Galaxias y Cuásares

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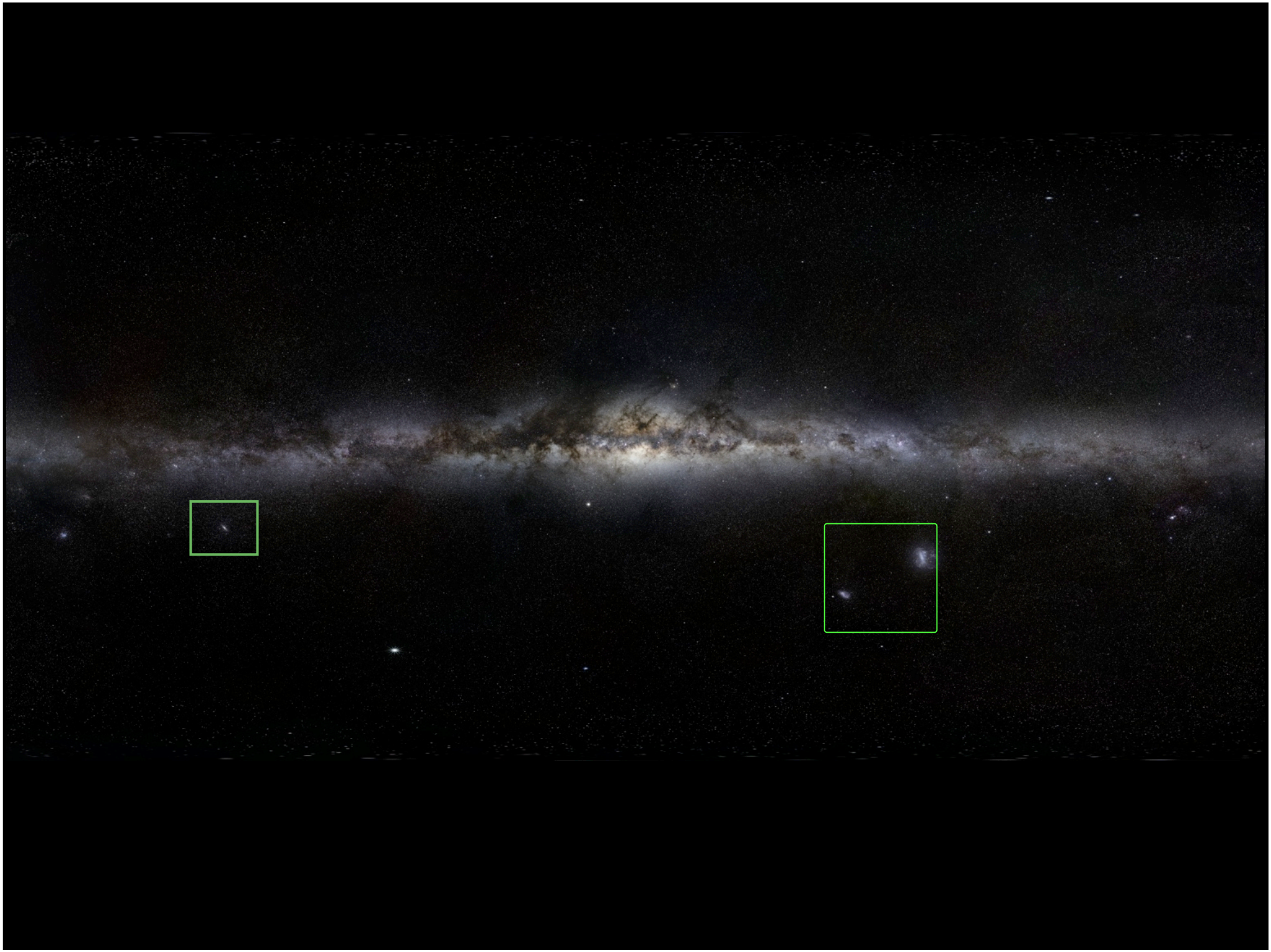
Universidad de Valencia

MUSEO ELDER
20 de Noviembre de 2009

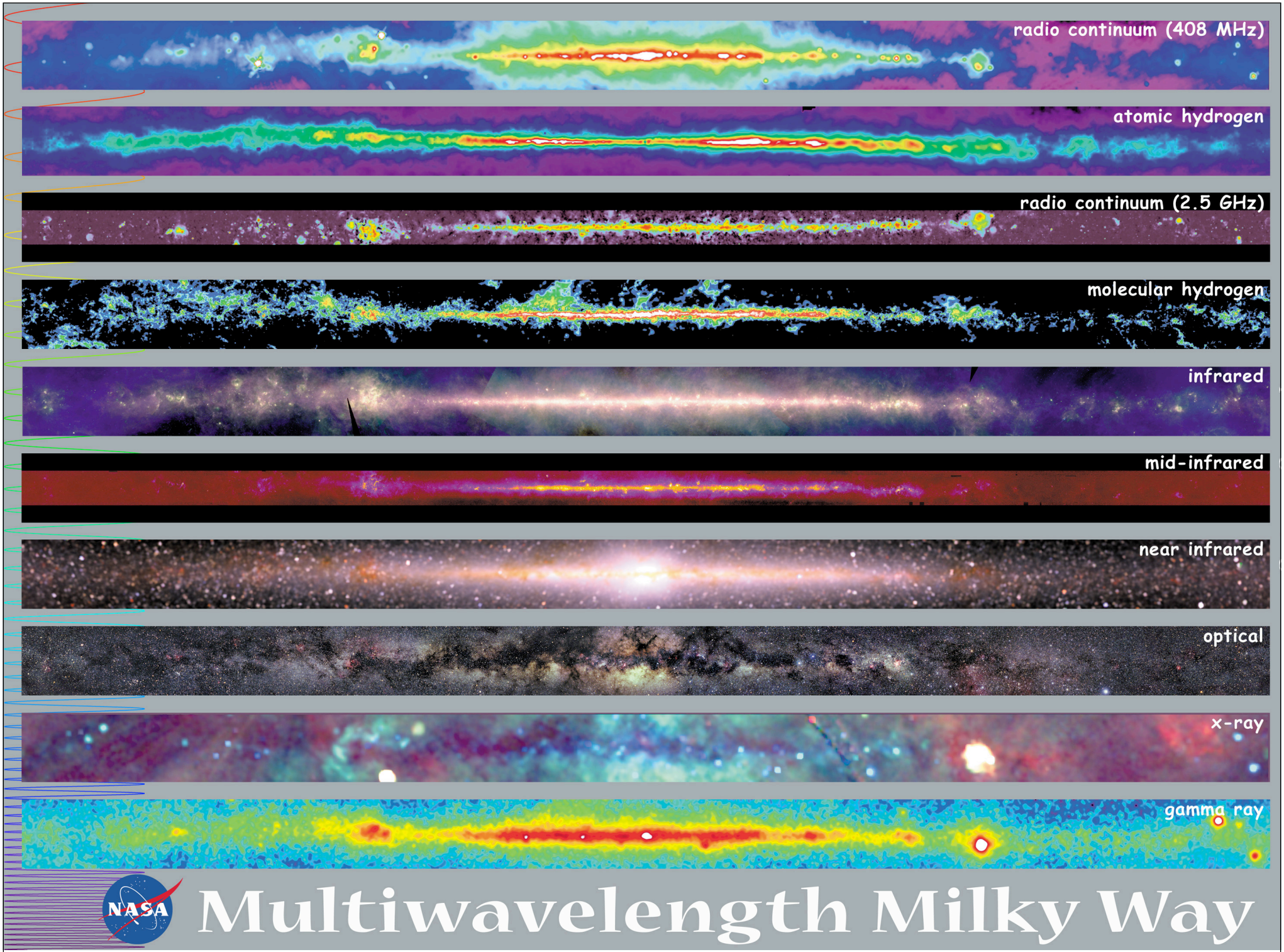
MUSEO ELDER
DE LA CIENCIA Y LA TECNOLOGÍA

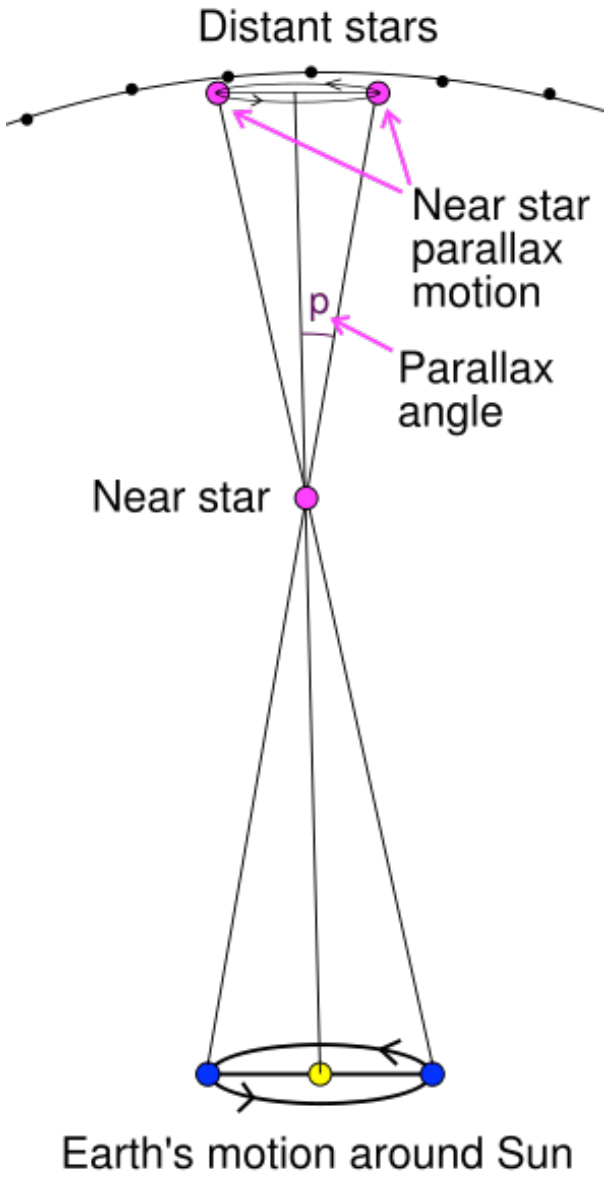


Galaxia de Andrómeda

a una distancia de

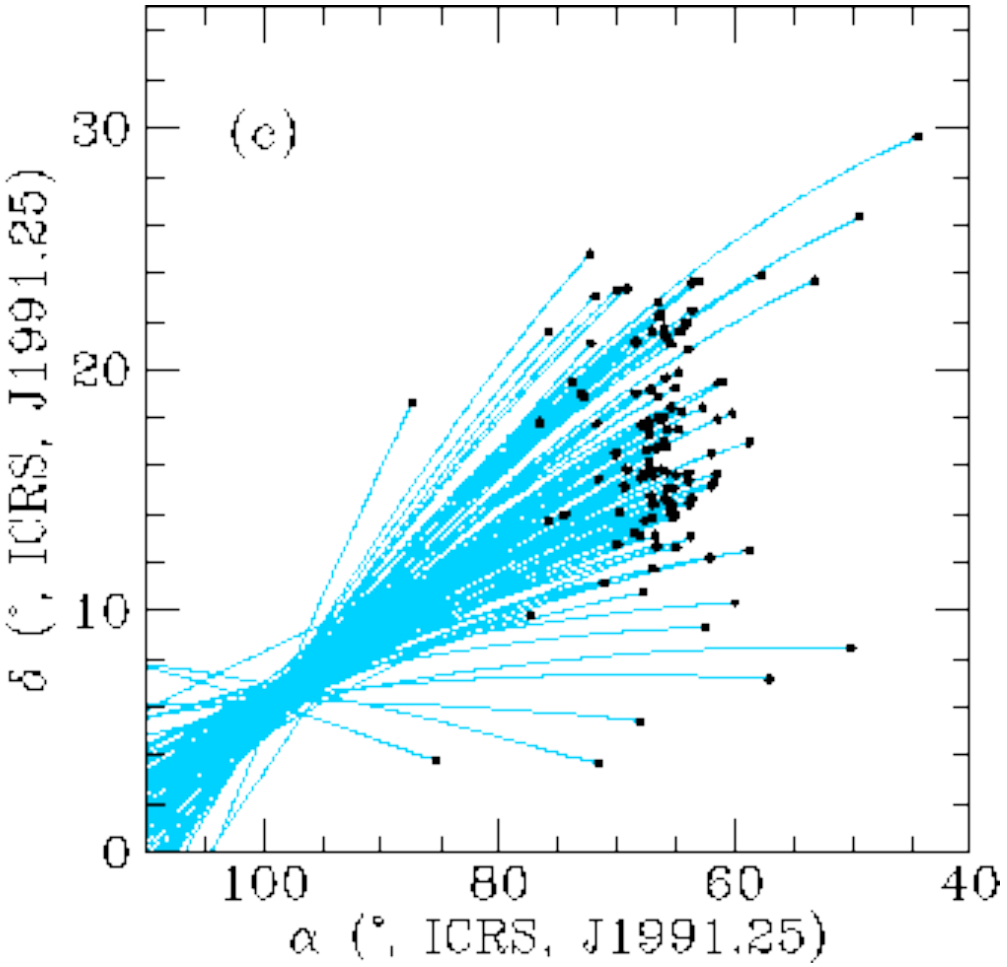
2,5 millones de años luz

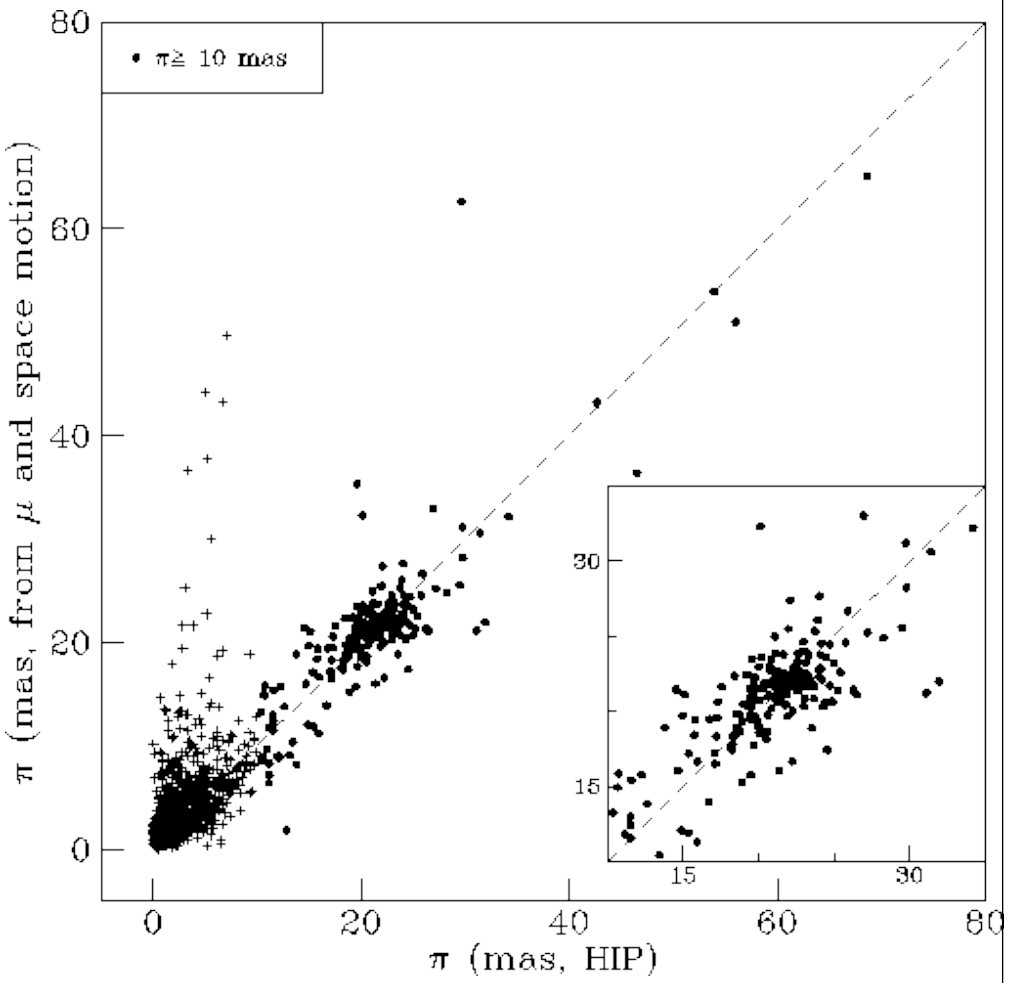

radio continuum (408 MHz)
atomic hydrogen
radio continuum (2.5 GHz)
molecular hydrogen
infrared
mid-infrared
near infrared
optical
x-ray
gamma ray
NASA
Multiwavelength Milky Way



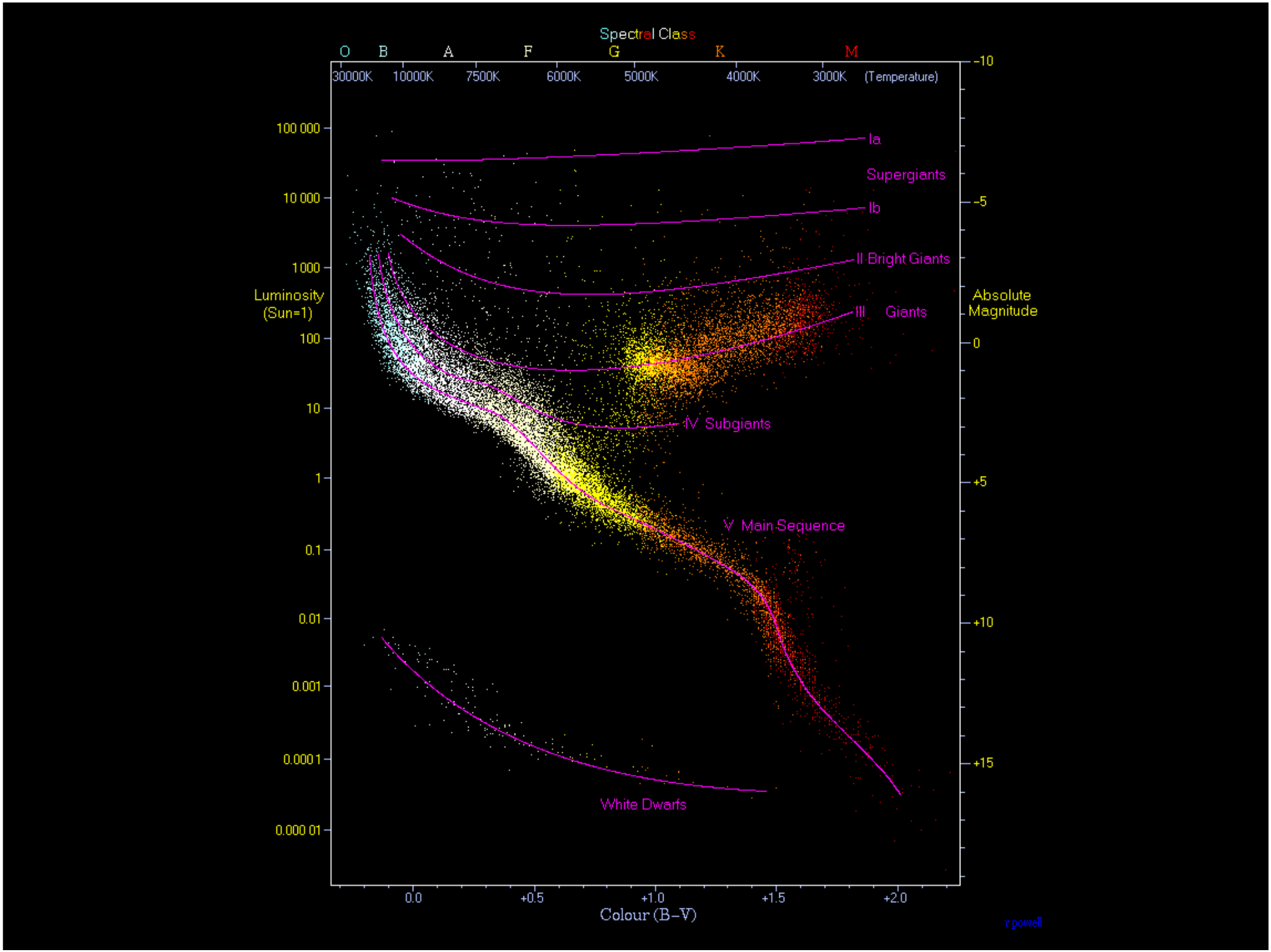
Hipparcos (***Hi**gh **P**recision **Par**allax **Co**llecting **S**atellite*)

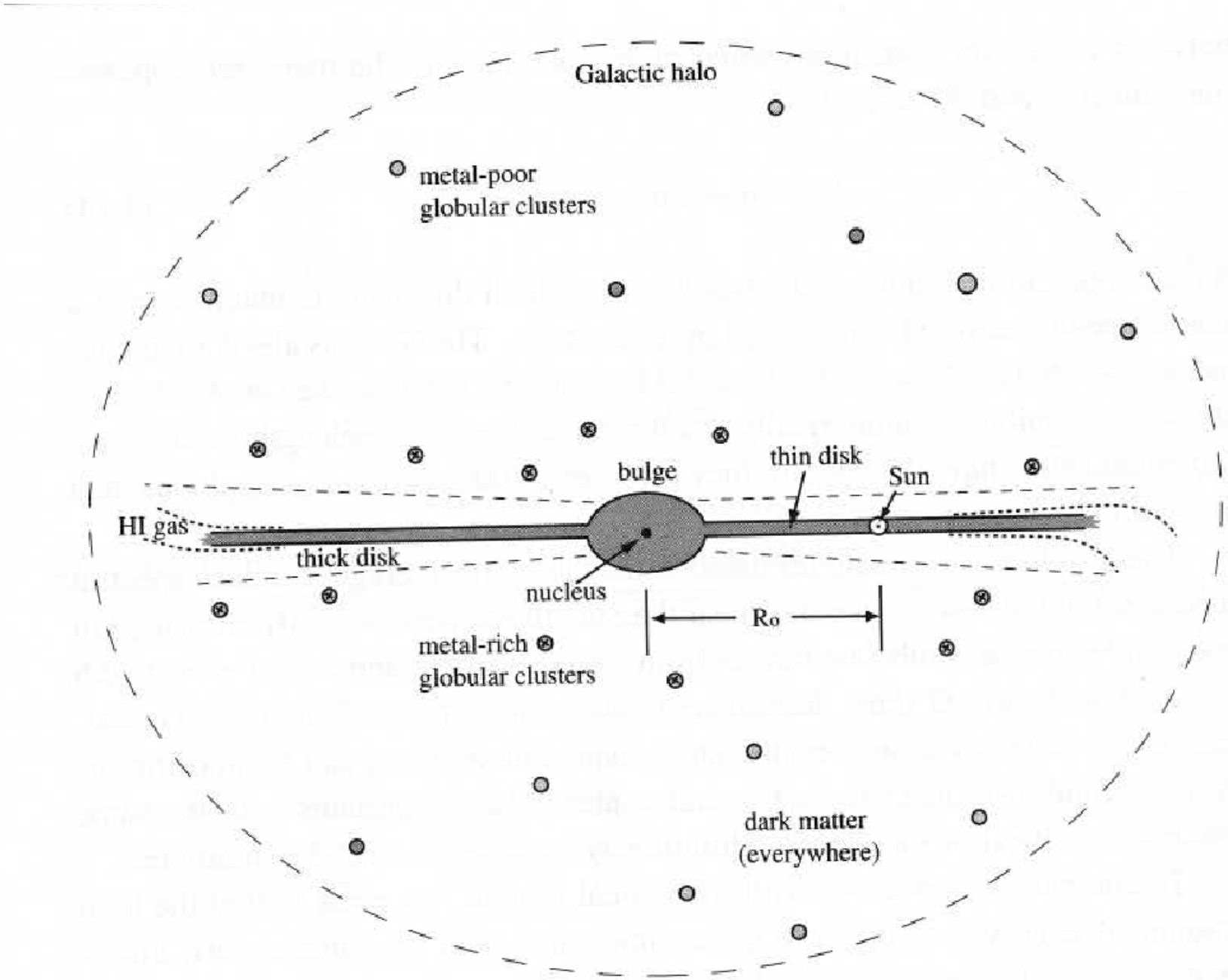
Ha medido la posición de 120.000 estrellas con un precisión de una milésima de segundo de arco

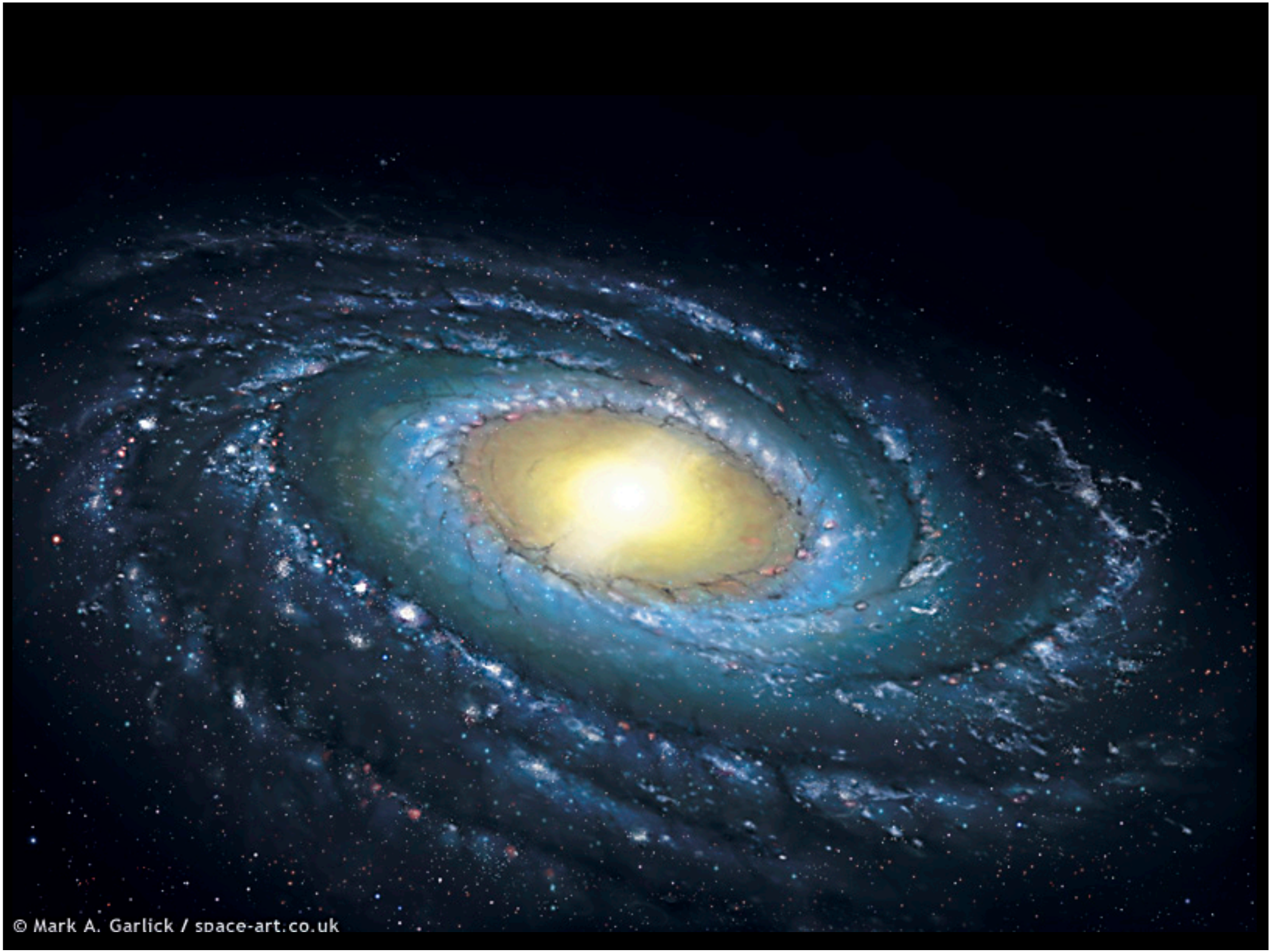




Distancia al cúmulo de las Hyades = 46.3 ± 0.3 pc (Perryman et al. 1998)


Spectral Class
O
B
A
F
G
K
M
30000K
10000K
7500K
6000K
5000K
4000K
3000K
(Temperature)
100 000
10 000
1000
100
10
1
0.1
0.01
0.001
0.0001
0.000 01
Luminosity
(Sun=1)
-10
-5
0
+5
+10
+15
Absolute
Magnitude
Ia
Supergiants
Ib
II Bright Giants
III Giants
IV Subgiants
V Main Sequence
White Dwarfs
0.0
+0.5
+1.0
+1.5
+2.0
Colour (B–V)
r powell


Galactic halo
metal-poor
globular clusters
bulge
thin disk
Sun
HI gas
thick disk
nucleus
Ro
metal-rich
globular clusters
dark matter
(everywhere)


© Mark A. Garlick / space-art.co.uk

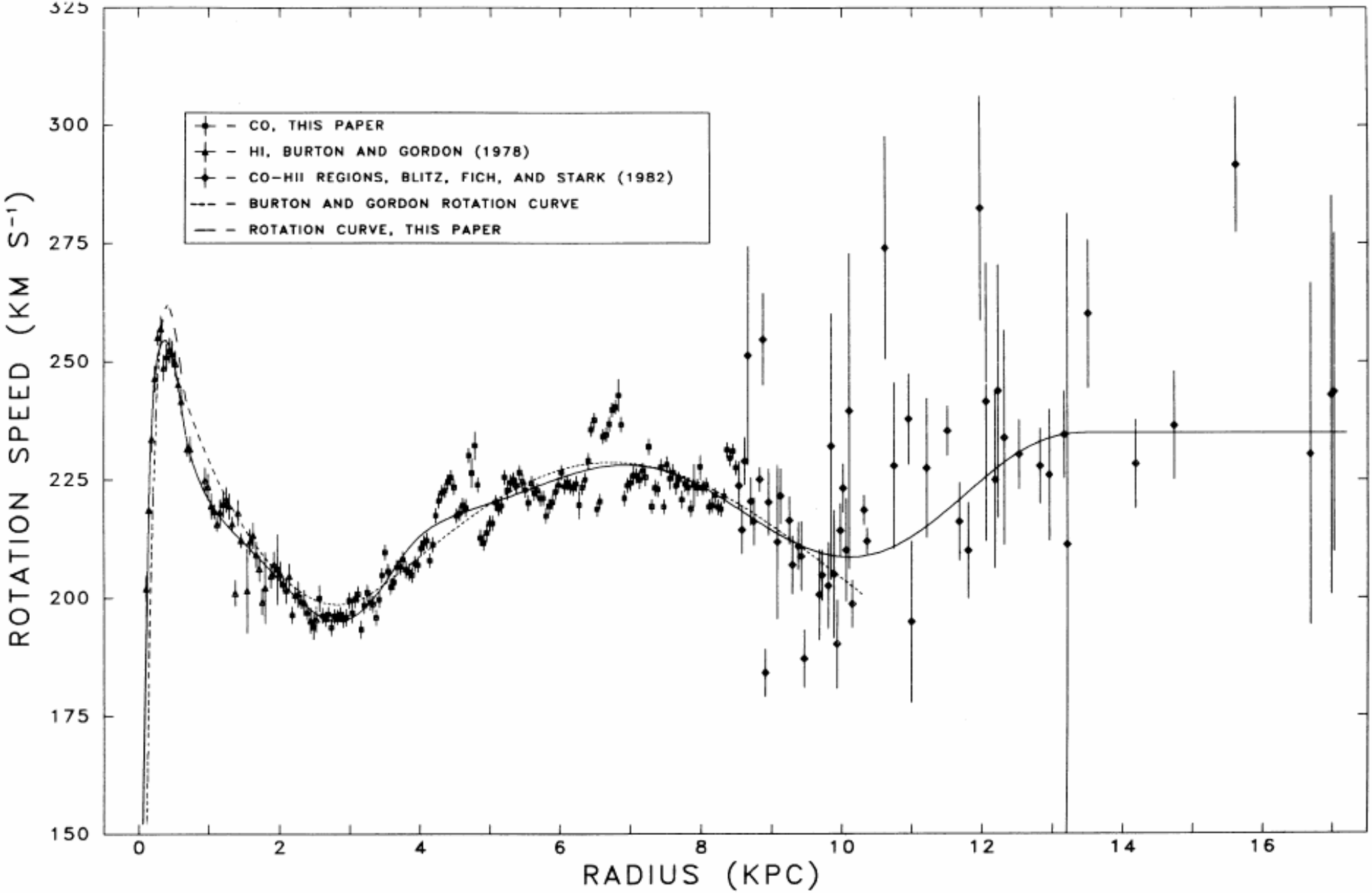
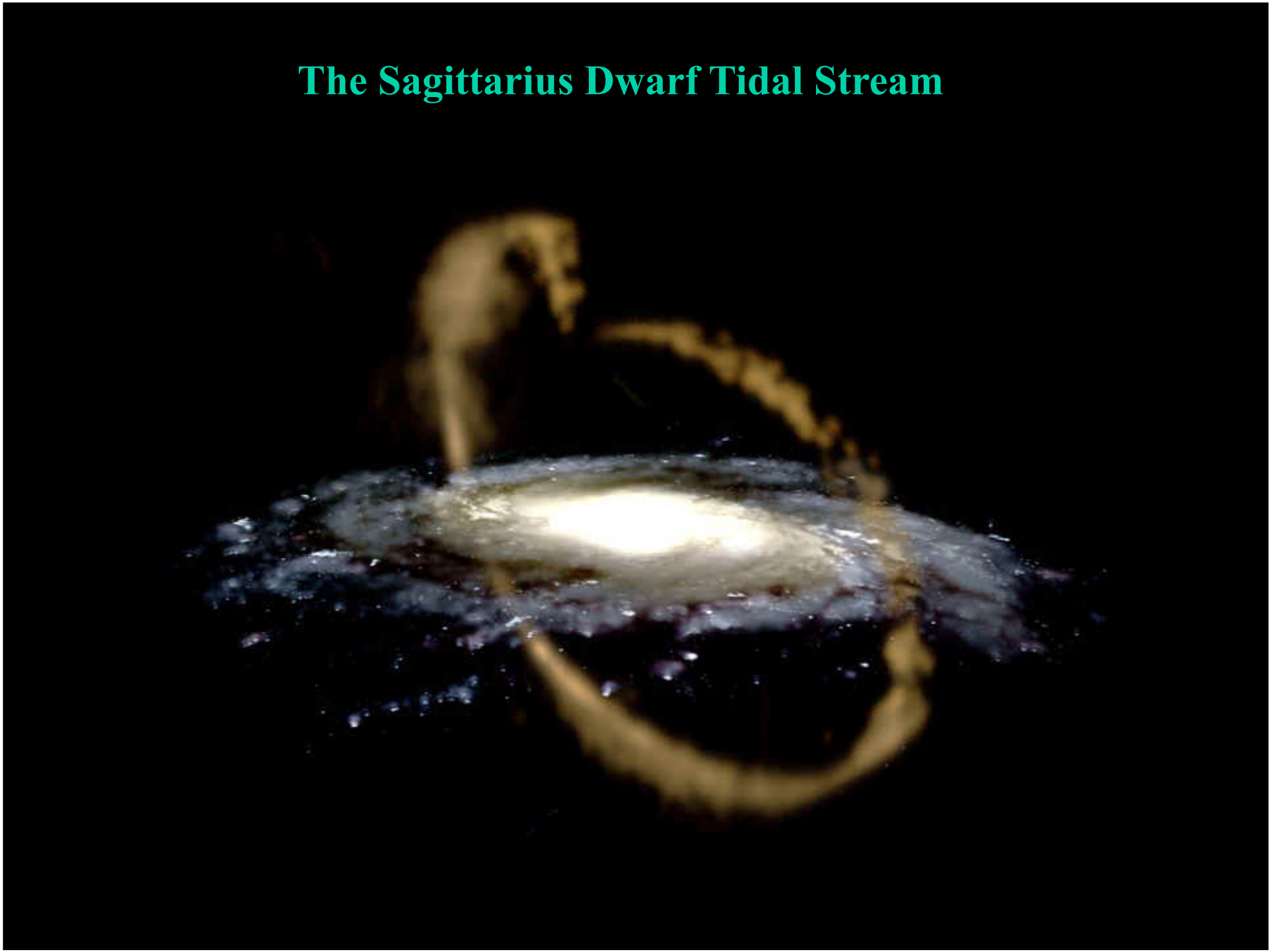
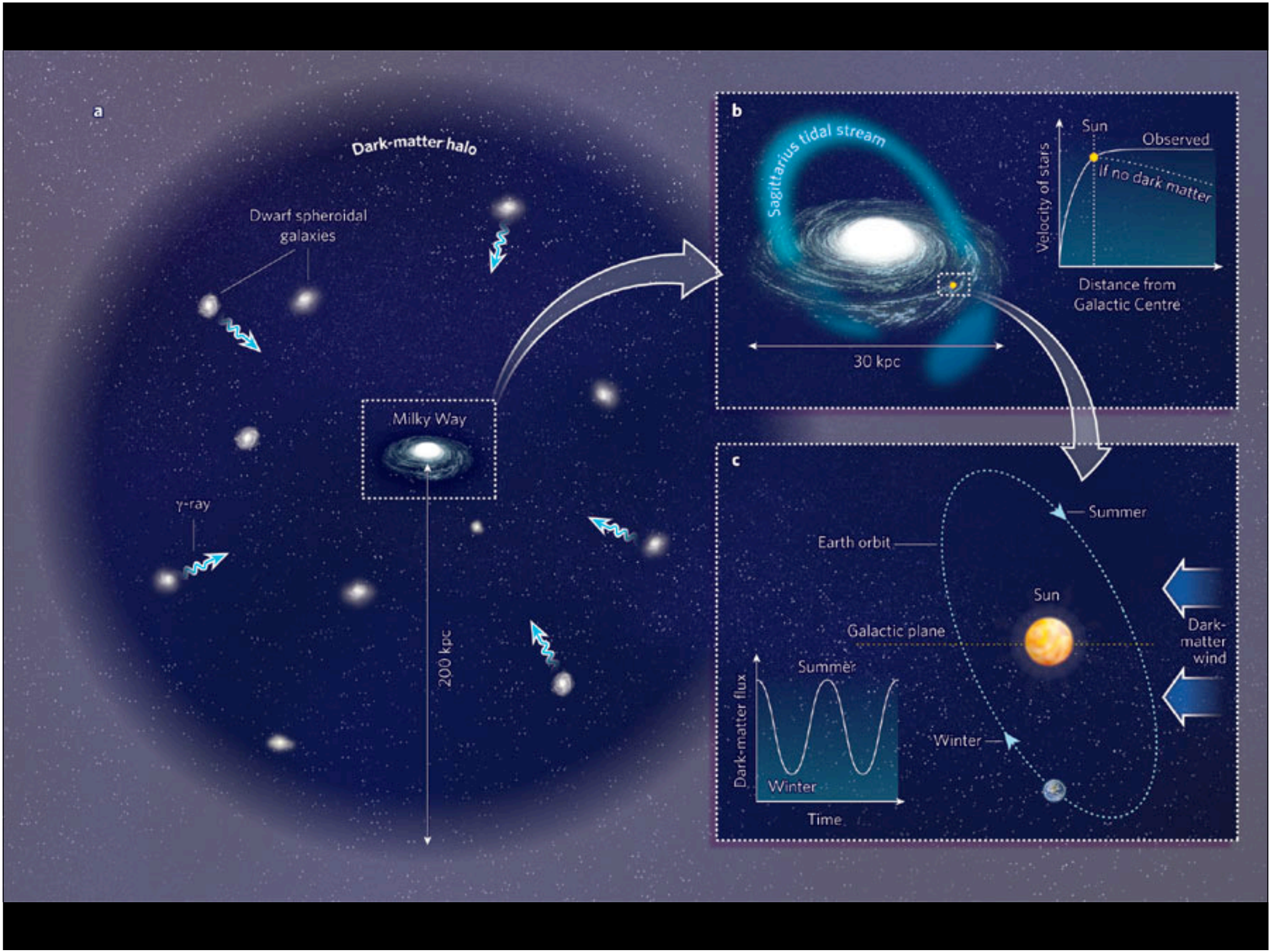
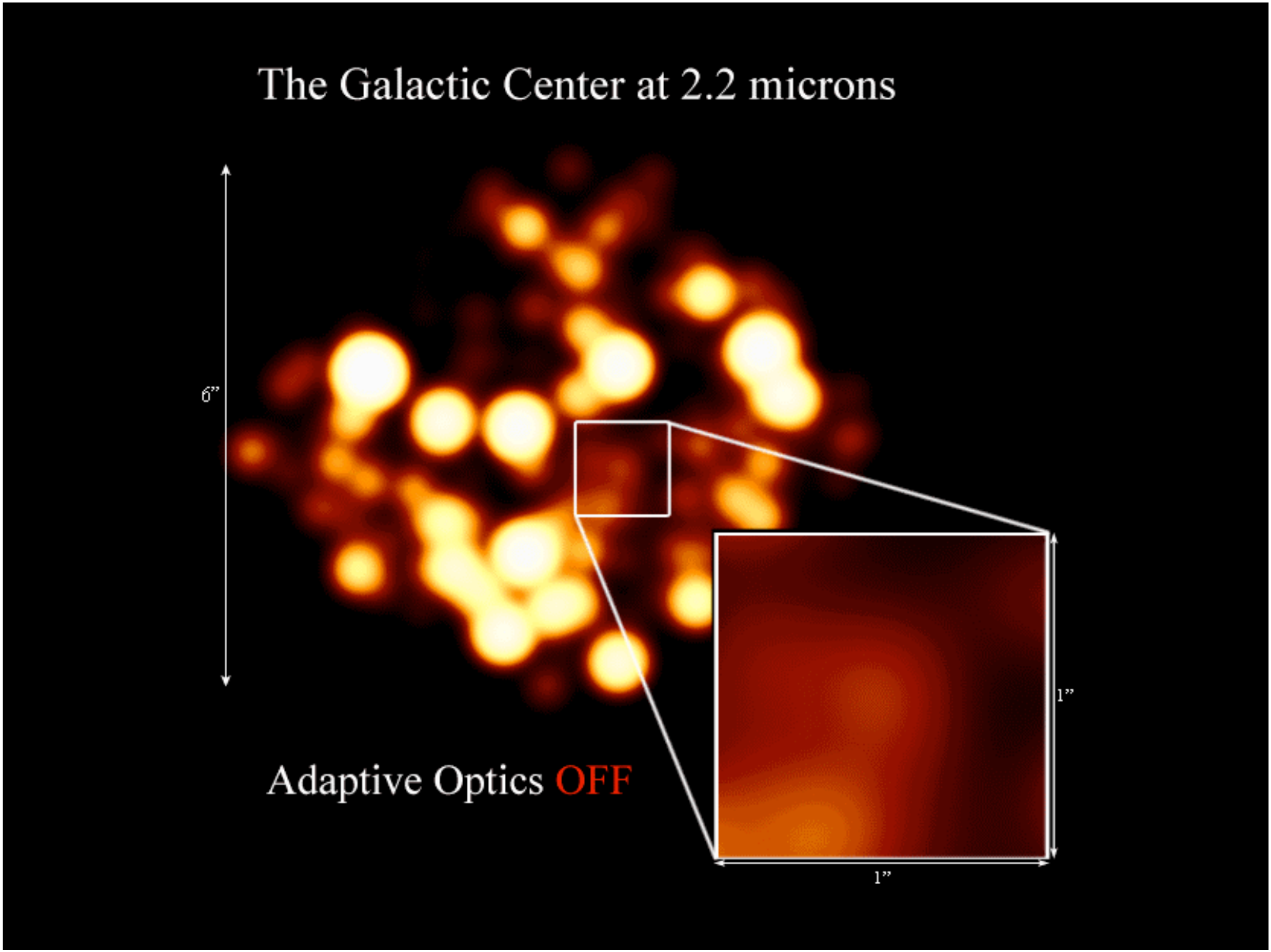


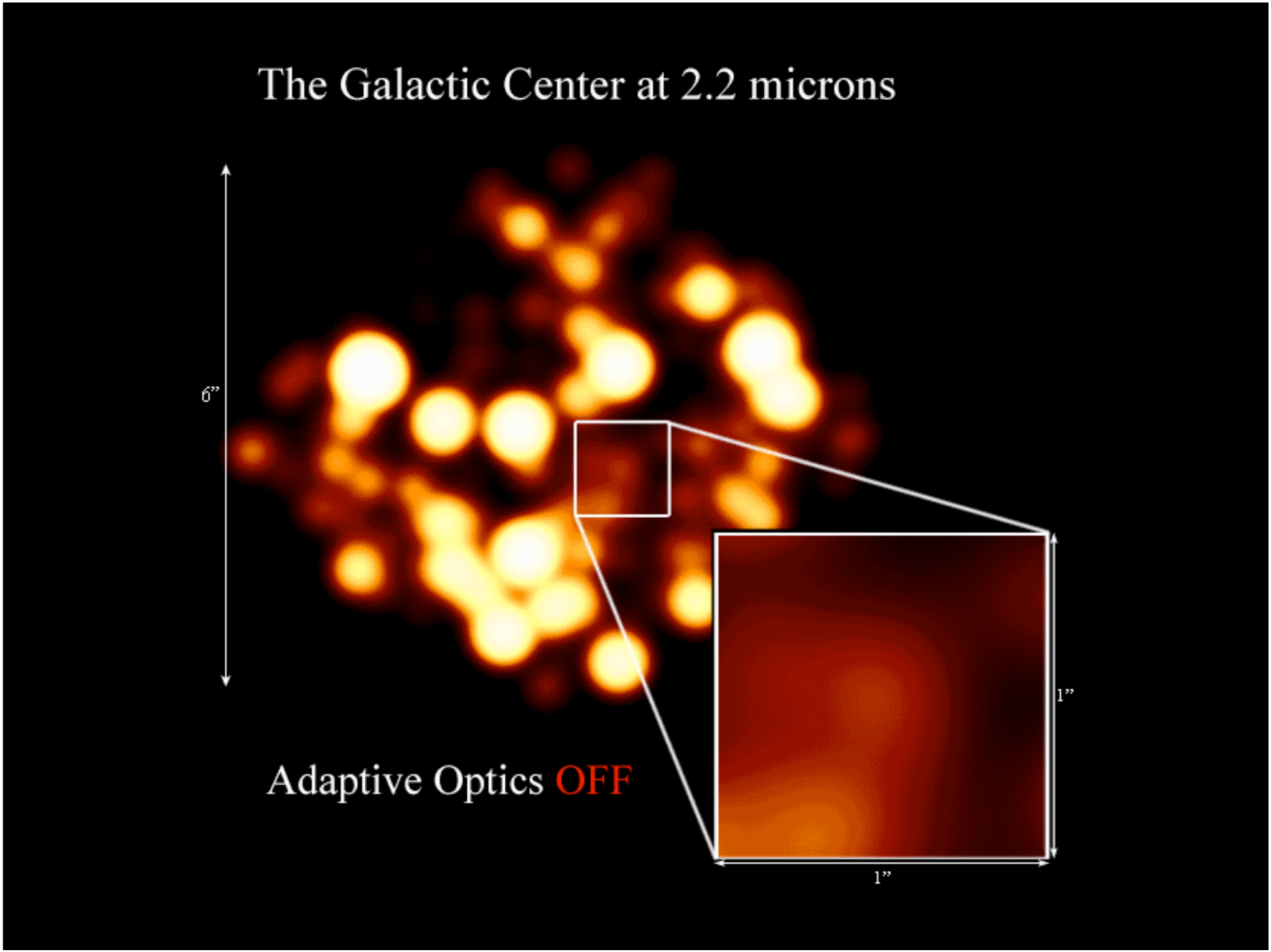
FIG. 3.—Plots of the rotation speed versus galactocentric radius. The solid lines correspond to the polynomials, and the dashed lines are the BG rotation curve. (*upper panel*)(R_0, θ_0) = (10 kpc, 220 km s^{-1}); (*lower panel*) (8.5 kpc, 220 km s^{-1}).

The Sagittarius Dwarf Tidal Stream




a
Dark-matter halo
Dwarf spheroidal galaxies
Milky Way
γ-ray
200 kpc
b
Sagittarius tidal stream
30 kpc
Velocity of stars
Sun
Observed
If no dark matter
Distance from Galactic Centre
c
Summer
Earth orbit
Sun
Galactic plane
Dark-matter wind
Winter
Dark-matter flux
Summer
Winter
Time


The Galactic Center at 2.2 microns
6”
1”
1”
Adaptive Optics OFF


The Galactic Center at 2.2 microns
6”
1”
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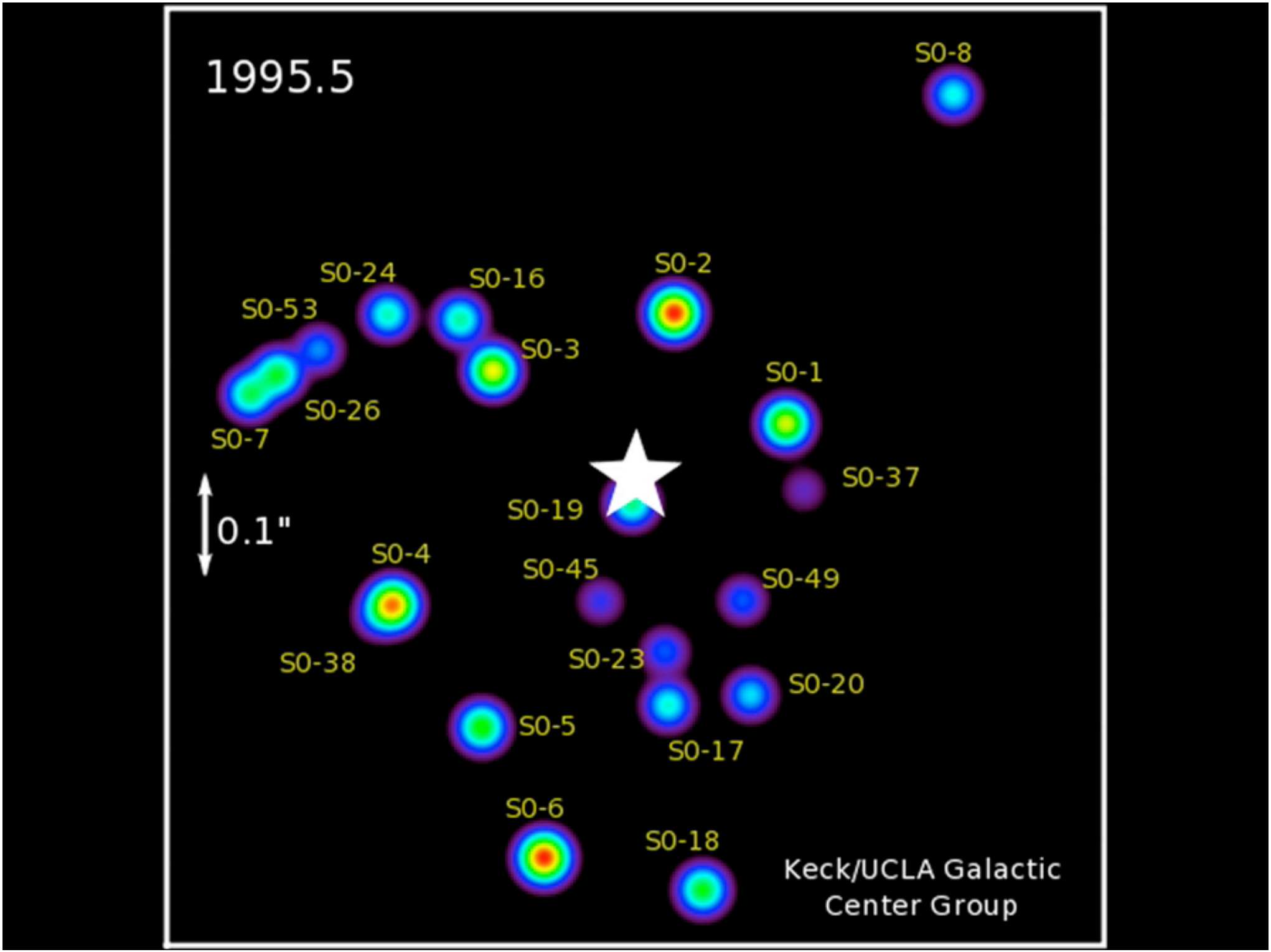
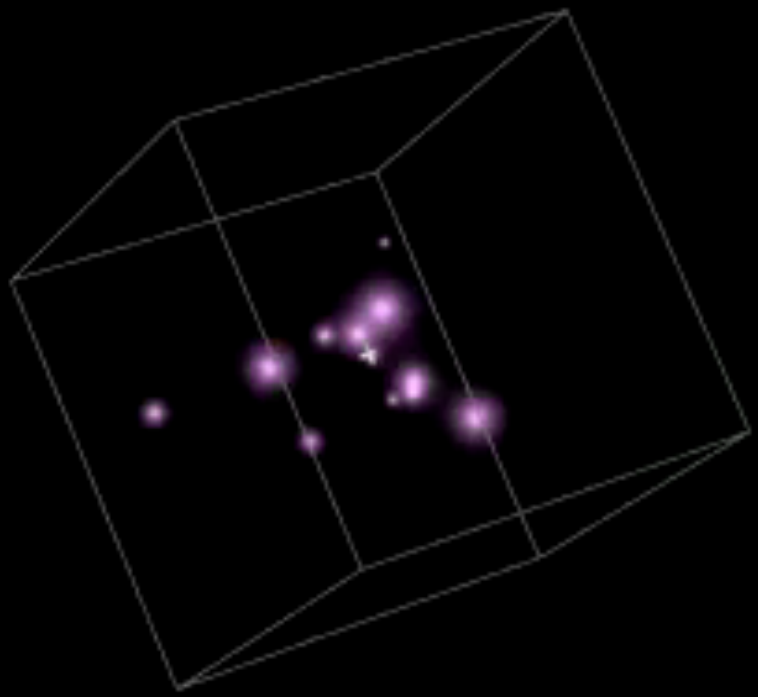

1995.5
S0-8
S0-24
S0-16
S0-2
S0-53
S0-3
S0-1
S0-26
S0-7
S0-37
0.1"
S0-19
S0-4
S0-45
S0-49
S0-38
S0-23
S0-20
S0-5
S0-17
S0-6
S0-18
Keck/UCLA Galactic
Center Group

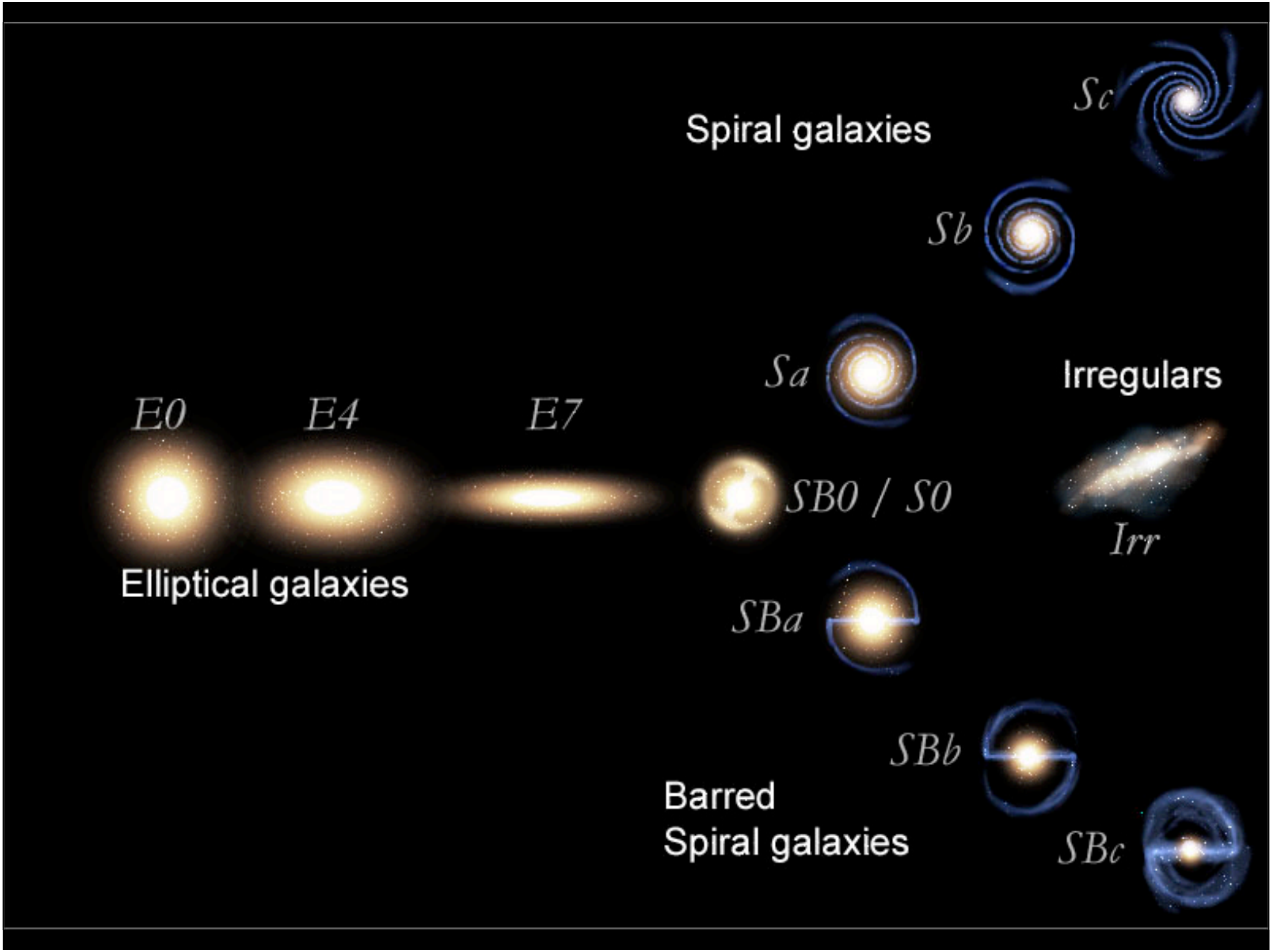
Year: 1995.0

The Acceleration of Stars Orbiting
the Milky Way's Central Black Hole

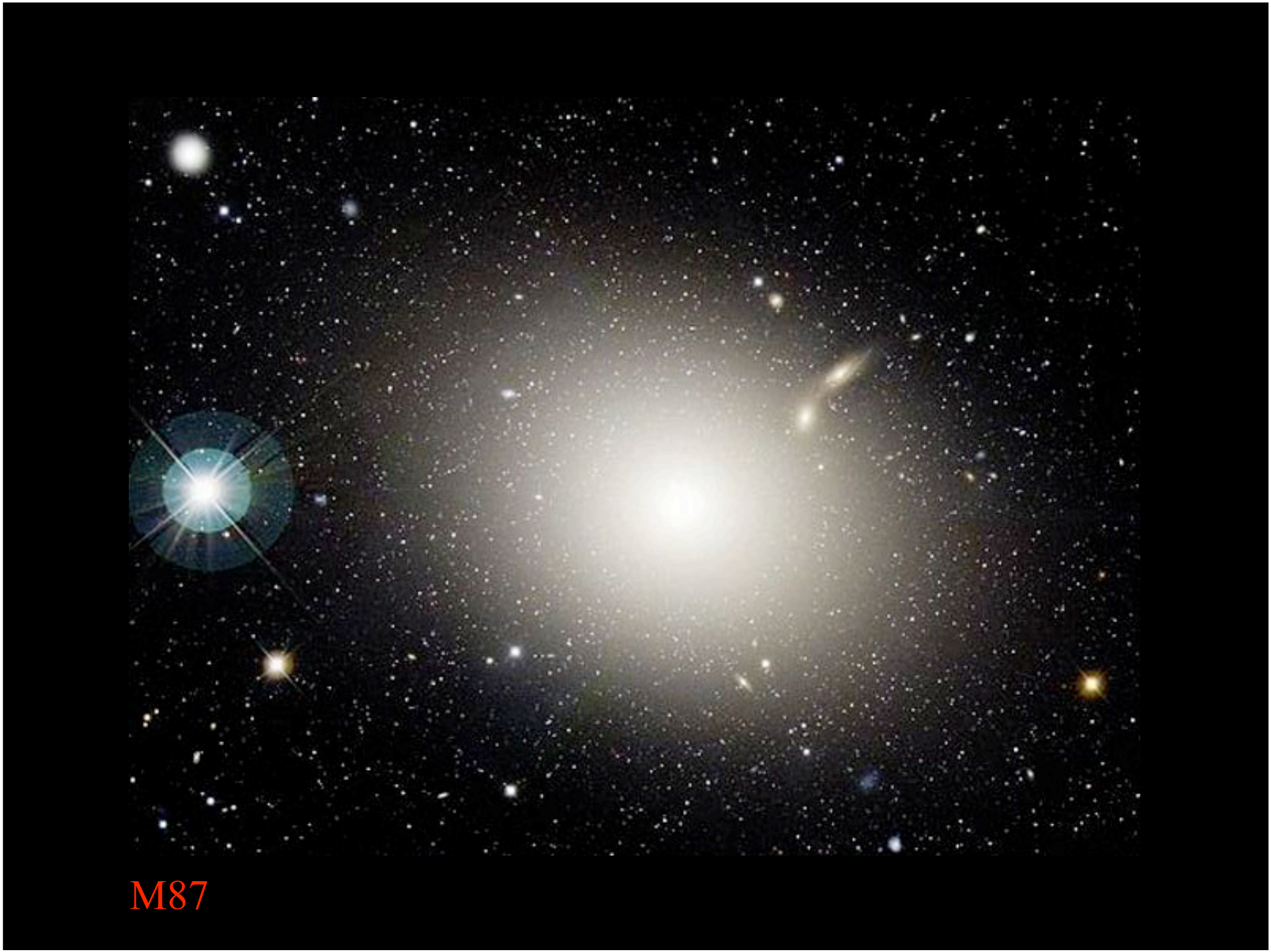


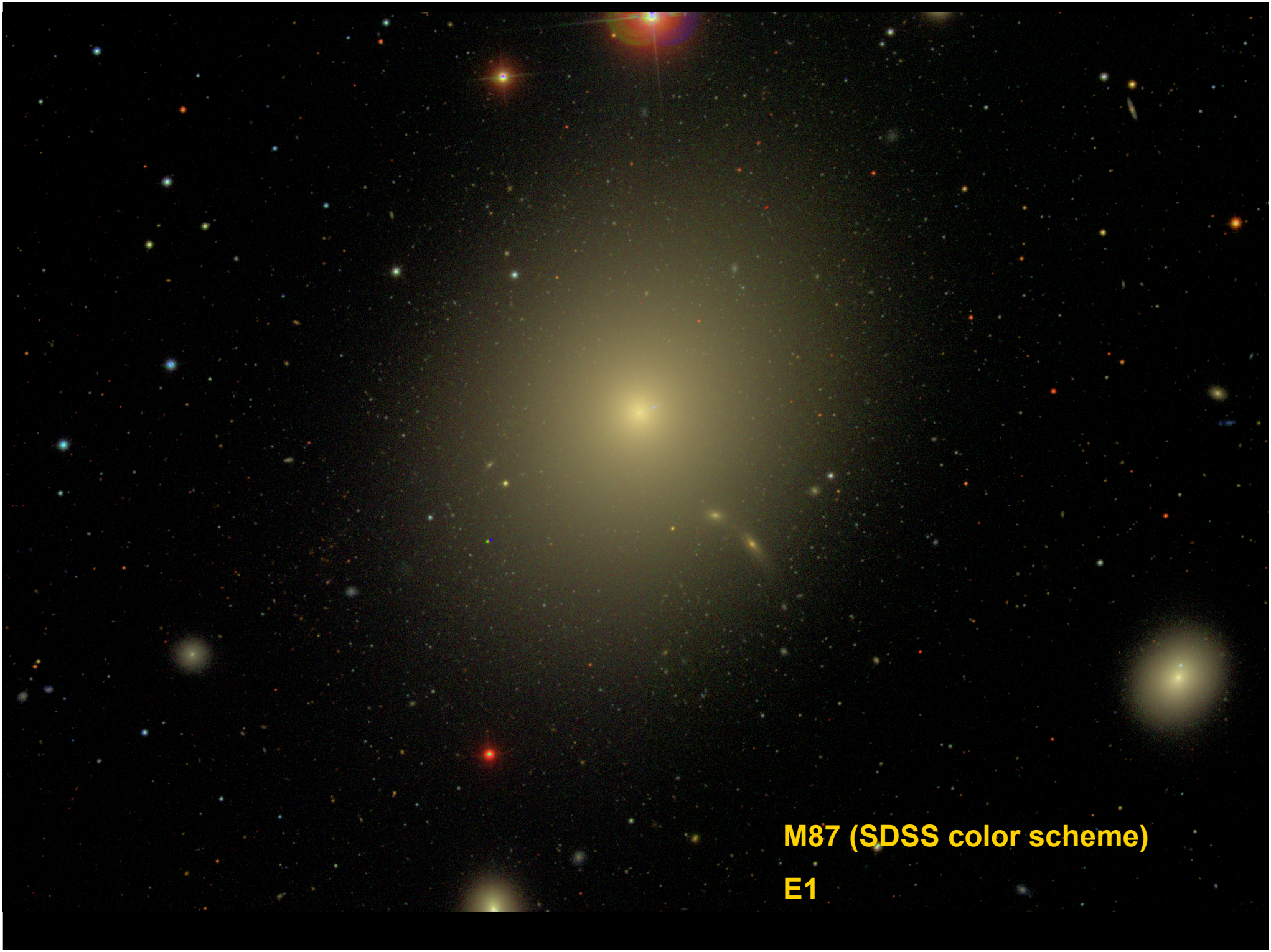
Data: Andrea Ghez, Jessica Lu (UCLA)
Visualization: Dinoj Surendran, Randy Landsberg,
Mark SubbaRao (UChicago / Adler / KICP)

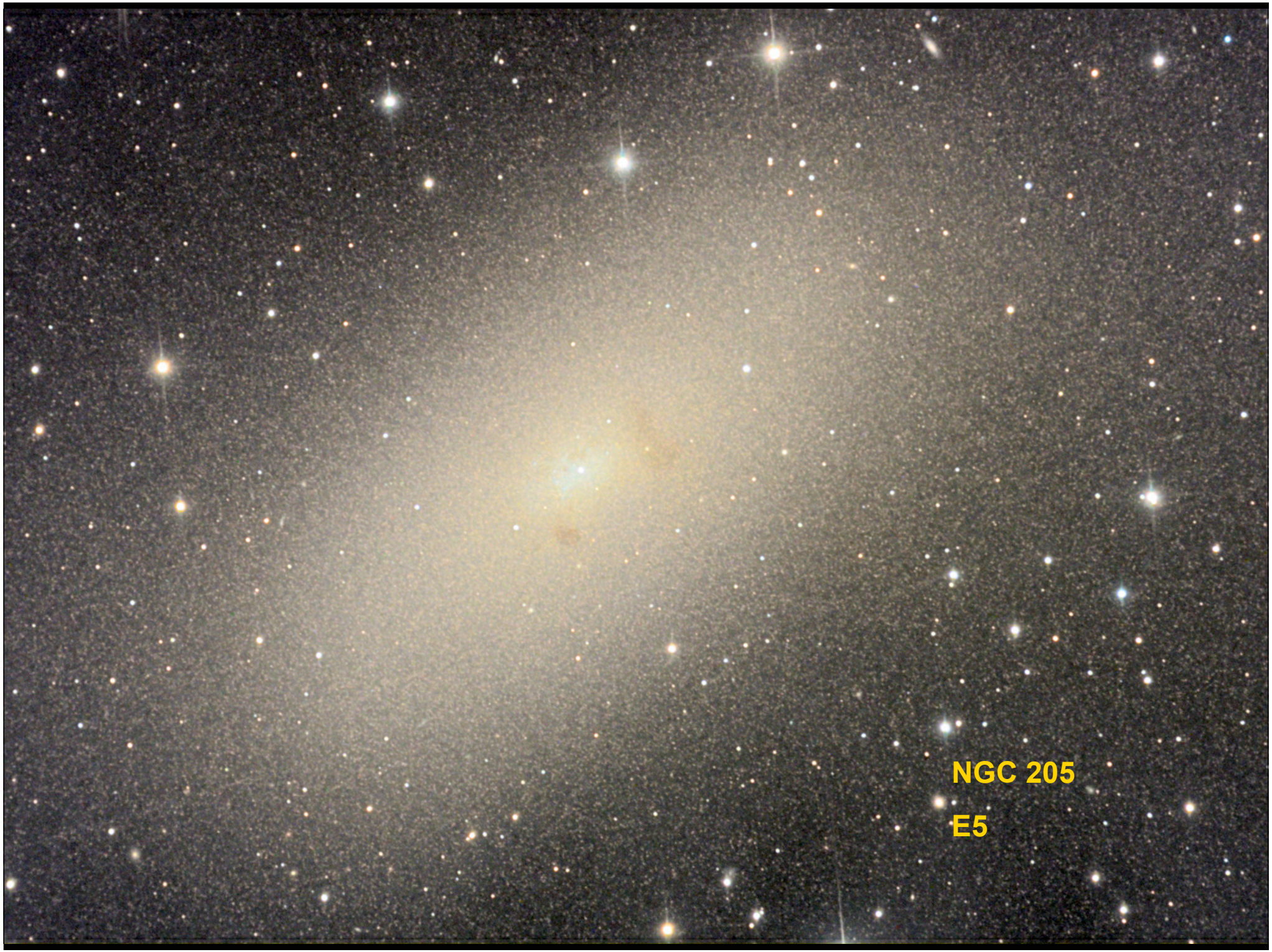
UCLA/Keck Galactic Center Group

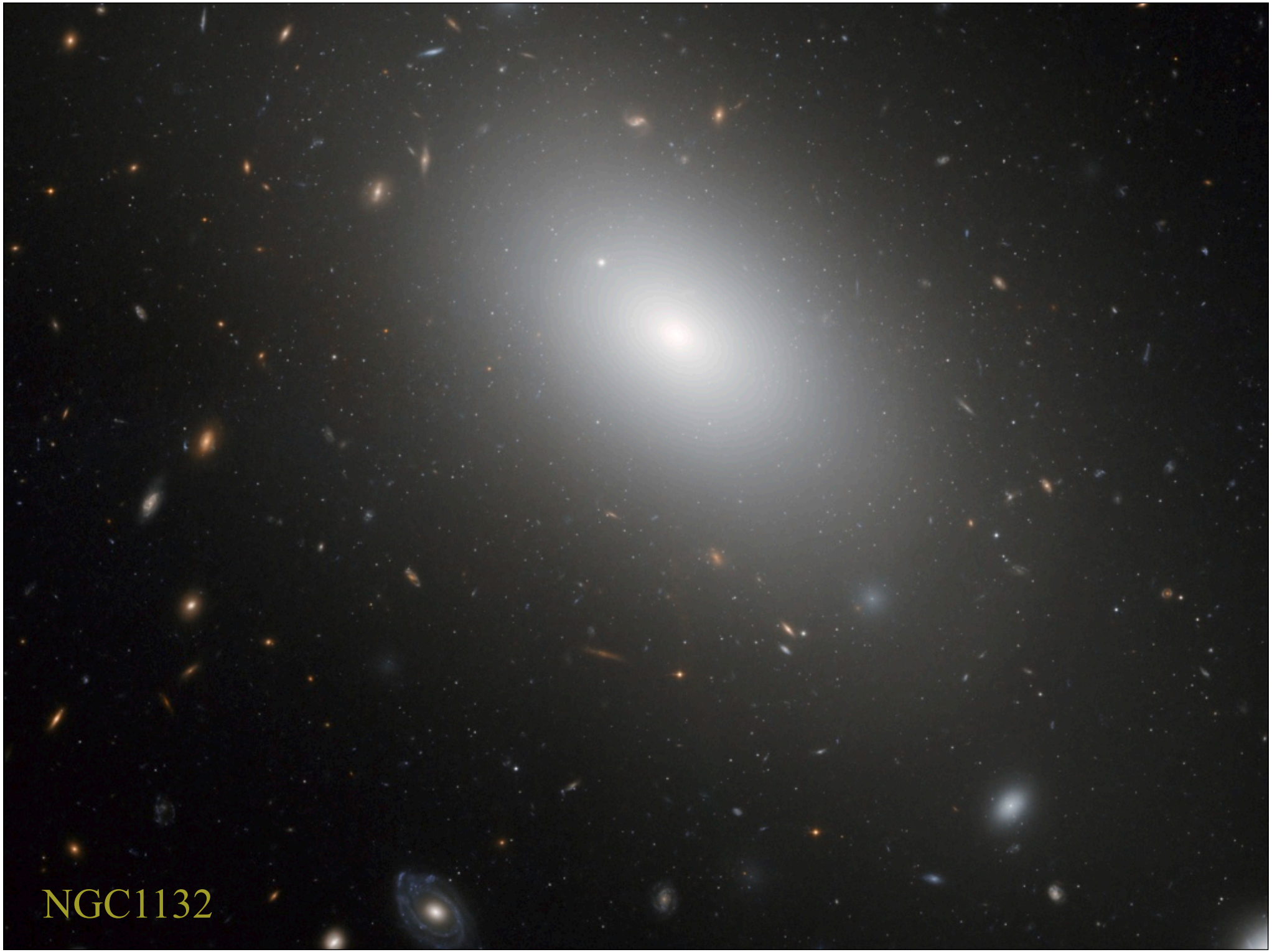

Sc
Spiral galaxies
Sb
Sa
Irregulars
E0
E4
E7
SB0 / S0
Irr
Elliptical galaxies
SBa
SBb
Barred
Spiral galaxies
SBc

Elliptical (E) galaxies


M87

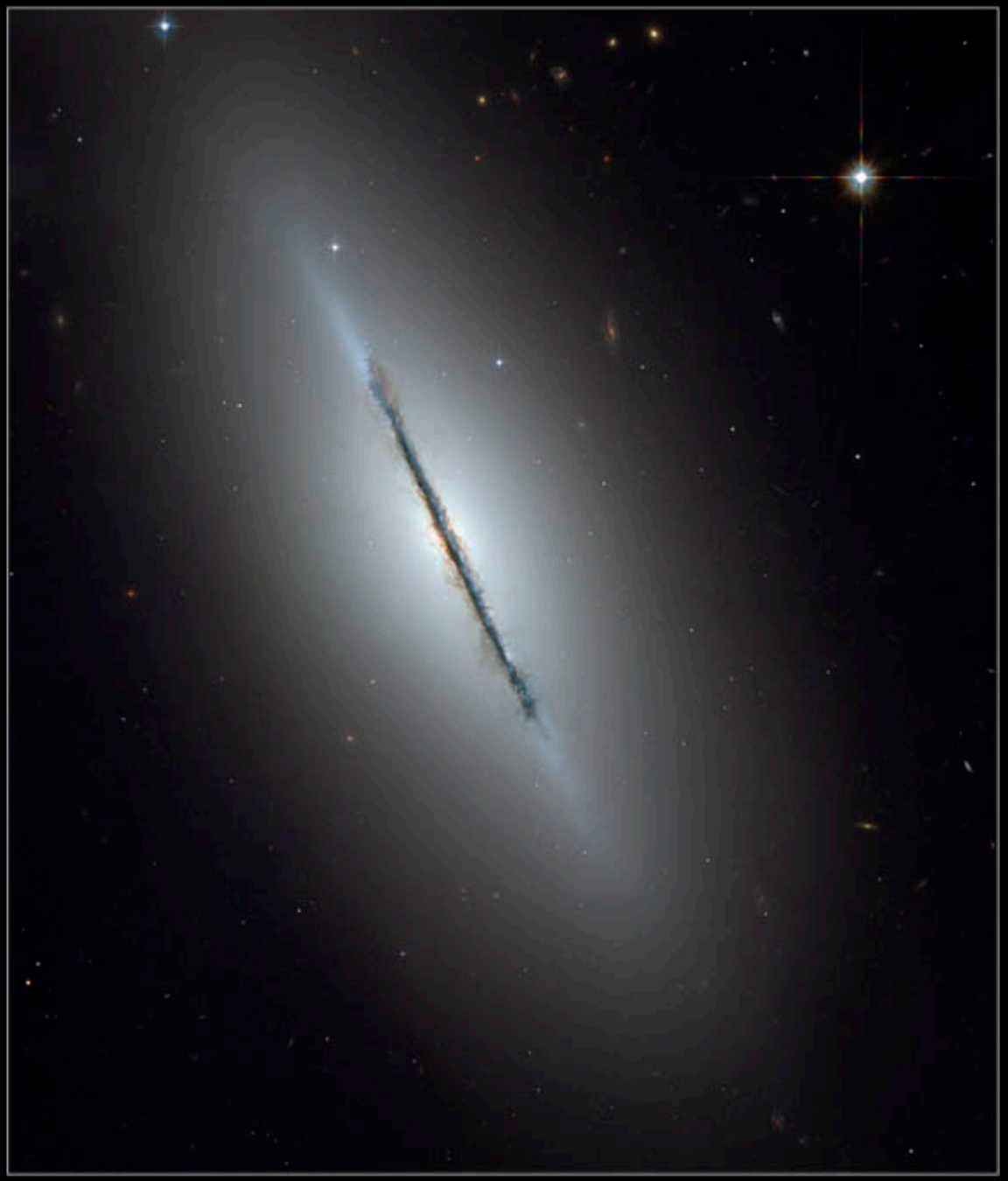

M87 (SDSS color scheme)
E1


NGC 205
E5


NGC1132

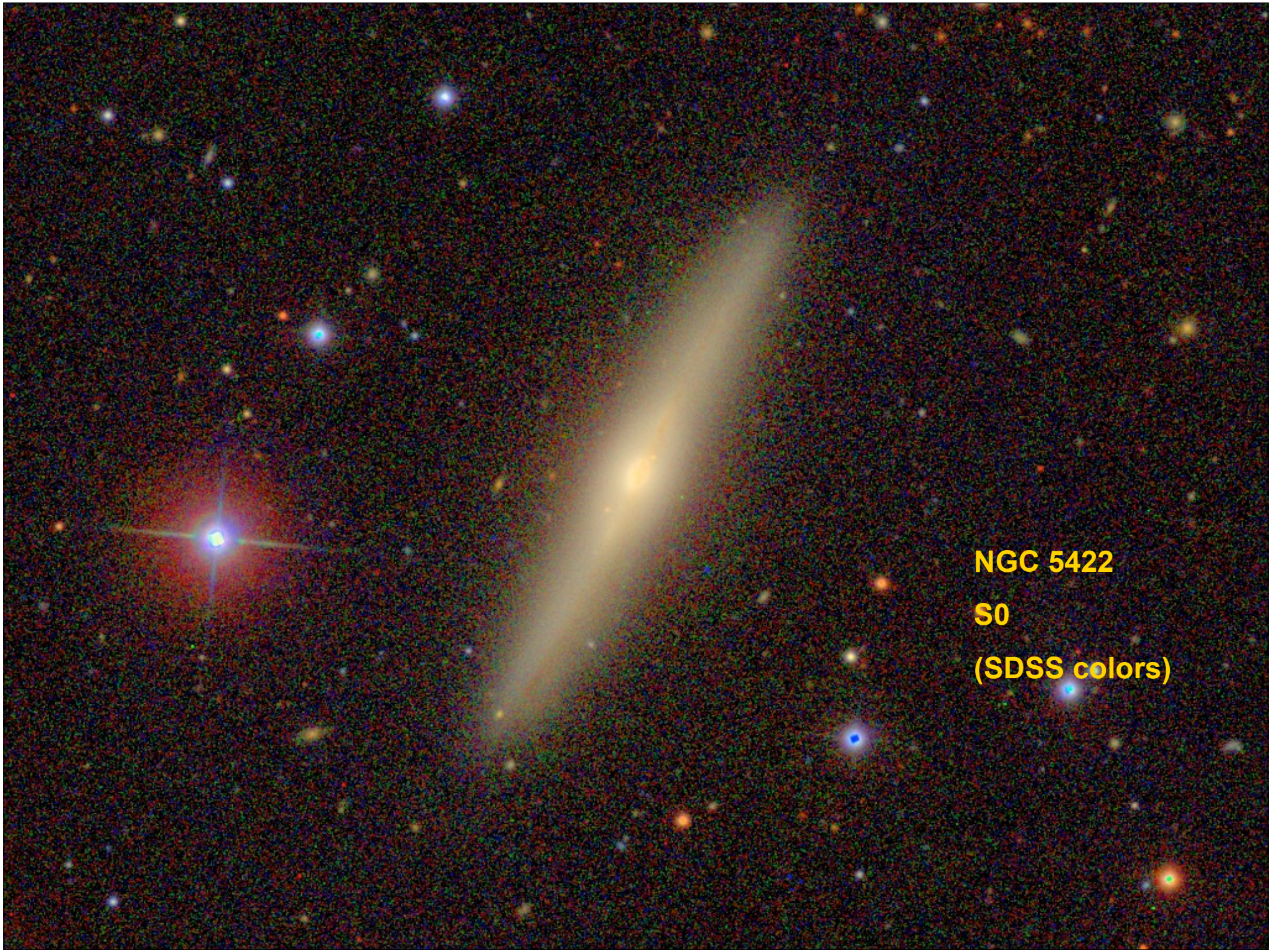
Lenticular (S0) galaxies

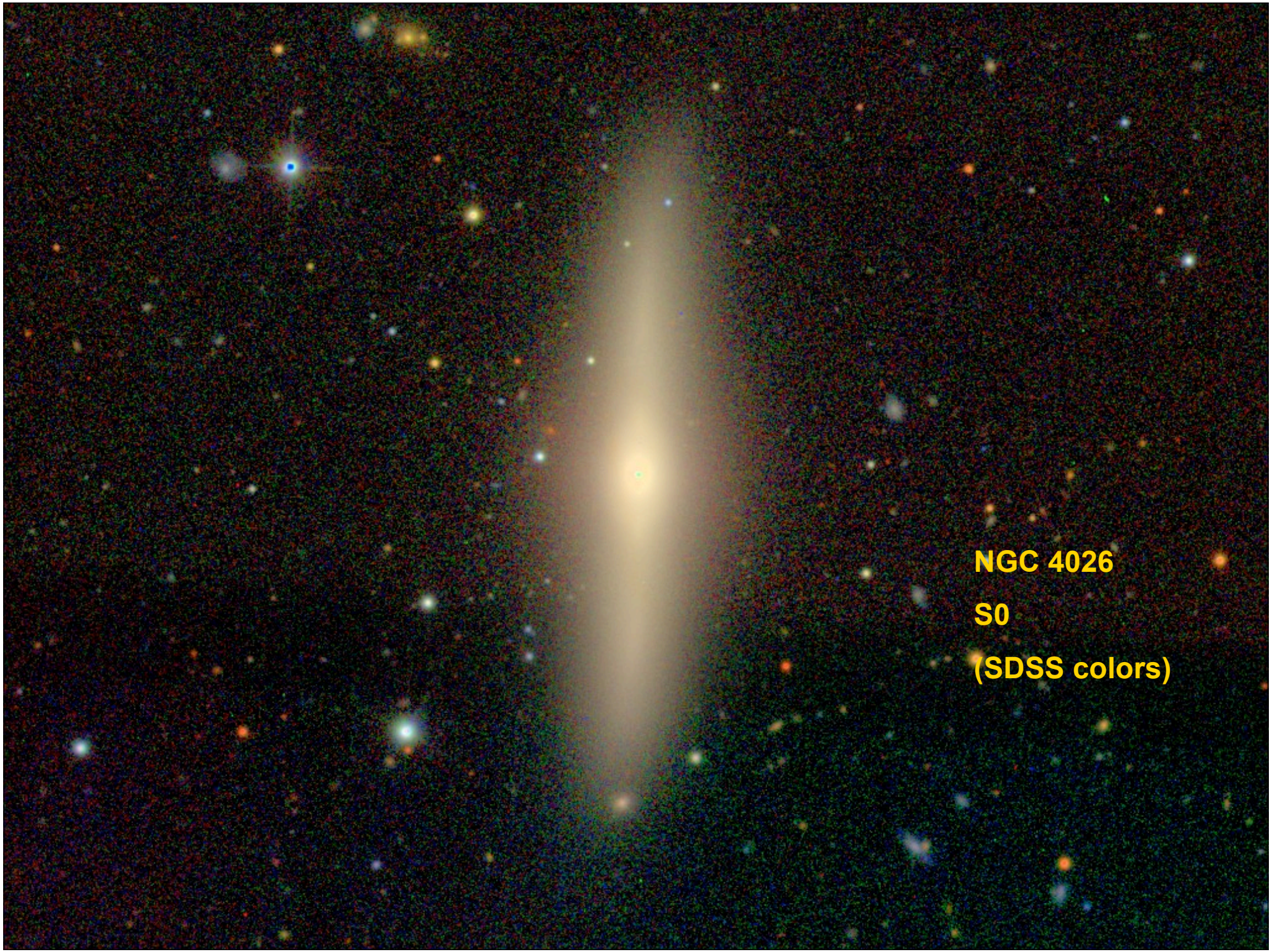
Edge-On Lenticular Galaxy NGC 5866



Hubble Heritage

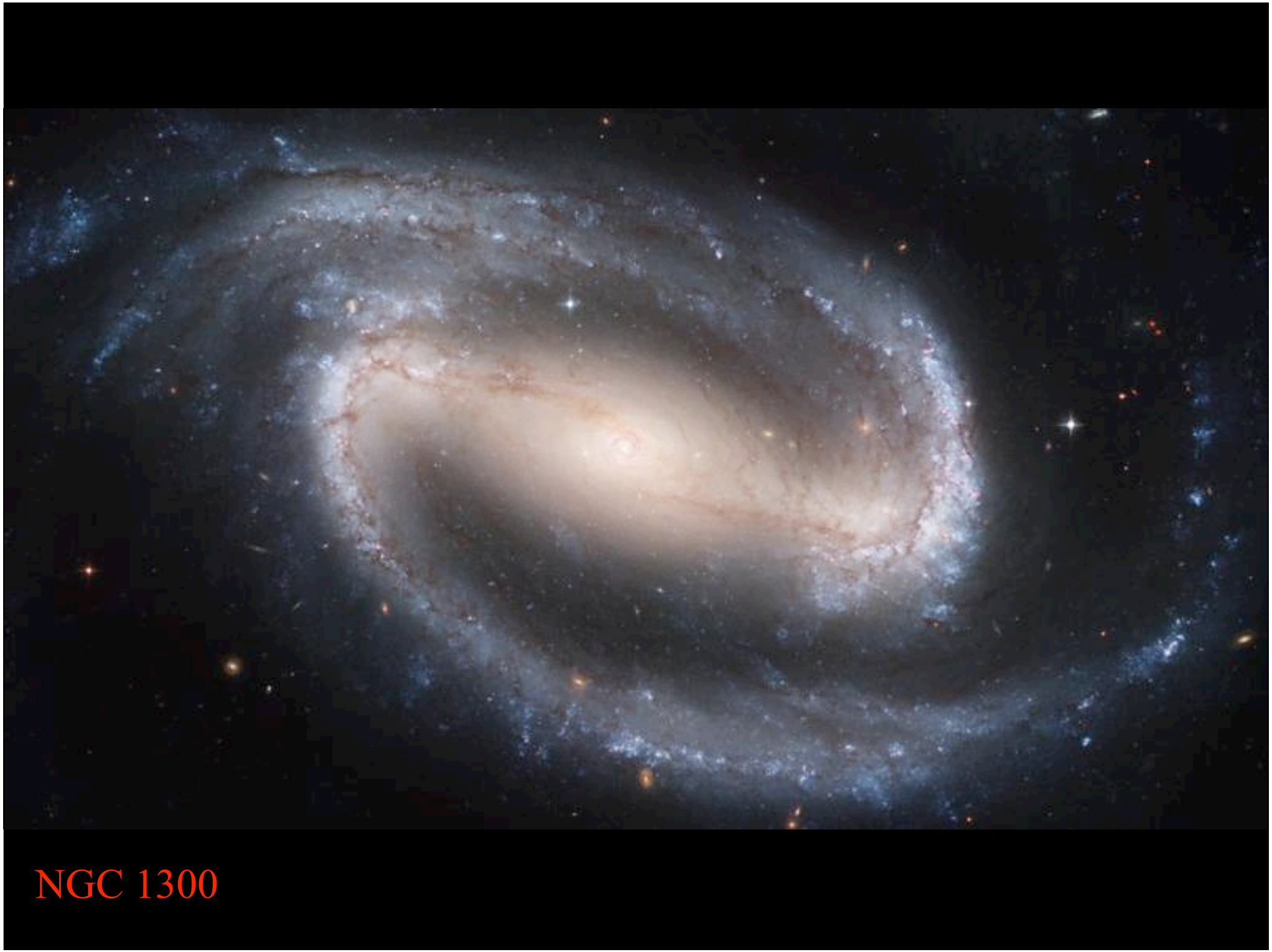
NASA, ESA, and The Hubble Heritage Team (STScI/AURA) • *Hubble Space Telescope* ACS • STScI-PRC06-24


NGC 5422
S0
(SDSS colors)

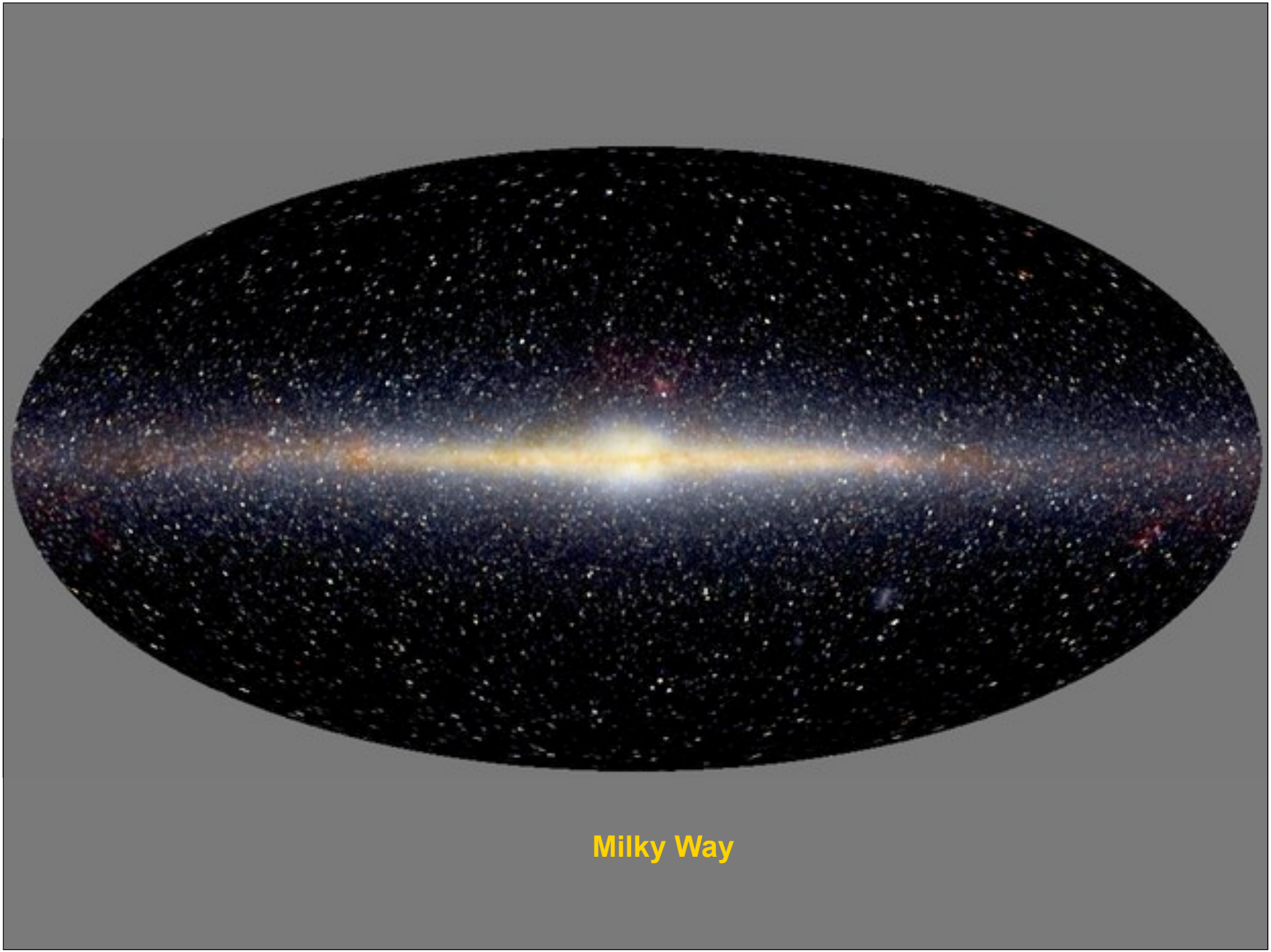

NGC 4026
S0
(SDSS colors)


M104

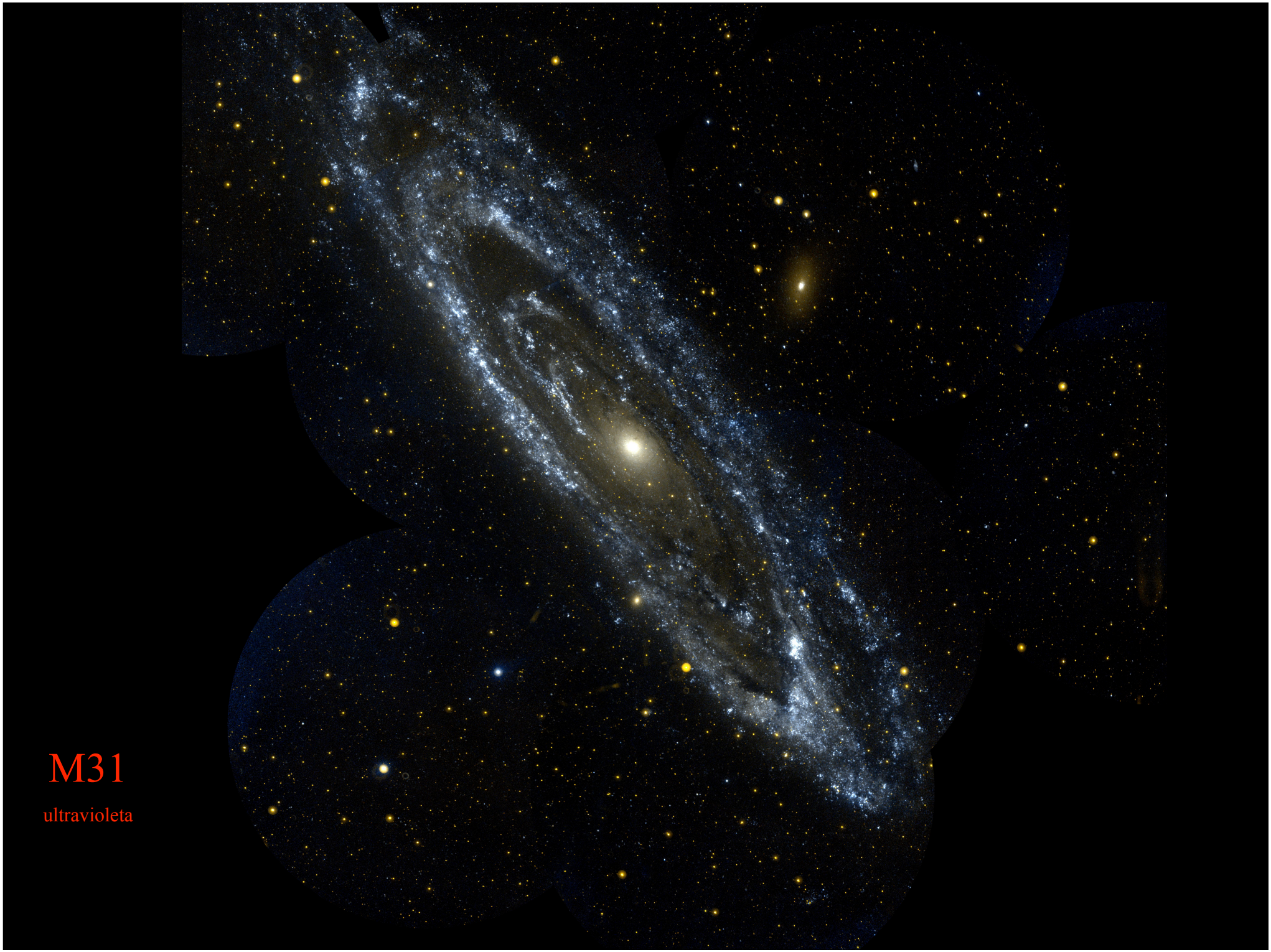
Spiral galaxies



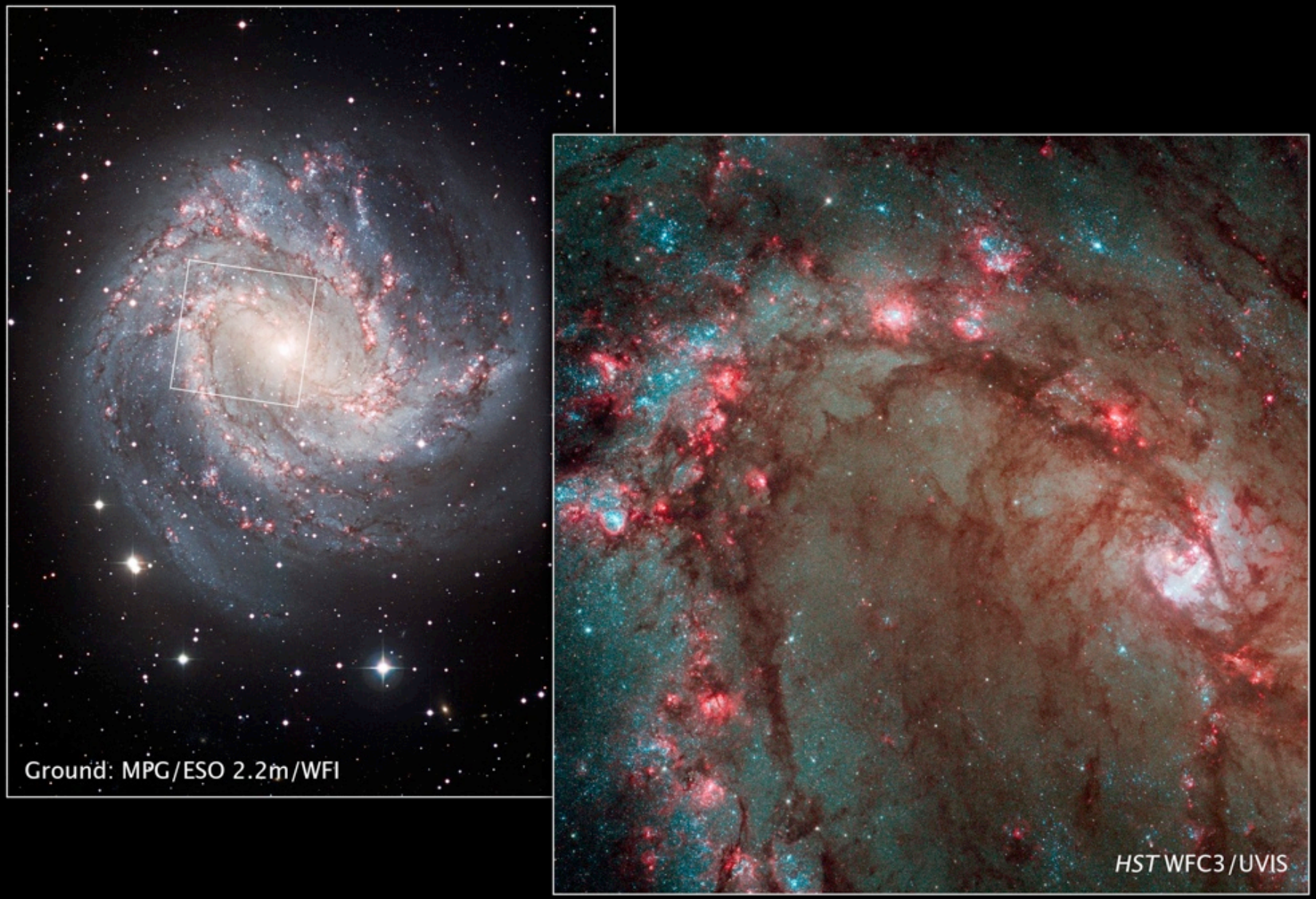
NGC 1300



Milky Way


M31
ultravioleta

M51



Spiral Galaxy M83

Hubble Space Telescope ▪ WFC3/UVIS

NASA, ESA, R. O'Connell (University of Virginia), the WFC3 Science Oversight Committee, and ESO

STScI-PRC09-29

Irregular galaxies


Magellanic
clouds


Large Magellanic Cloud
Irr
© Anglo-Australian Obs./Royal Obs. Edinburgh


Small Magellanic Cloud
Irr
© Anglo-Australian Obs./Royal Obs. Edinburgh

Blue Compact Dwarf Galaxy I Zwicky 18
Hubble Space Telescope • ACS • WFPC2

NASA, ESA Y. Izotov (MAO, Kyiv, UA) and T. Thuan (University of Virginia) STScI-PRC04-35

Dwarf Irregular Galaxy NGC 1427A

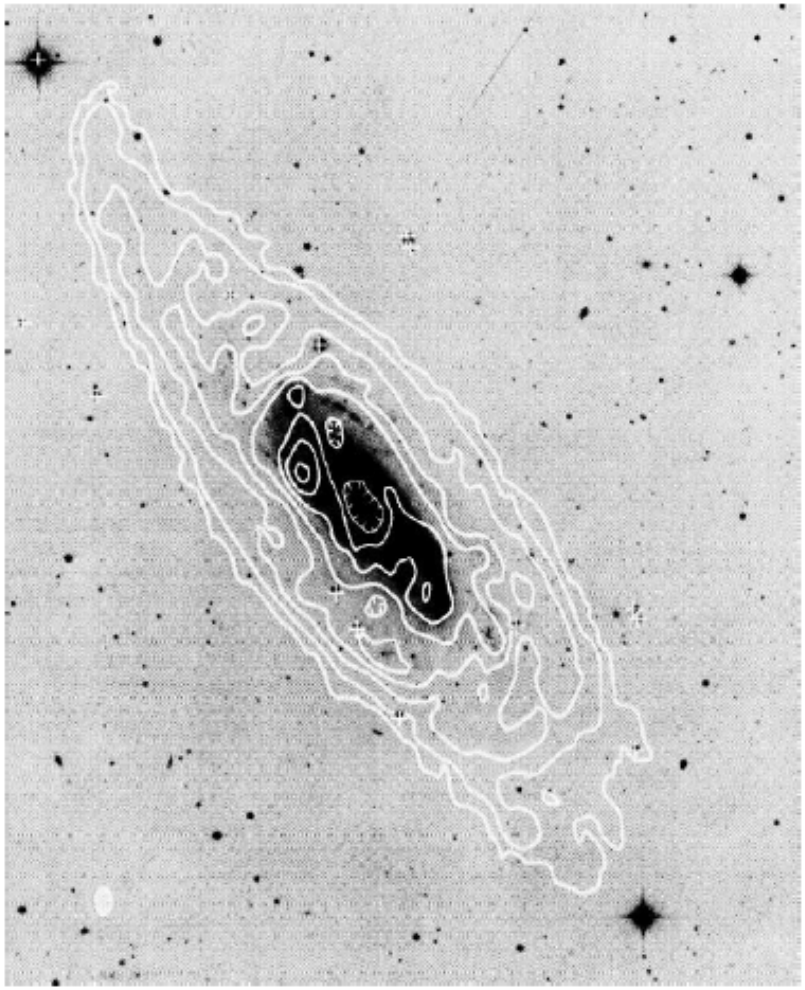
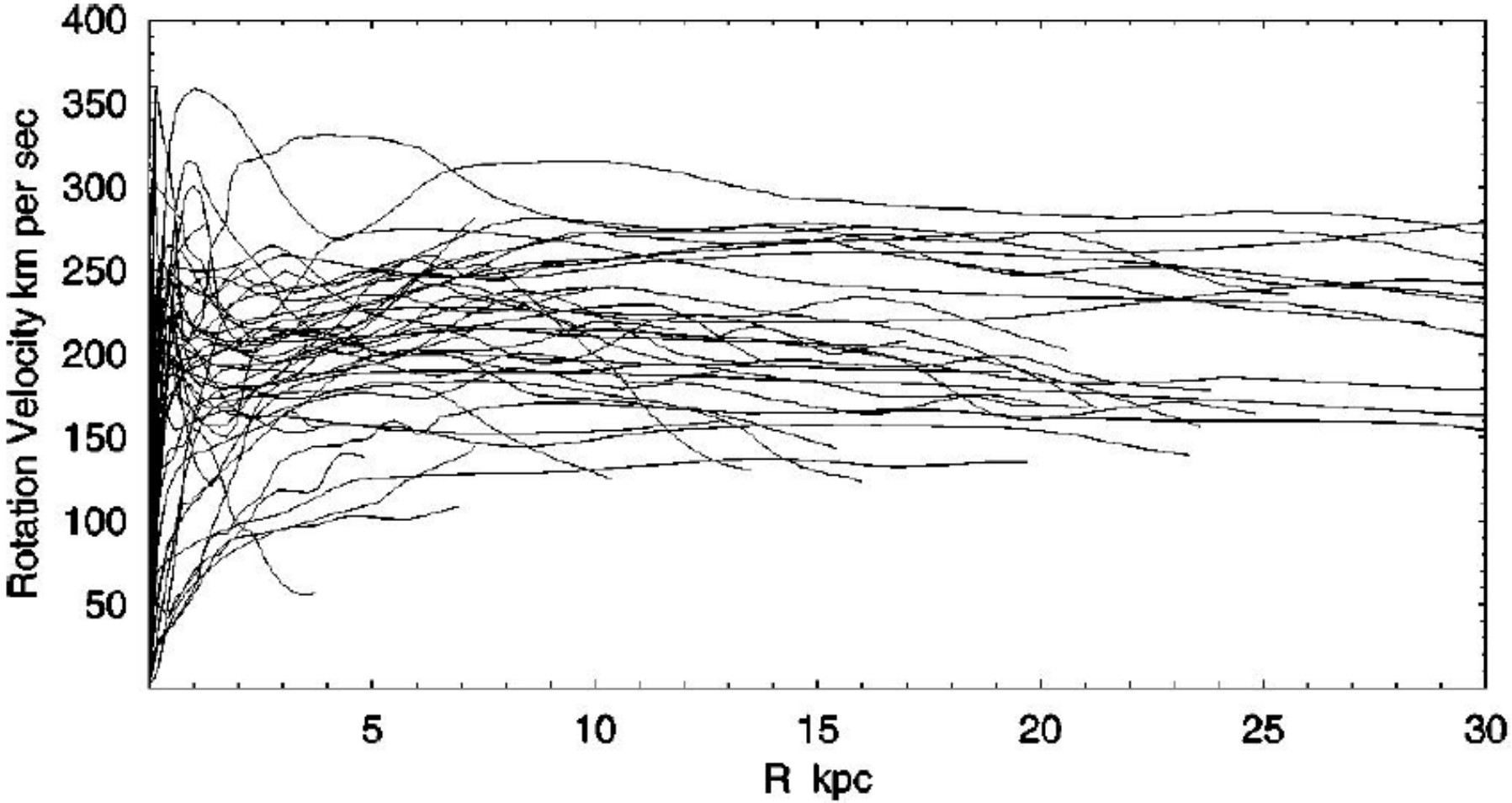
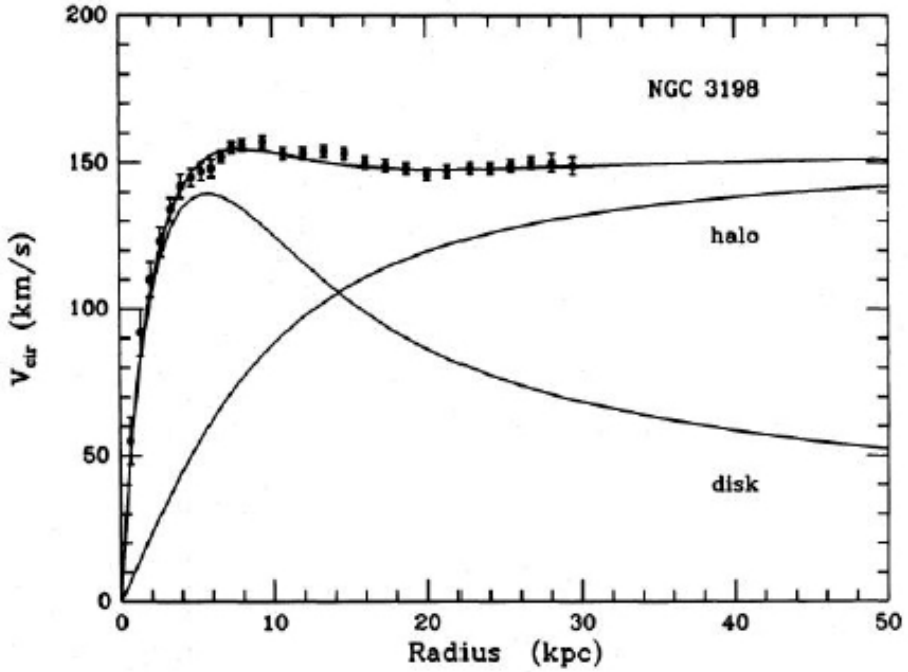


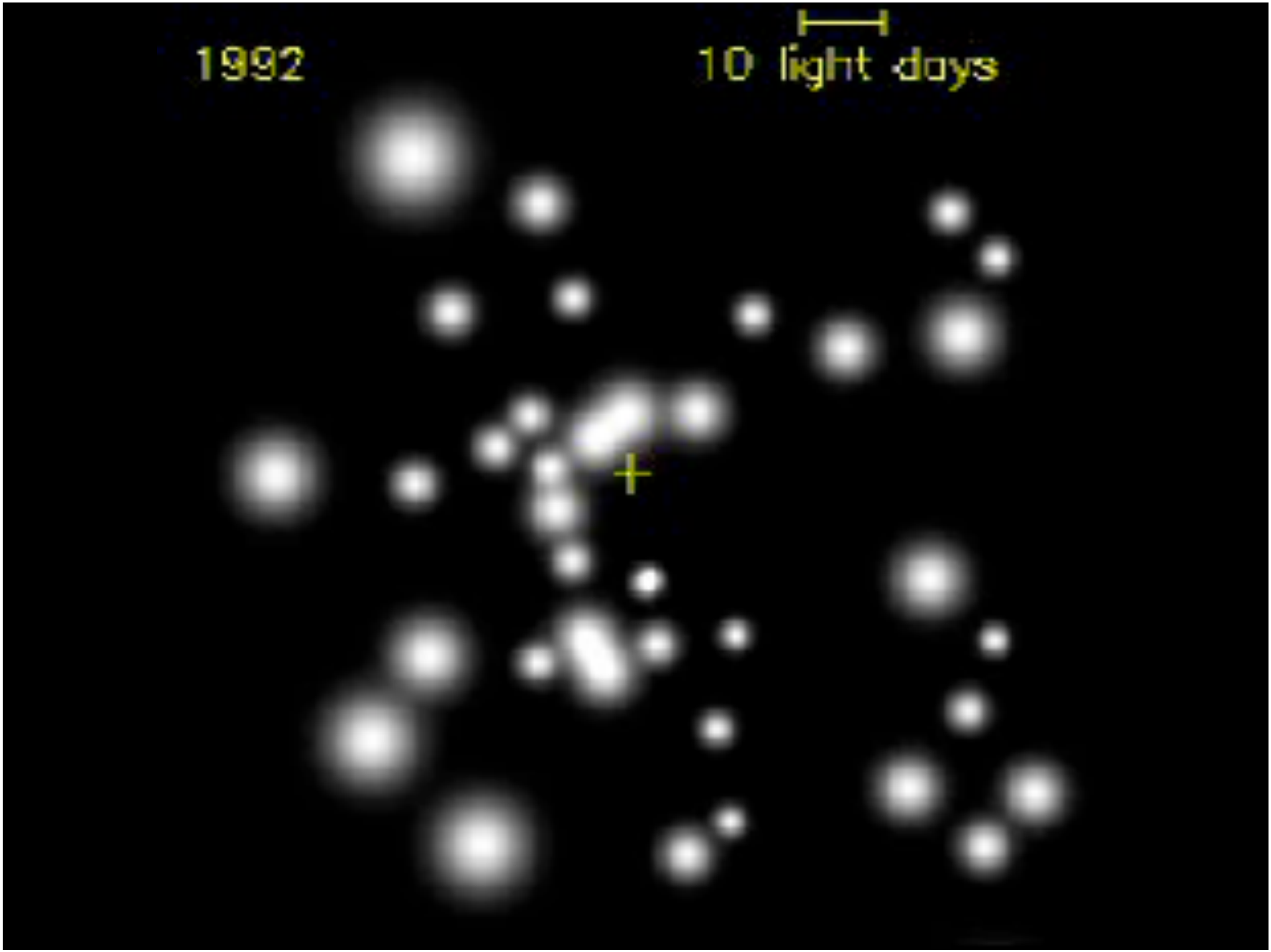
Fig. 2.— optical image and neutral hydrogen (HI) map (contours) for NGC 3198. Notice that the HI distribution is much more extended.



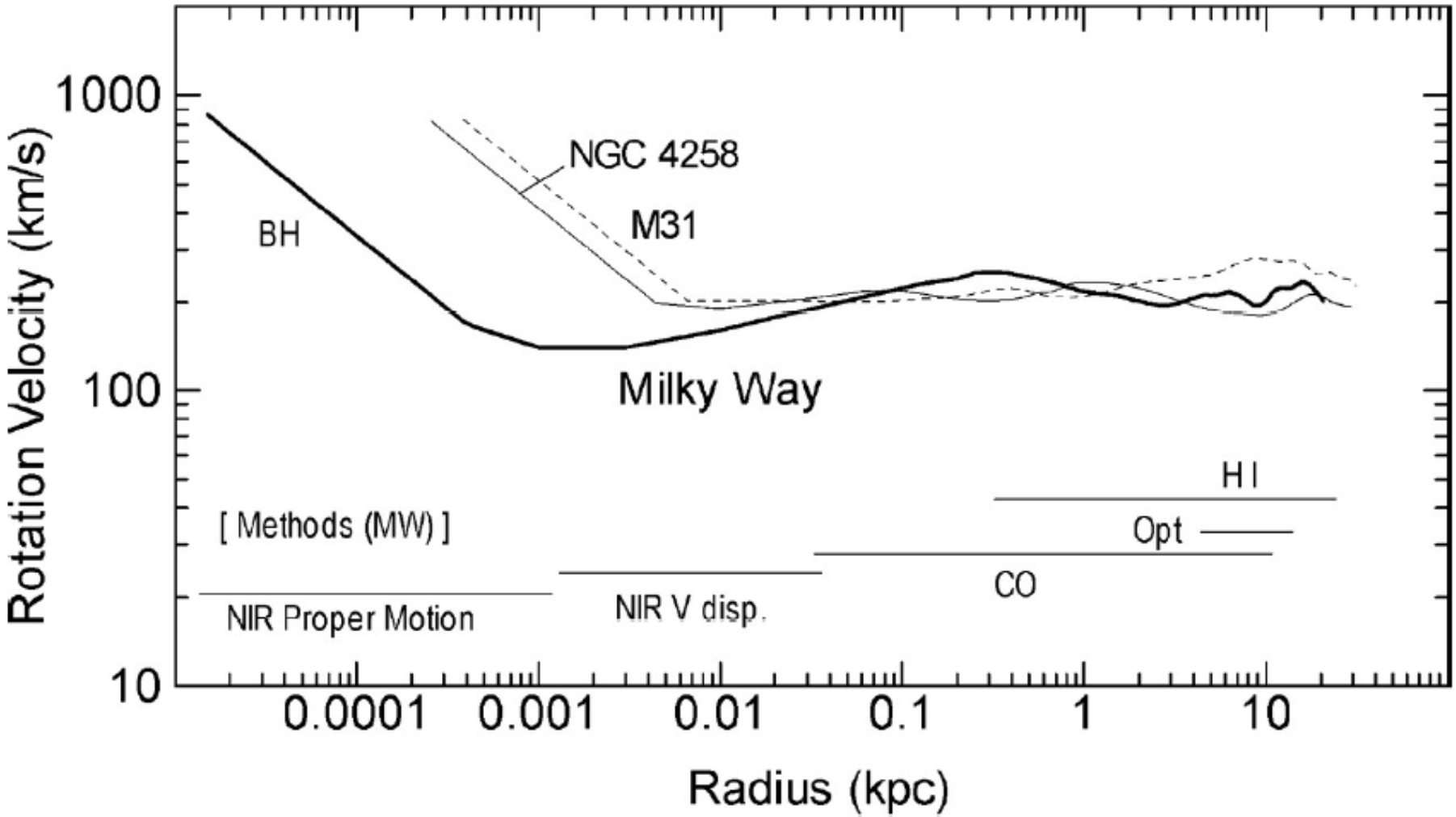
Curvas de rotación para muchas galaxias espirales

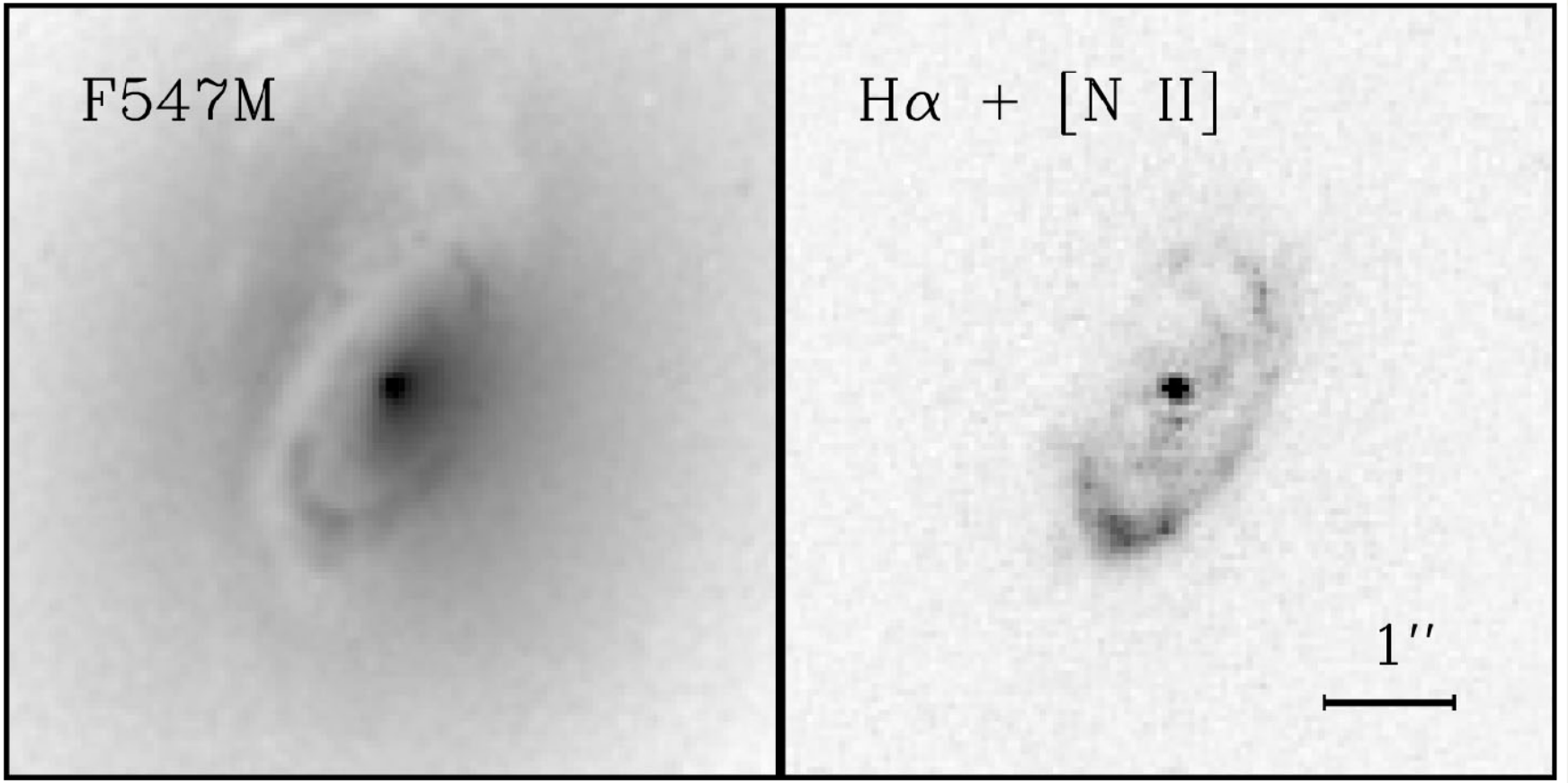


Curva de rotación para NGC3198


1992
10 light days

Agujero negro central





Disco de polvo y gas ionizado observado con el HST en la galaxia S0 NGC 3245 (1”= 100pc)

Observaciones de H_2O masers (emisión maser de vapor de agua a λ=1.35cm)

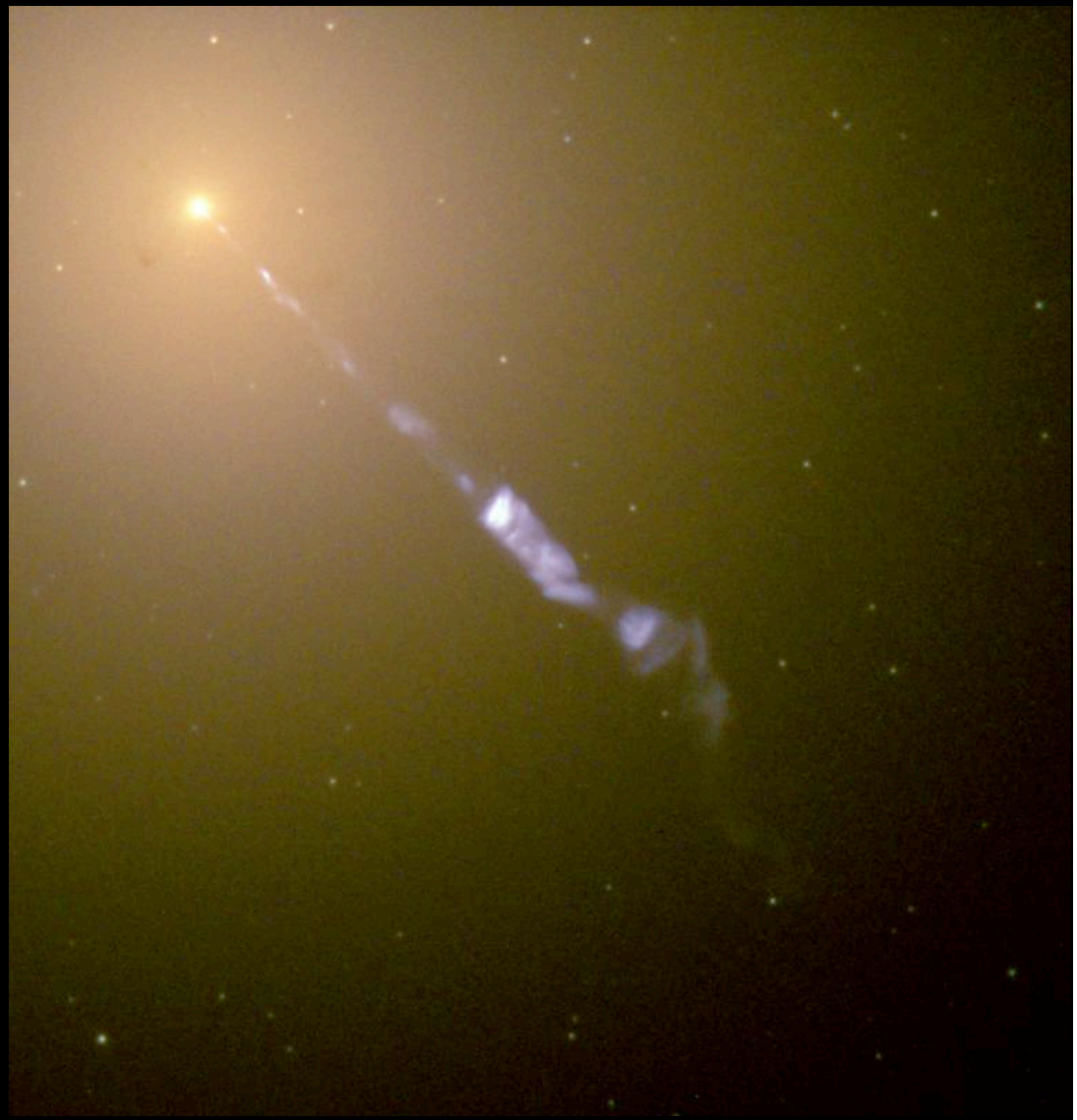
NGC 4258

Órbira kepleriana hasta 0.14pc (3.9mas)

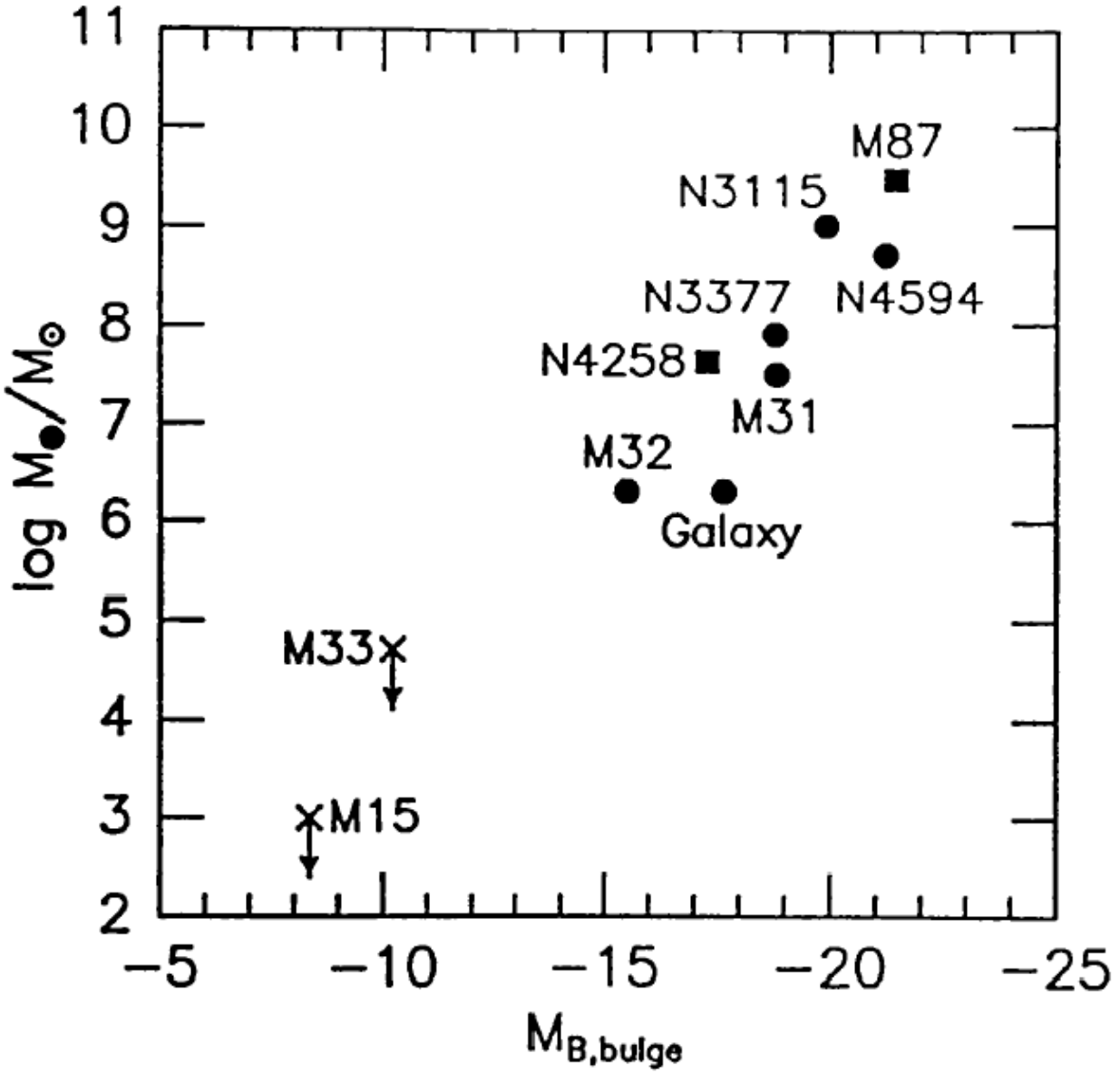
$$M_{BH} = 3.9 \times 10^{7} M$$

Miyoshi et al. (1995)

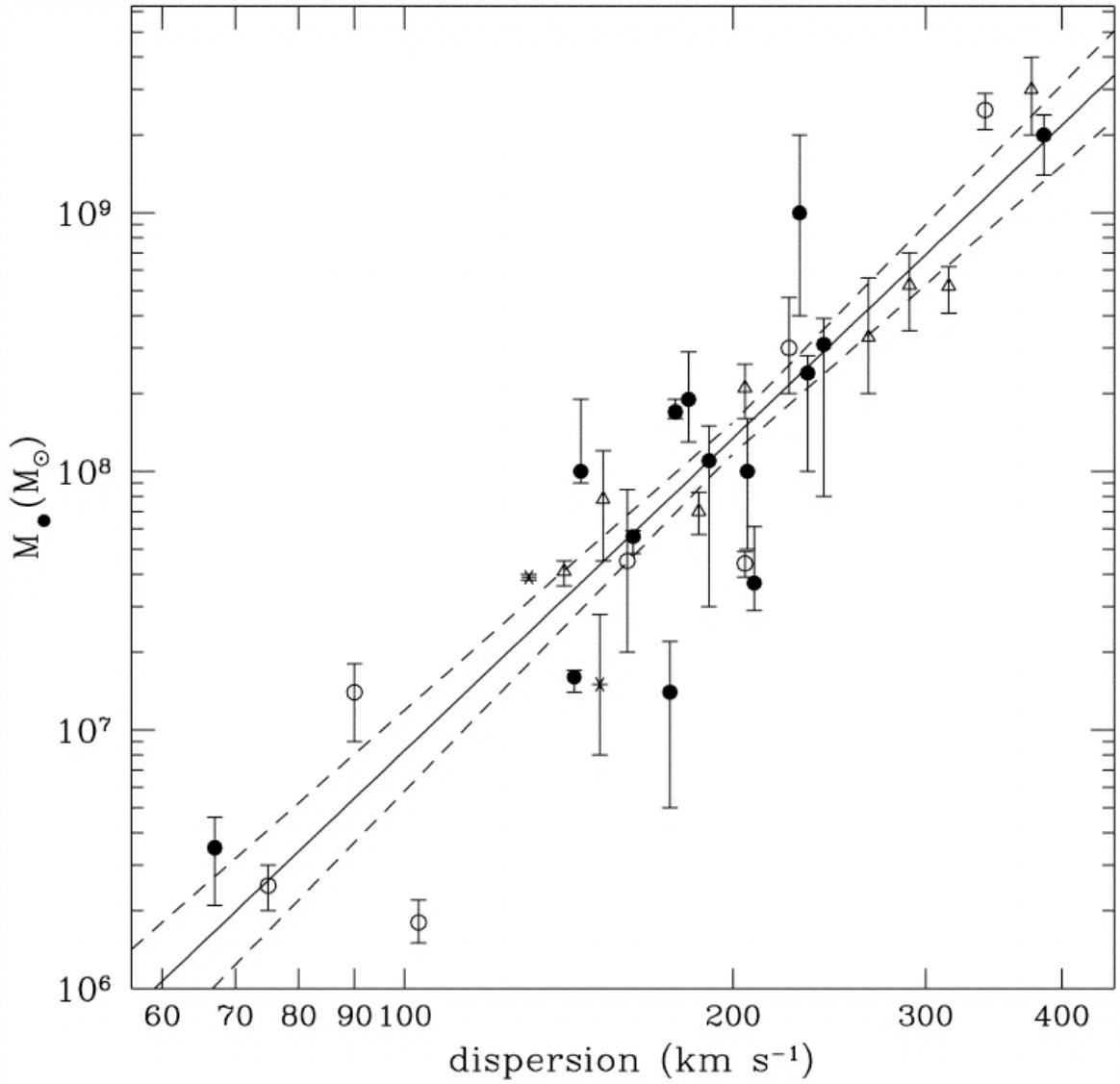
M87



$M_{BH} = (2.4 \pm 0.7) \times 10^9 M_\odot$



•Kormendy, J., & Richstone, D. 1995, ARA&A



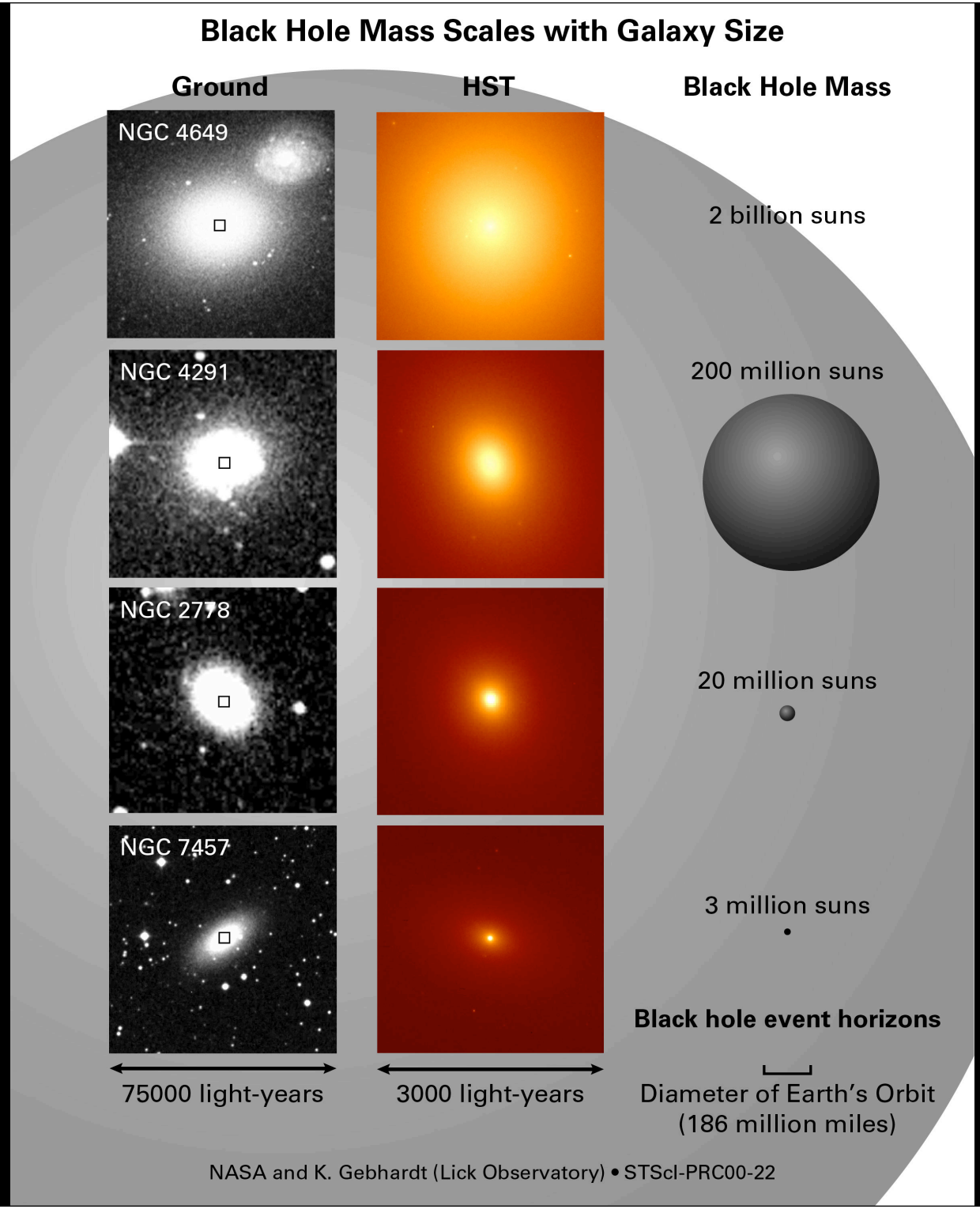
$$\log(M_{\rm BH}/M_\odot) = \alpha + \beta \log(\sigma/\sigma_0)$$

($\sigma_0 = 200$ km s^{-1})

$$\alpha = 8.13 \pm 0.06\,, \quad \beta = 4.02 \pm 0.32$$

- Tremaine, S., et al. 2002, ApJ

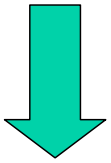
Black Hole Mass Scales with Galaxy Size



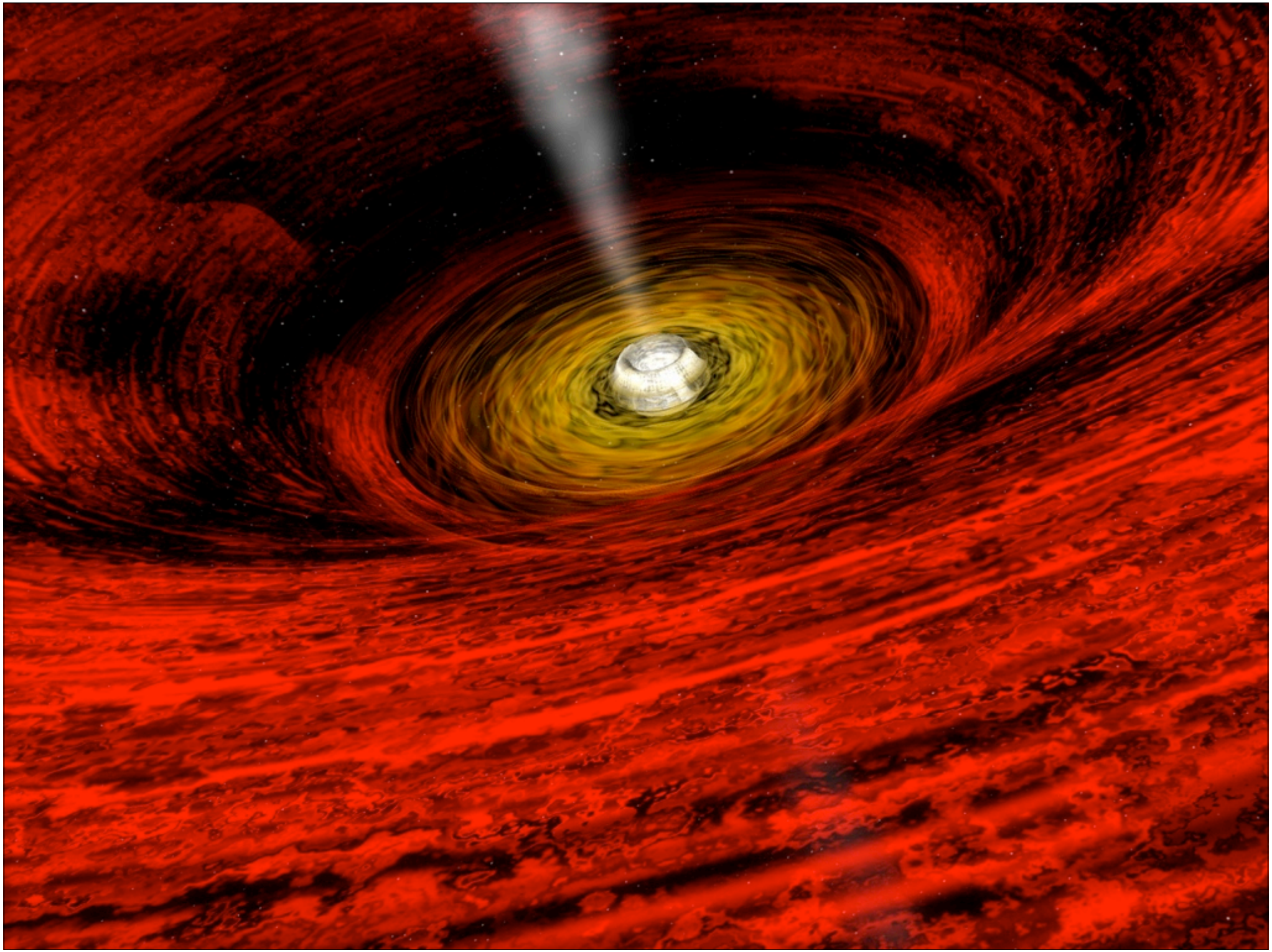
NASA and K. Gebhardt (Lick Observatory) • STScI-PRC00-22

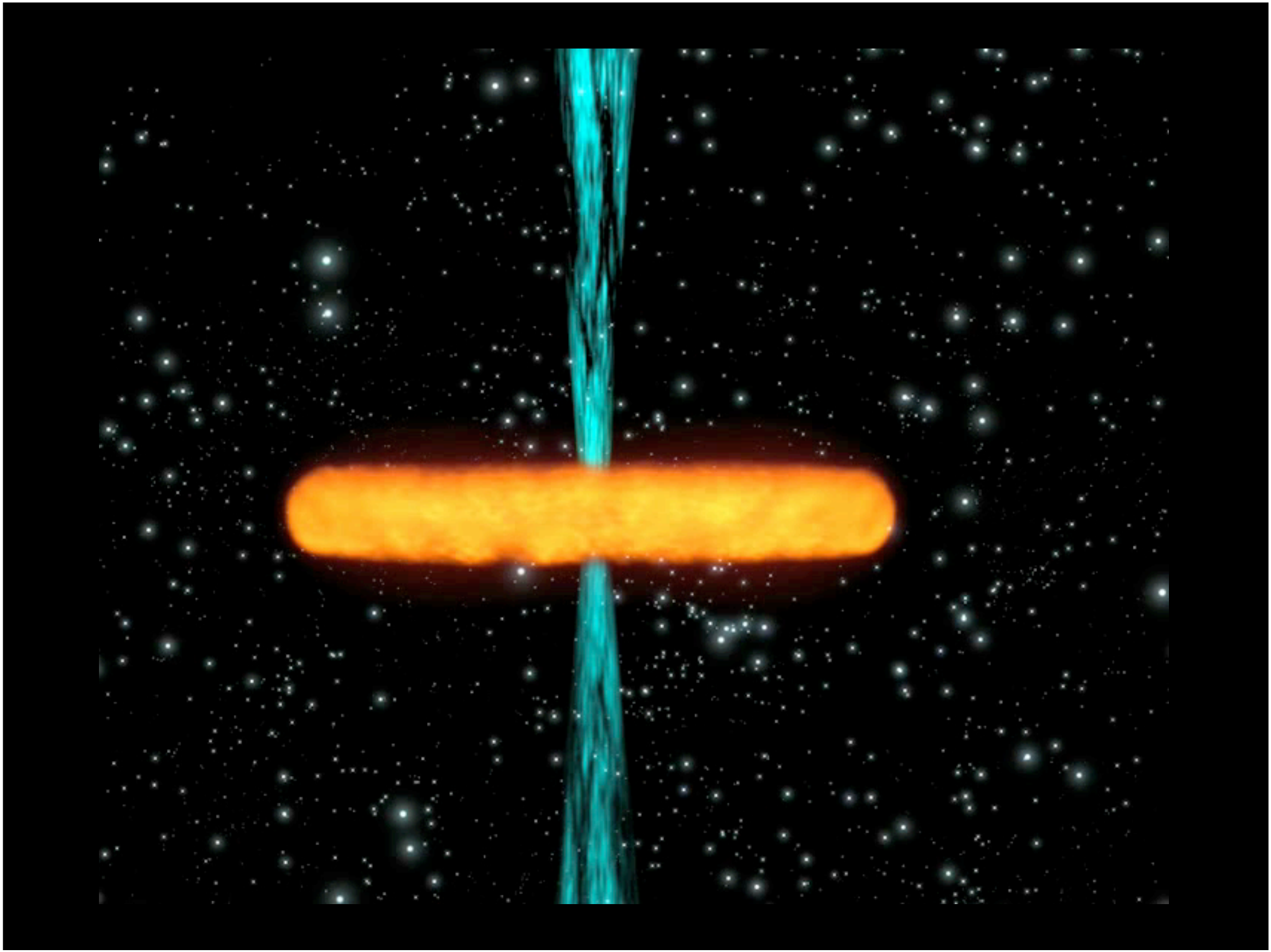
Galaxias activas y Cuásares

galaxia activa

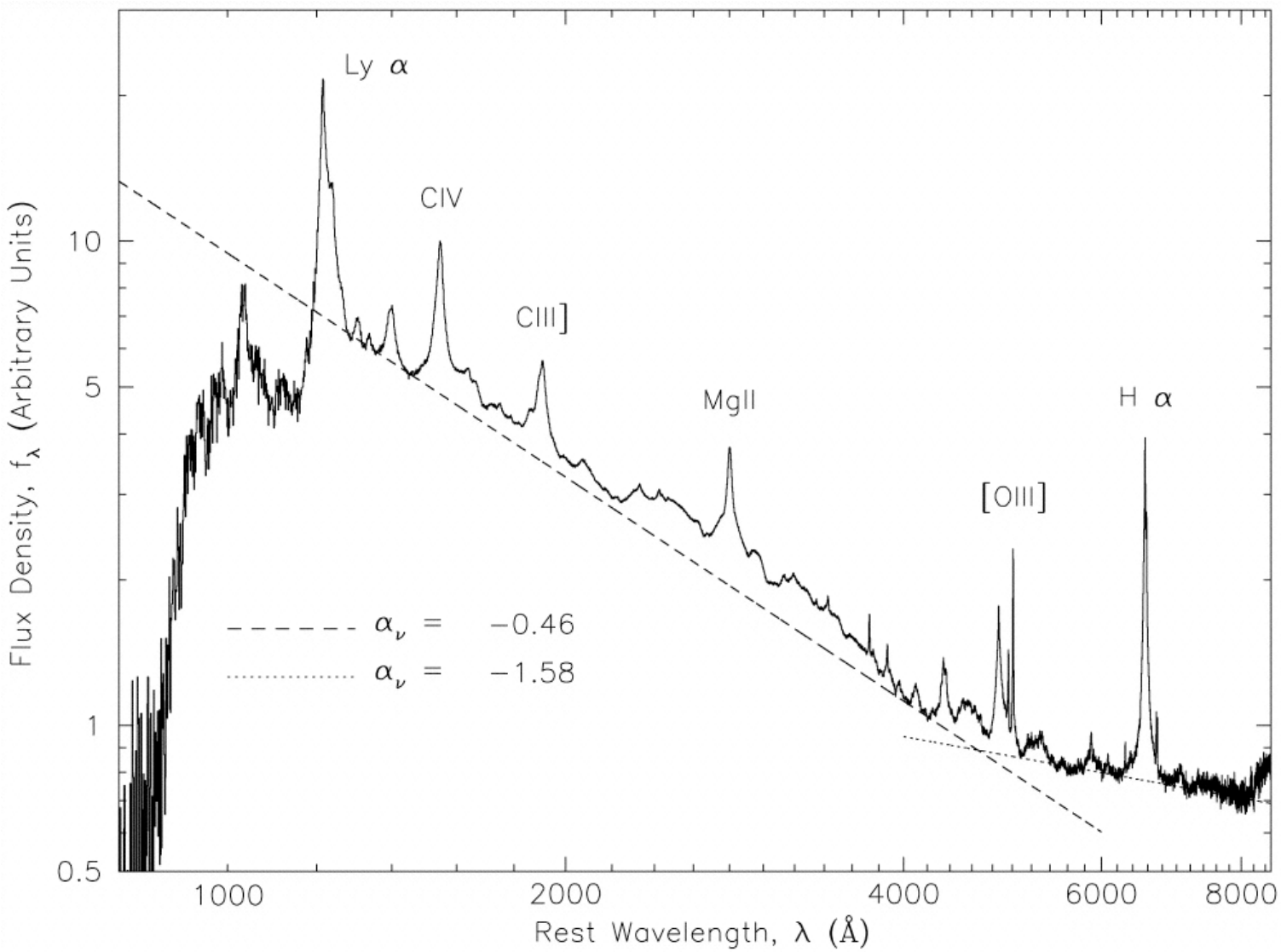


galaxia “normal” + núcleo activo (AGN)

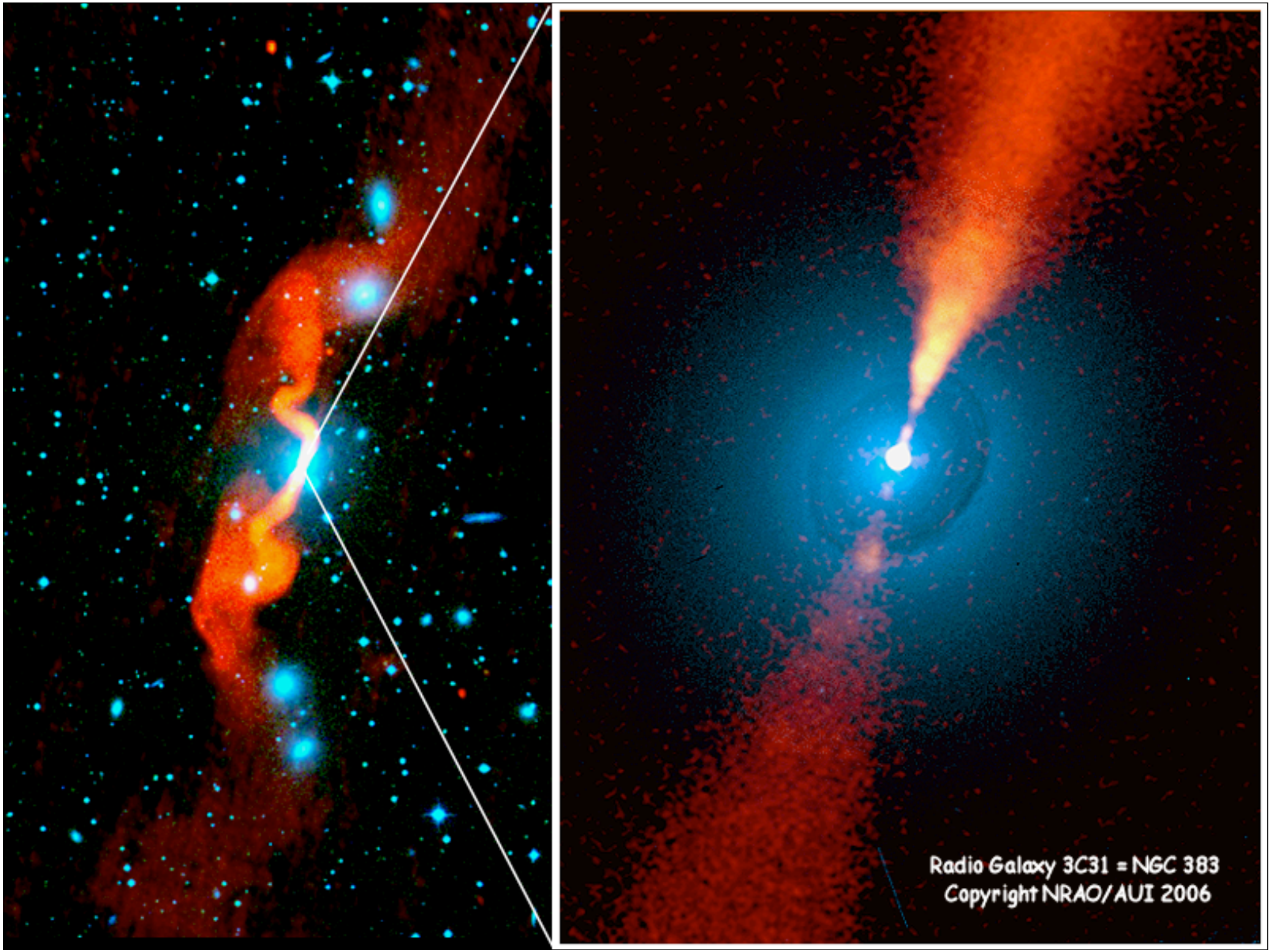


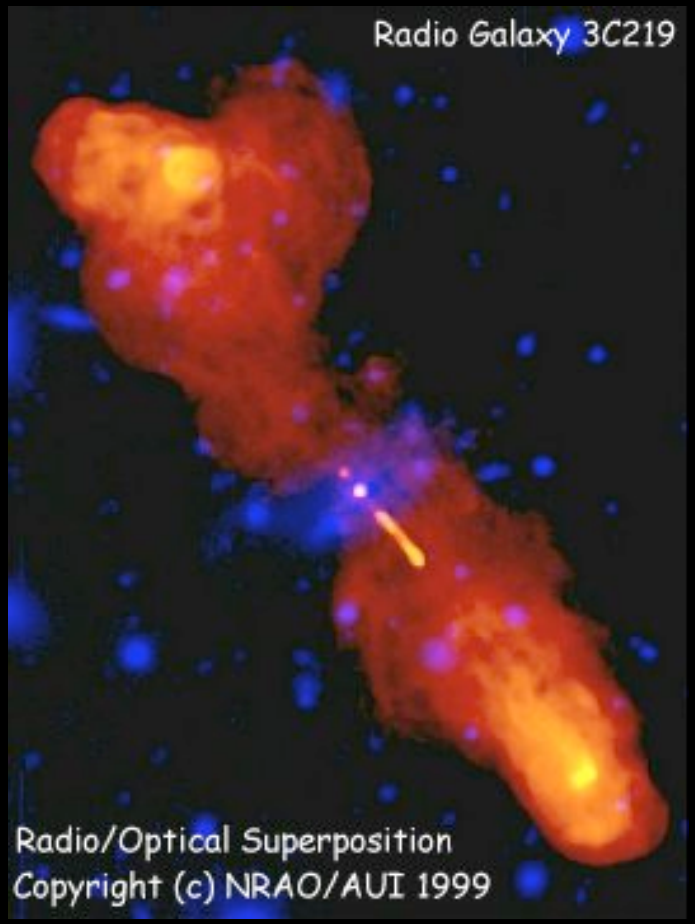


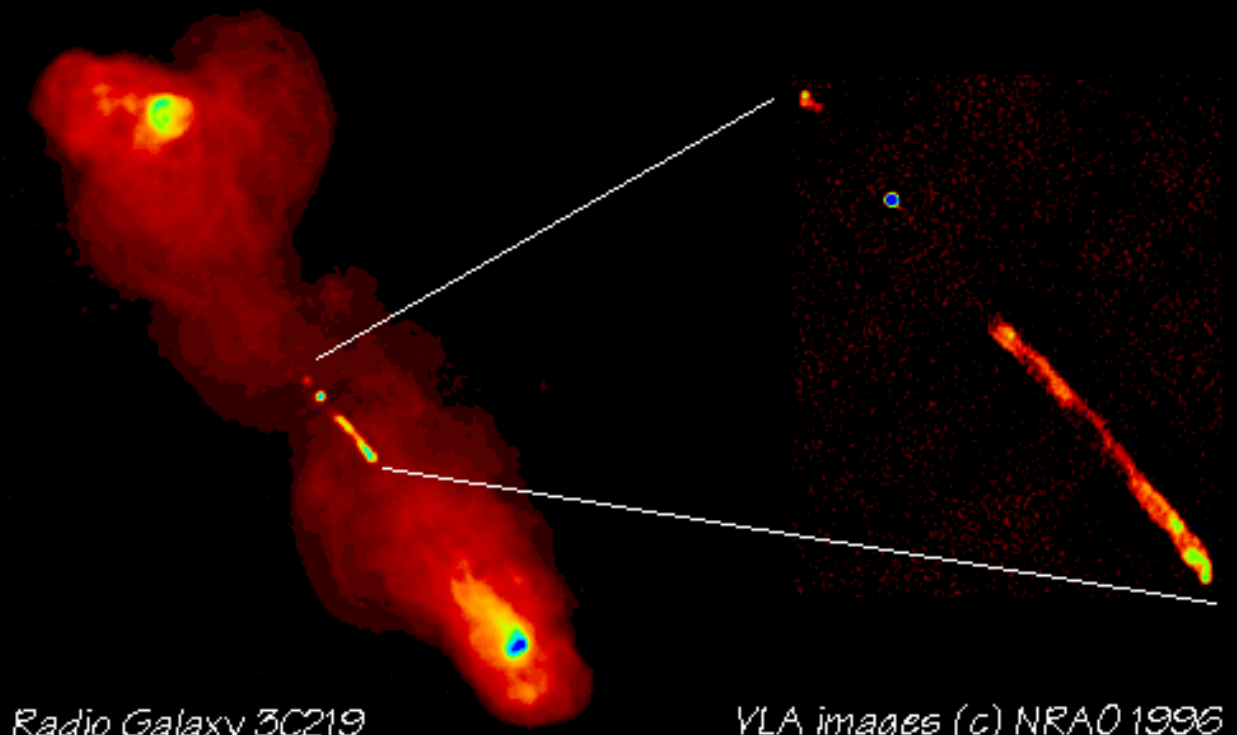
QSOs



COMPOSITE QUASAR SPECTRA FROM THE SLOAN DIGITAL SKY SURVEY
Vanden Berk etal. ApJ 2001

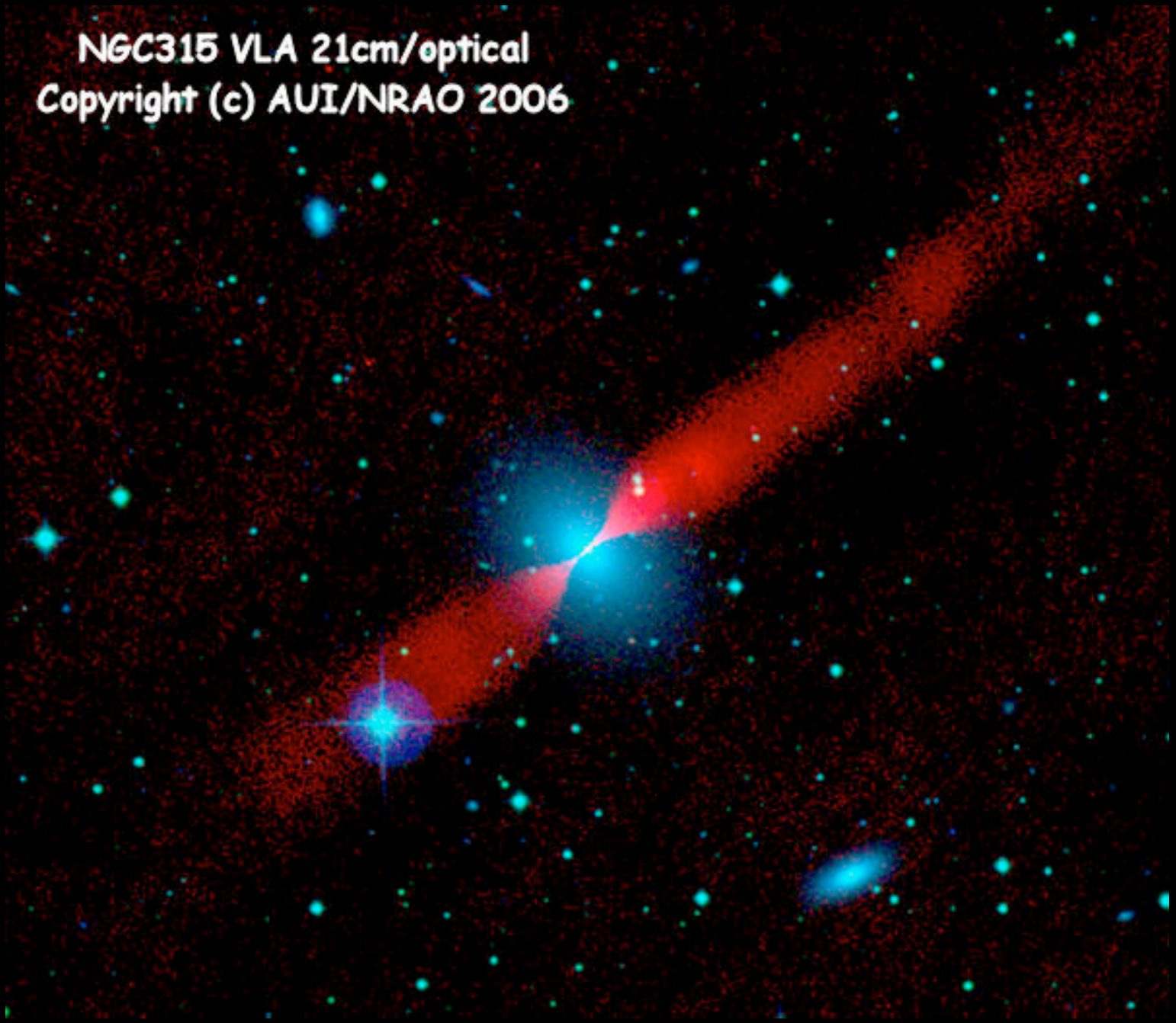

Radio Galaxy 3C31 = NGC 383
Copyright NRAO/AUI 2006

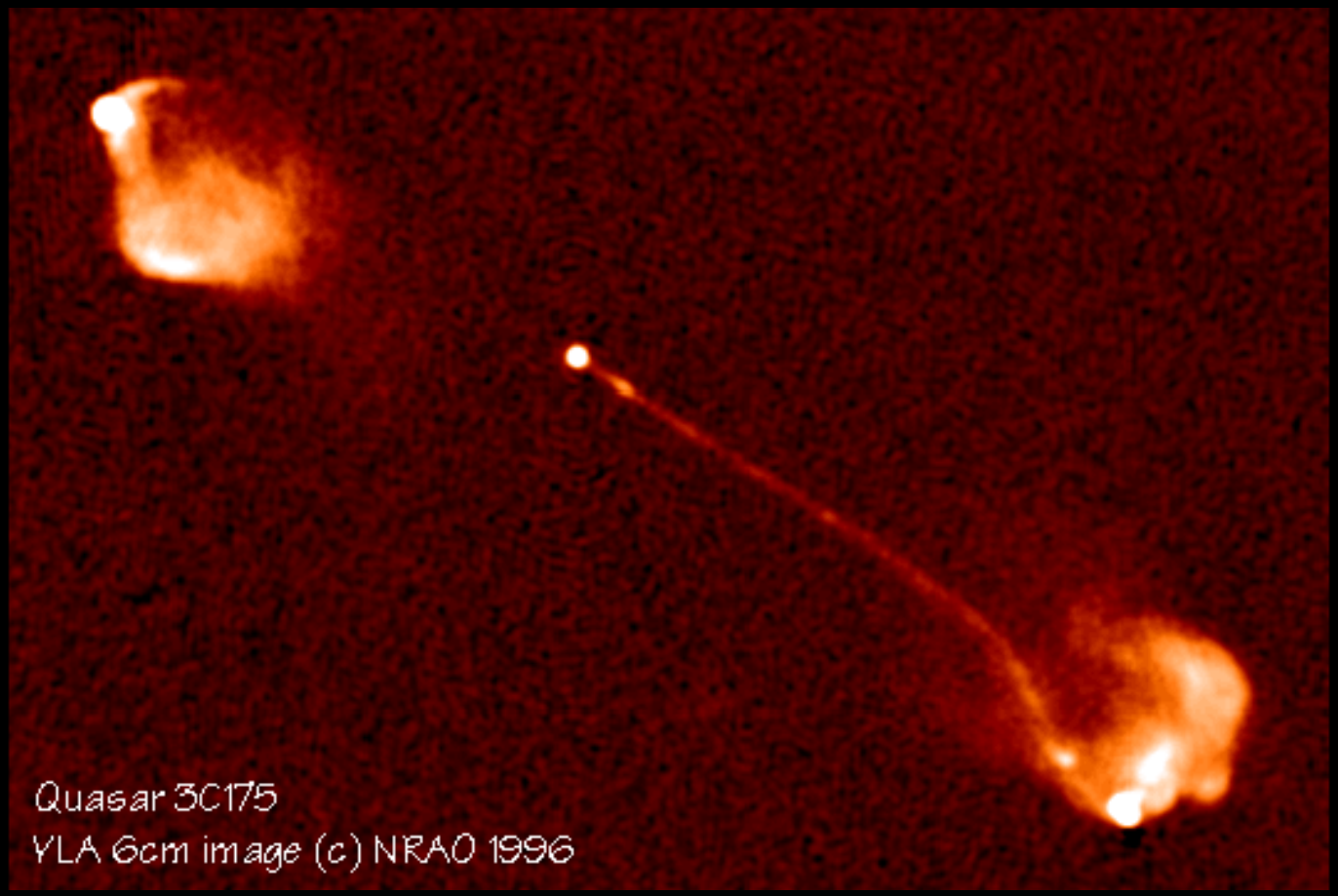


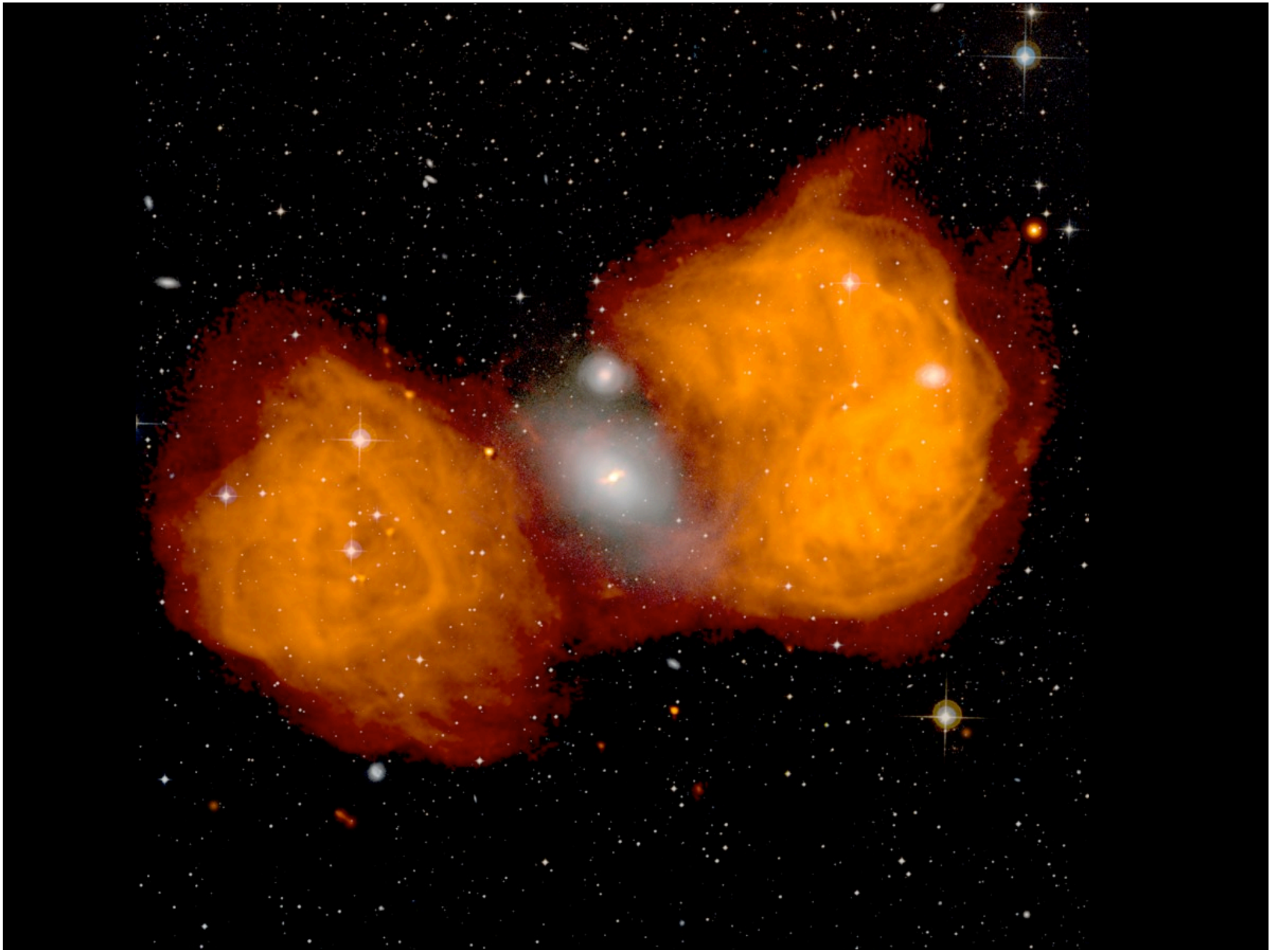


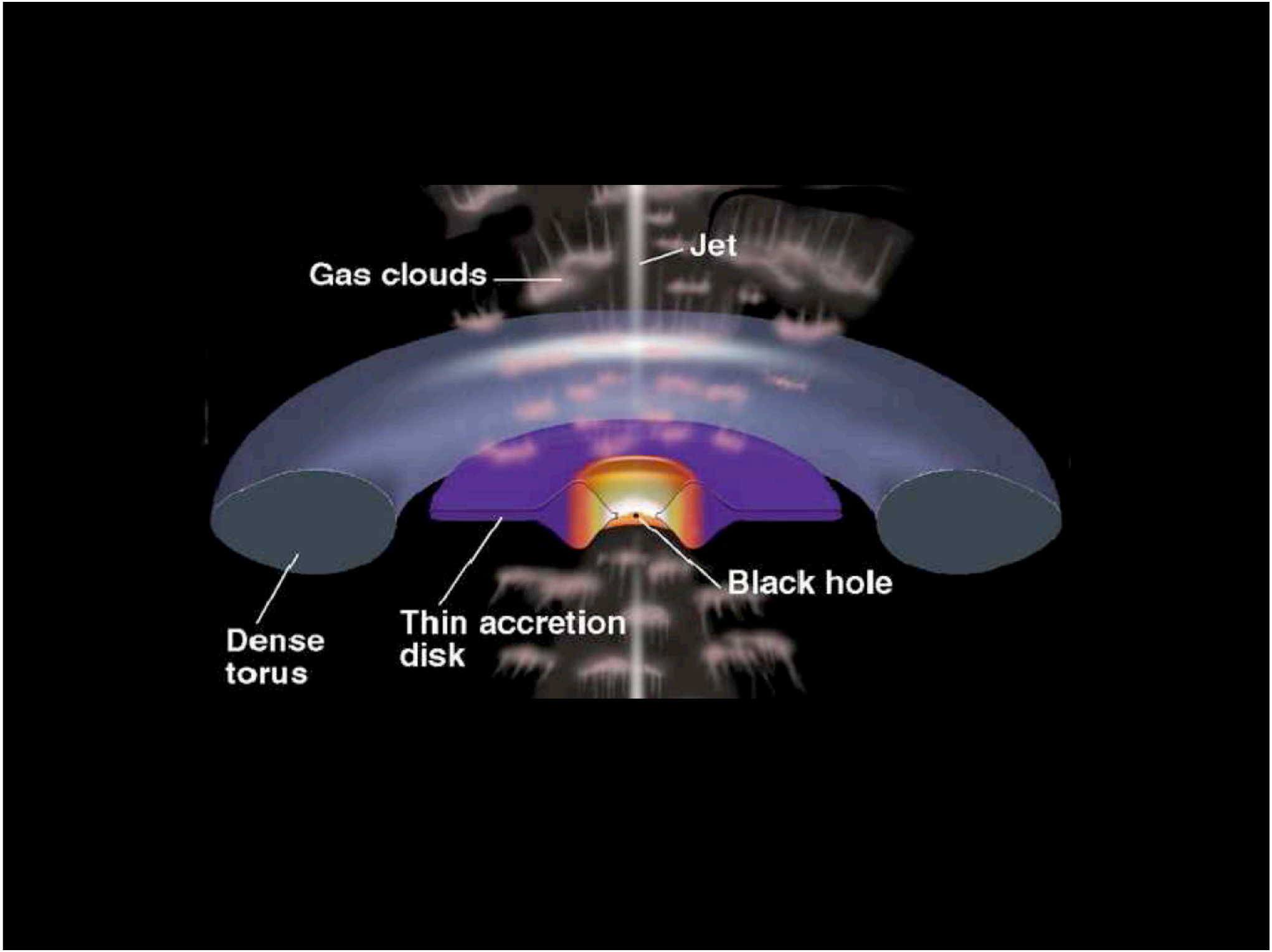
Radio Galaxy 3C219

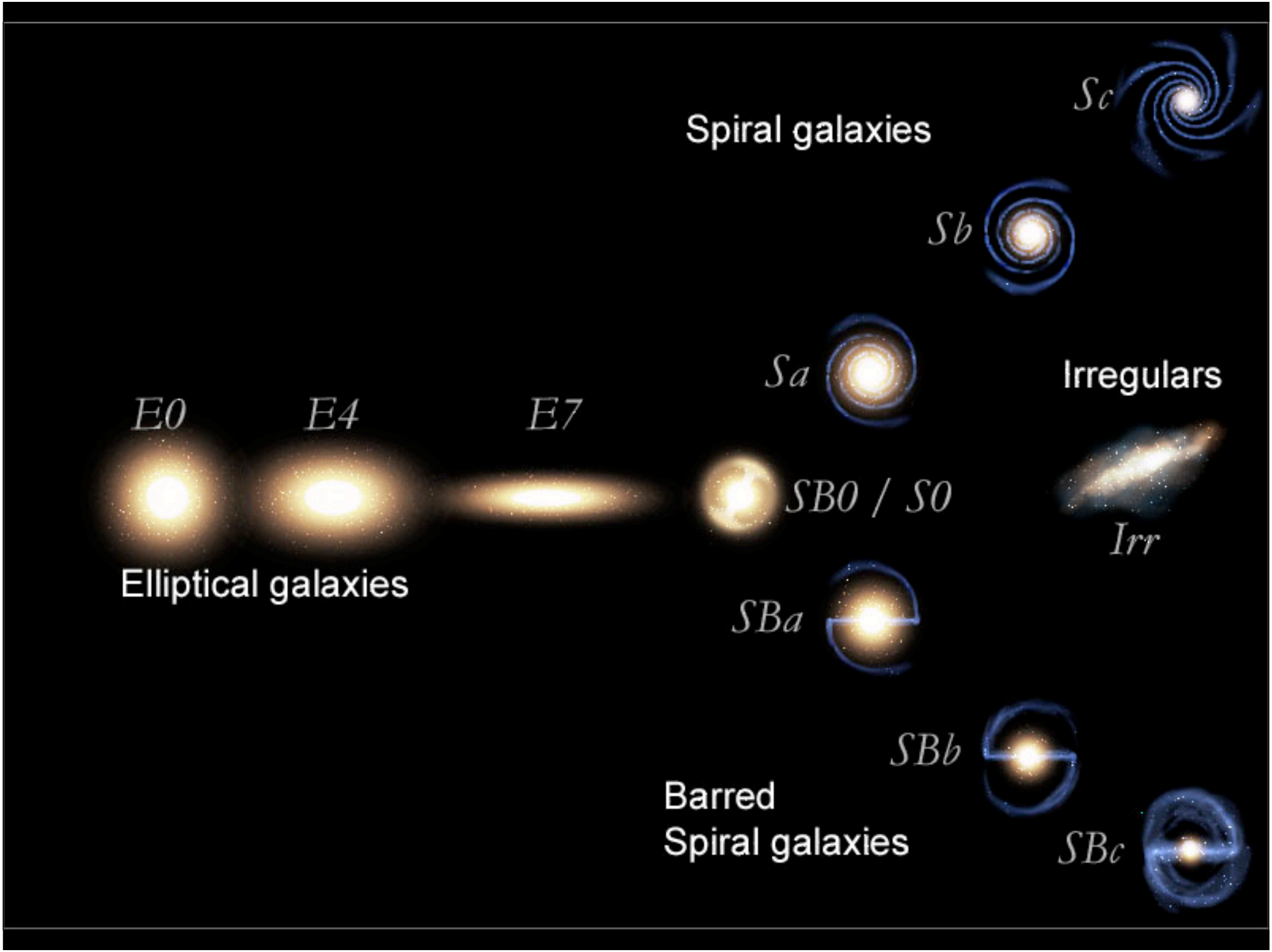
VLA images (c) NRAO 1996

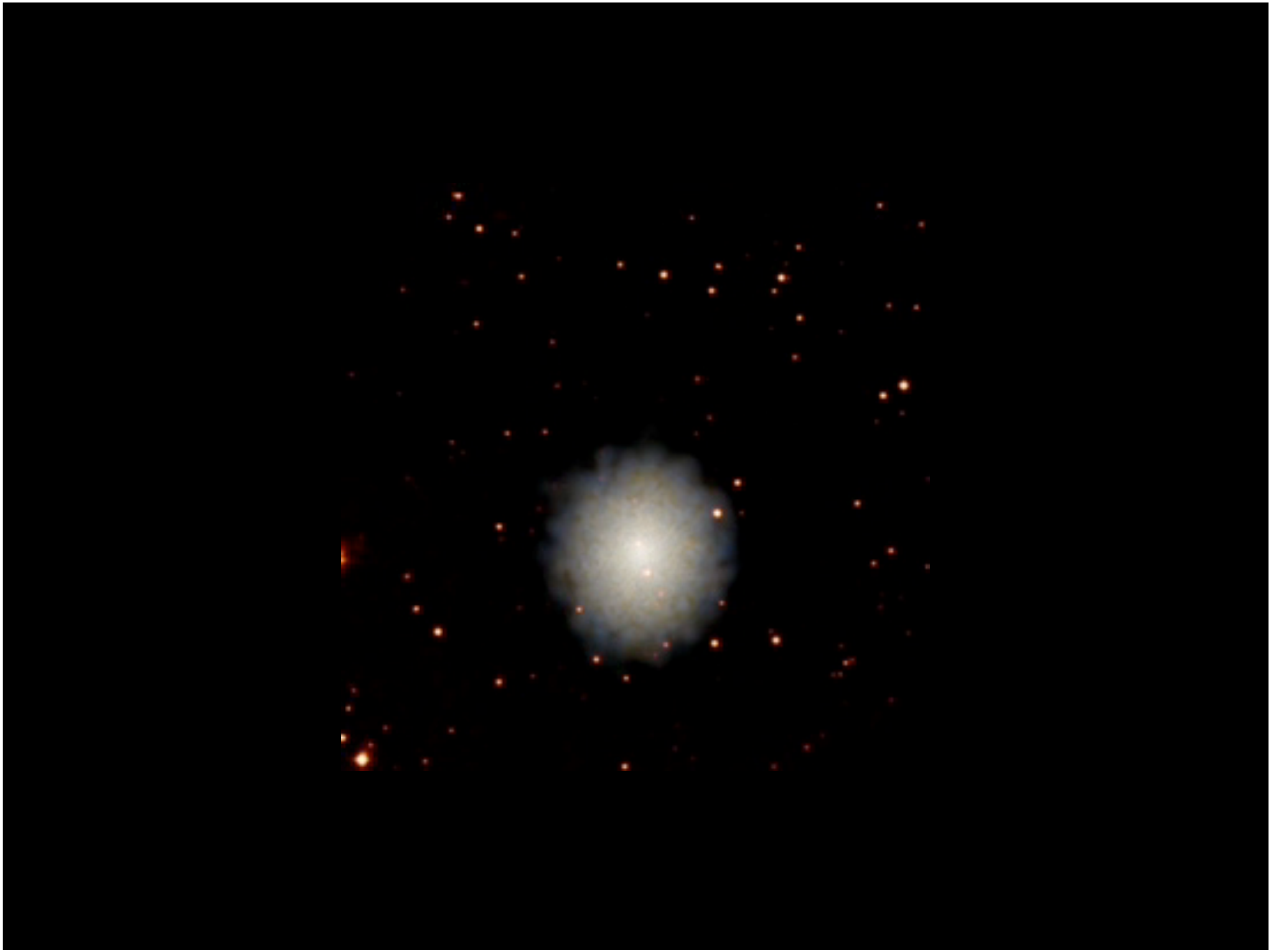

NGC315 VLA 21cm/optical
Copyright (c) AUI/NRAO 2006


Quasar 3C175
VLA 6cm image (c) NRAO 1996




Jet
Gas clouds
Black hole
Thin accretion disk
Dense torus


Sc
Spiral galaxies
Sb
Sa
Irregulars
E0
E4
E7
SB0 / S0
Irr
Elliptical galaxies
SBa
SBb
Barred
Spiral galaxies
SBc



CUMULOS DE GALAXIAS

- Grupos de galaxias

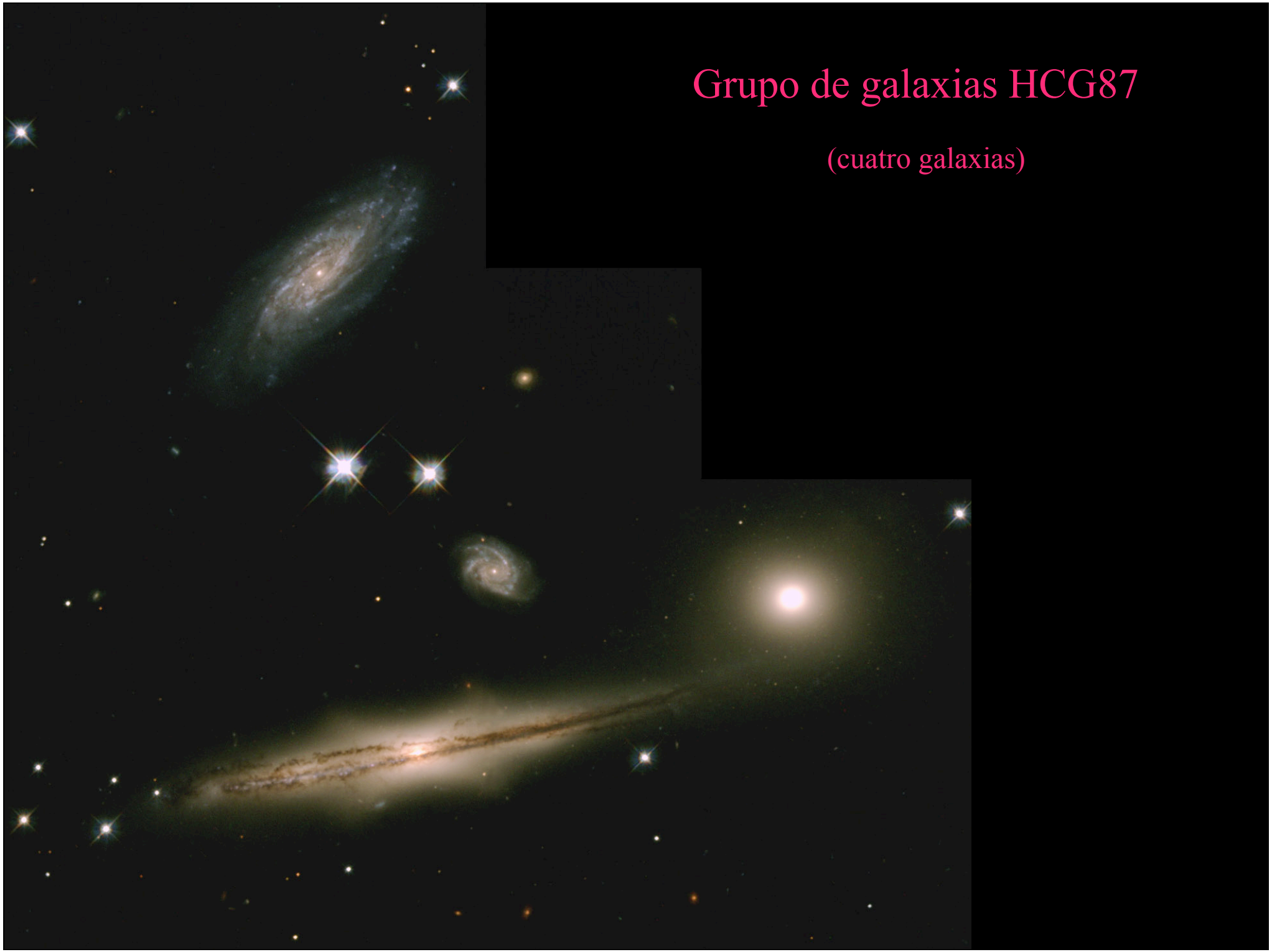
  Menos de 50 galaxias en un diámetro típico de 1-2 Mpc

- Cúmulos de galaxias

  Centenares o incluso miles de galaxias en un diámetro típico de 2-10 Mpc

- Supercúmulos

  Agrupaciones de galaxias aisladas, grupo de galaxias y cúmulos de galaxias



Grupo de galaxias HCG87

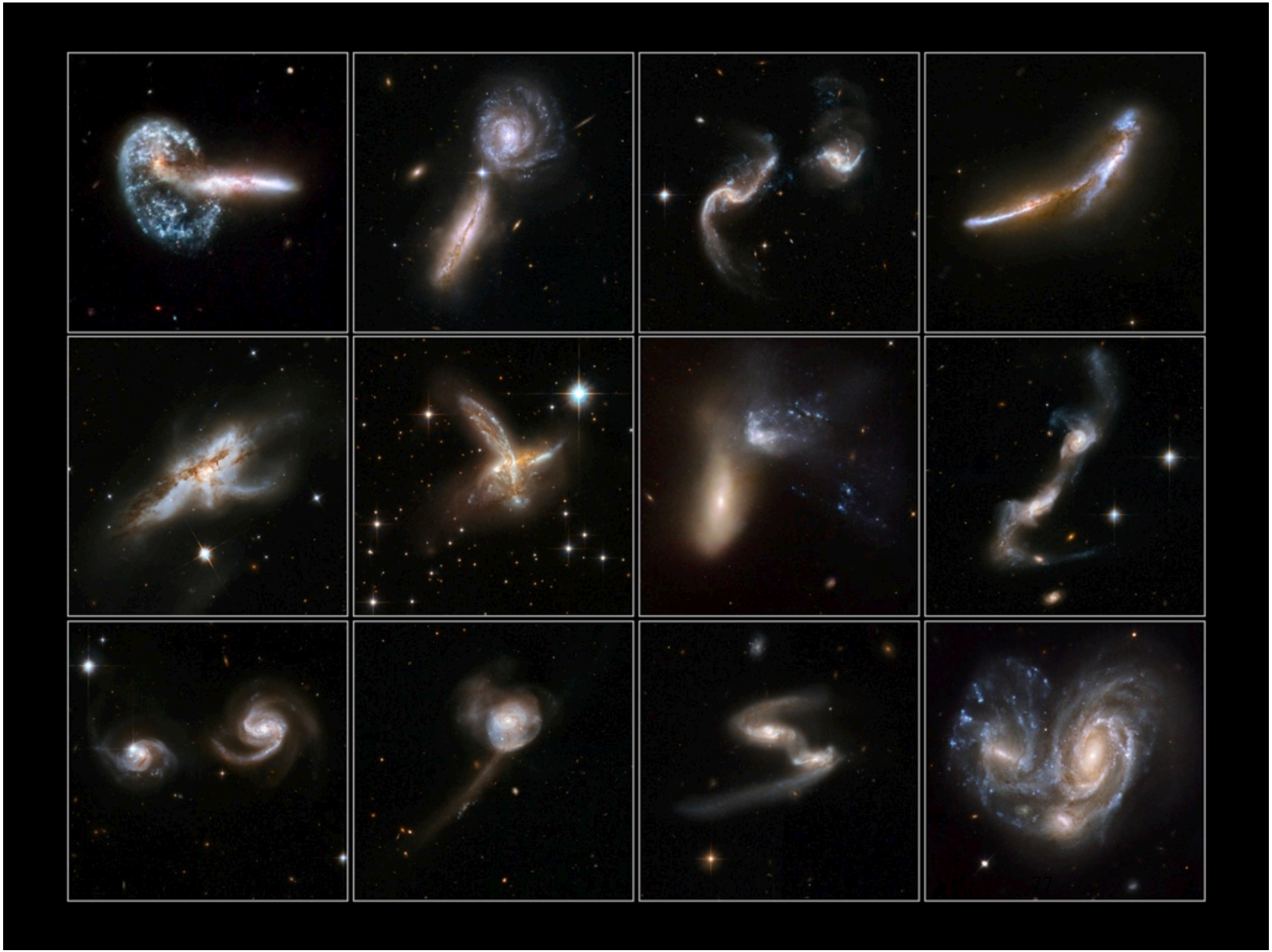
(cuatro galaxias)


Grupo de 6 galaxias en
proceso de colisión

Interacting Galaxies • Arp 87

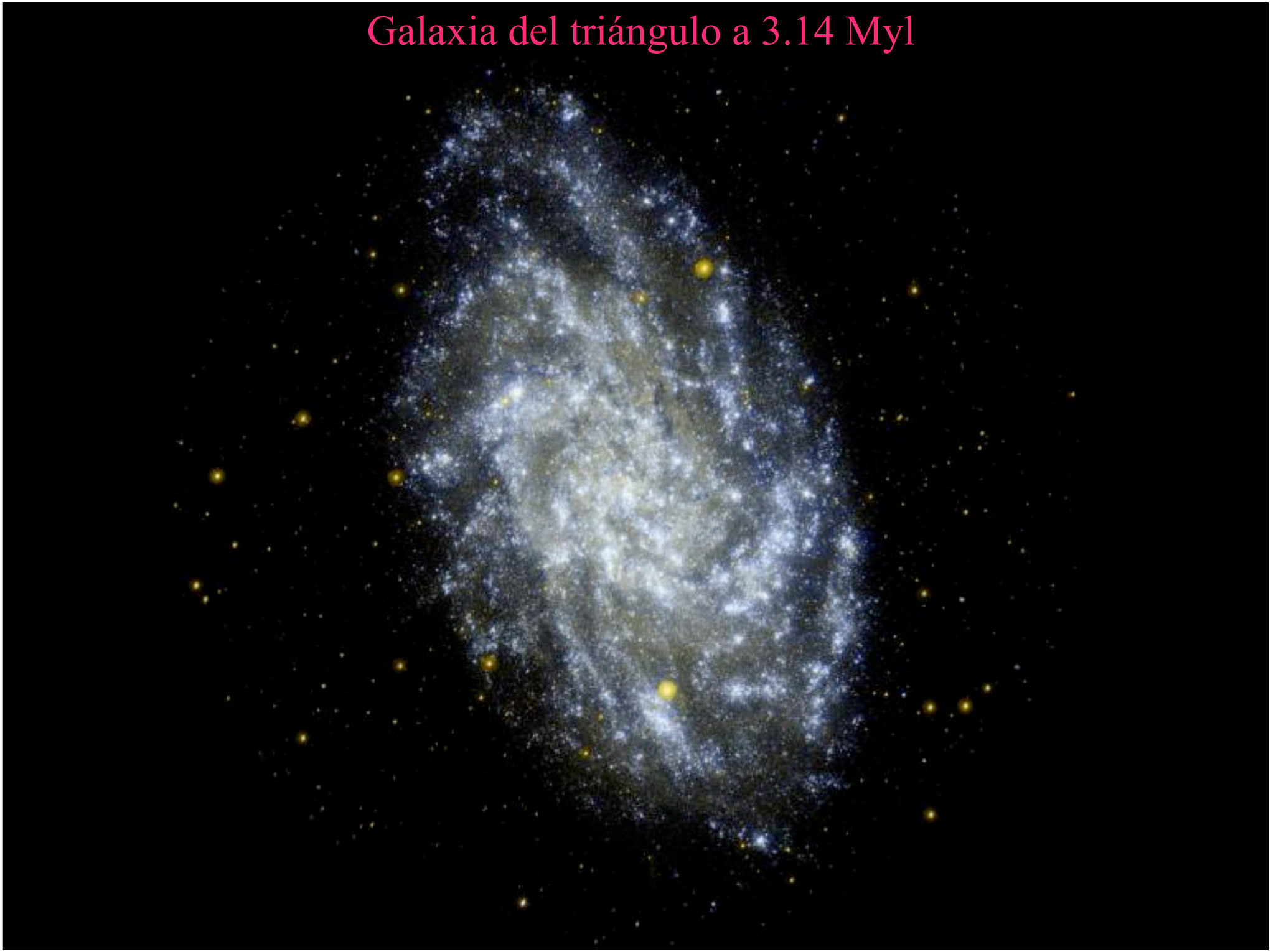
Hubble Heritage

NASA, ESA, and the Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope WFPC2 • STScI-PRC07-36

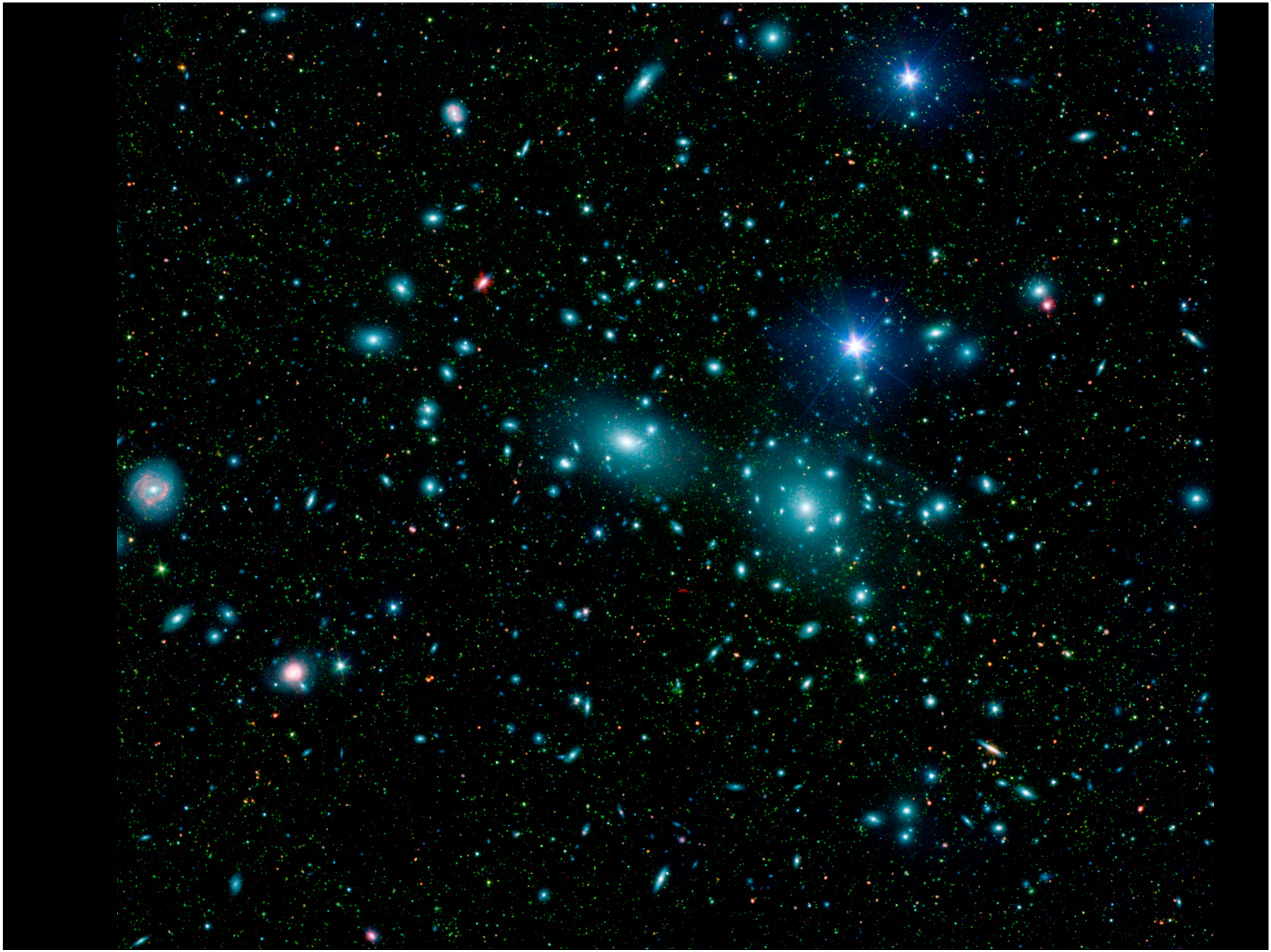


Andromeda a 2.5 Myl

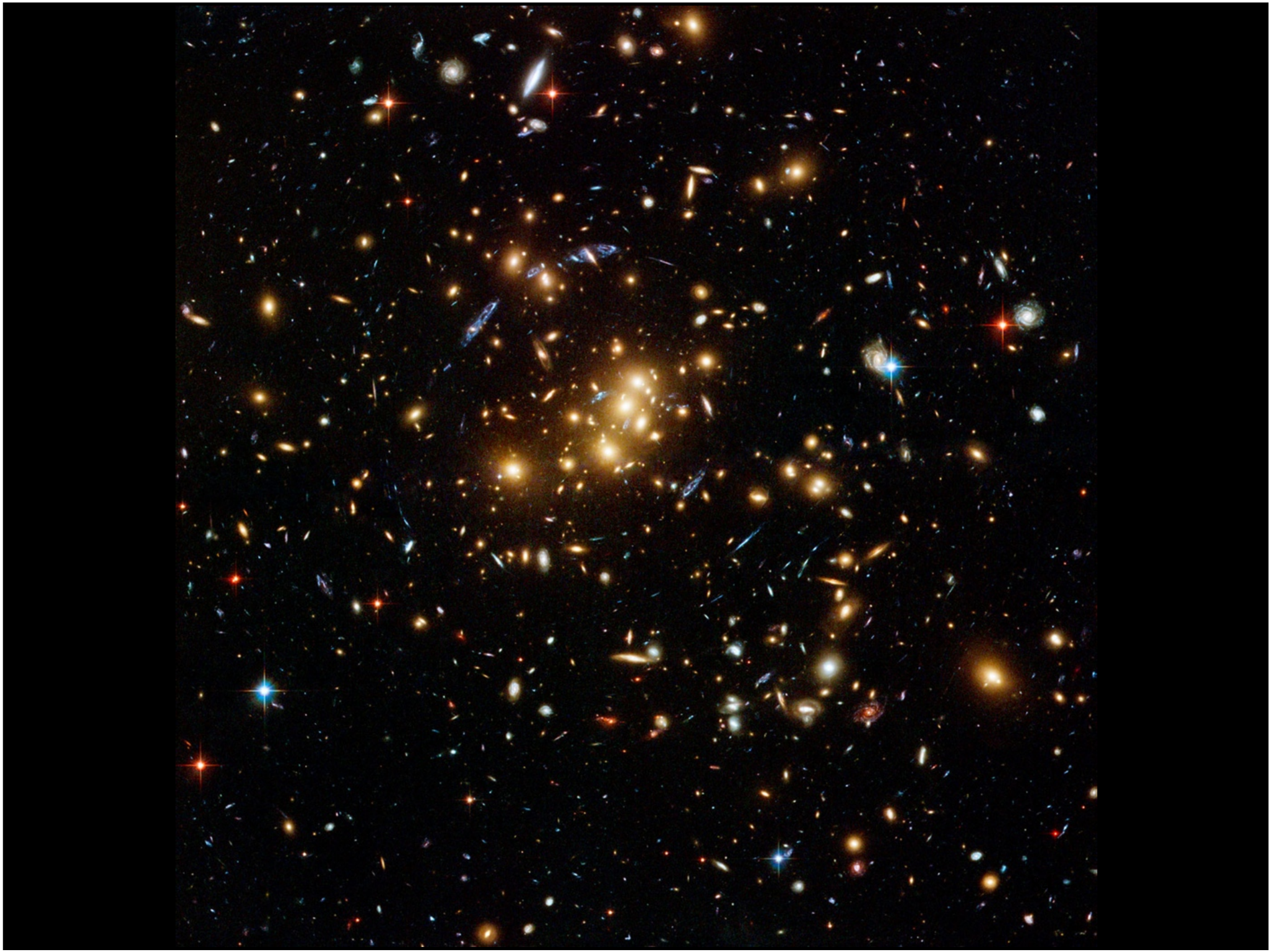
Galaxia del triángulo a 3.14 Myl

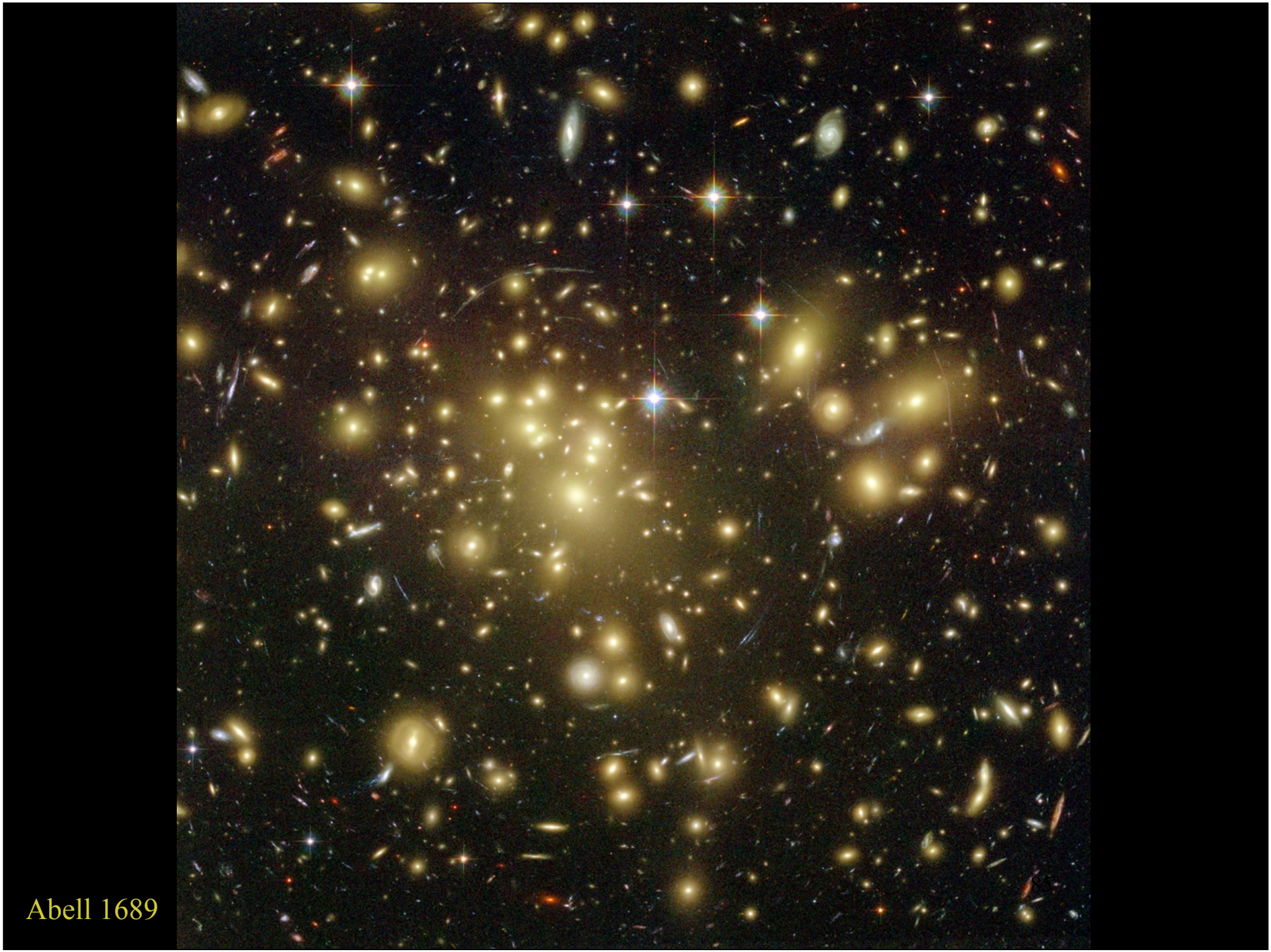



Cúmulo de Abell S0740



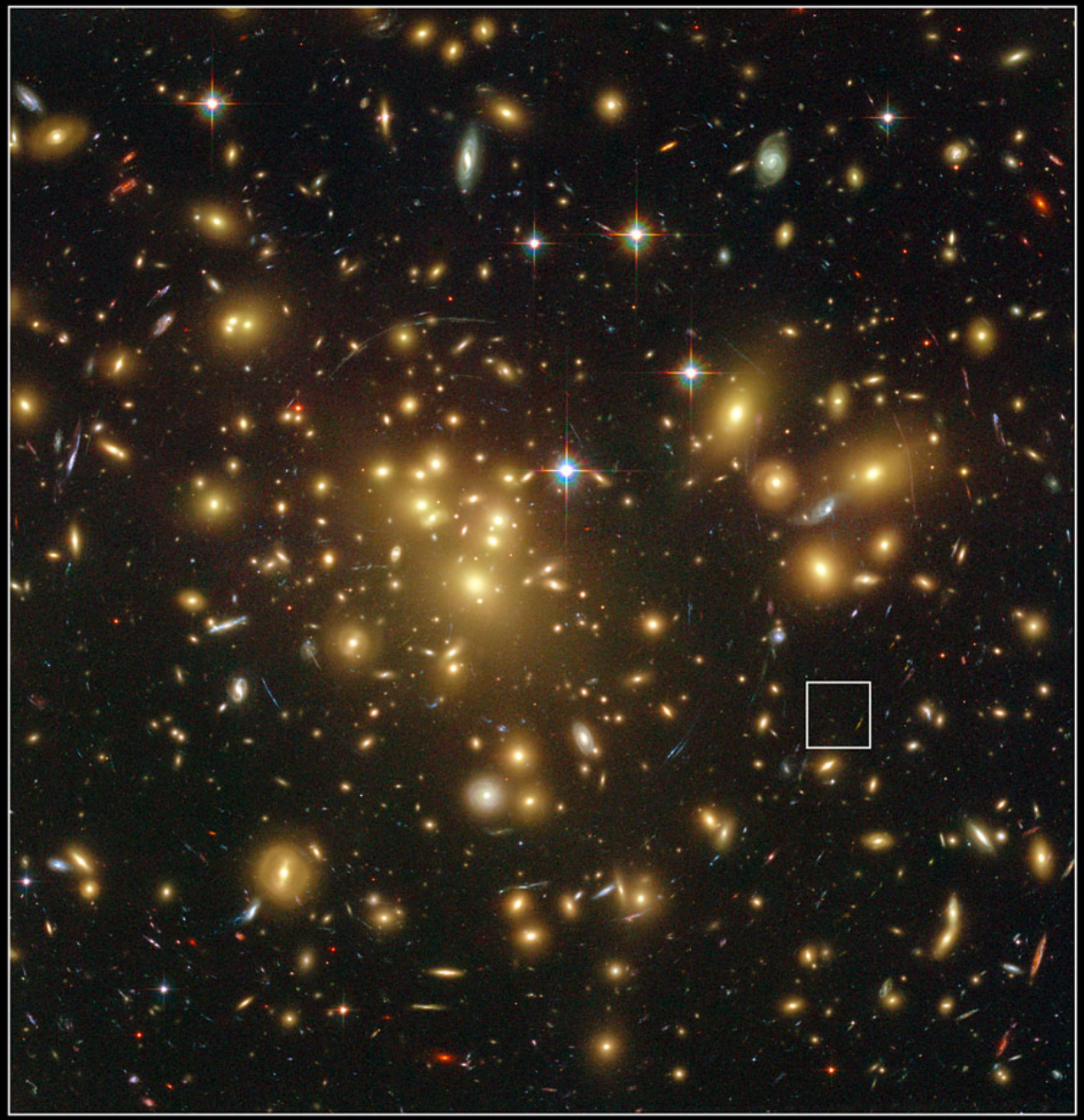

Abell 2151

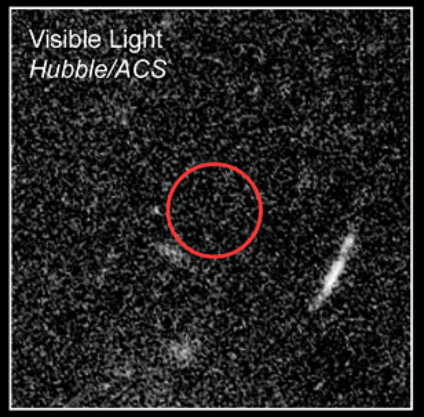


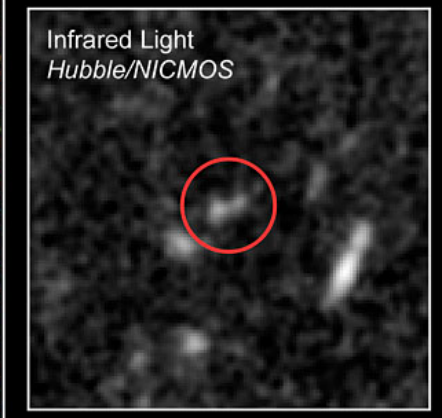


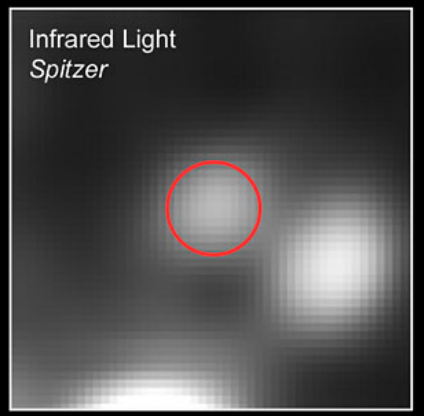
Abell 1689

Galaxia más distante conocida (z=7.6)







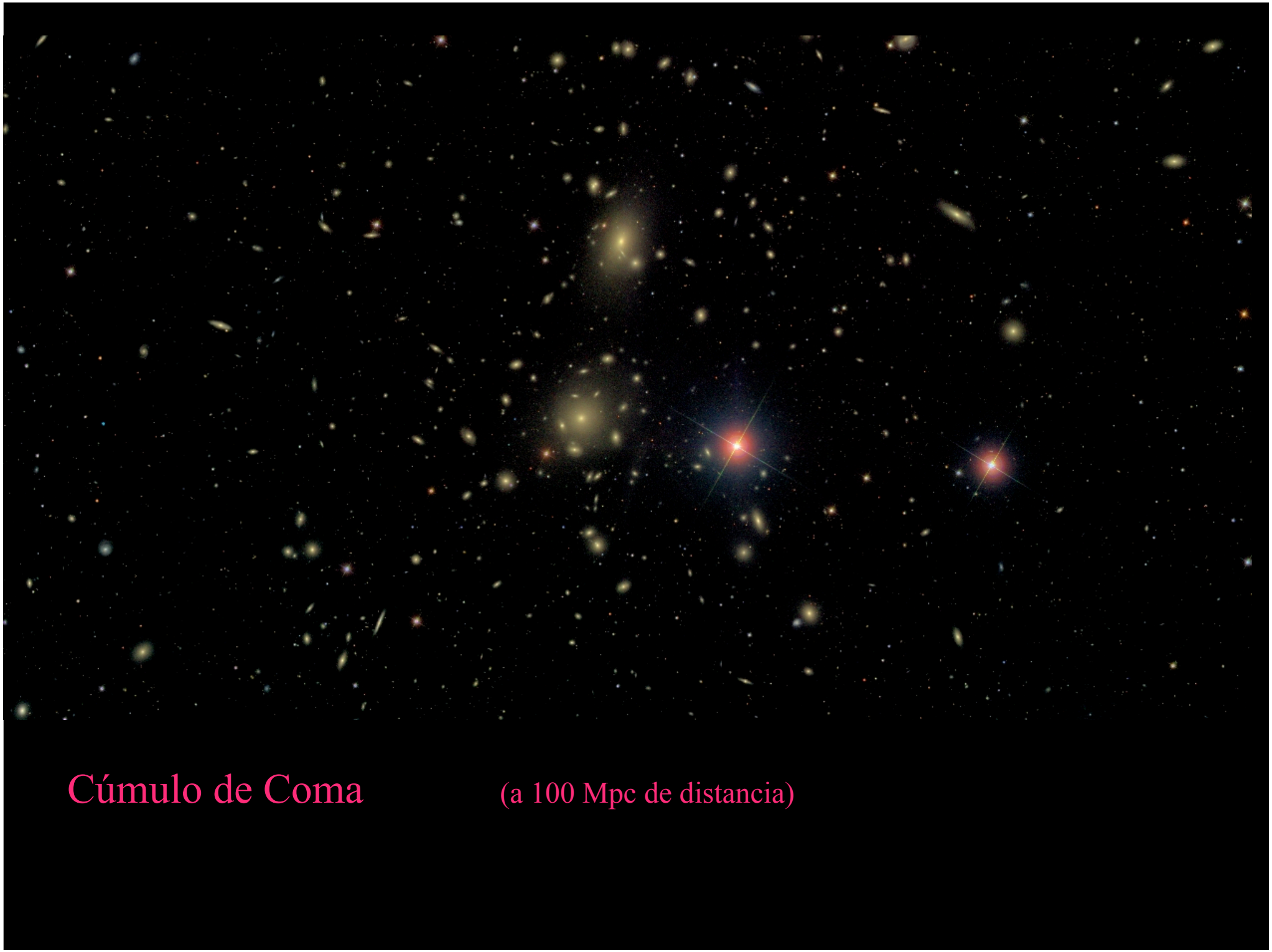


Medio intracúmulo (ICM)

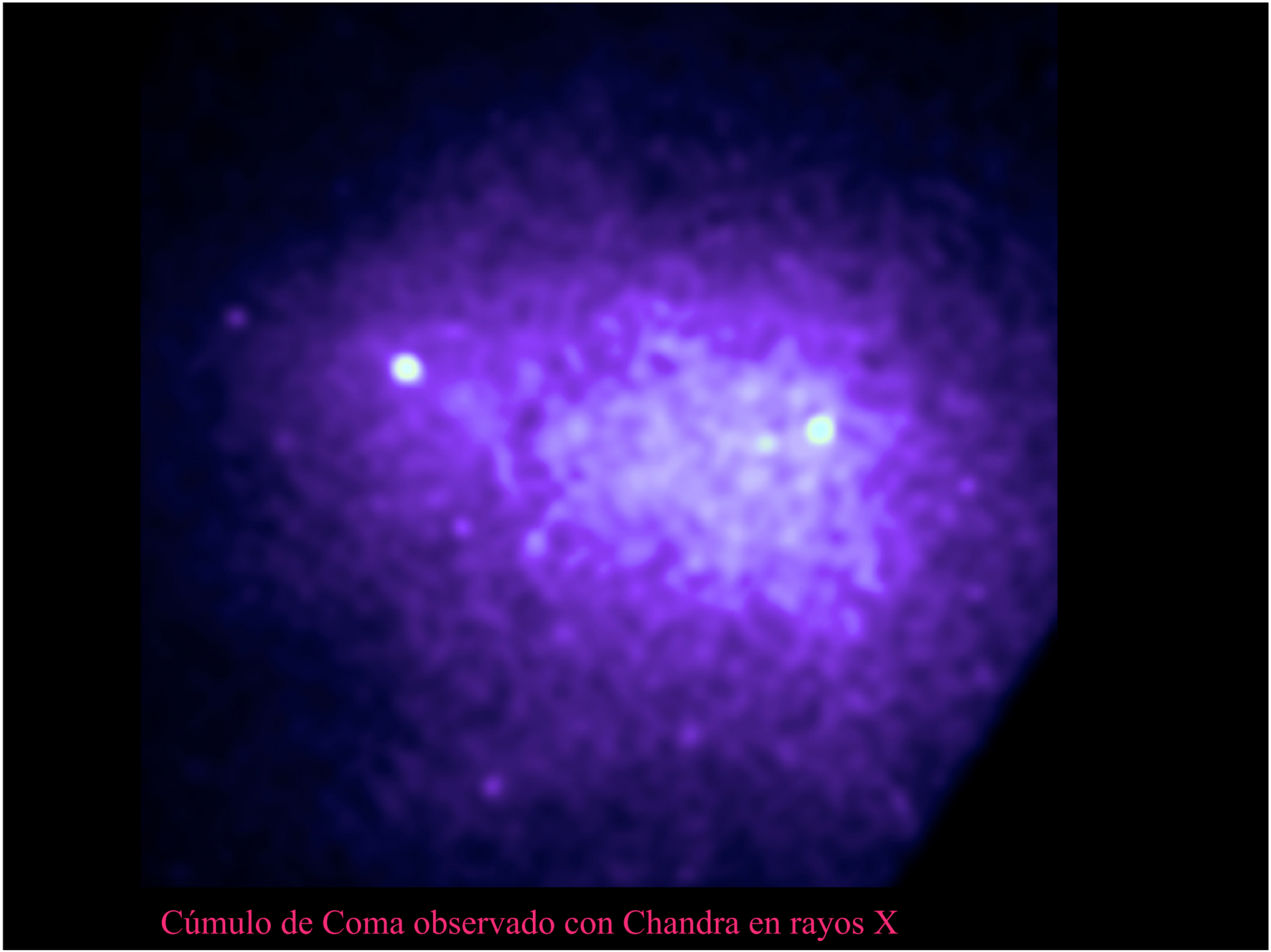
- Las galaxias de un cúmulo están inmersas en una nube de gas ionizado a una teperatura de $T=10^{7}$-10^{8} K

- El gas es materia ordinaria (bariones) con una densidad de 10^{-3} atomos/cm^{3}

- La masa en forma de gas es superior (tipicamente en un factor 2) a la masa de las estrellas que forman las galaxias del cúmulo



Cúmulo de Coma (a 100 Mpc de distancia)



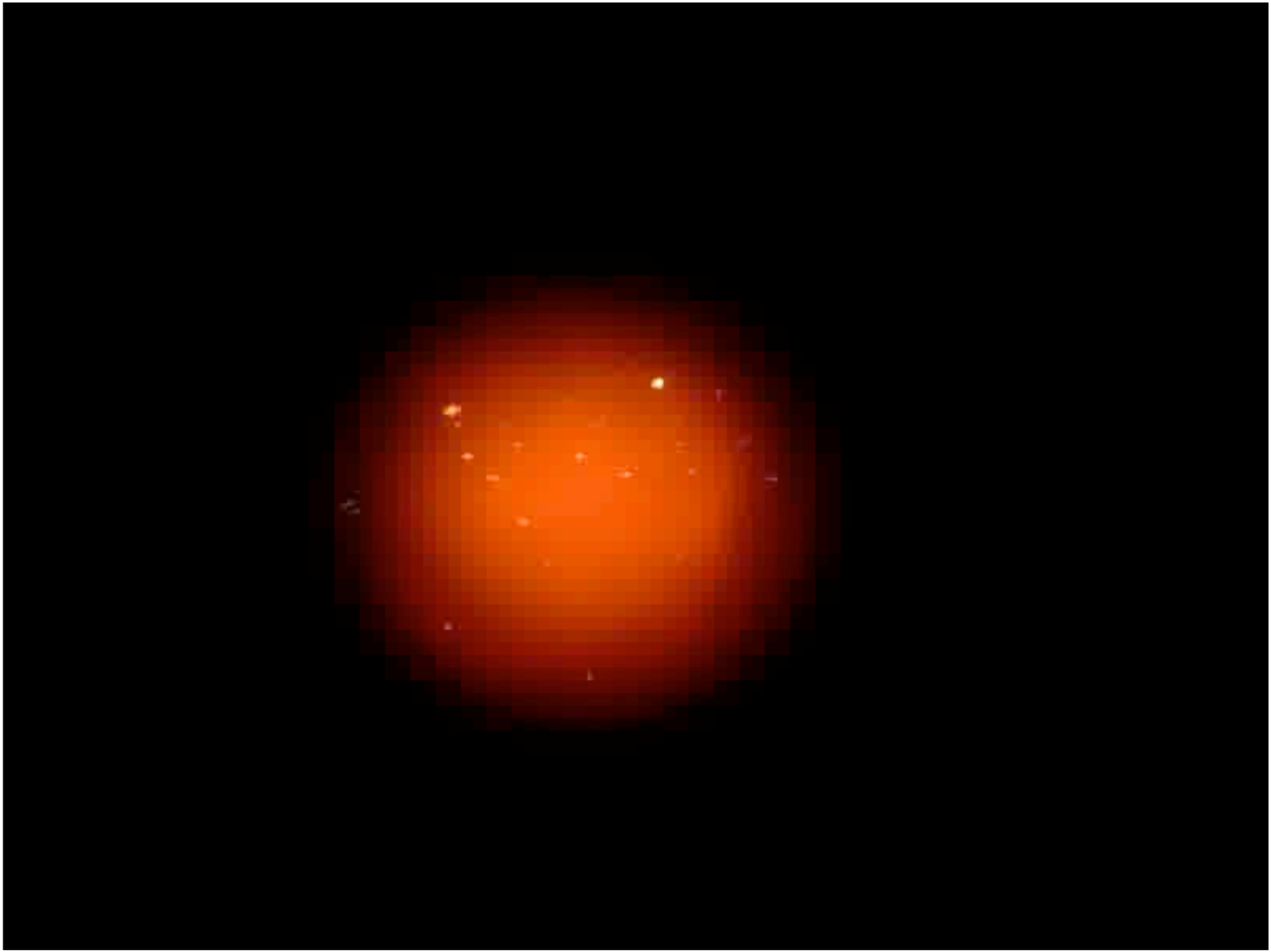
Cúmulo de Coma observado con Chandra en rayos X

Cúmulo MACSJ1423 a z=0.54

Imagen óptica en 3 filtros con Subaru

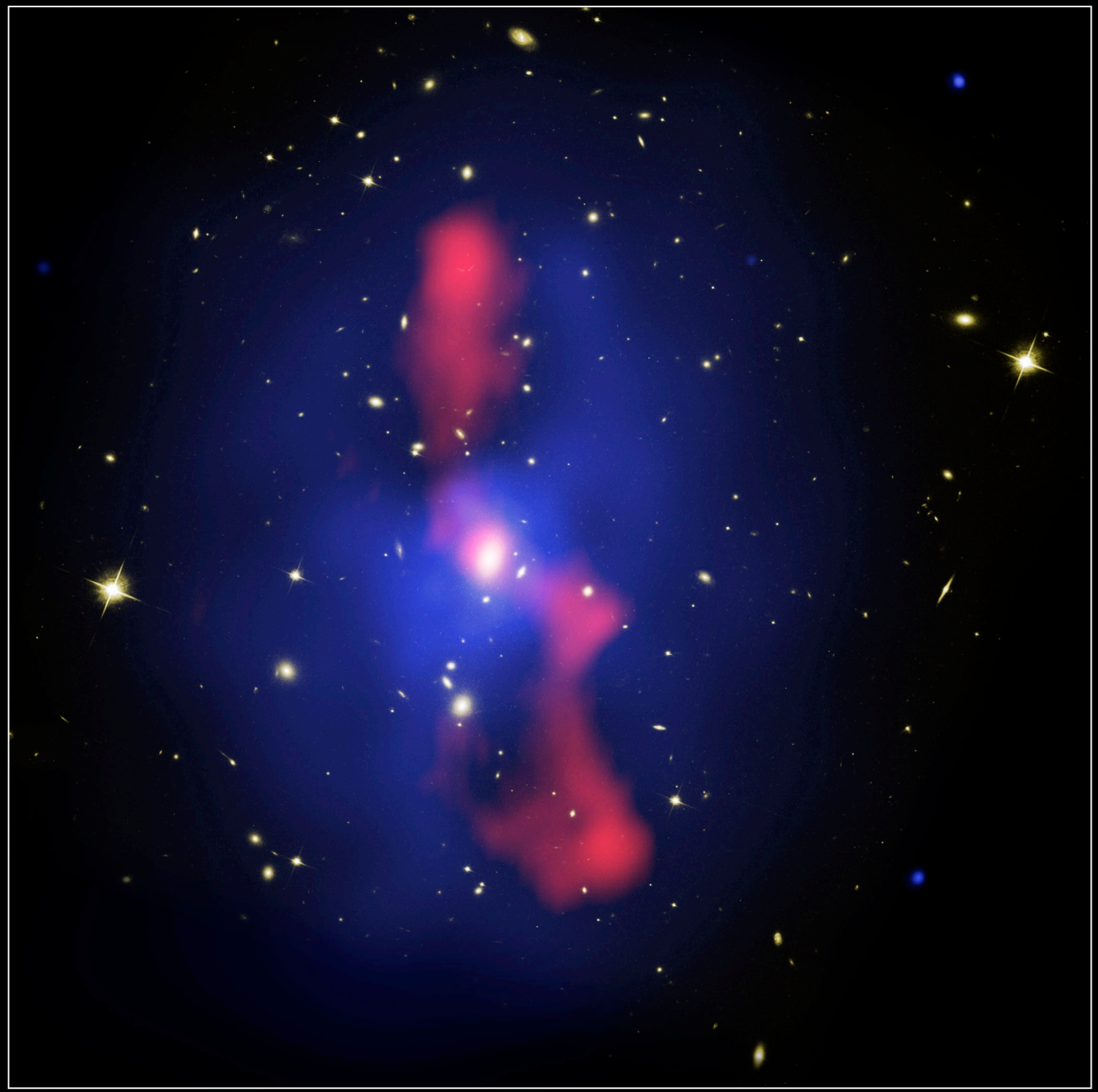
Imagen en rayos X con Chandra

(La masa en forma de gas ionizado es 6 veces superior a la masa de las estrellas)

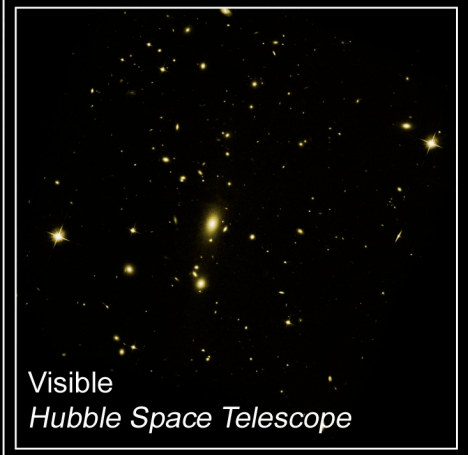


Galaxy Cluster MS 0735.6+7421

CXO ▪ HST ▪ VLA



X-ray
Chandra X-Ray Observatory

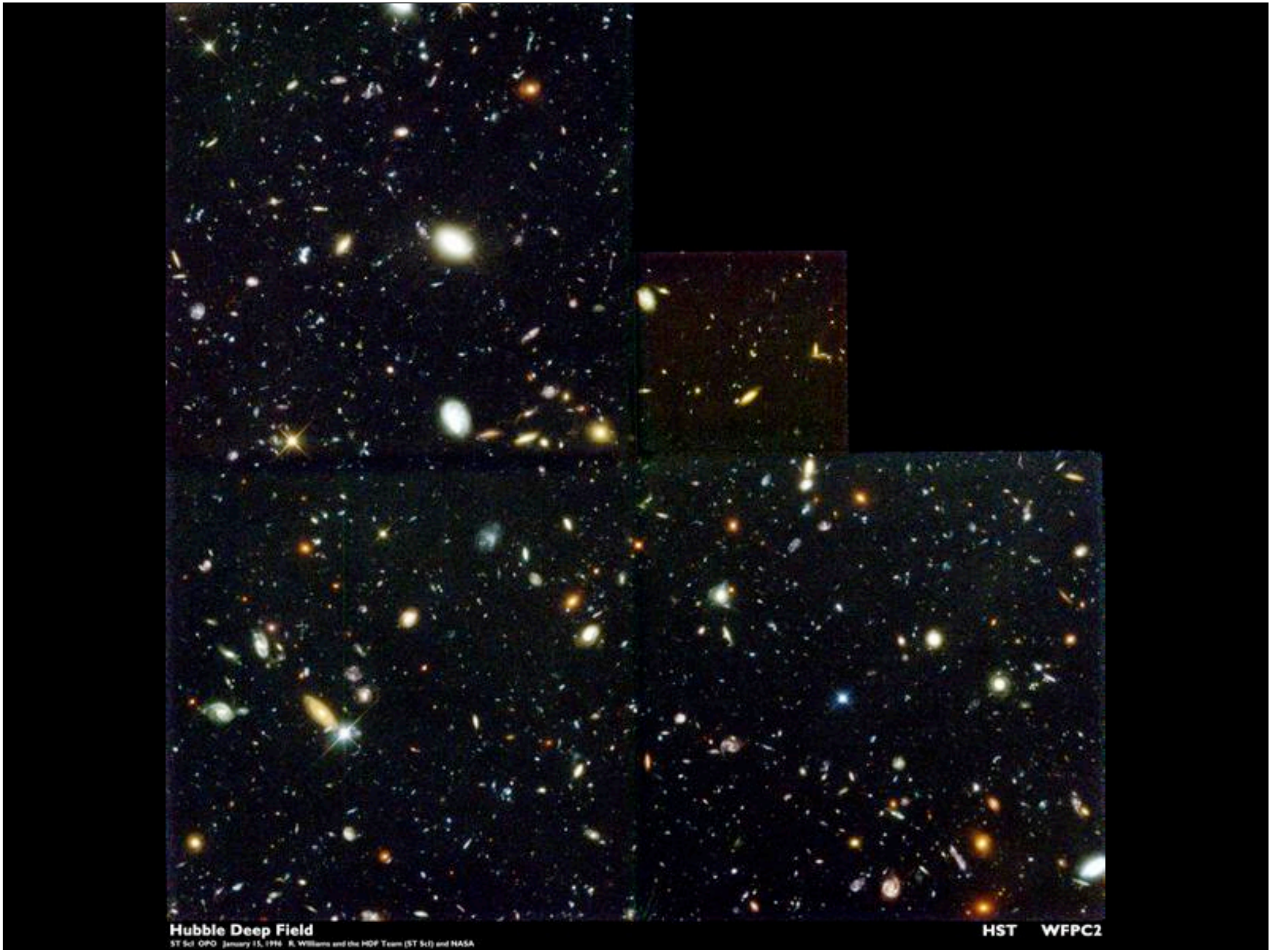


Visible
Hubble Space Telescope

Radio
Very Large Array

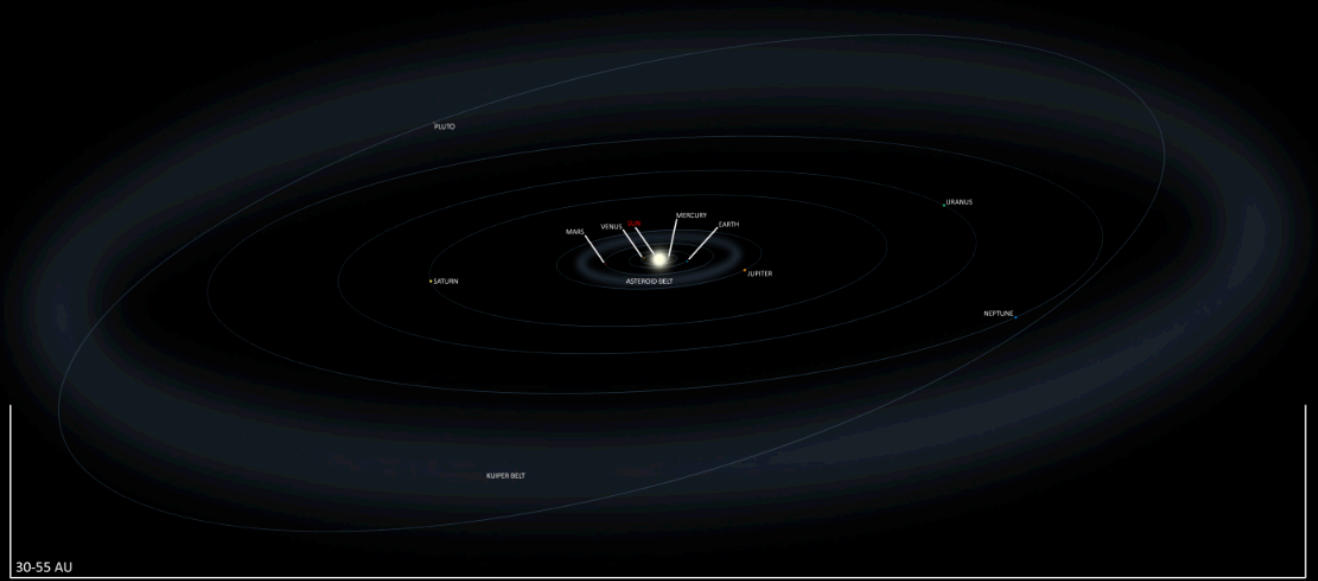
NASA, ESA, CXC/NRAO/STScI, B. McNamara (University of Waterloo and Ohio University)

STScI-PRC06-51

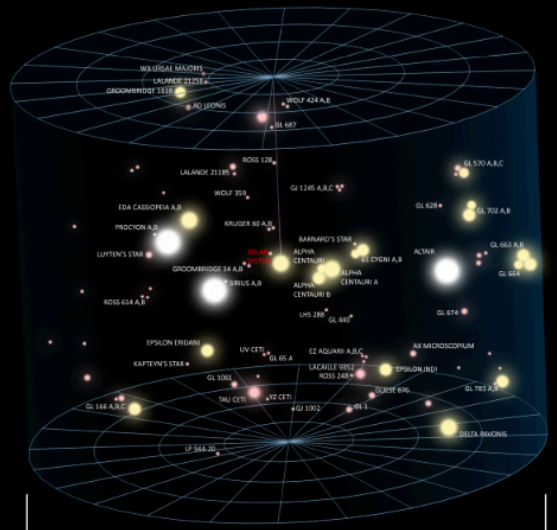

Hubble Deep Field
HST WFPC2
ST ScI OPO January 15, 1996 R. Williams and the HDF Team (ST ScI) and NASA

SUN'S NEIGHBORHOOD

SOLAR SYSTEM

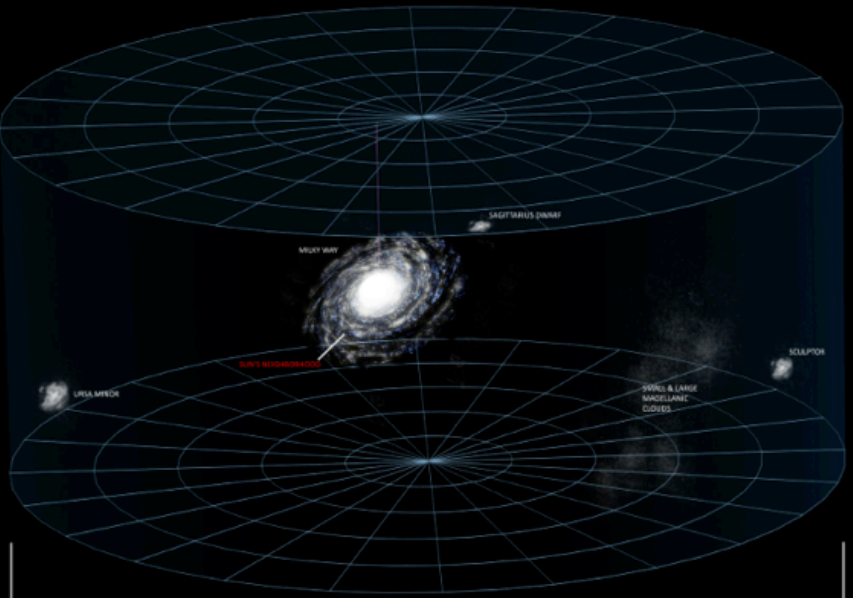


30-55 AU



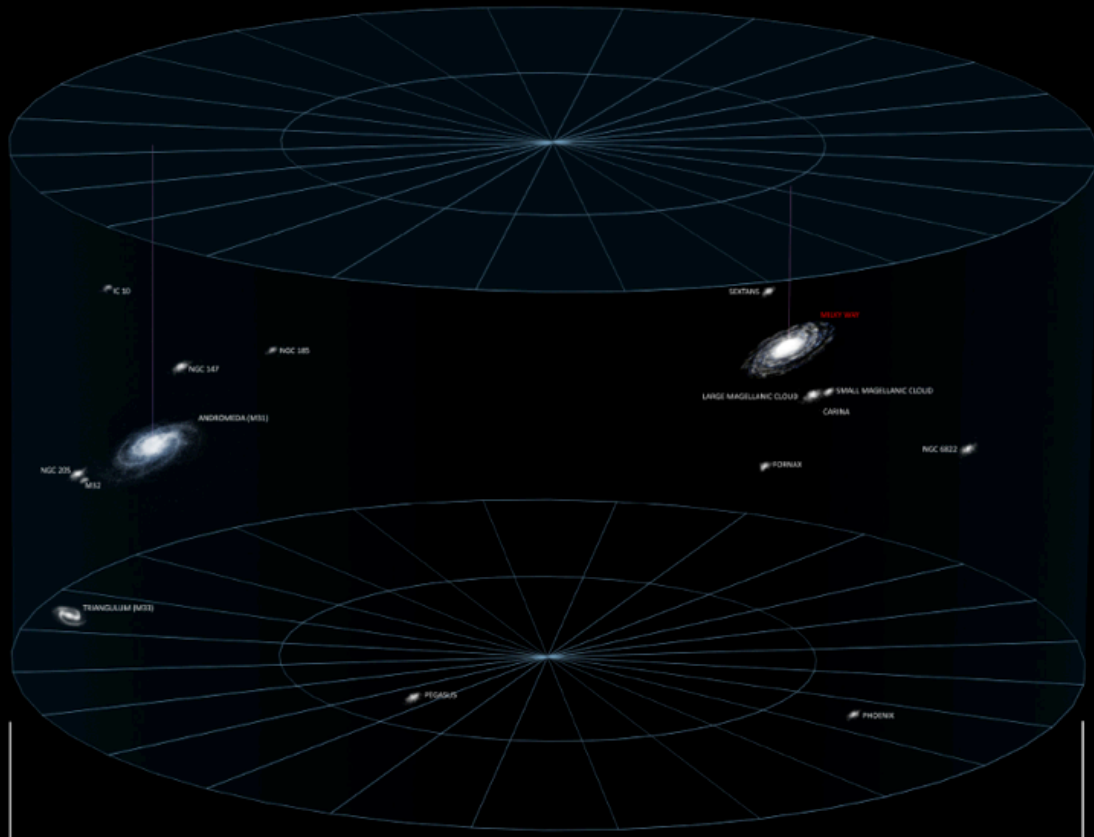
40 LIGHT-YEARS

GALACTIC REALM

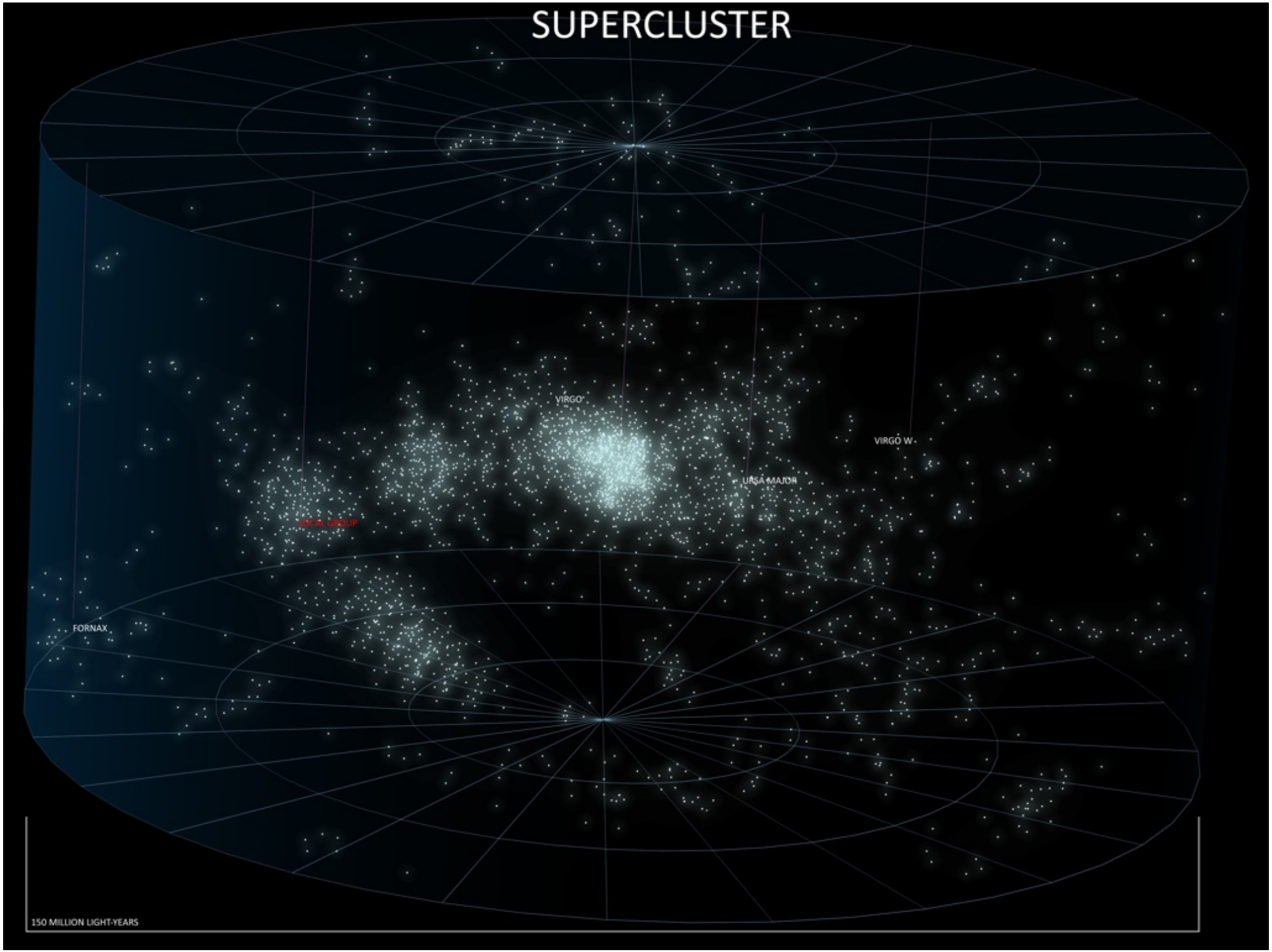


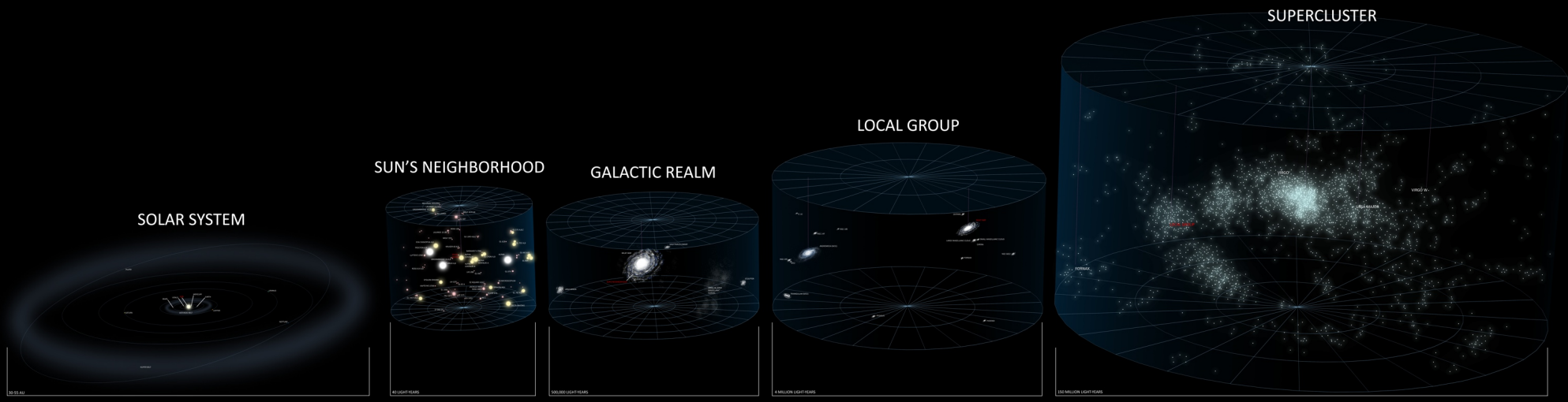
500,000 LIGHT-YEARS

LOCAL GROUP

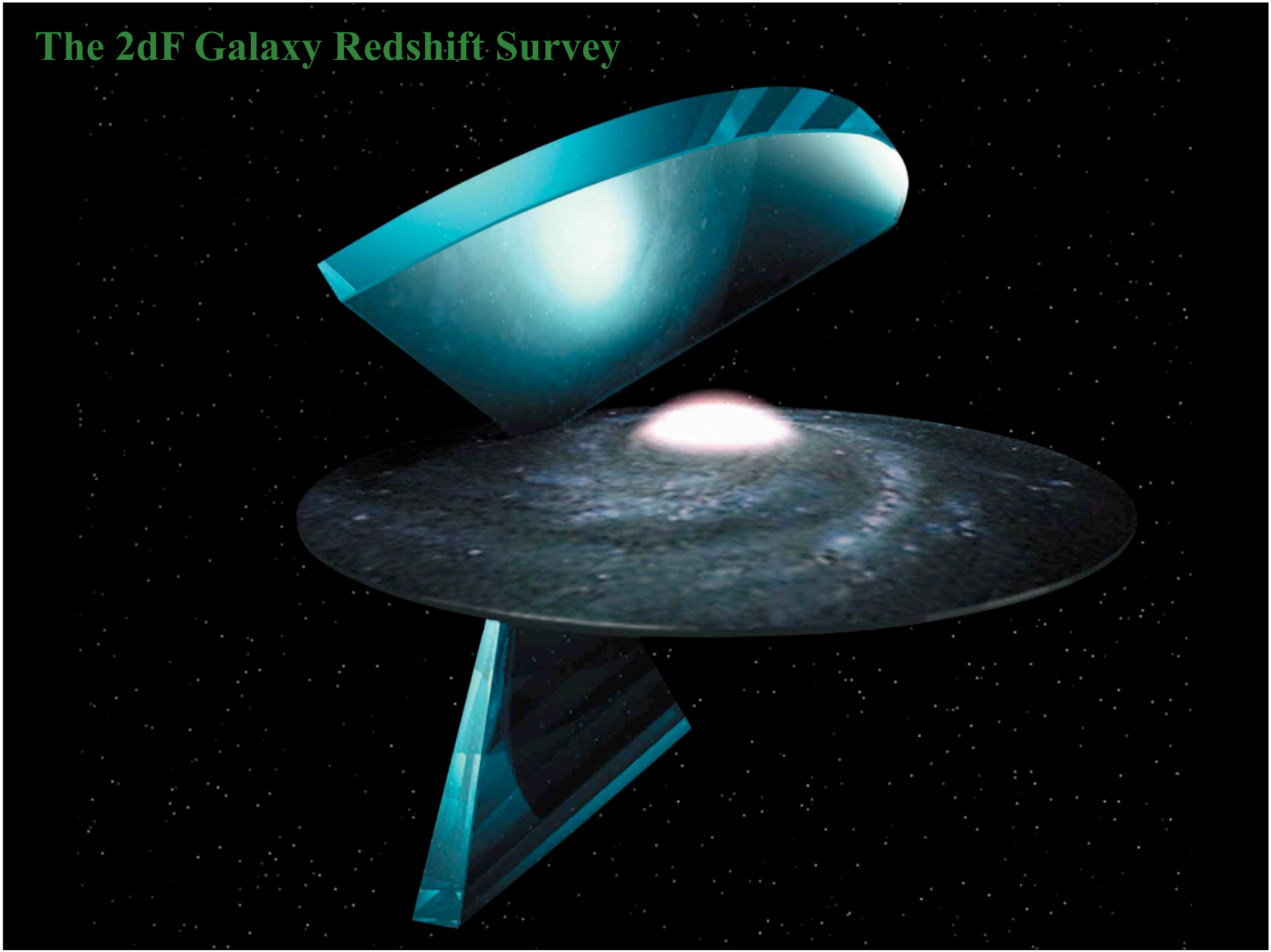


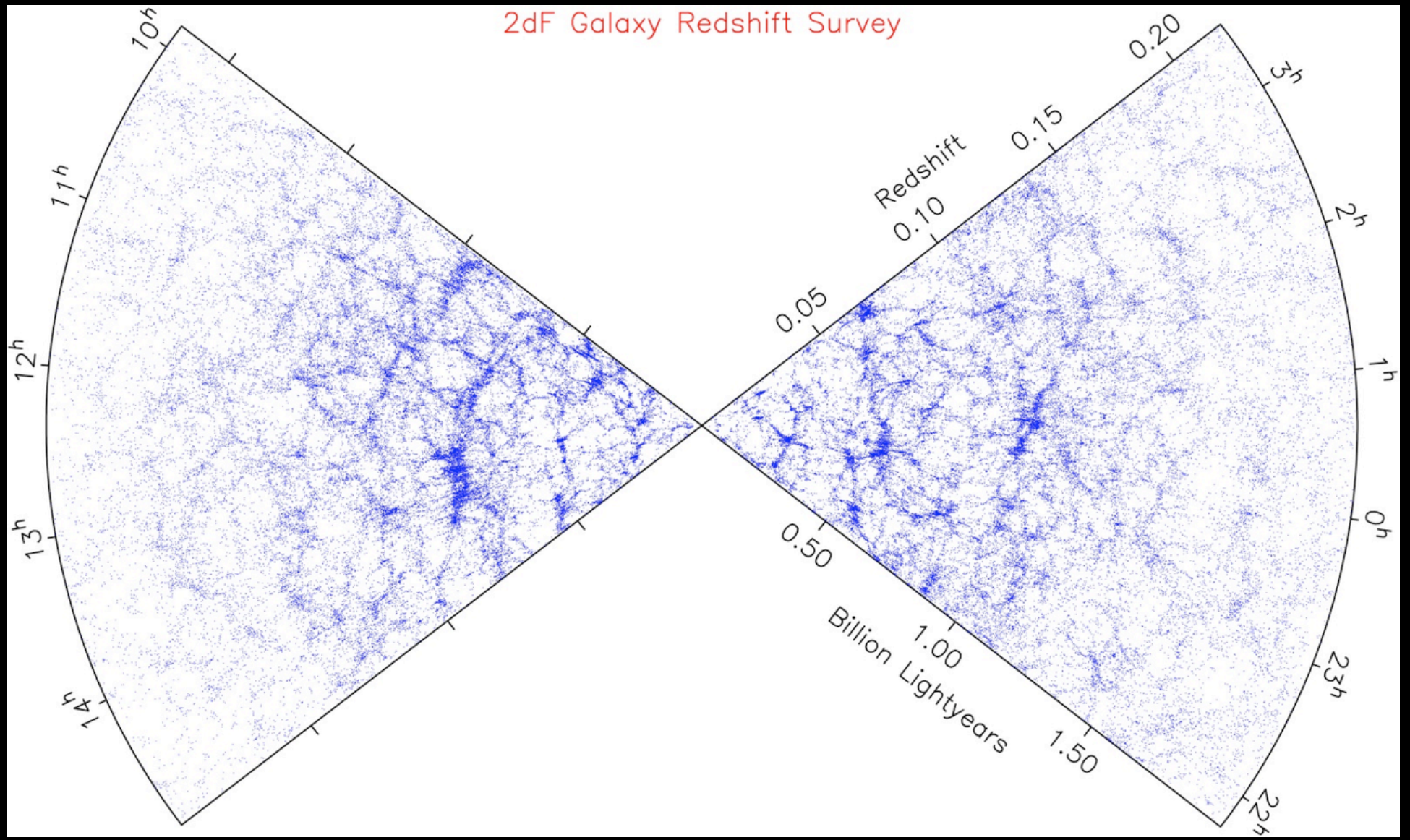
4 MILLION LIGHT-YEARS

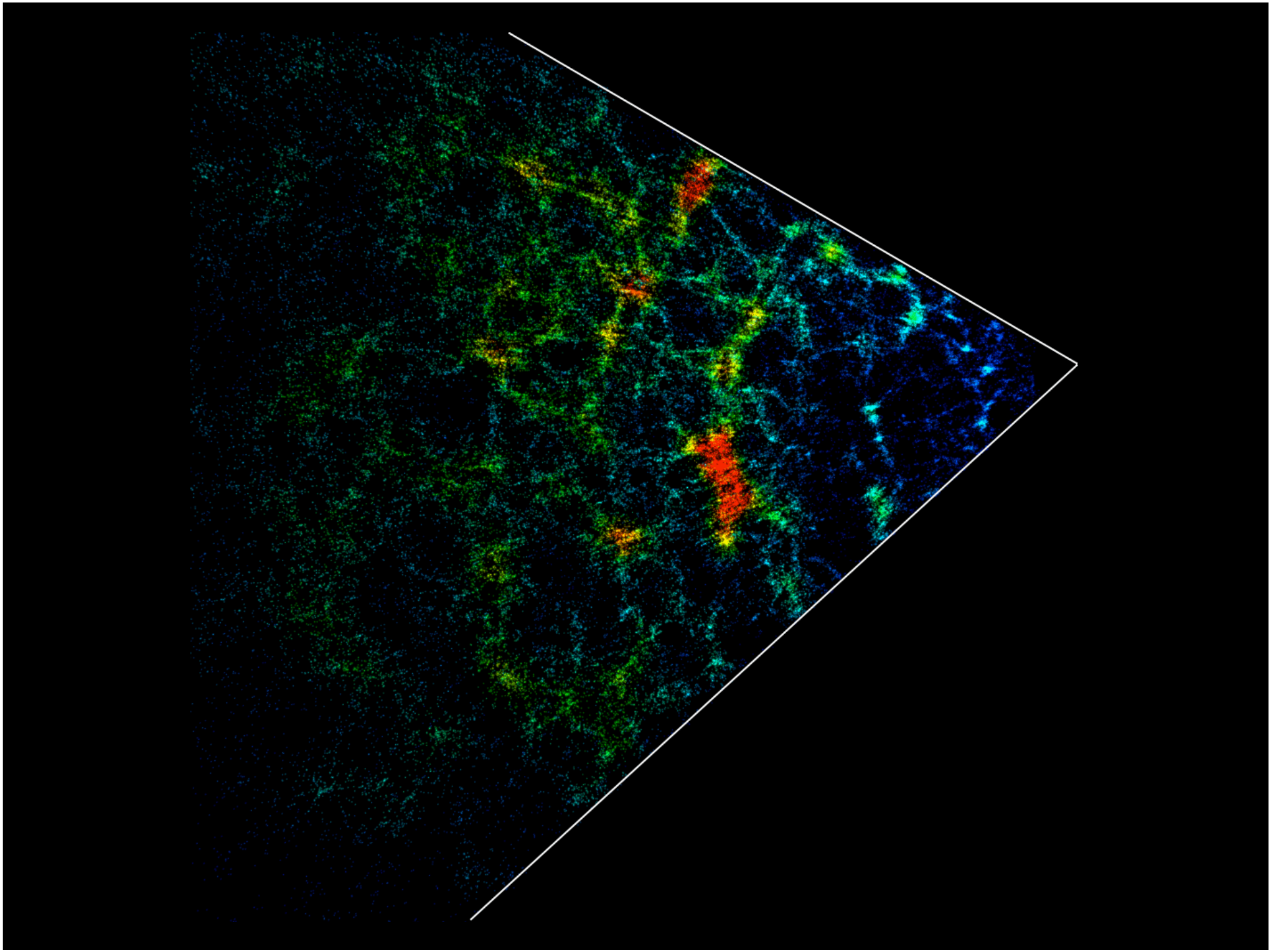

SUPERCLUSTER
VIRGO
VIRGO W
URSA MAJOR
LOCAL GROUP
FORNAX
150 MILLION LIGHT-YEARS

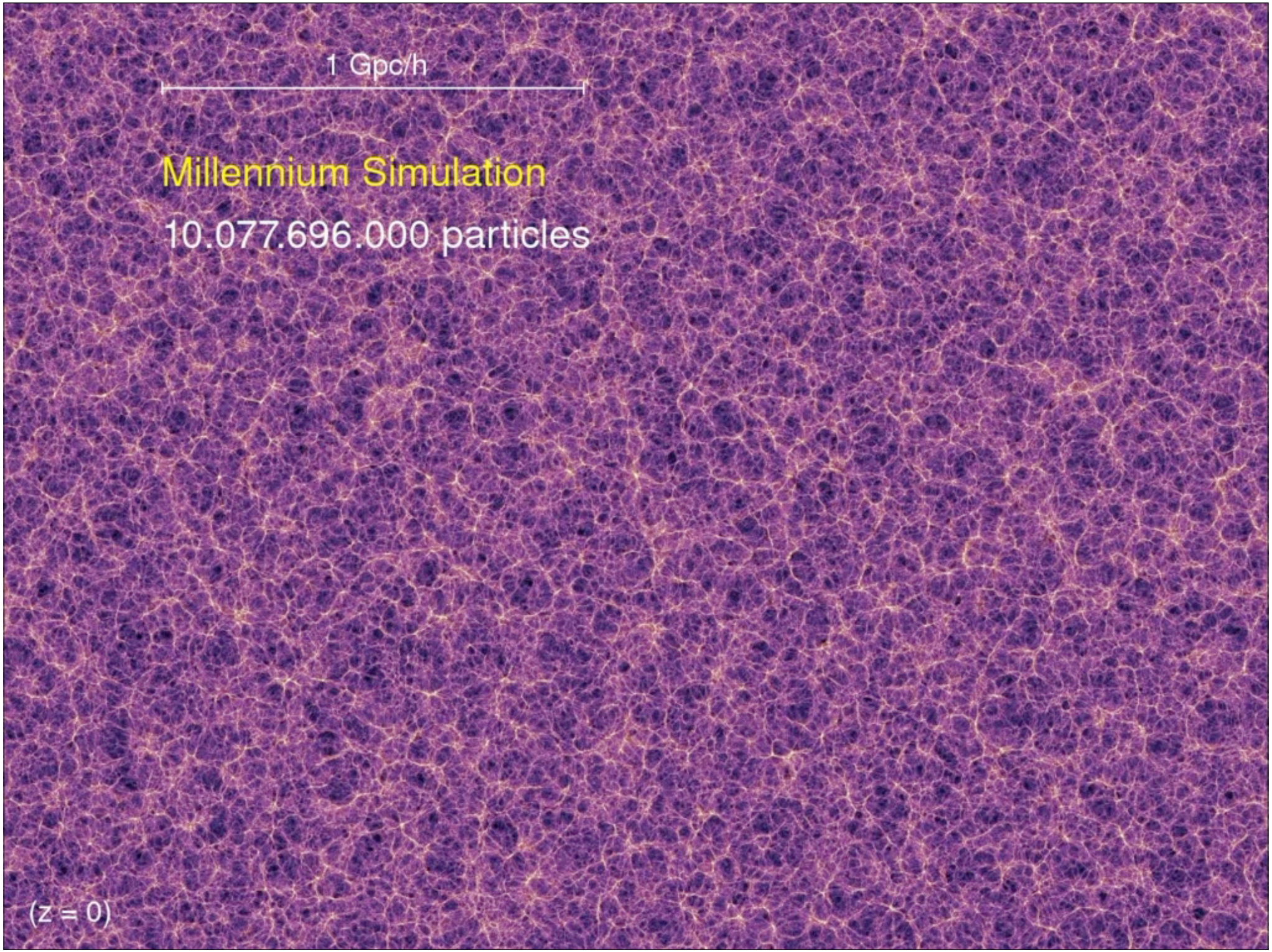

SOLAR SYSTEM
SUN'S NEIGHBORHOOD
GALACTIC REALM
LOCAL GROUP
SUPERCLUSTER
50-55 AU
40 LIGHT-YEARS
500,000 LIGHT-YEARS
4 MILLION LIGHT-YEARS
150 MILLION LIGHT-YEARS

The 2dF Galaxy Redshift Survey




2dF Galaxy Redshift Survey
10h
11h
12h
13h
14h
0.20
3h
0.15
Redshift
0.10
2h
0.05
1h
0h
0.50
1.00
Billion Lightyears
1.50
23h
22h




1 Gpc/h
Millennium Simulation
10.077.696.000 particles
(z = 0)