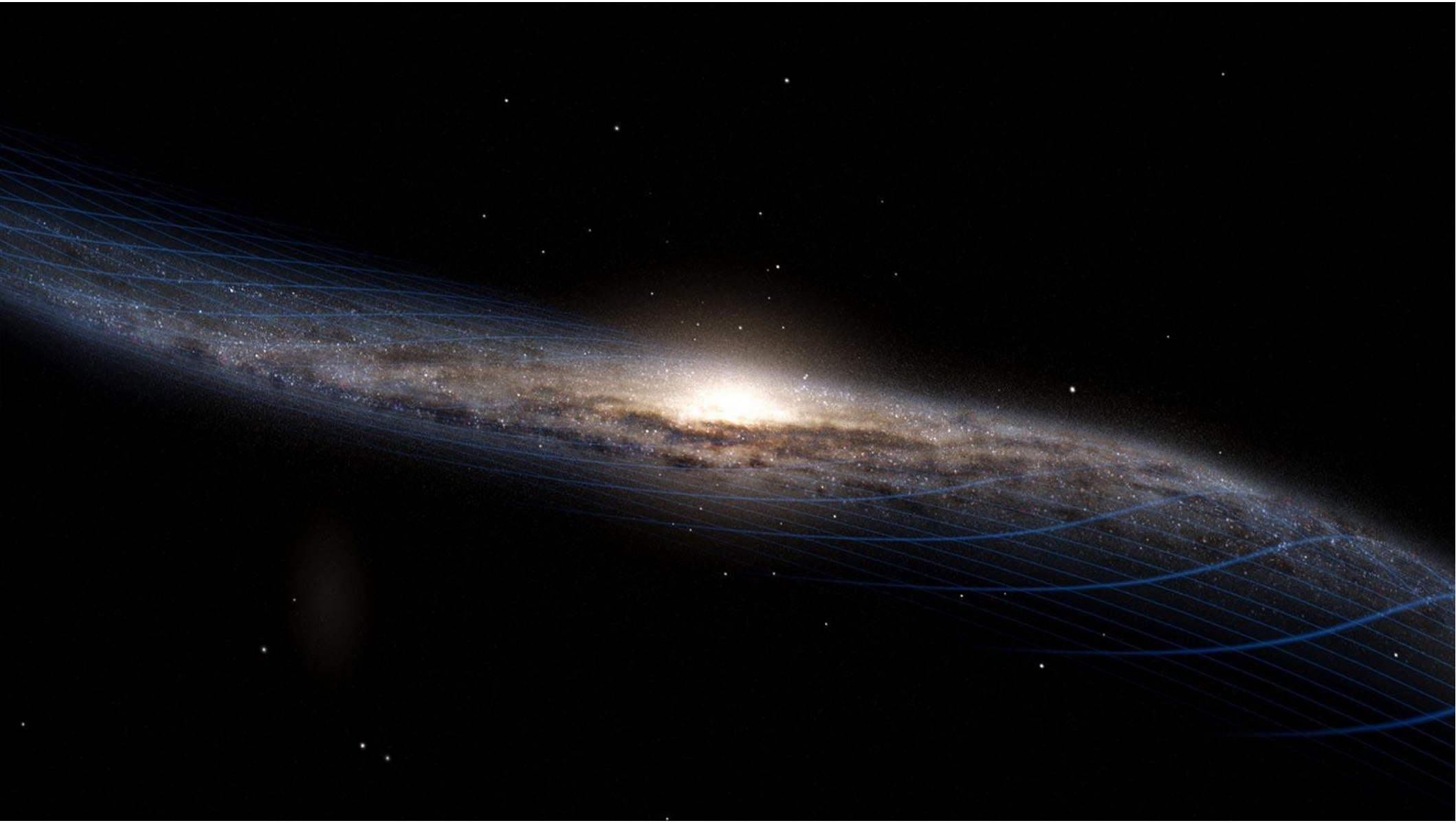
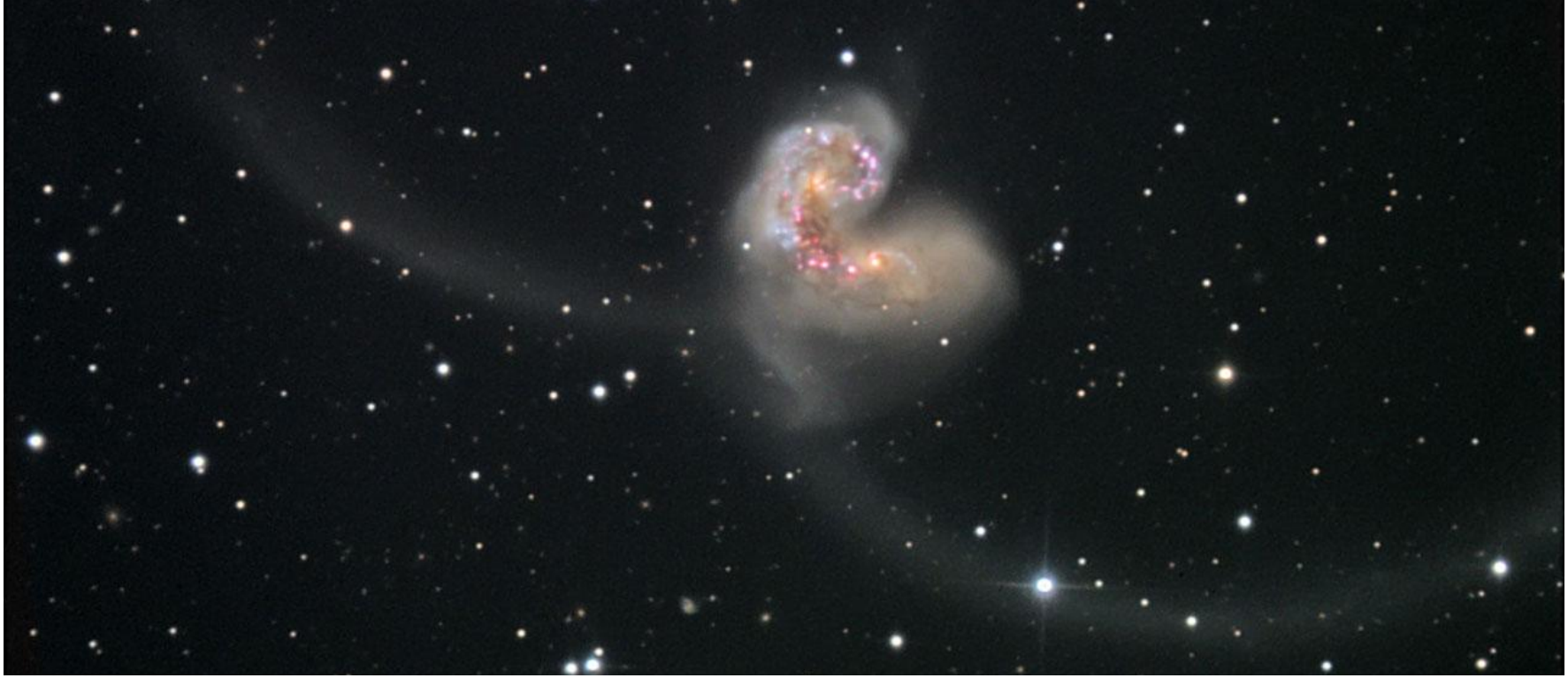
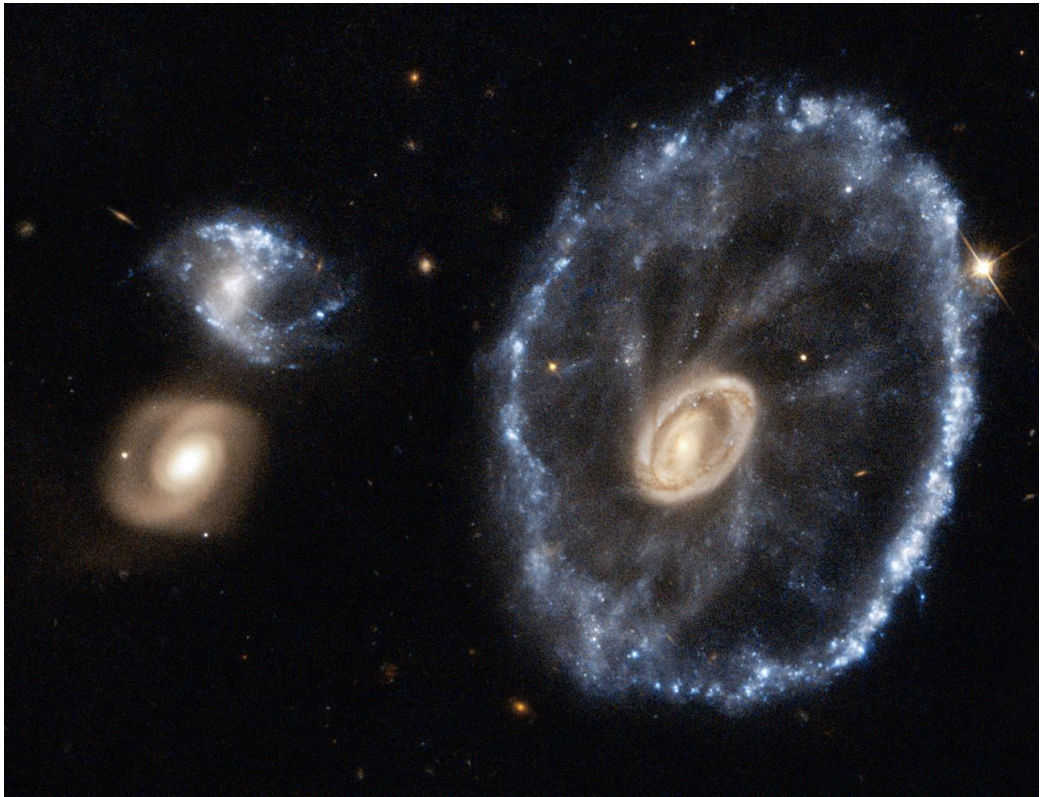
ASTR368
Galaxy Formation

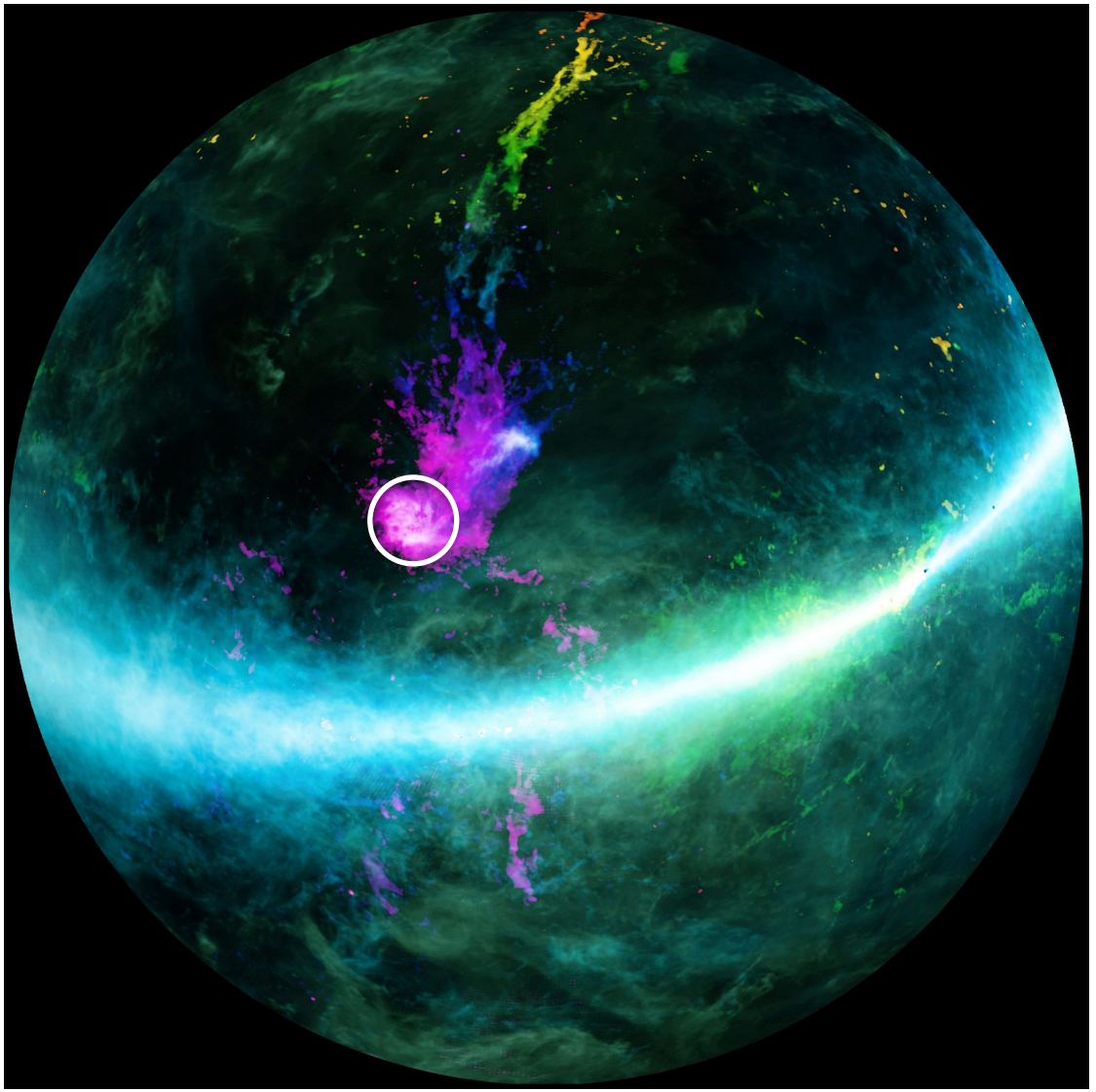


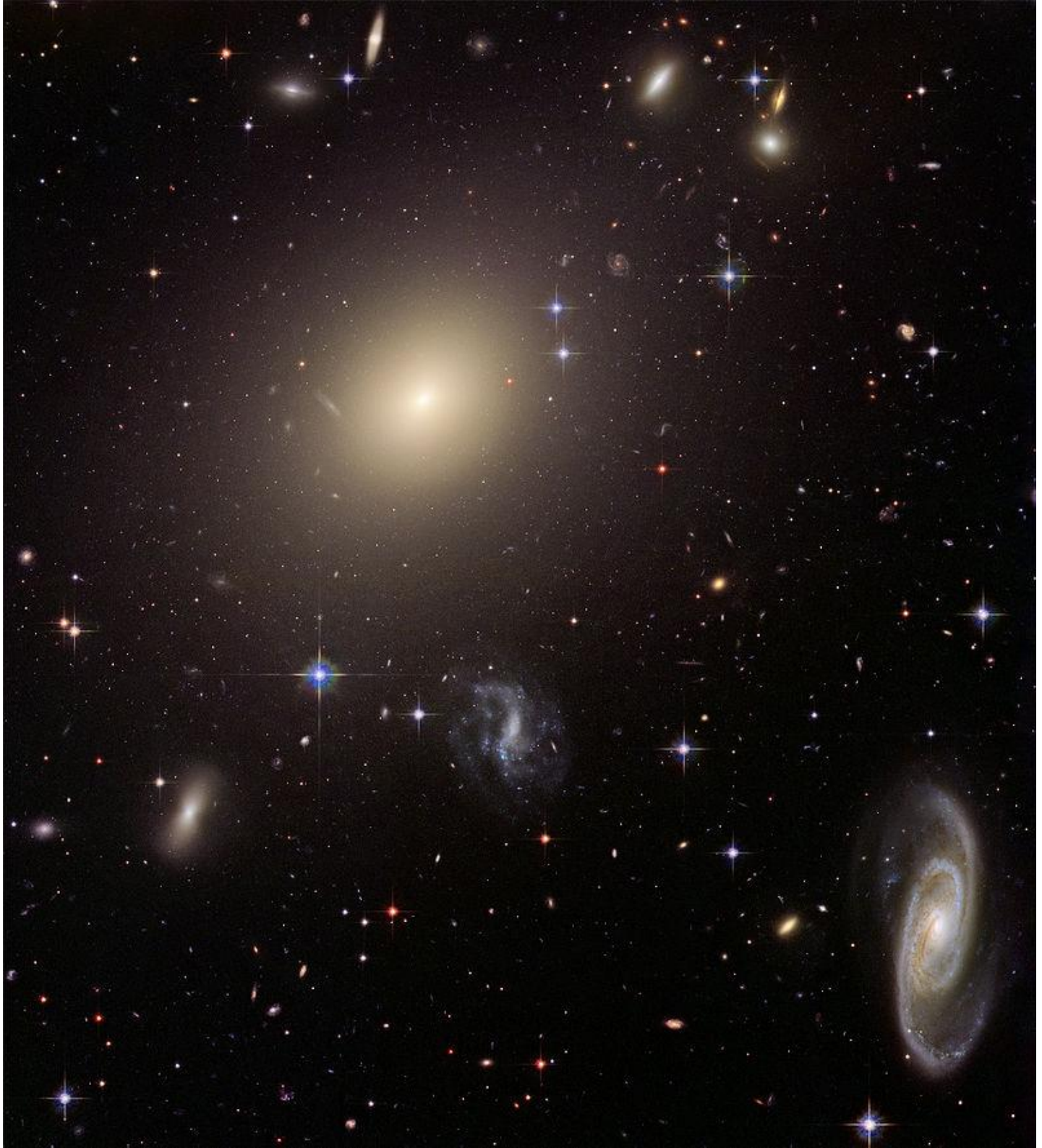
Dusty Ellipticals

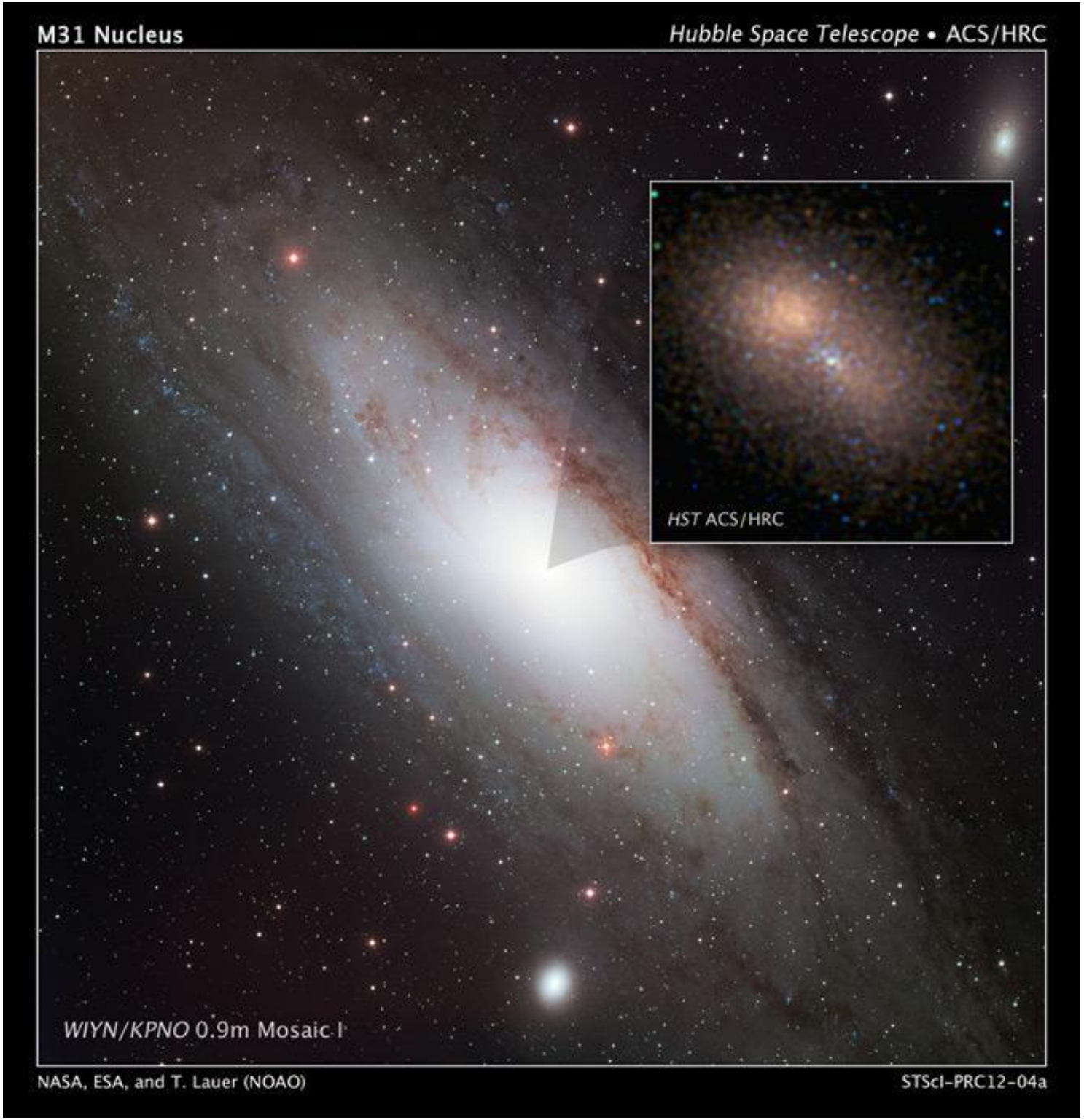




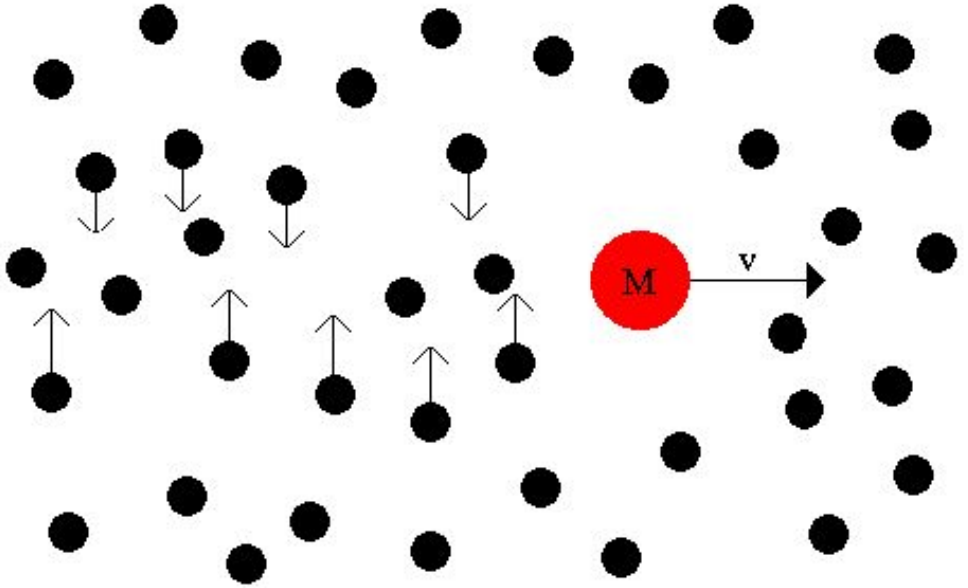
Tidal Radius of LMC



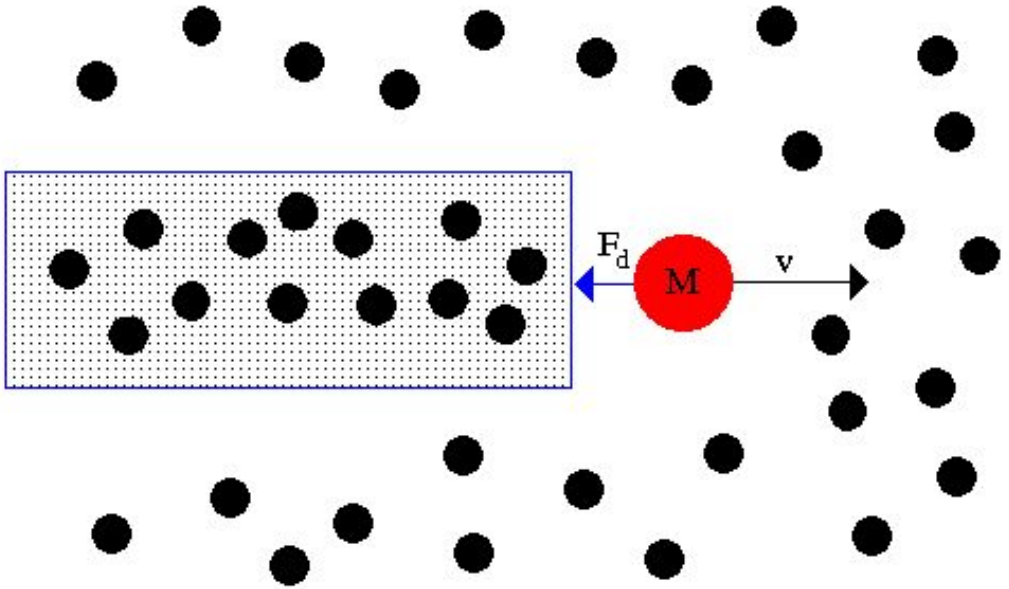



M31 Nucleus
Hubble Space Telescope • ACS/HRC
HST ACS/HRC
WIYN/KPNO 0.9m Mosaic I
NASA, ESA, and T. Lauer (NOAO)
STScI-PRC12-04a

consider a mass, M, moving through a uniform sea of stars. Stars in the wake are displaced inward.



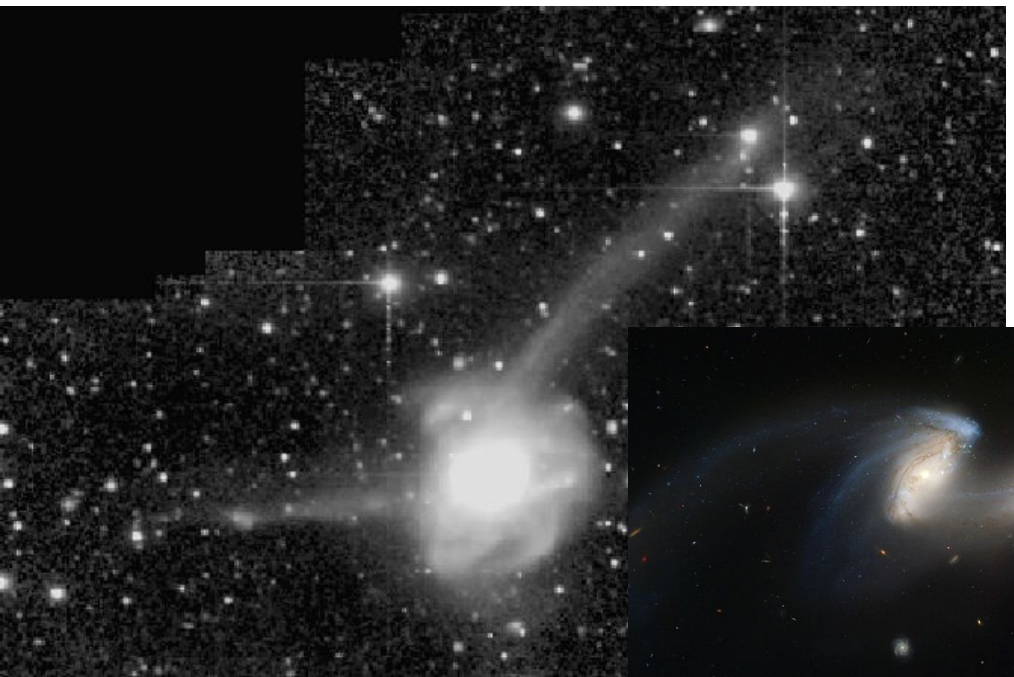
this results in an enhanced region of density behind the mass, with a drag force, F_d known as dynamical friction

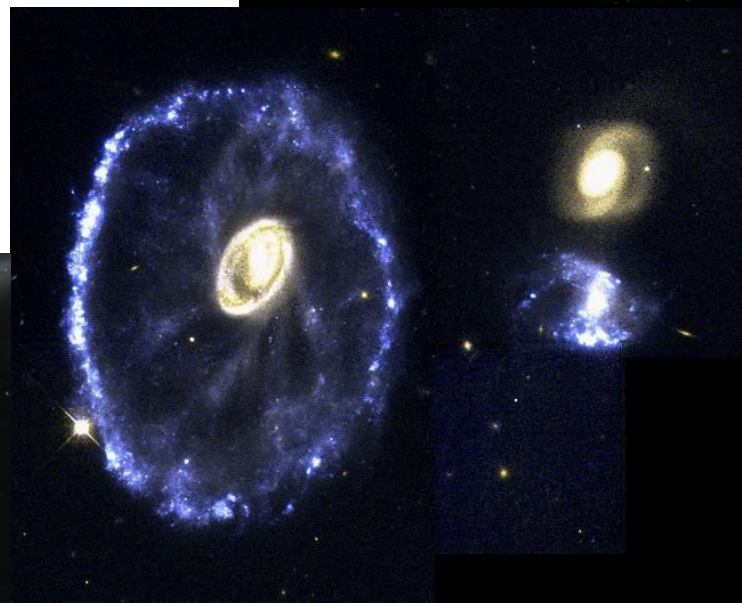
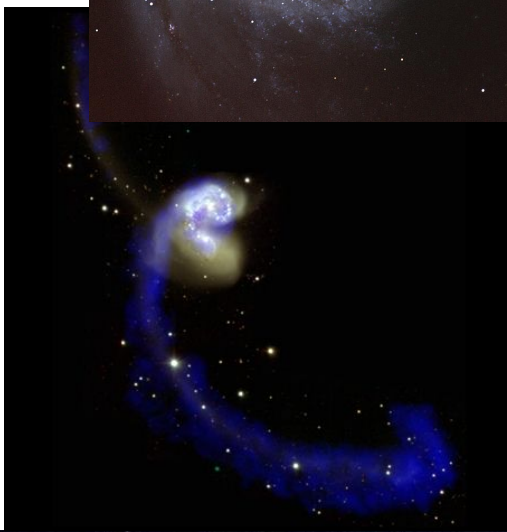
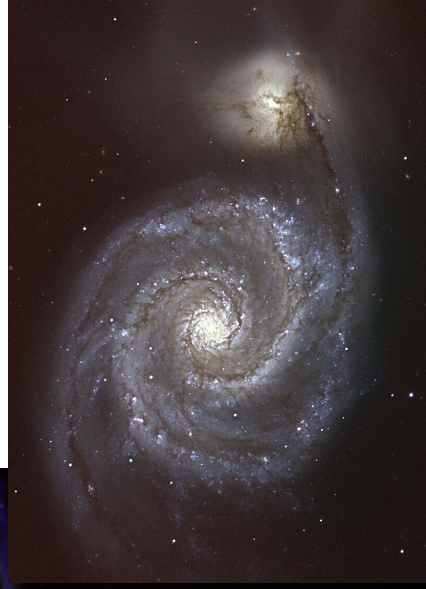


Simulating Interactions

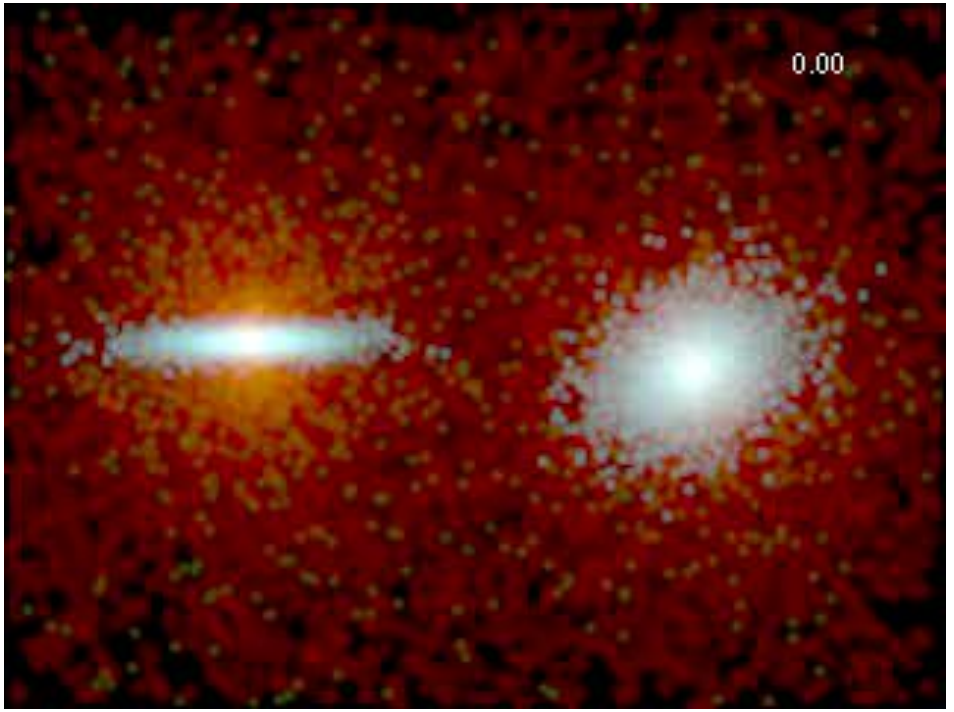
We can run computer simulations to determine how each merger occurred and how it will evolve.

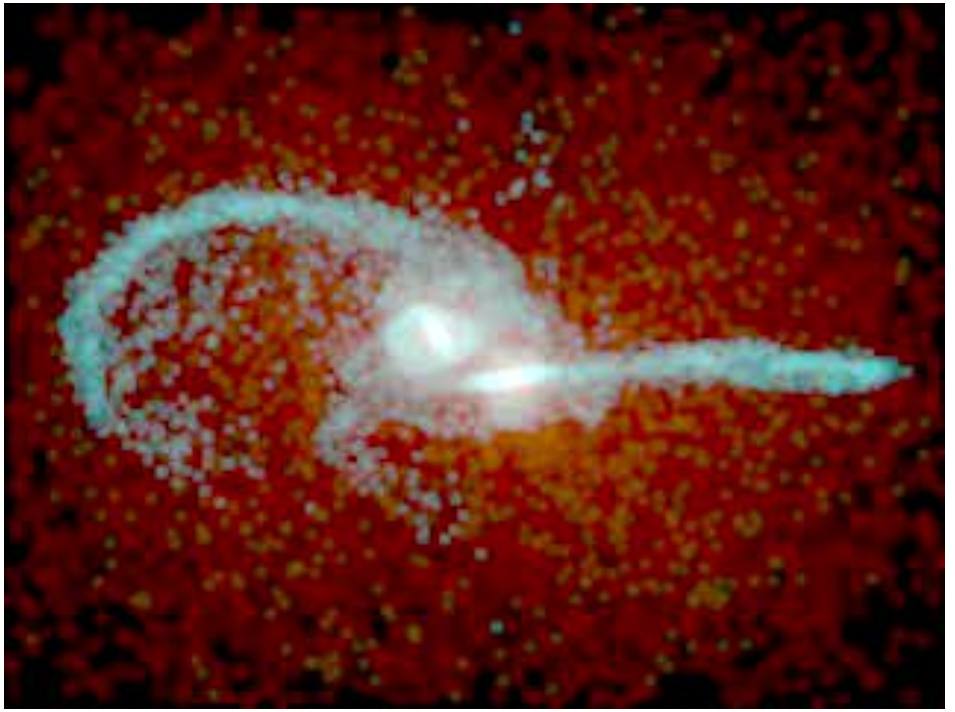
GalCrash



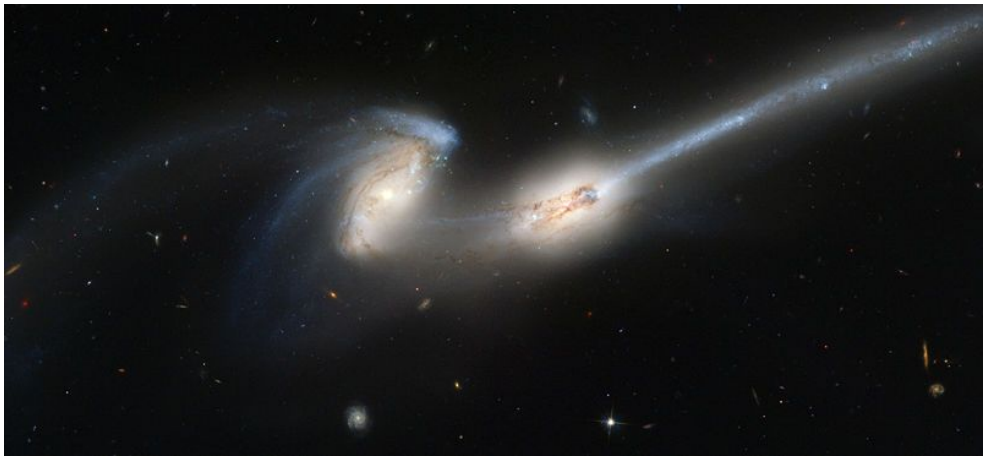




“The Mice”



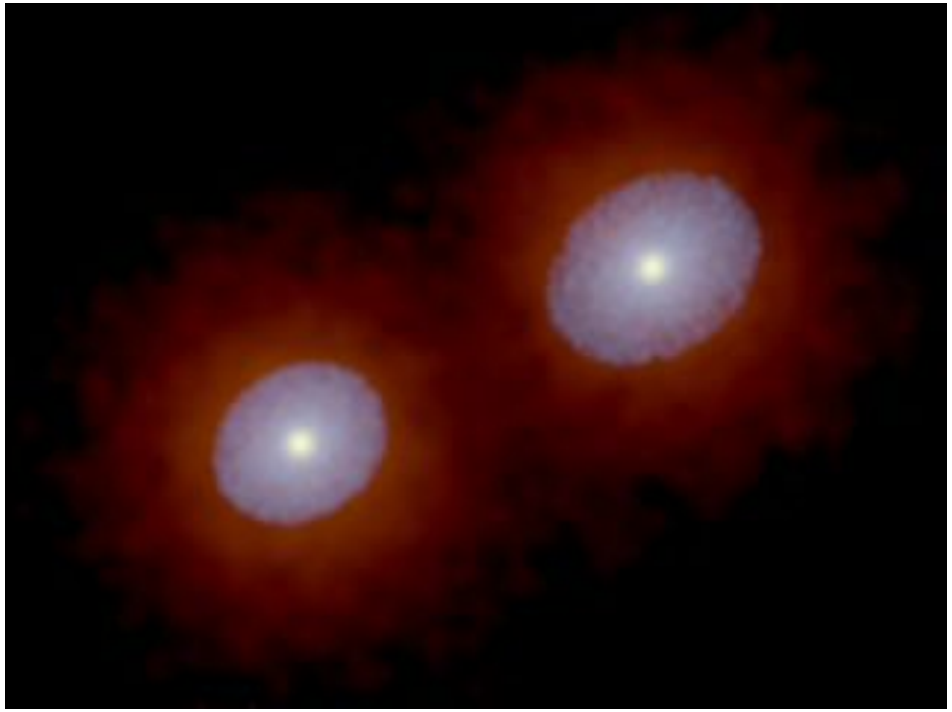


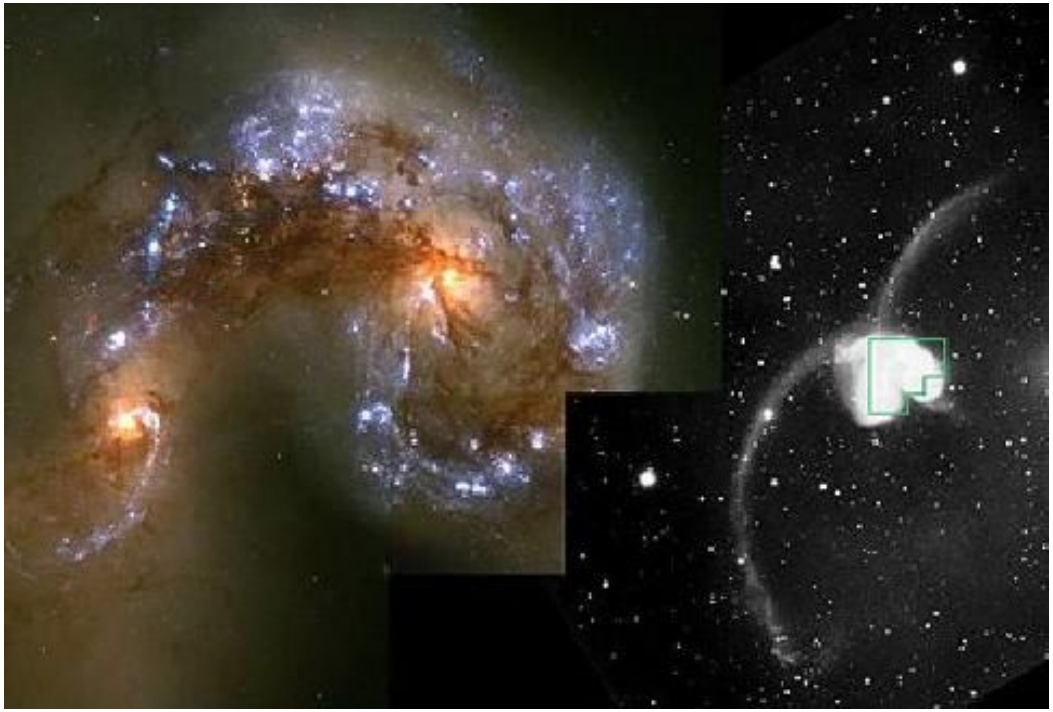
A simulation of the interacting galaxies called “The Mice”



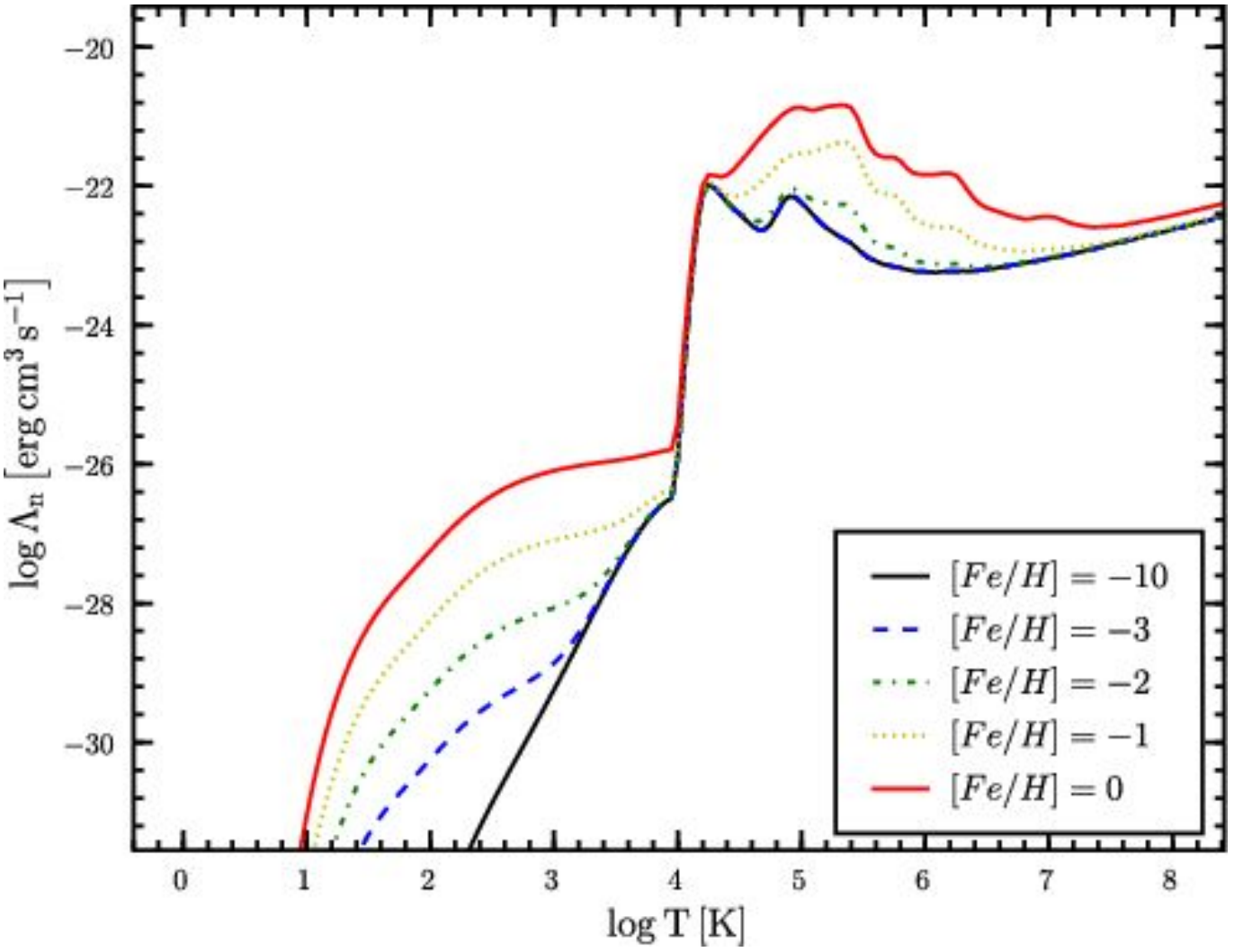
Starburst Galaxies

- Galaxy interactions can compress gas clouds in a galaxy triggering star formation (particularly in the center of a galaxy).

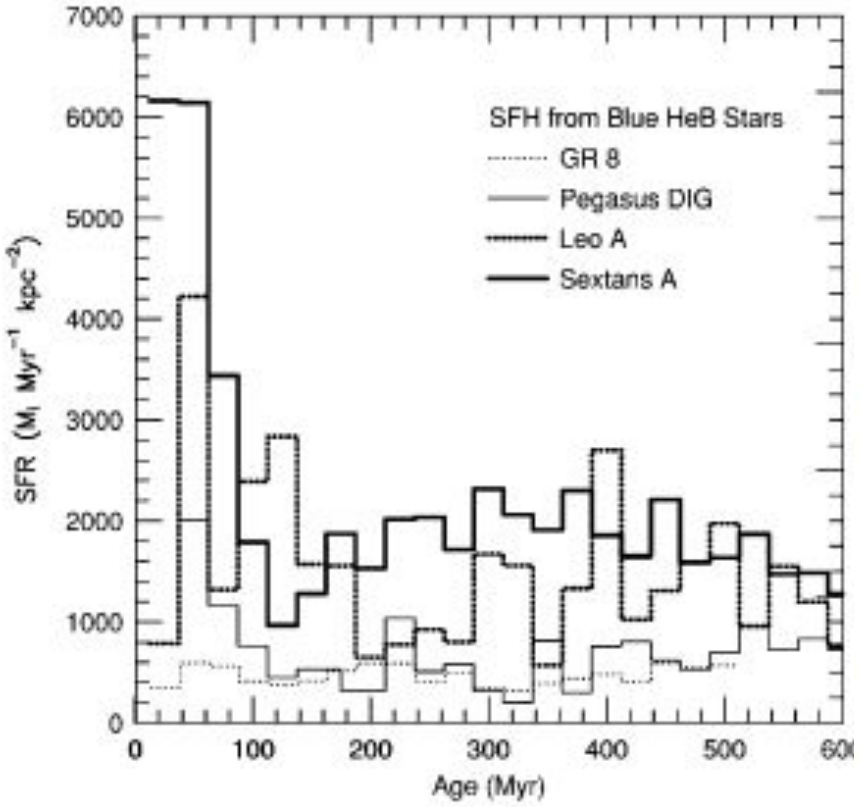


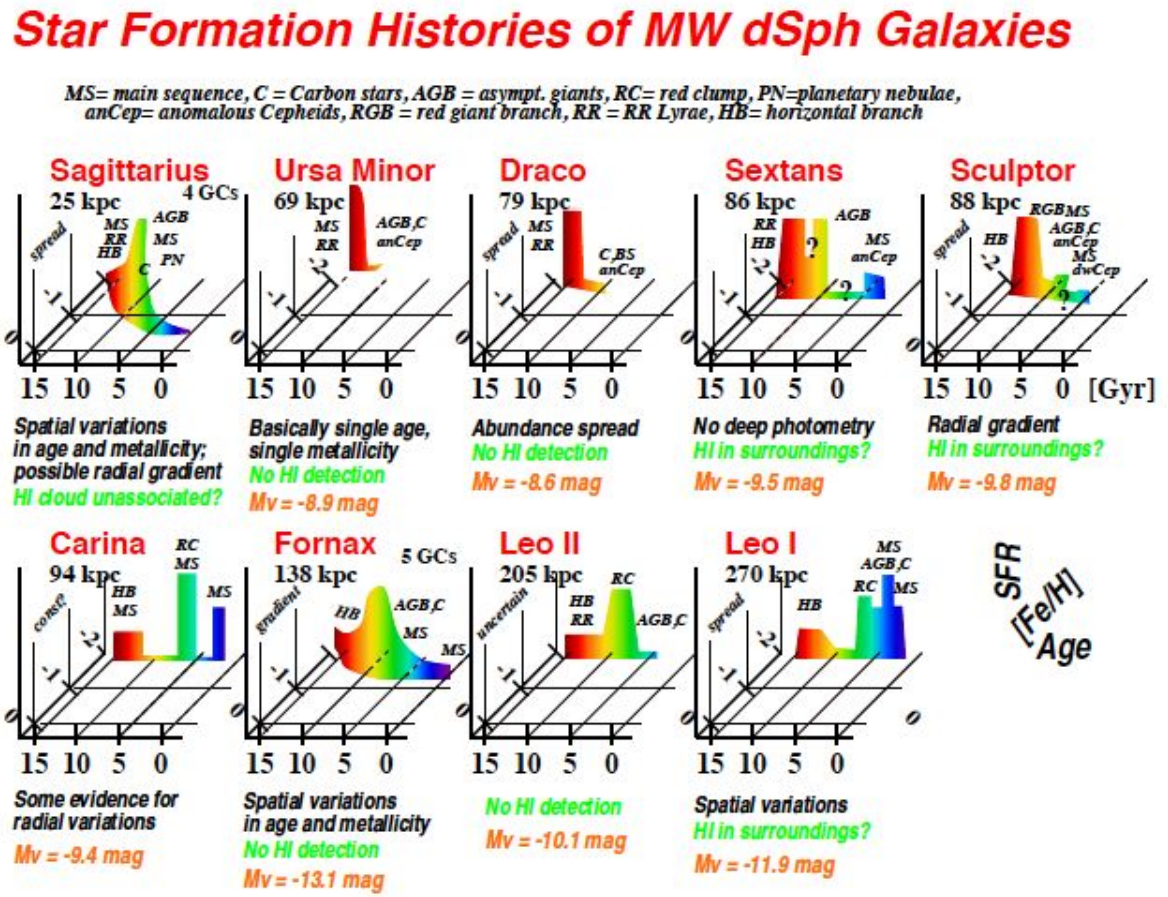


Cooling Function

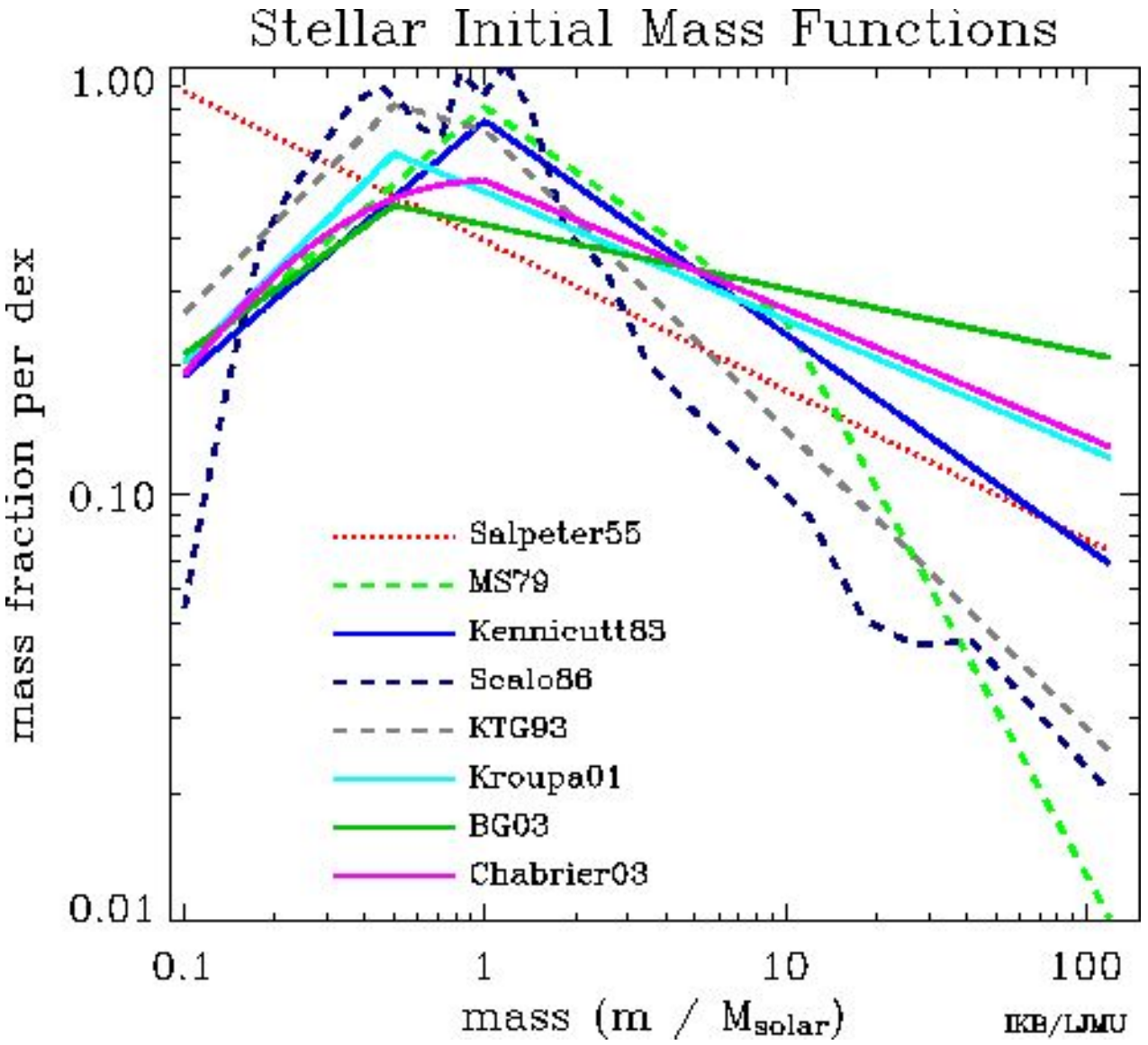


Galaxy Star Formation Histories

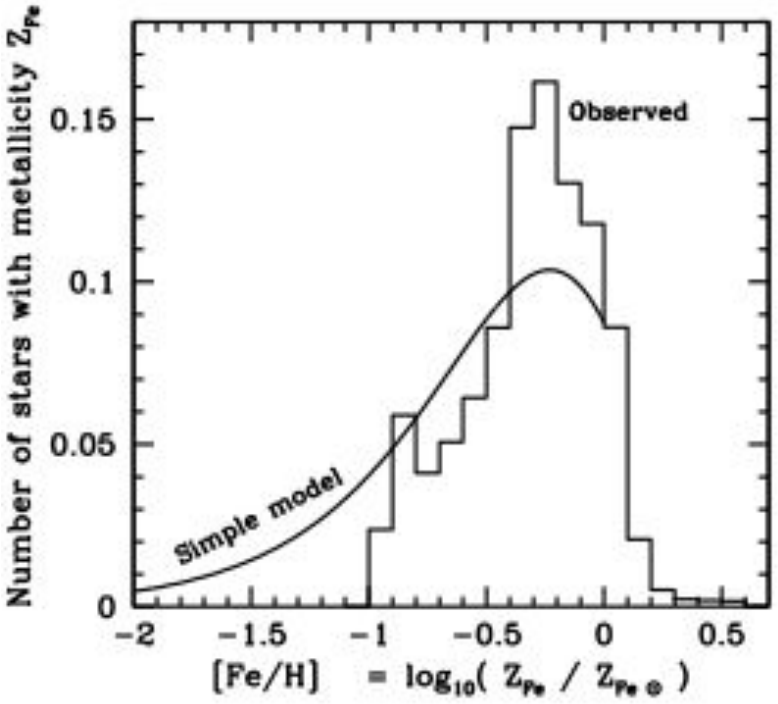


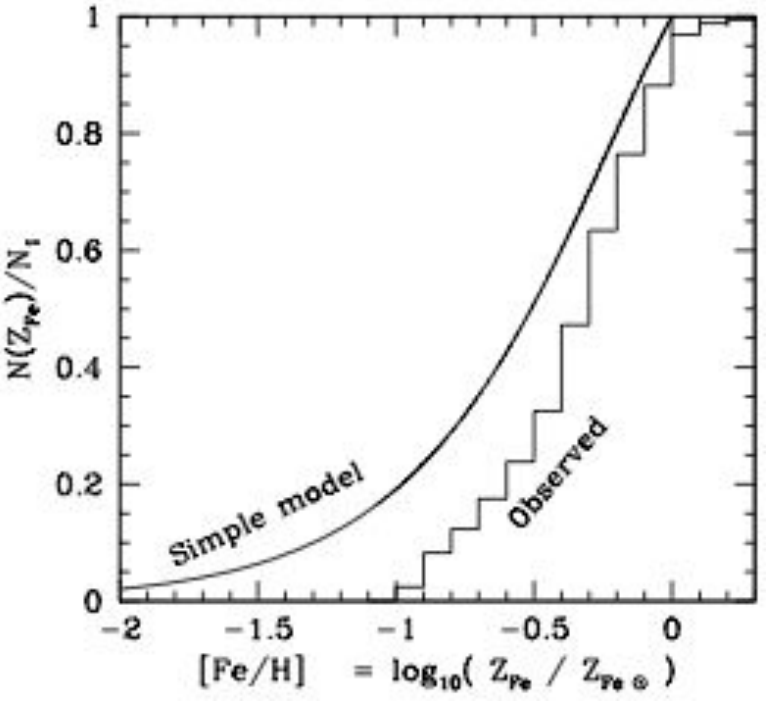


Initial Mass Functions



G-dwarf problem

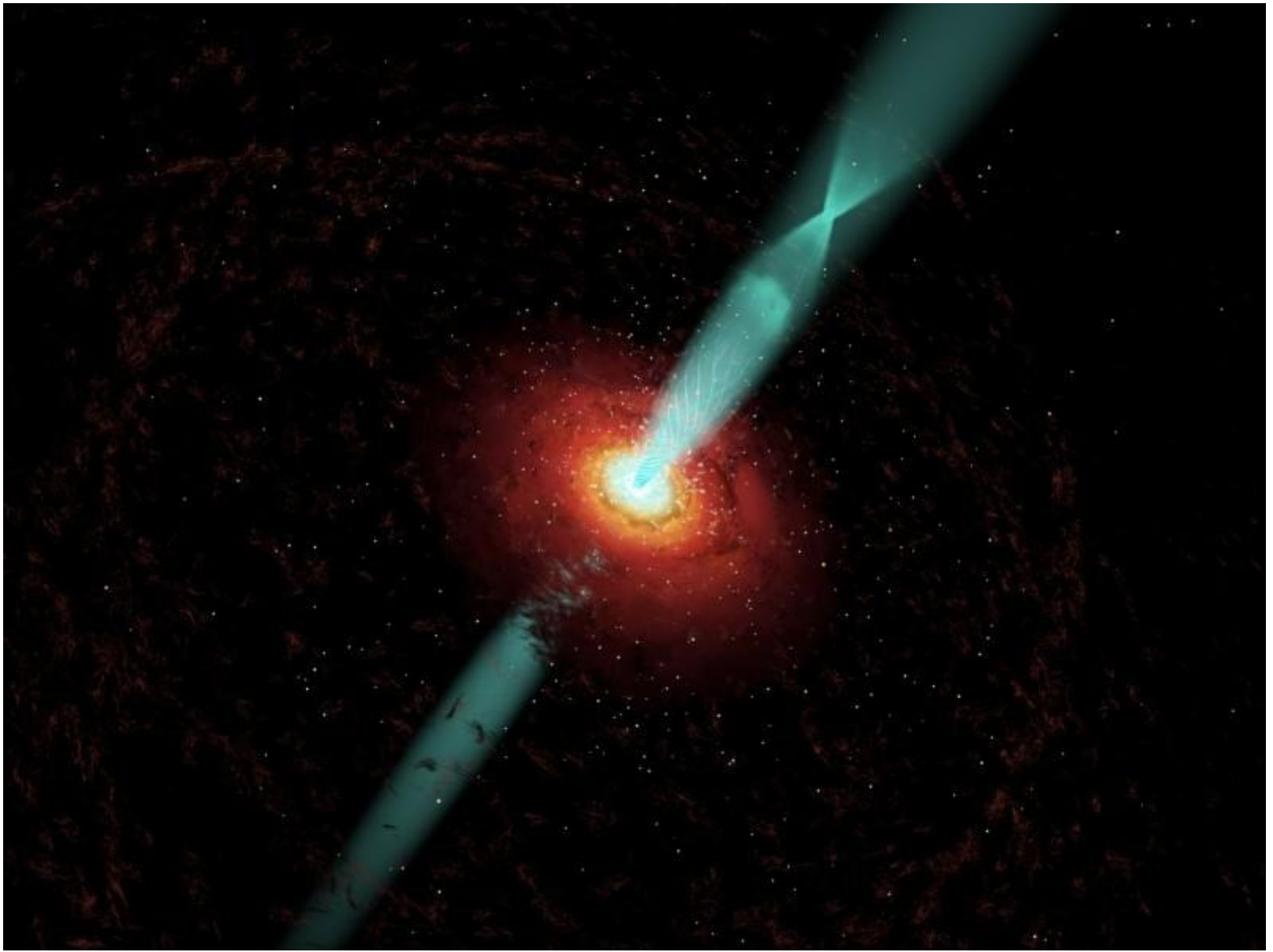


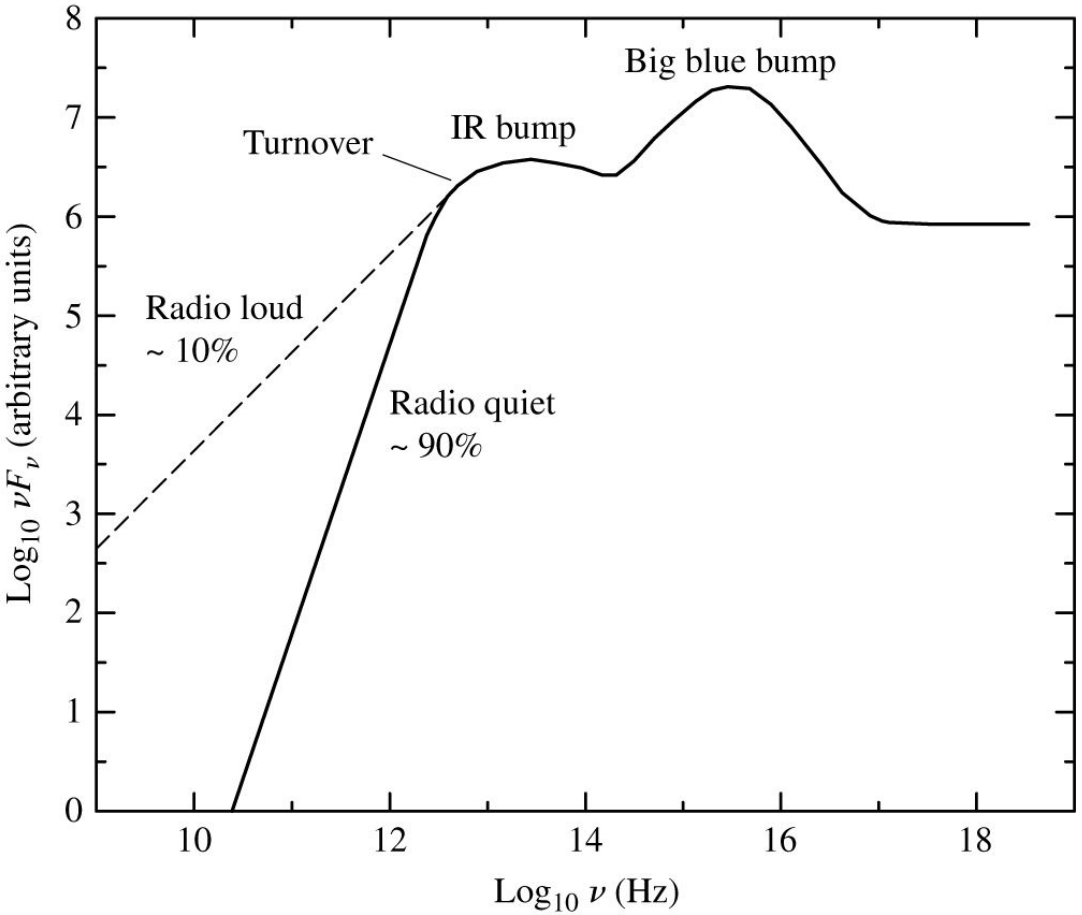


Simulation!

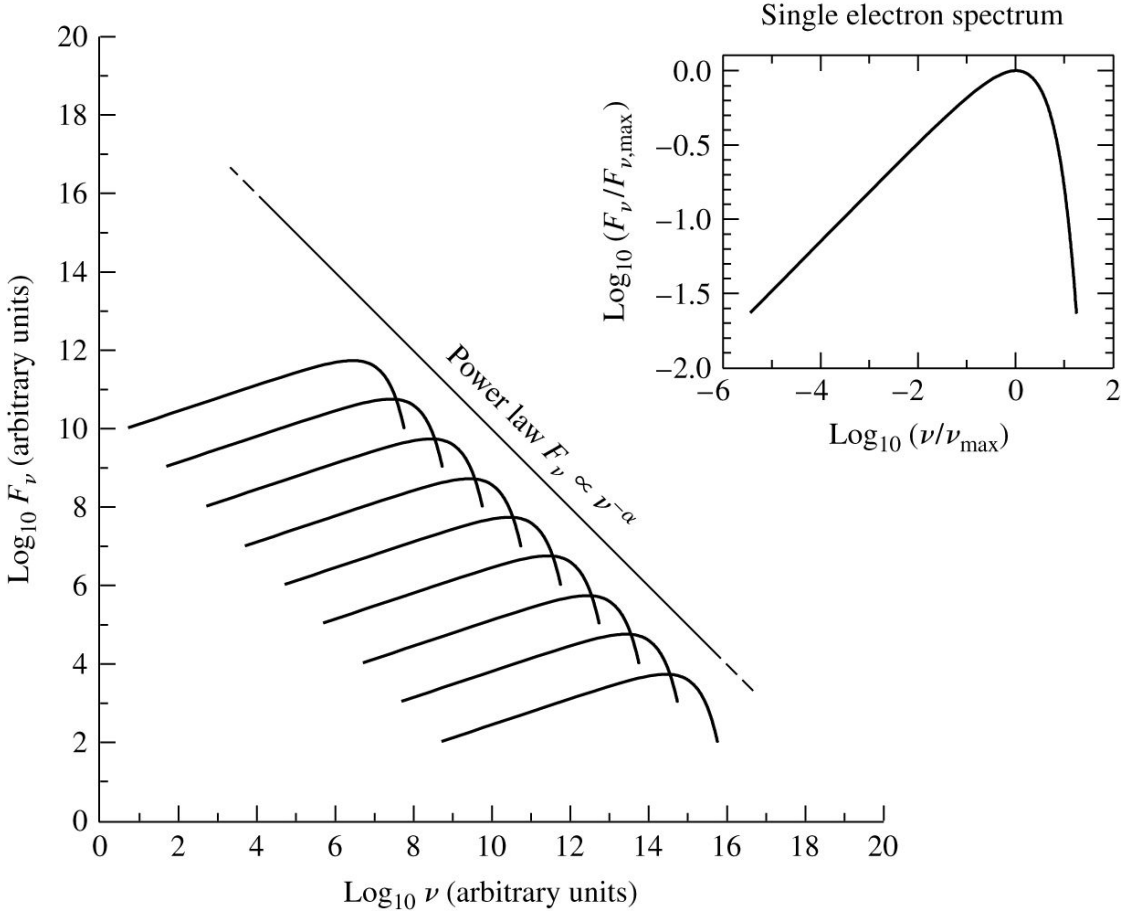
http://apod.nasa.gov/apod/ap120717.html

ASTR368
AGN

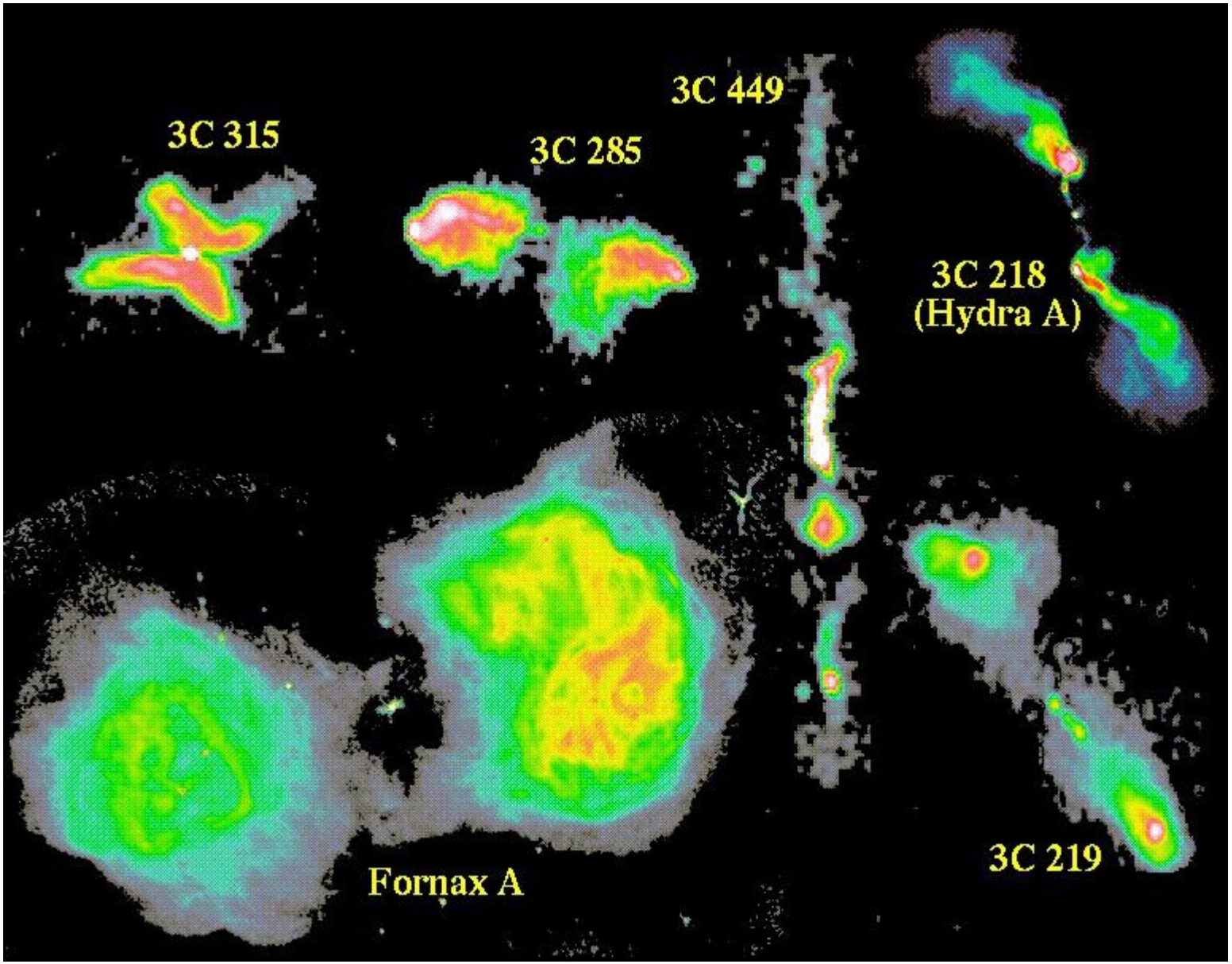



Big blue bump
IR bump
Turnover
Radio loud
~ 10%
Radio quiet
~ 90%
$\mathrm{Log}_{10}\,\nu F_\nu$ (arbitrary units)
$\mathrm{Log}_{10}\,\nu$ (Hz)
0
1
2
3
4
5
6
7
8
10
12
14
16
18

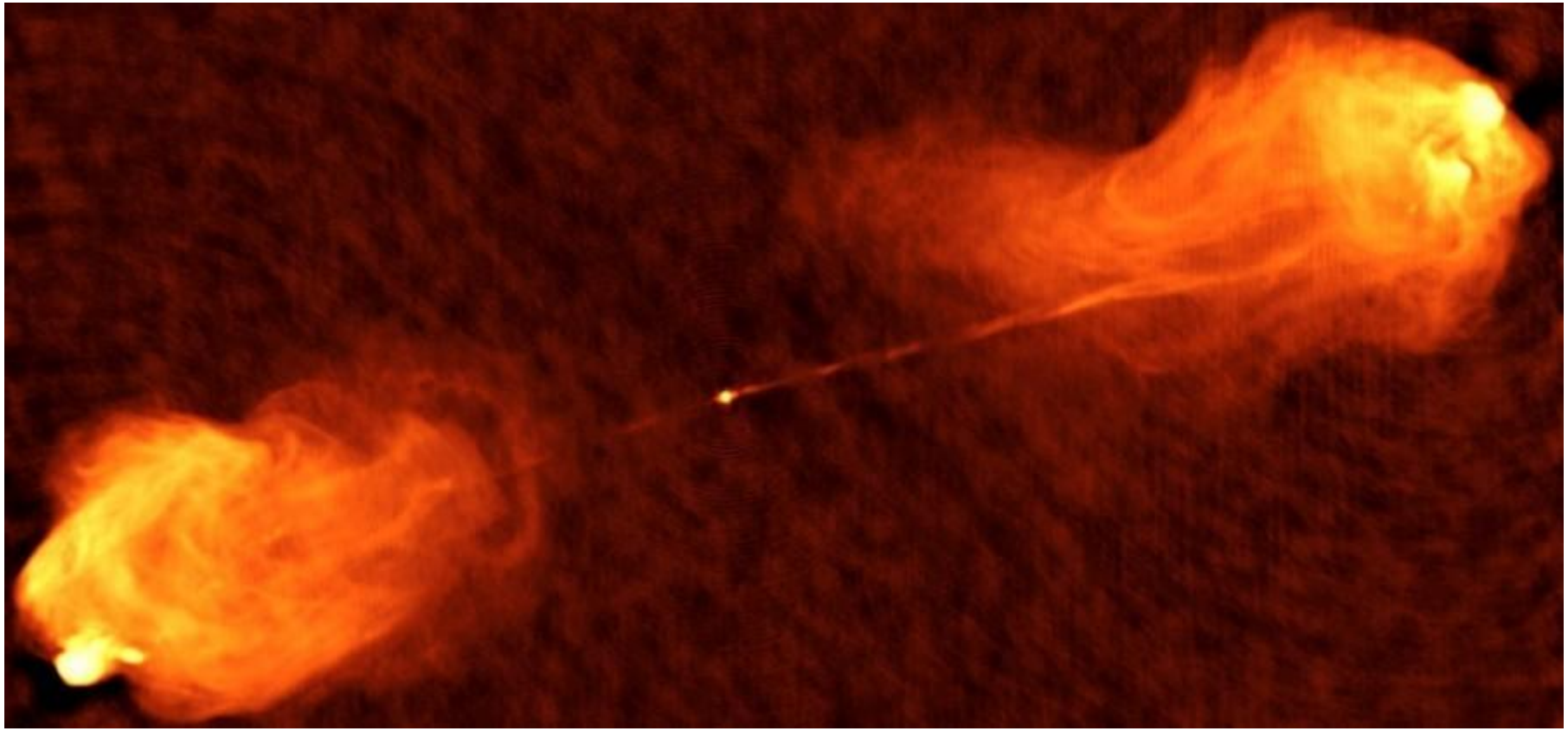
Synchrotron Radiation

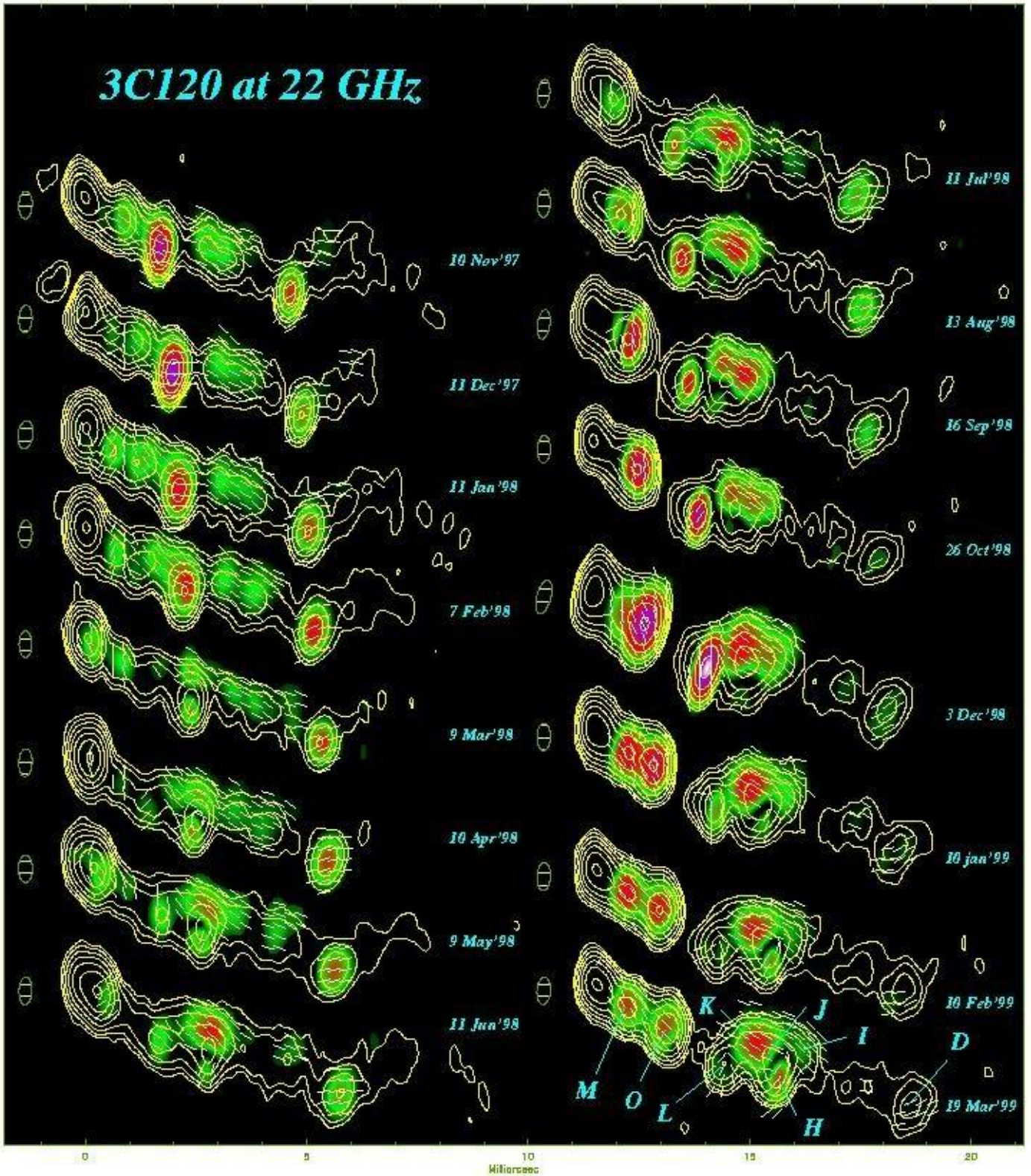


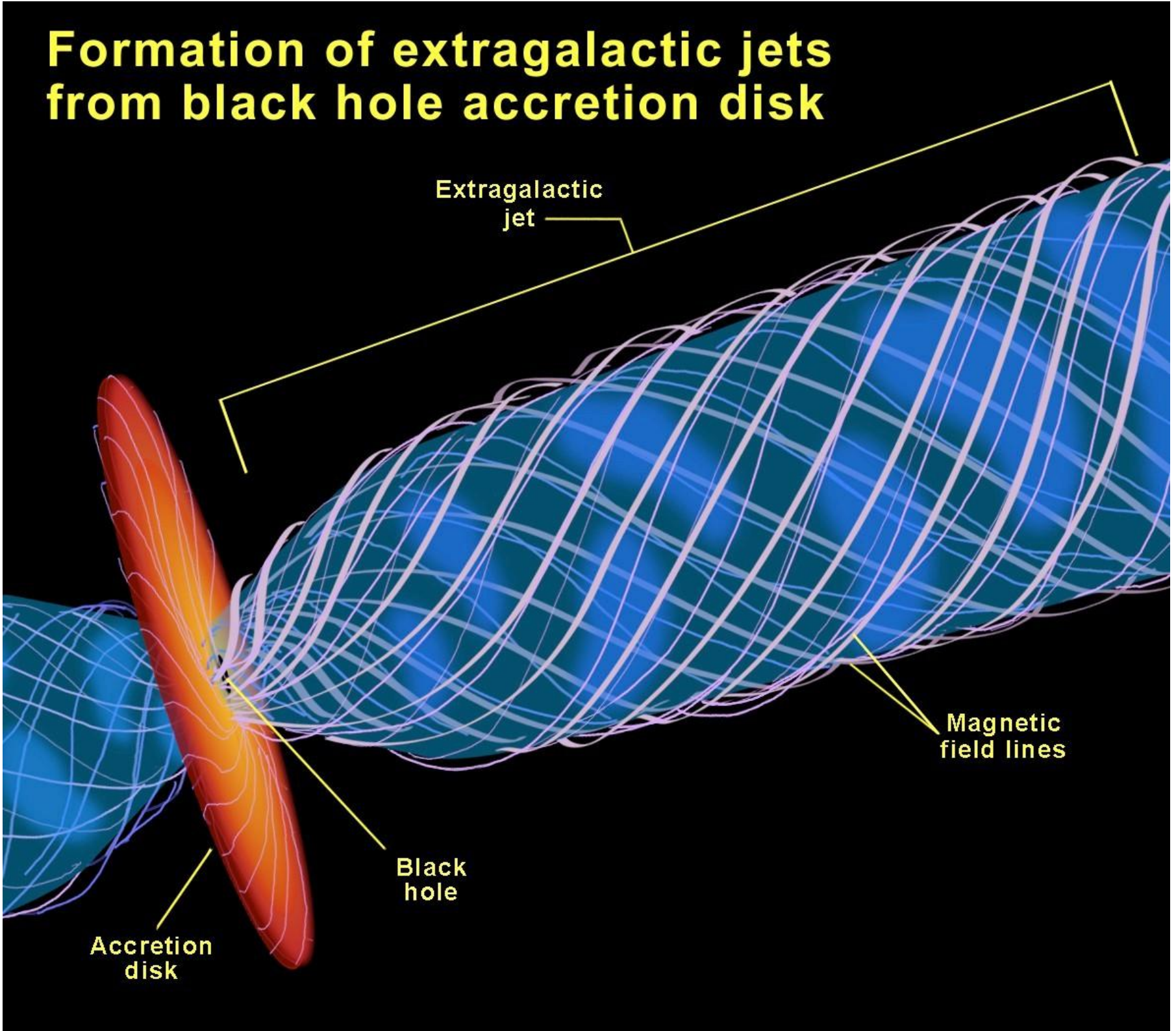
Radio Galaxies

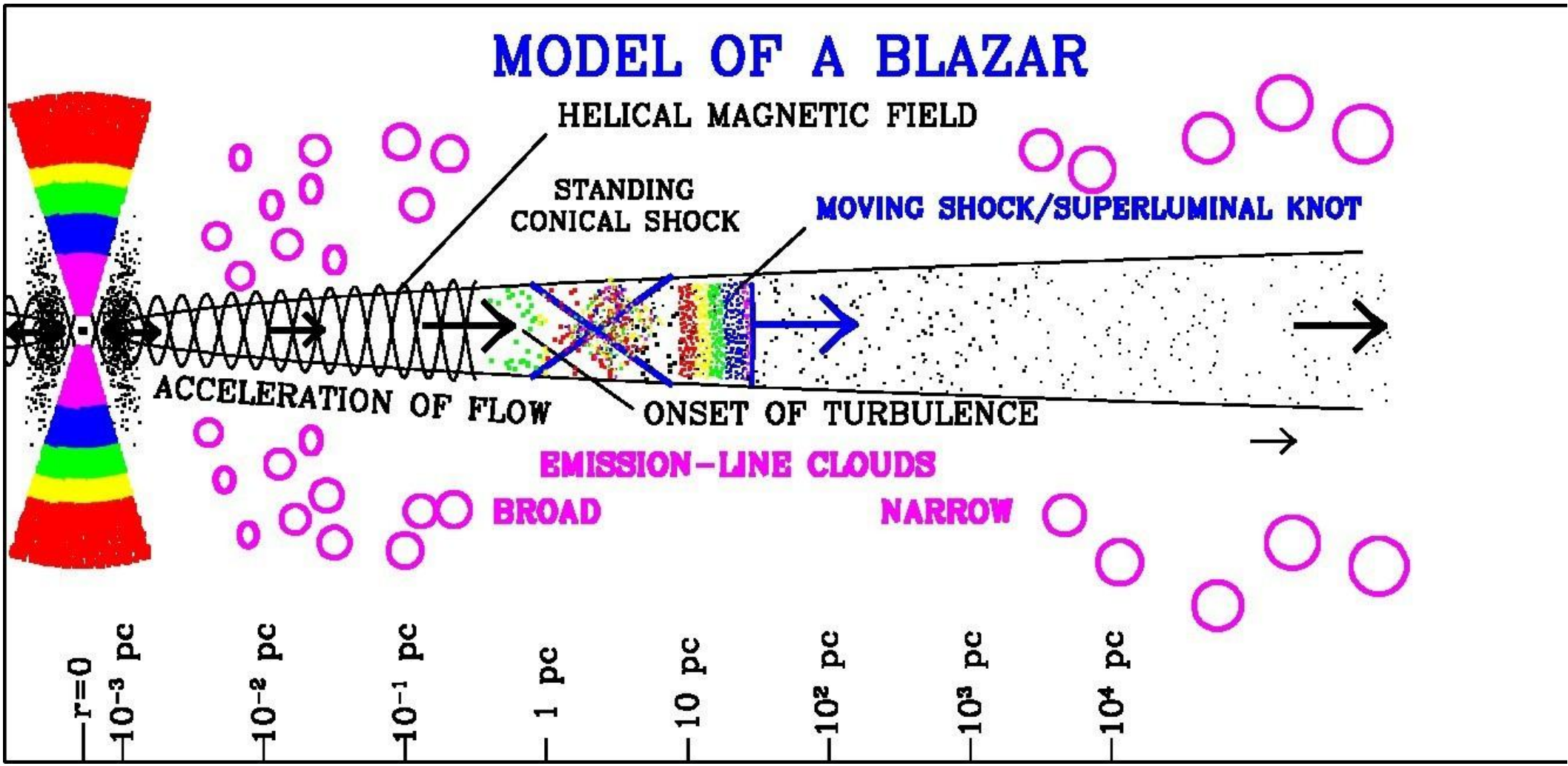


Cygnus A




3C120 at 22 GHz
10 Nov'97
11 Dec'97
11 Jan'98
7 Feb'98
9 Mar'98
10 Apr'98
9 May'98
11 Jun'98
11 Jul'98
13 Aug'98
16 Sep'98
26 Oct'98
3 Dec'98
10 jan'99
10 Feb'99
19 Mar'99
K
J
I
D
M
O
L
H
0
5
10
15
20
Milliarcsec


Formation of extragalactic jets from black hole accretion disk
Extragalactic jet
Magnetic field lines
Black hole
Accretion disk


MODEL OF A BLAZAR
HELICAL MAGNETIC FIELD
STANDING
CONICAL SHOCK
MOVING SHOCK/SUPERLUMINAL KNOT
ACCELERATION OF FLOW
ONSET OF TURBULENCE
EMISSION-LINE CLOUDS
BROAD
NARROW
r=0
10⁻³ pc
10⁻² pc
10⁻¹ pc
1 pc
10 pc
10² pc
10³ pc
10⁴ pc

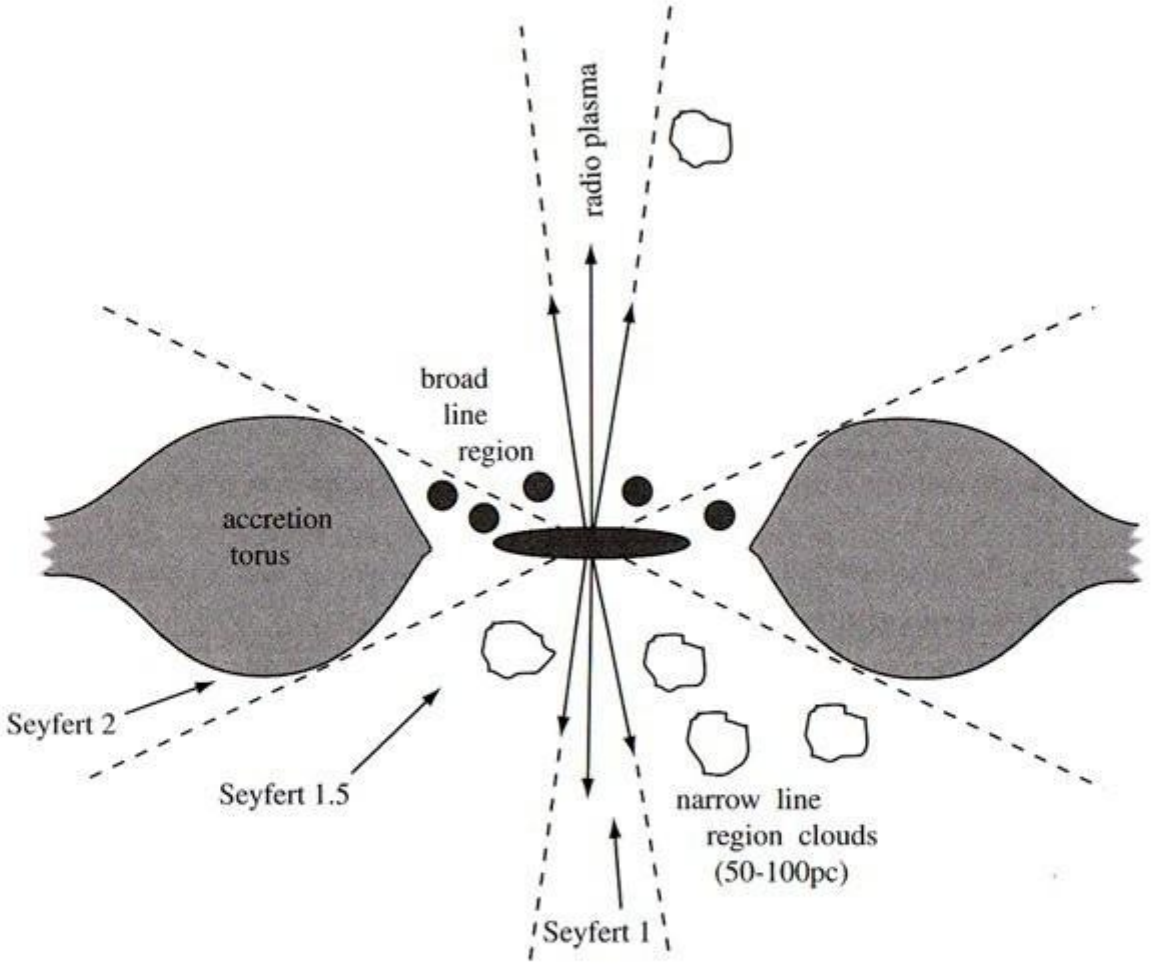
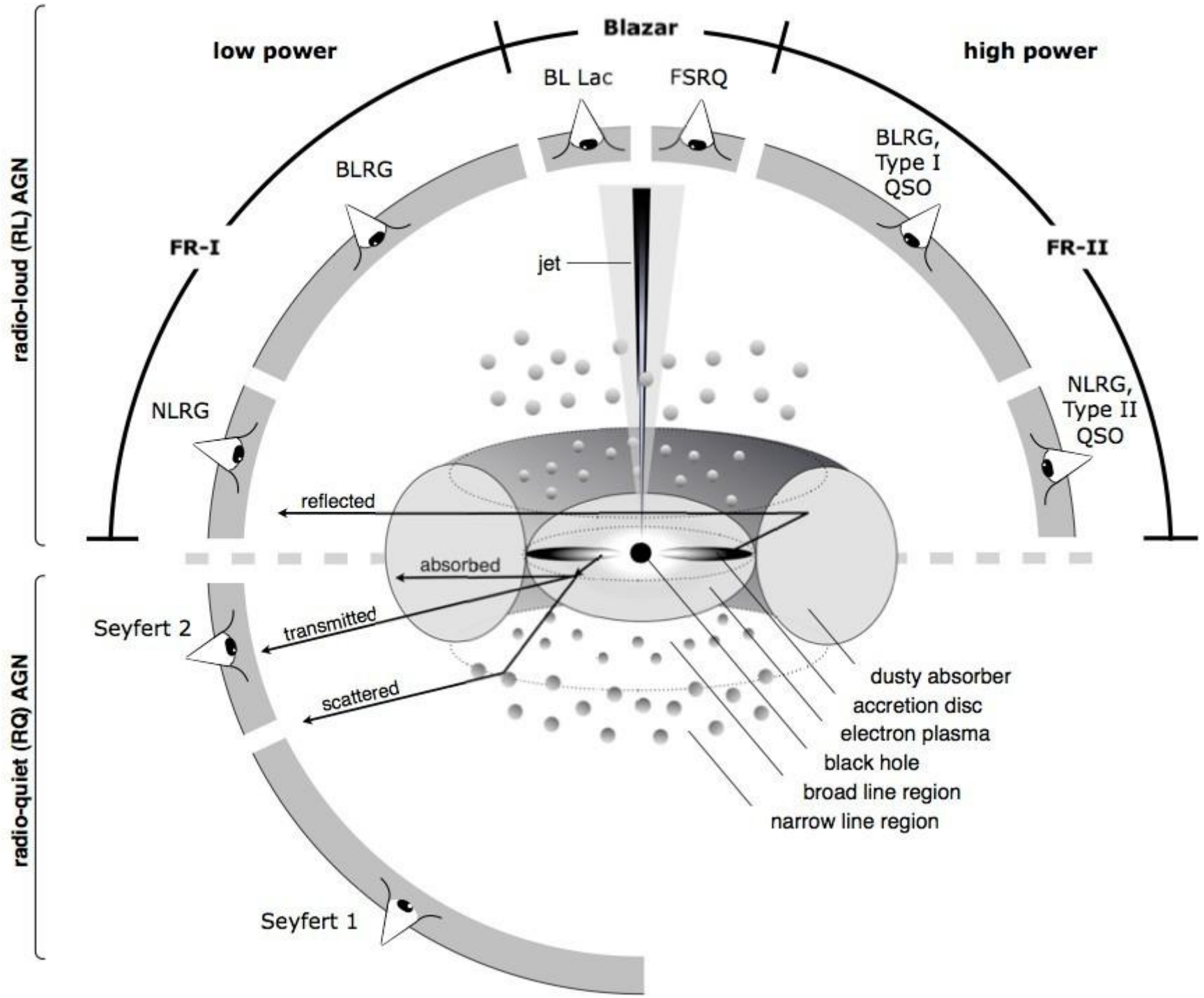
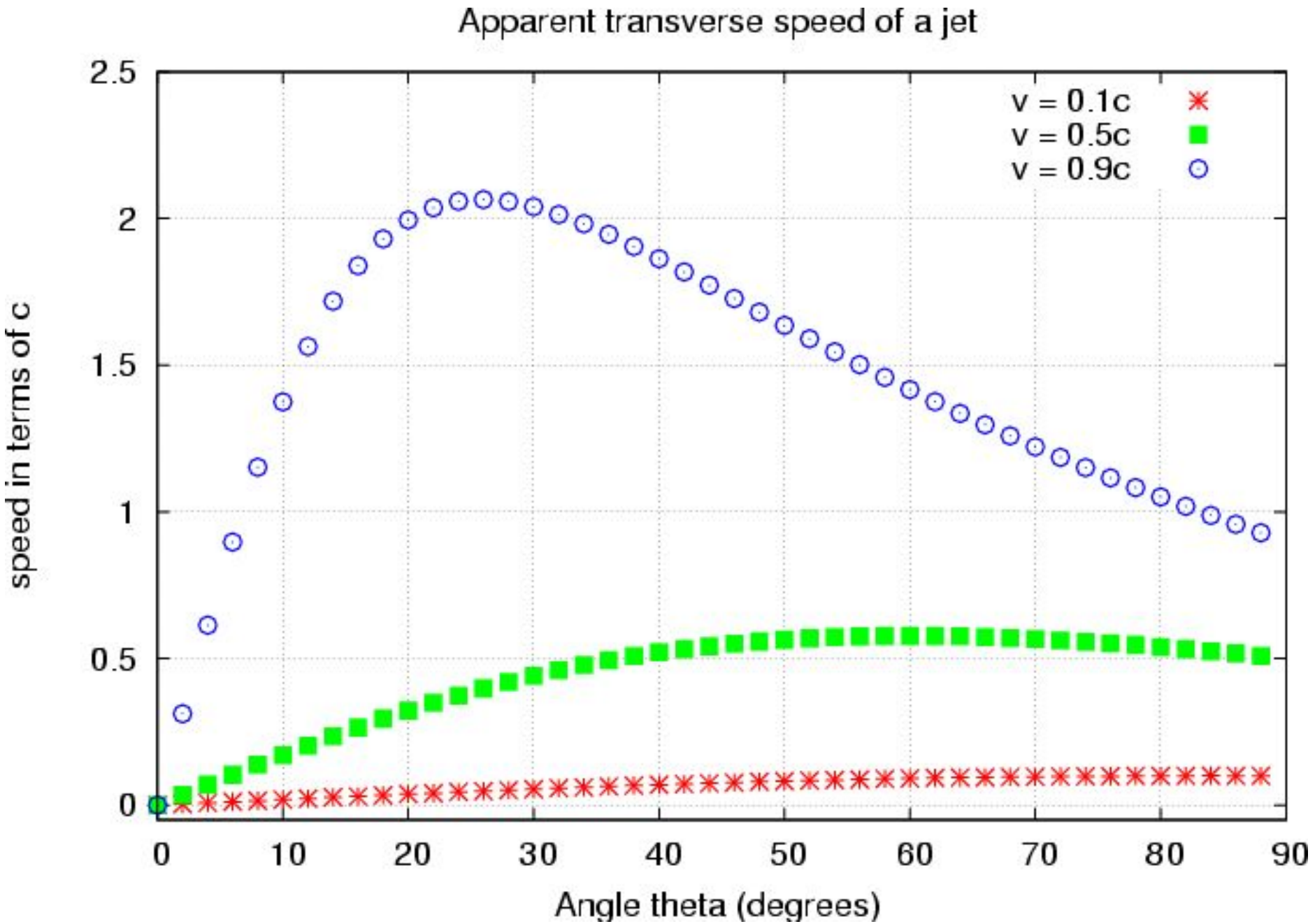


Figure 8.3 Simple model for an active nucleus. Energetic twin jets emerge at near-light speeds along the spin axis of the central accretion disk. Radiation from the disk and jet photoionizes the dense fast-moving clouds of the broad-line region, which is often $\lesssim$1 pc across. The more diffuse and slower-moving gas of the narrow-line region is at larger radii. Observers looking directly down the jet would see a brilliant Seyfert 1 nucleus. But when viewed sideways, through the opaque accretion torus (grey), we have a Seyfert 2 galaxy.


radio-loud (RL) AGN
radio-quiet (RQ) AGN
low power
Blazar
high power
BL Lac
FSRQ
BLRG
BLRG,
Type I
QSO
FR-I
FR-II
jet
NLRG
NLRG,
Type II
QSO
reflected
absorbed
Seyfert 2
transmitted
scattered
dusty absorber
accretion disc
electron plasma
black hole
broad line region
narrow line region
Seyfert 1


Apparent transverse speed of a jet
v = 0.1c
v = 0.5c
v = 0.9c
speed in terms of c
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
Angle theta (degrees)