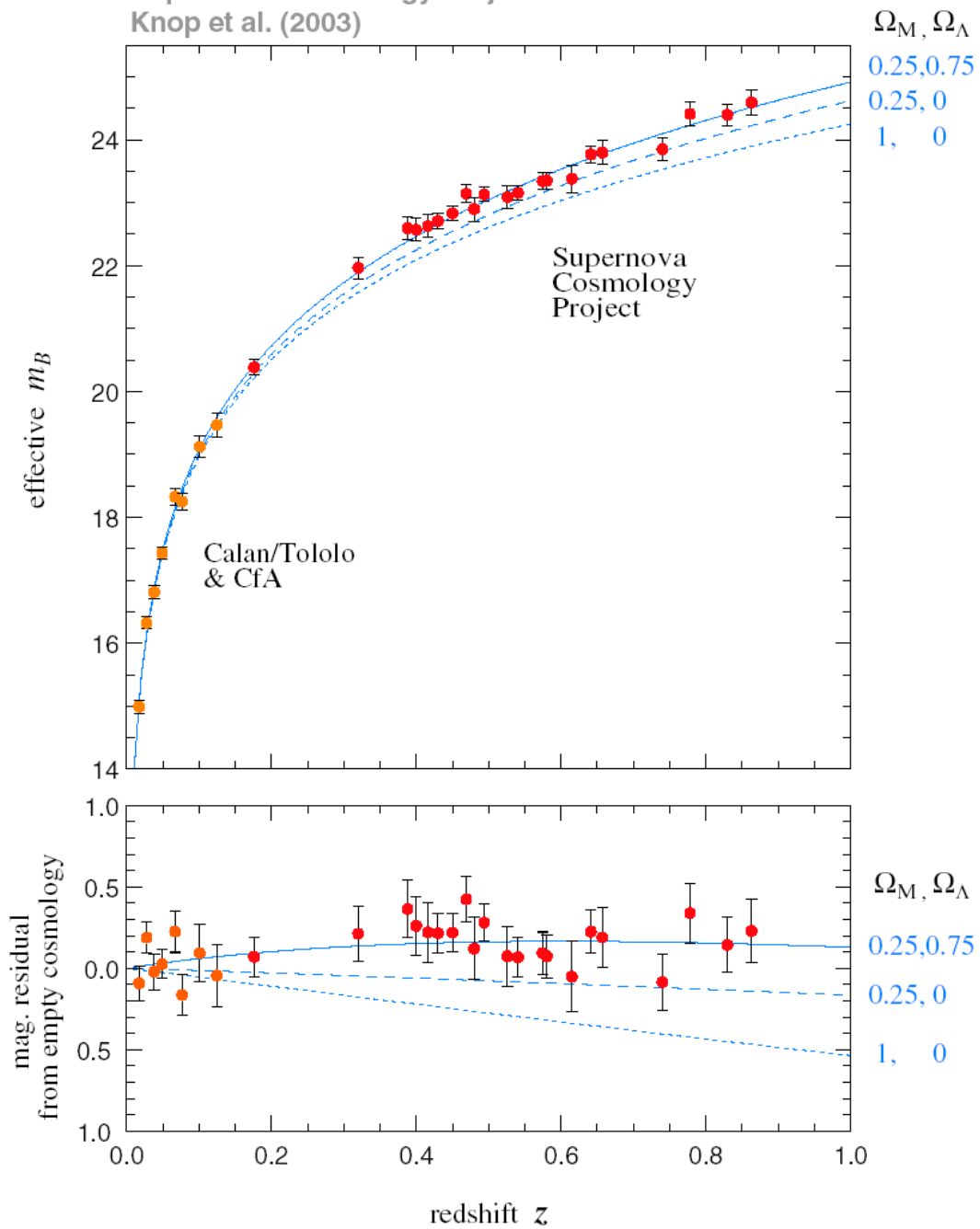
inne WIMPs

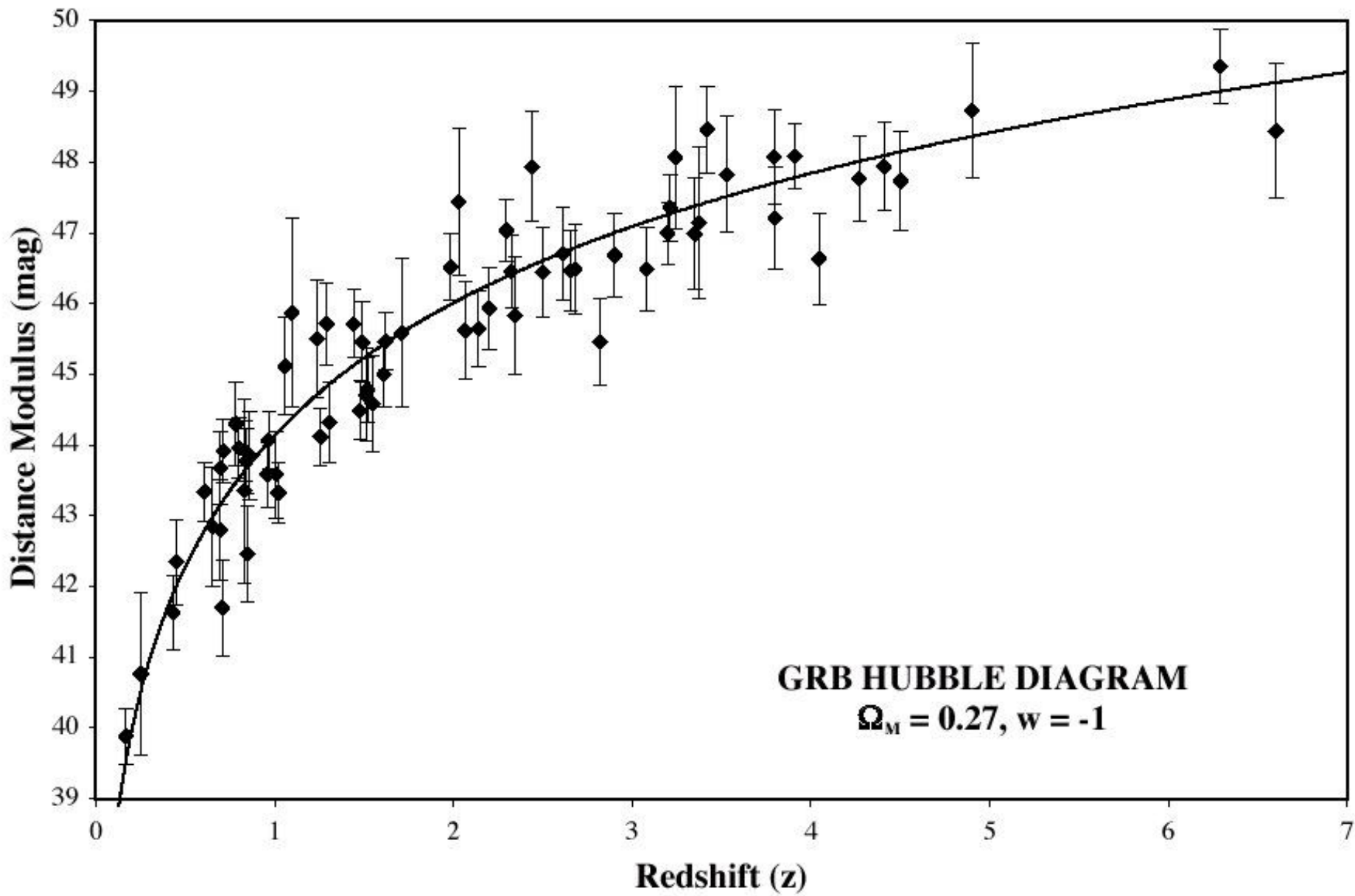
Gęstość cząstek ciemnej materii w otoczeniu Słońca

$$n_{\text{DM}} \text{ (clock icon)} 0.3 (1\text{GeV}/m) 1/\text{cm}^3$$

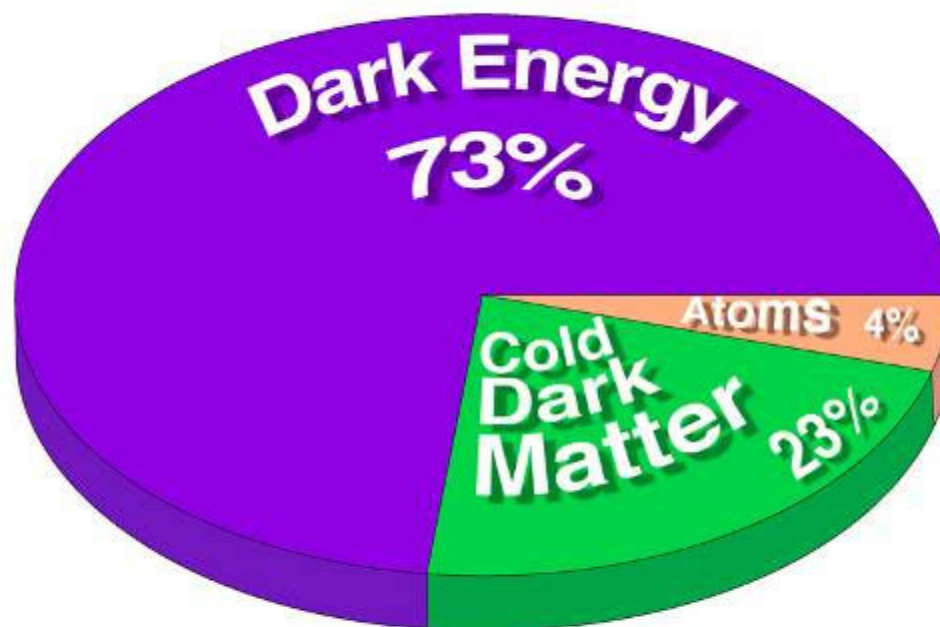


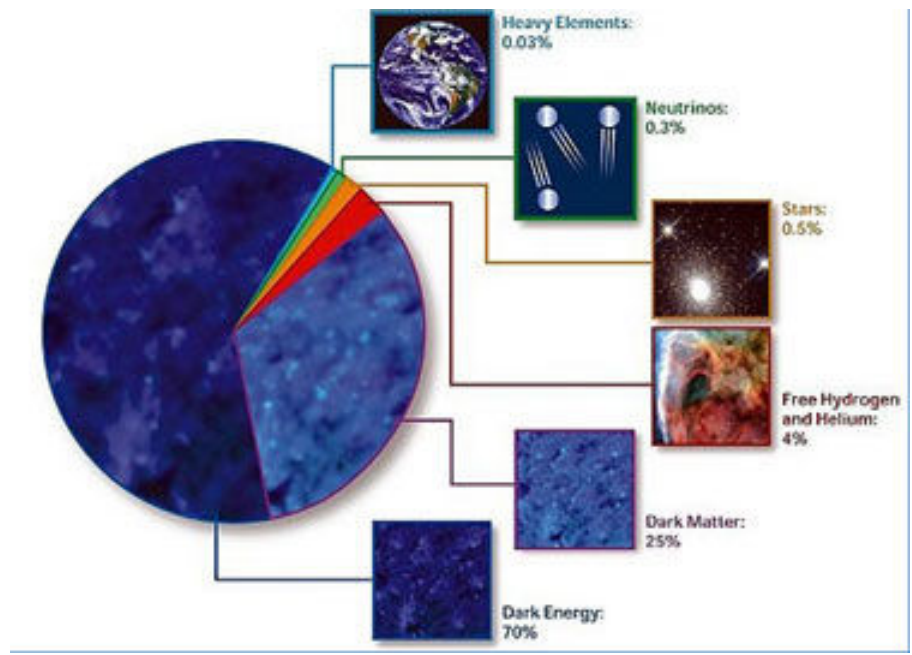
Supernova Cosmology Project
Knop et al. (2003)





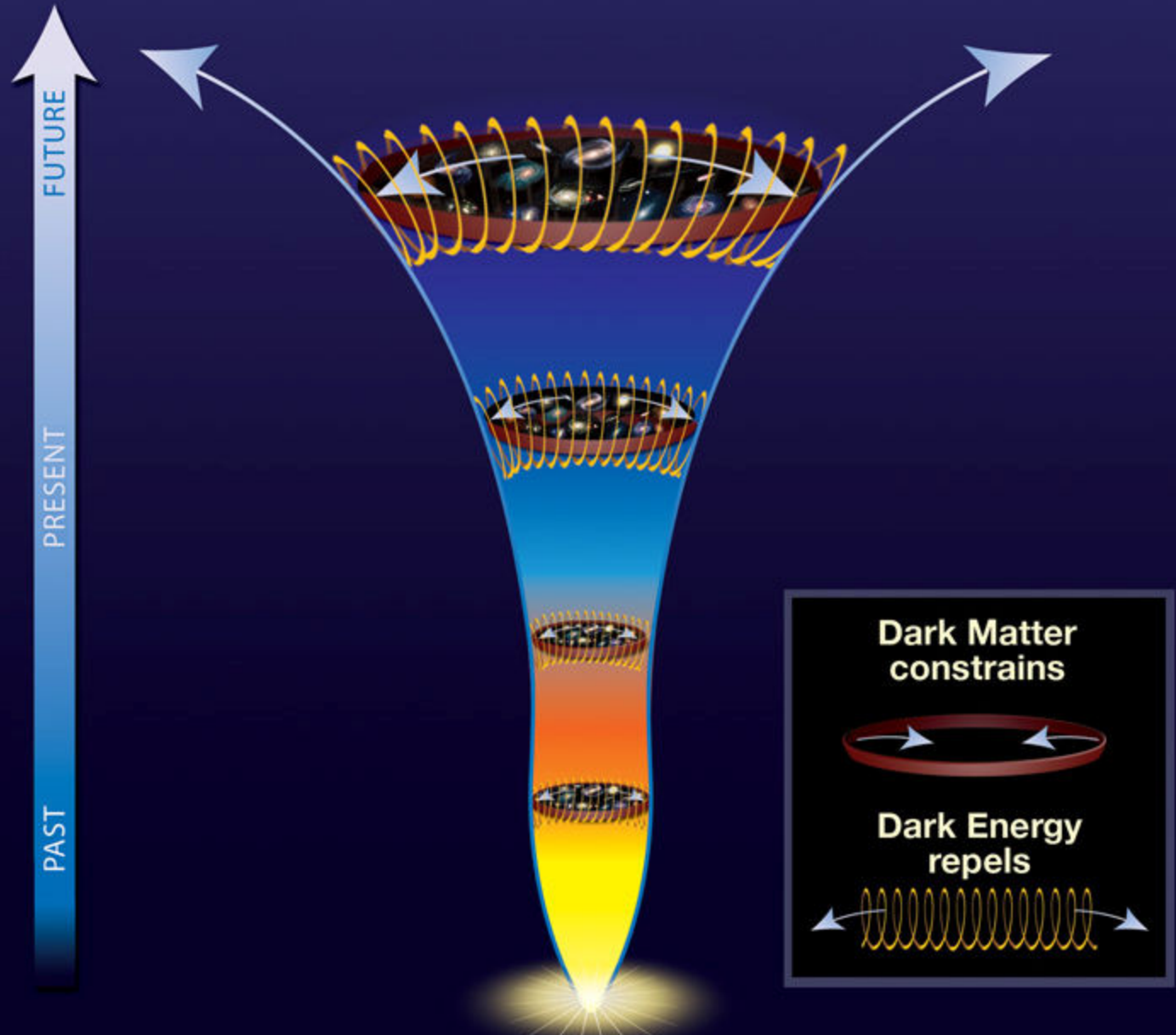
Podstawowe składniki Wszechświata

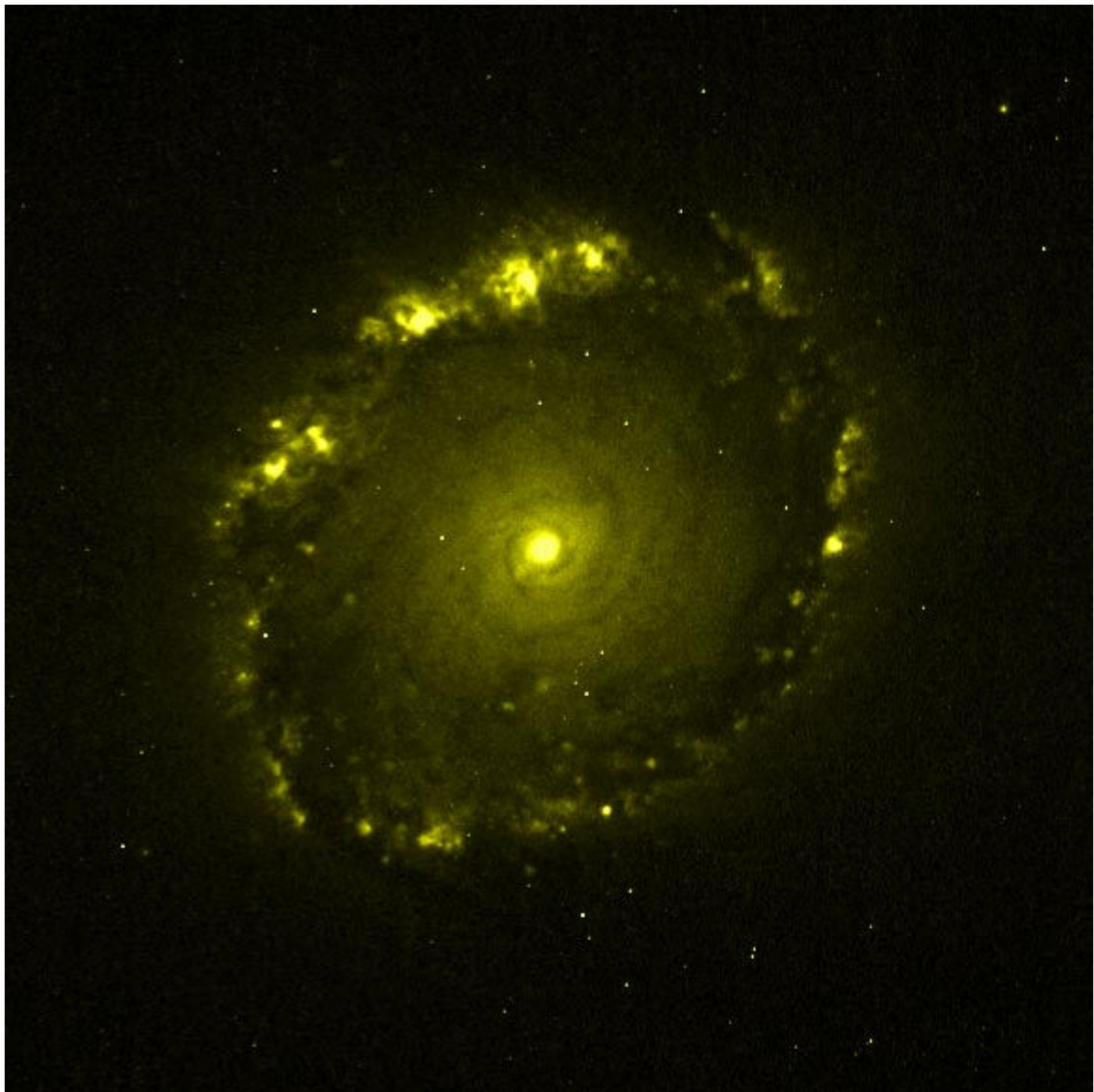




Cosmic tug of war

The force of dark energy surpasses that of dark matter as time progresses.





Whirlpool Galaxy • M51



Hubble
Heritage

NASA and The Hubble Heritage Team (STScI/AURA)
Hubble Space Telescope WFPC2 • STScI-PRC01-07

