ΡΑΔΙΟΚΥΜΑΤΑ: ΑΚΟΥΜΕ Η' ΒΛΕΠΟΥΜΕ;

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Ελληνικό Ανοικτό Παν/ο
Σχολή Θετικών Επιστημών & Τεχνολογίας

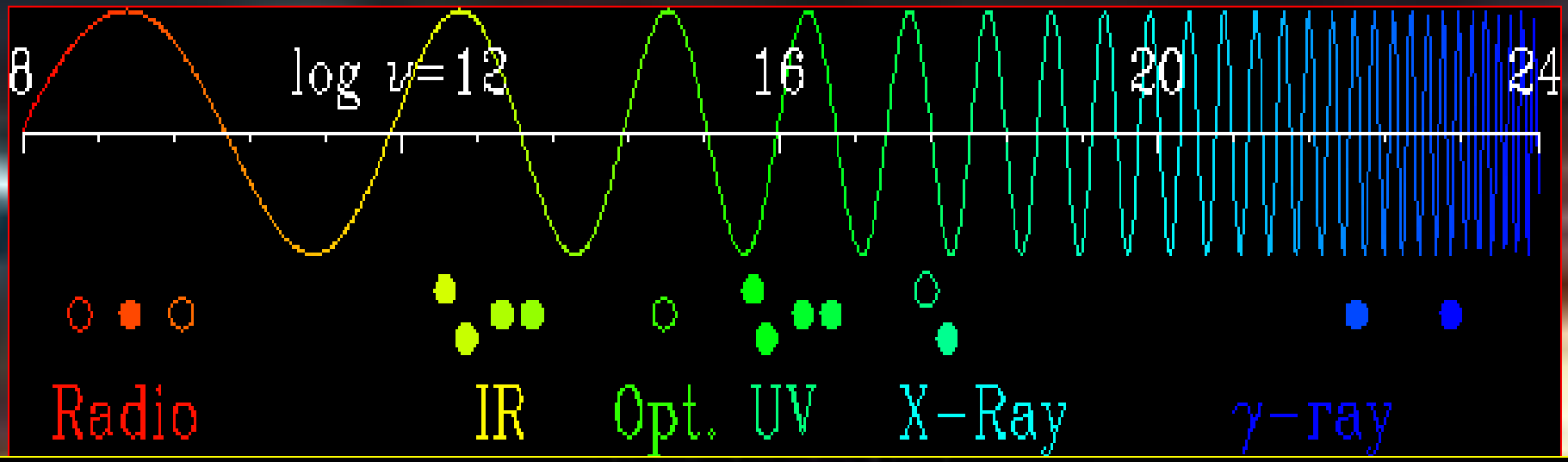
Ηλεκτρομαγνητικό Φάσμα

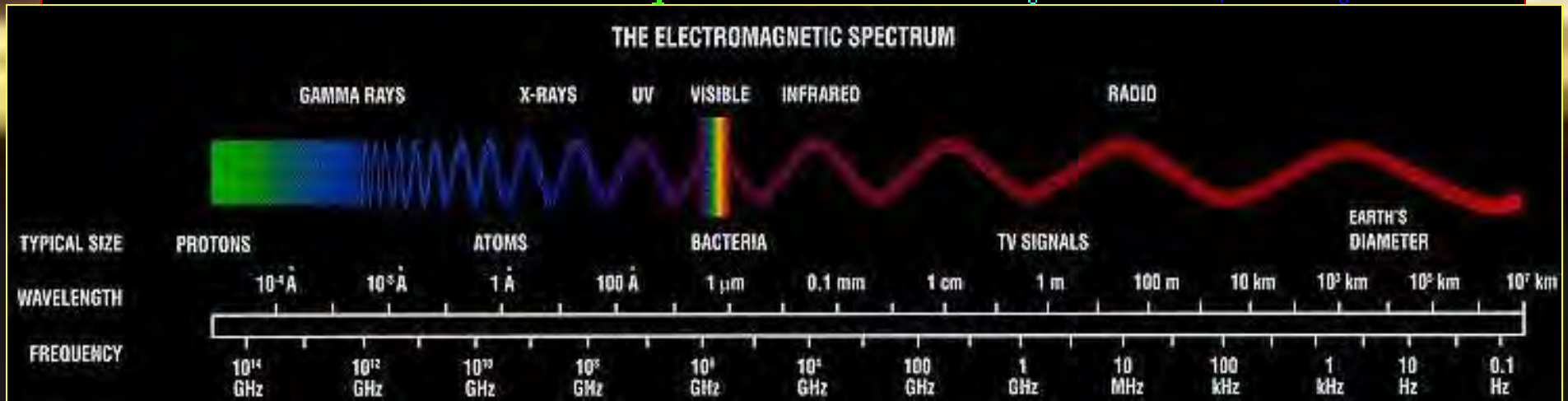
Διαφορετικές Φυσικές Διαδικασίες:

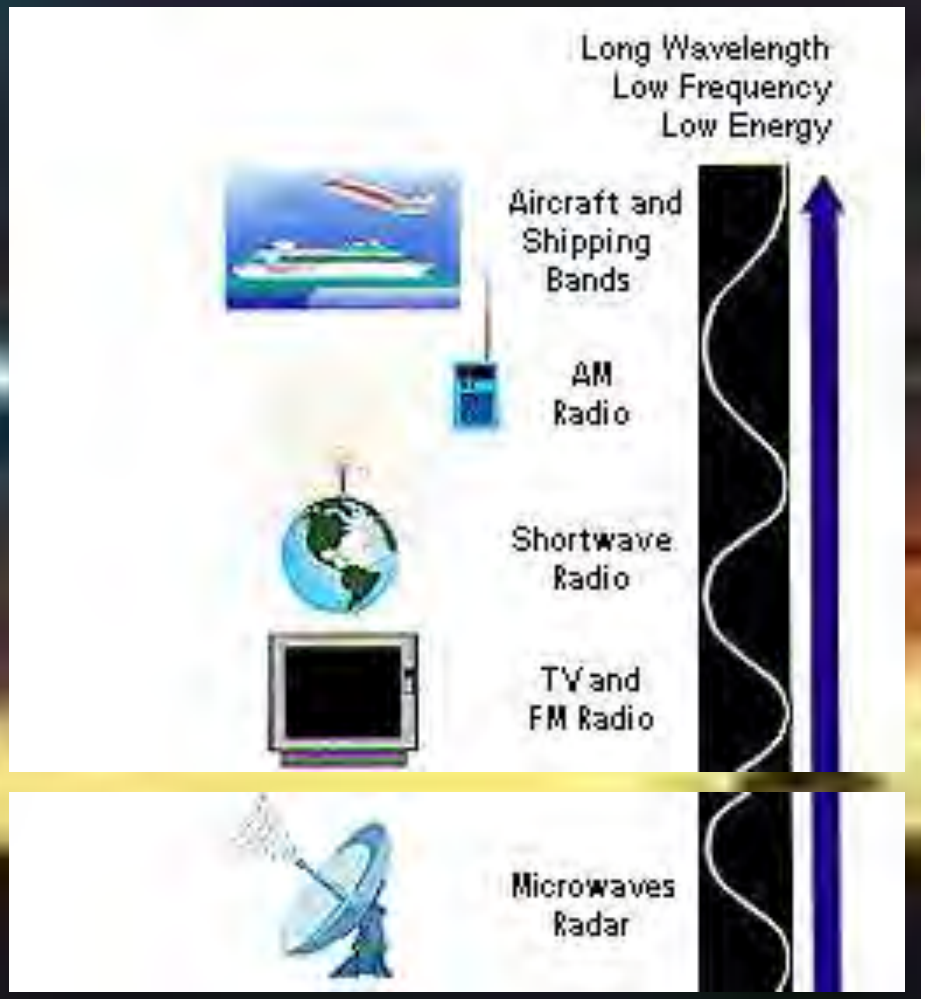
Radio-synchrotron

infrared: thermal dust emission,

X-rays-inverse compton

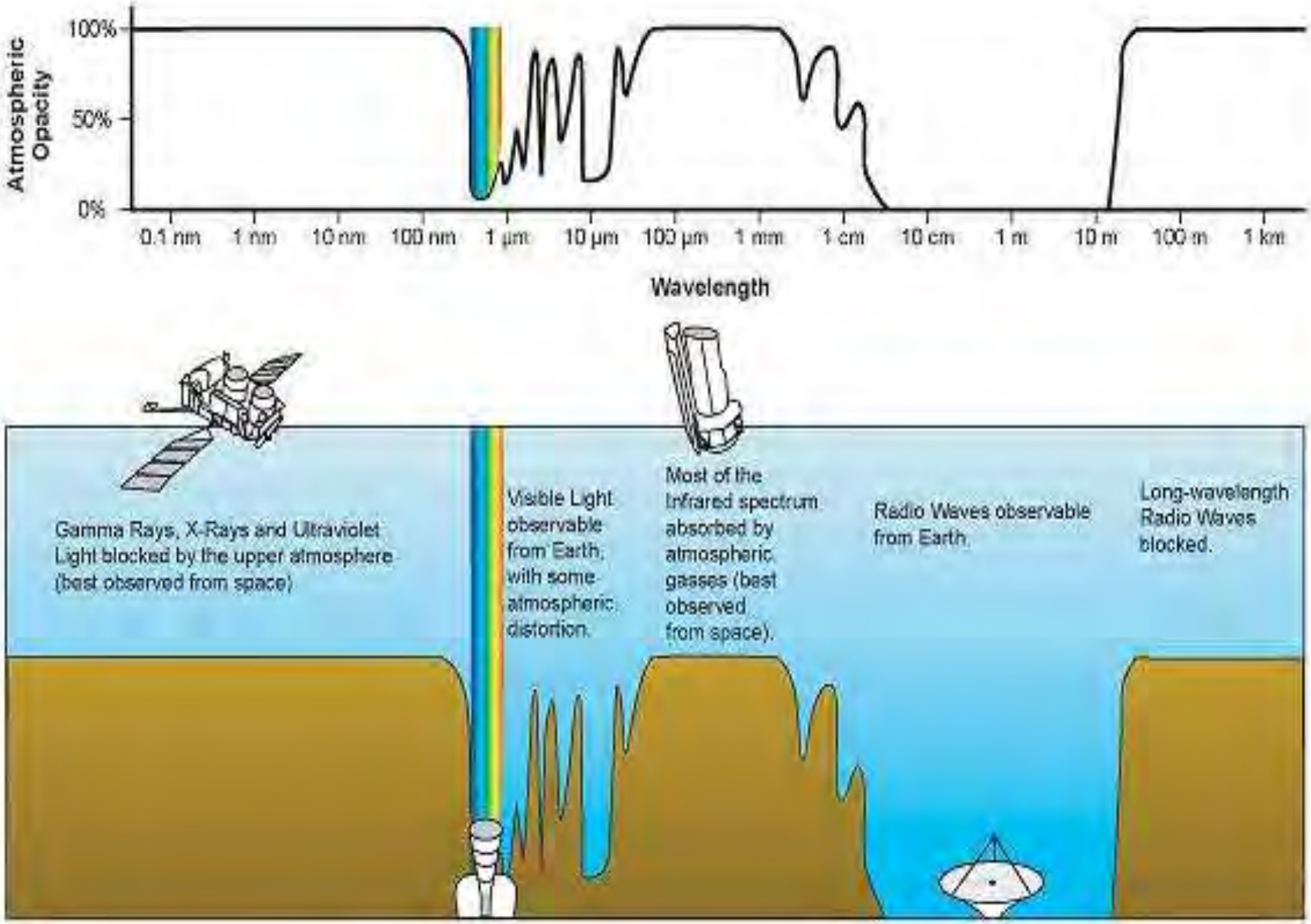





Long Wavelength
Low Frequency
Low Energy
Aircraft and
Shipping
Bands
AM
Radio
Shortwave
Radio
TV and
FM Radio
Microwaves
Radar


Infrared
Light
Visible
Ultraviolet
Light
Ouch !
X-rays
Gamma-rays
Short Wavelength
High Frequency
High Energy

Gamma Ray
X-Ray
Ultraviolet
Visible
Infrared
Radio
500 km
100 km
10 km
sea level


Atmospheric Opacity
100%
50%
0%
0.1 nm
1 nm
10 nm
100 nm
1 μm
10 μm
100 μm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1 km
Wavelength
Gamma Rays, X-Rays and Ultraviolet Light blocked by the upper atmosphere (best observed from space)
Visible Light observable from Earth, with some atmospheric distortion.
Most of the Infrared spectrum absorbed by atmospheric gasses (best observed from space).
Radio Waves observable from Earth.
Long-wavelength Radio Waves blocked.

RADIO: ● from km (ISM) to mm -> mm,

INFRARED: from 1○ to 100s ○s

X-RAYS: The emission from AGN dominated by a

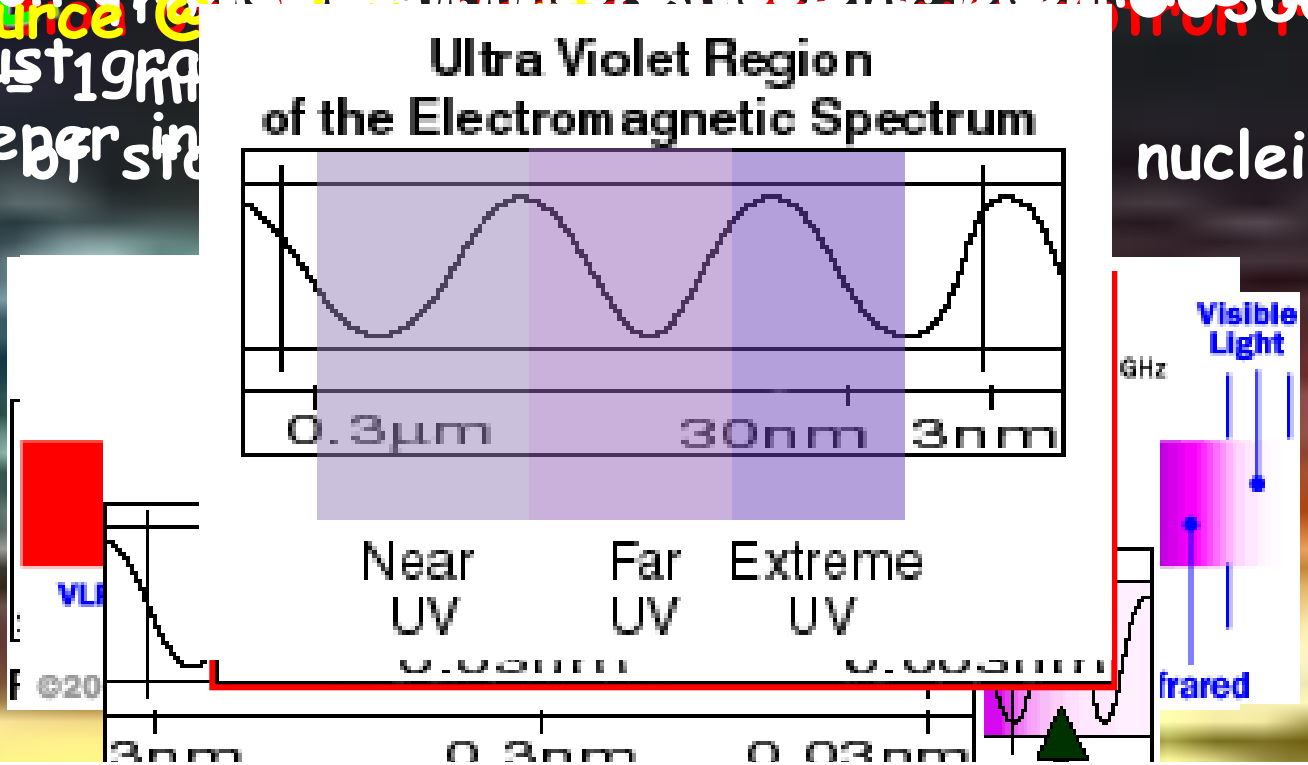
Detection of starlight, dominated emission, thermal emission

OPTICAL: Point source @ [illegible] from radi[illegible]

from dust gra[illegible] 10000 Å – 19[illegible]

See deeper in [illegible]

Detection of st[illegible] nuclei



γ-rays: Veeery high energies (1 TeV from cosmic sources)

ULTRAVIOLET:

Detection of H in galaxy, starlight

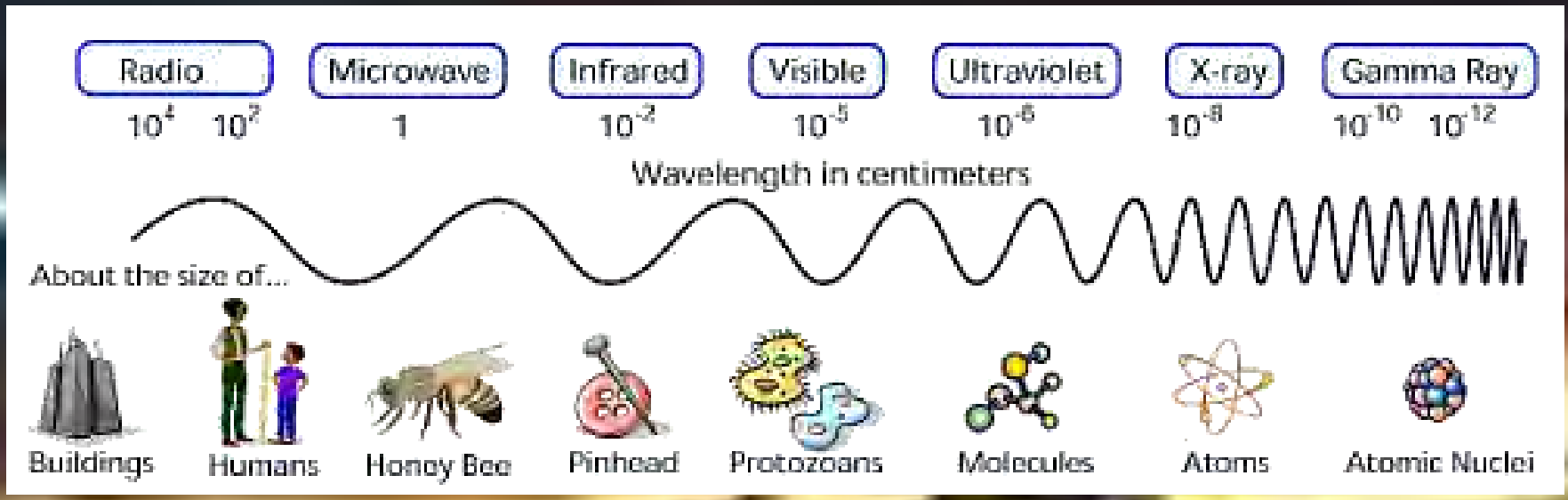
Extreme UV: ~ 10-500 Å

Radio spectrum

ELF	SLF	ULF	VLF	LF	MF	HF	VHF	UHF	SHF	EHF
3 Hz	30 Hz	300 Hz	3 kHz	30 kHz	300 kHz	3 MHz	30 MHz	300 MHz	3 GHz	30 GHz
30 Hz	300 Hz	3 kHz	30 kHz	300 kHz	3 MHz	30 MHz	300 MHz	3 GHz	30 GHz	300 GHz

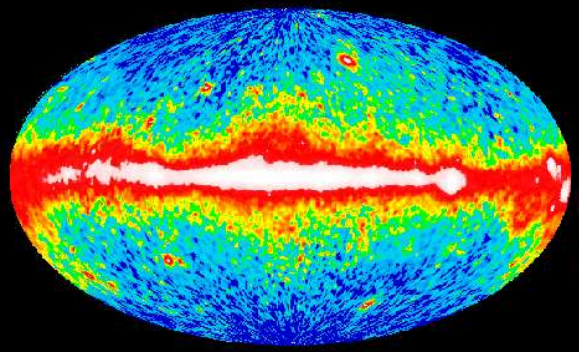
$$\lambda = c/v$$

Μέγεθος

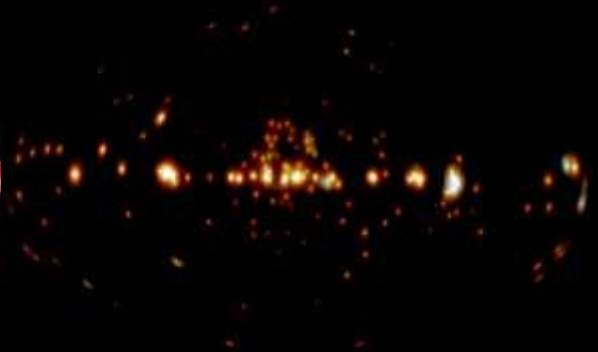

Radio
Microwave
Infrared
Visible
Ultraviolet
X-ray
Gamma Ray
10^{4} 10^{2}
1
10^{-2}
10^{-5}
10^{-8}
10^{-10} 10^{-12}
Wavelength in centimeters
About the size of...
Buildings
Humans
Honey Bee
Pinhead
Protozoans
Molecules
Atoms
Atomic Nuclei

ο Γαλαξίας μας

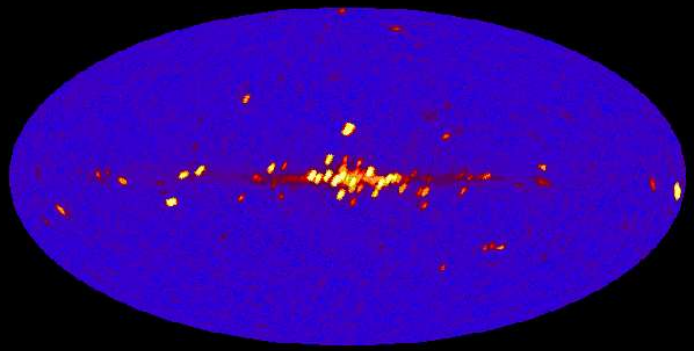

100,000 ly
Sun
Nuclear bulge
Disk
Halo
Globular cluster



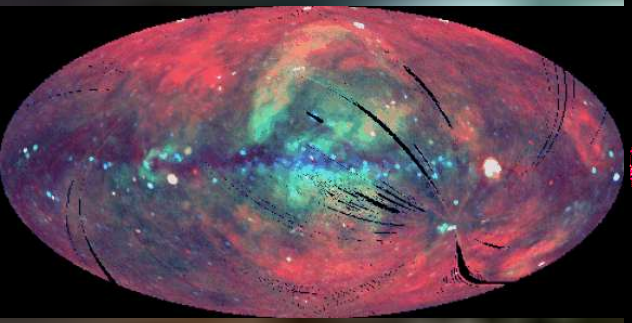
Gamma-Ray >100MeV
CGRO



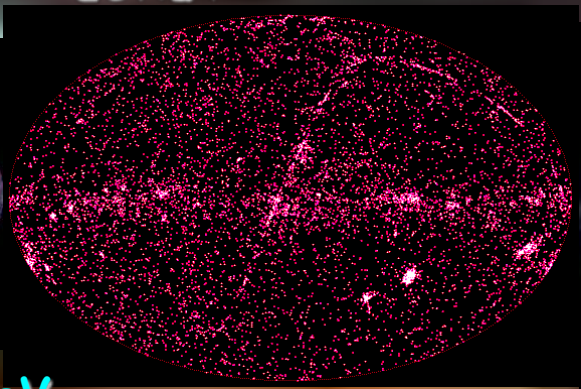
Gamma-Ray
EGRET



X-Ray 2-10keV
HEAO-1



X-Ray 0.25, 0.75, 1.5 keV
ROSAT

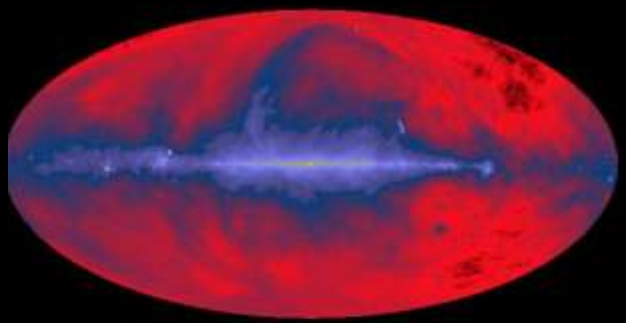


Ultraviolet

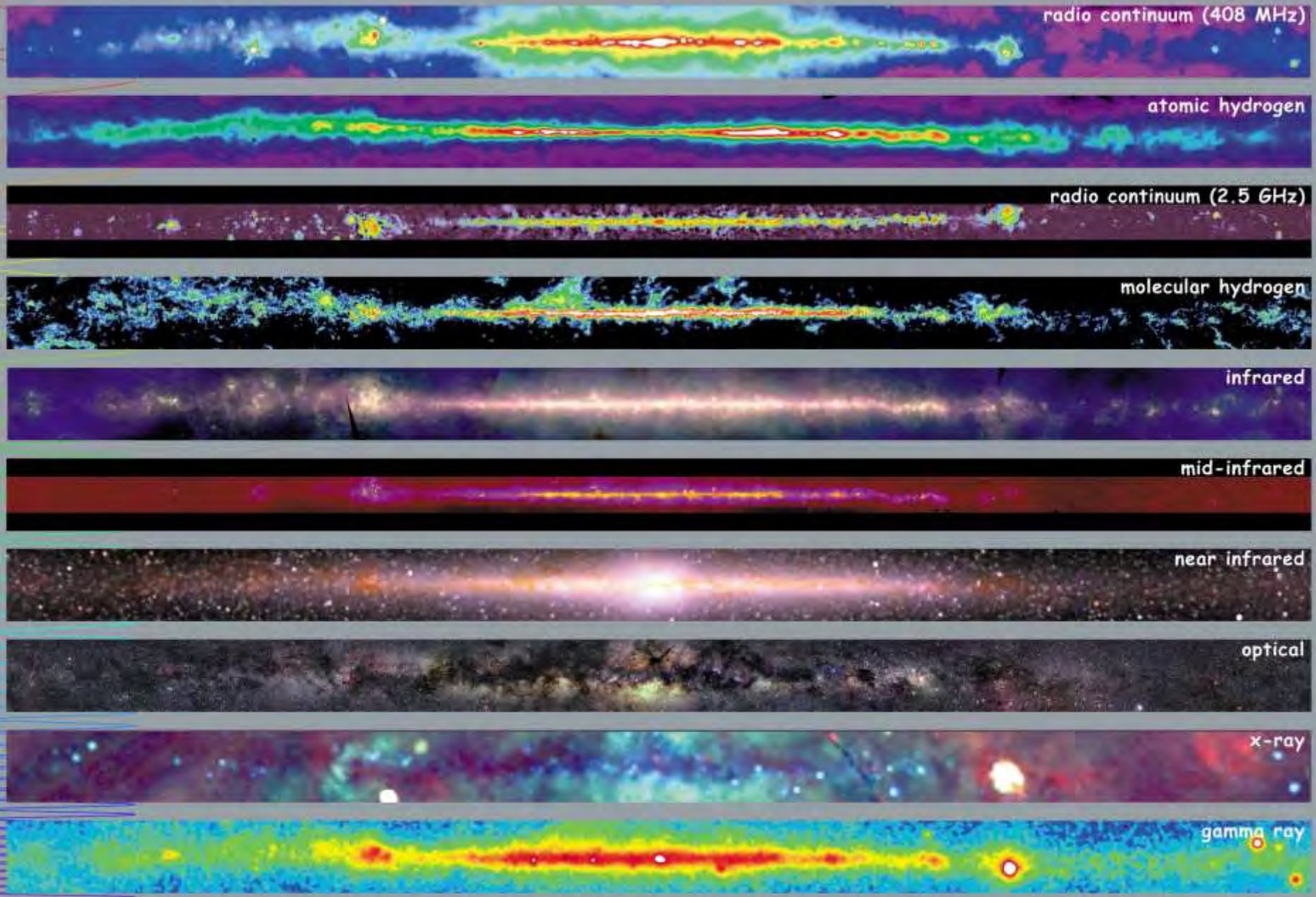
Visible

Infrared, COBE

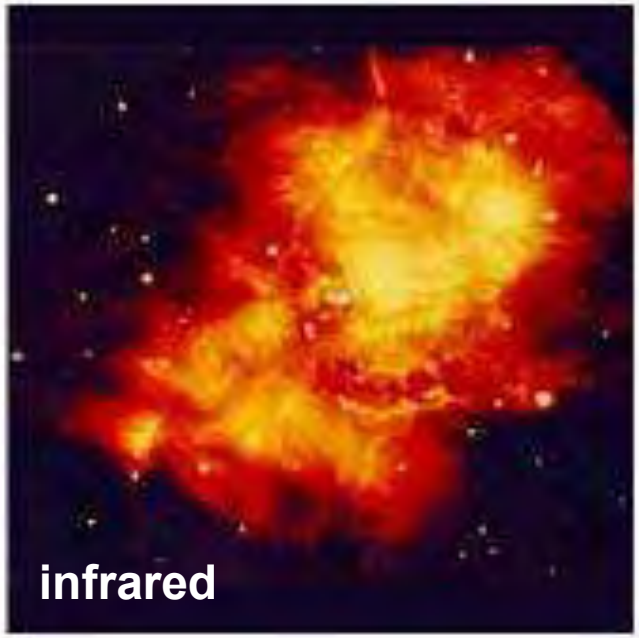
Radio 1420MHz

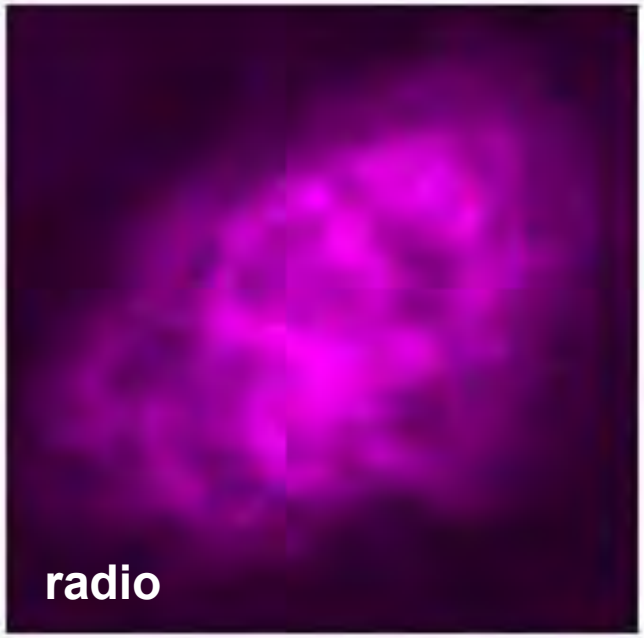


Radio 408MHz


radio continuum (408 MHz)
atomic hydrogen
radio continuum (2.5 GHz)
molecular hydrogen
infrared
mid-infrared
near infrared
optical
x-ray
gamma ray
http://adc.gsfc.nasa.gov/mw
NASA
Multiwavelength Milky Way

Crab Nebula

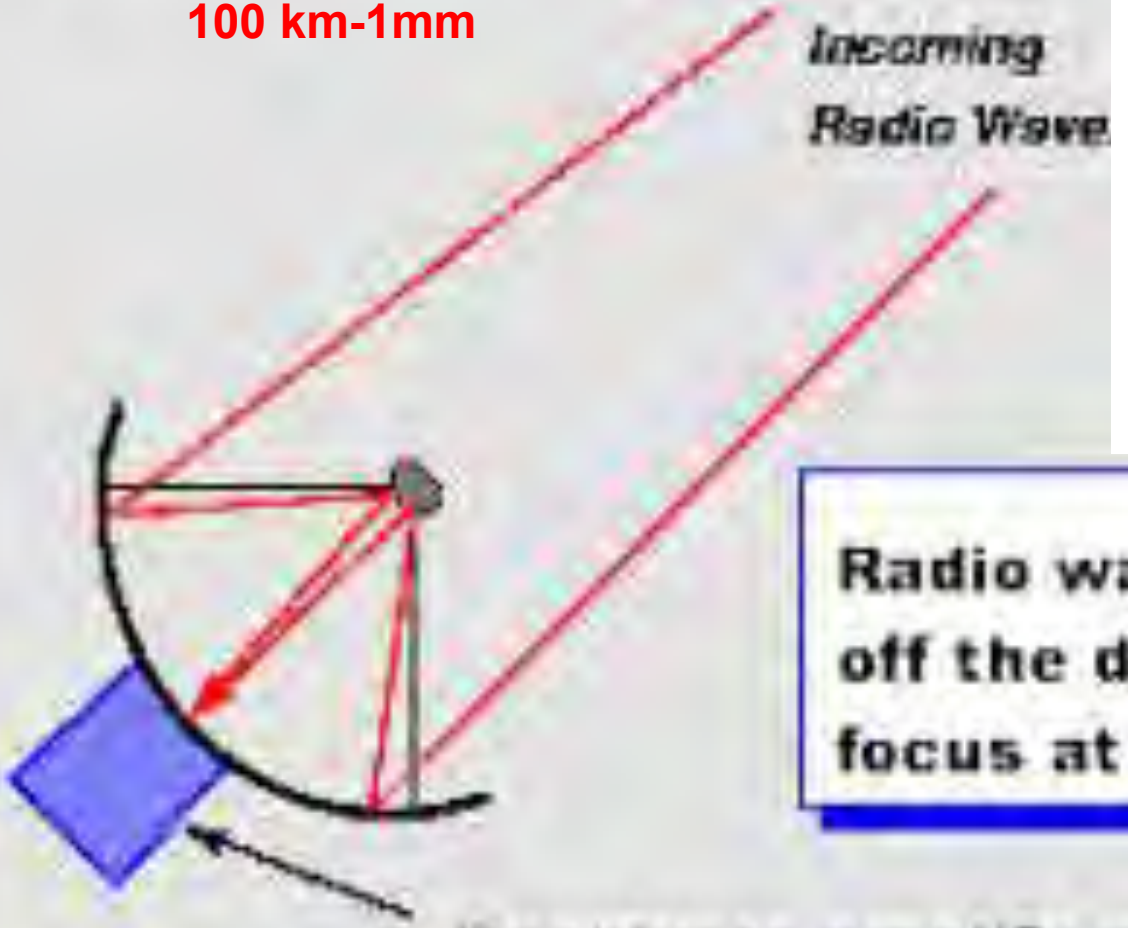


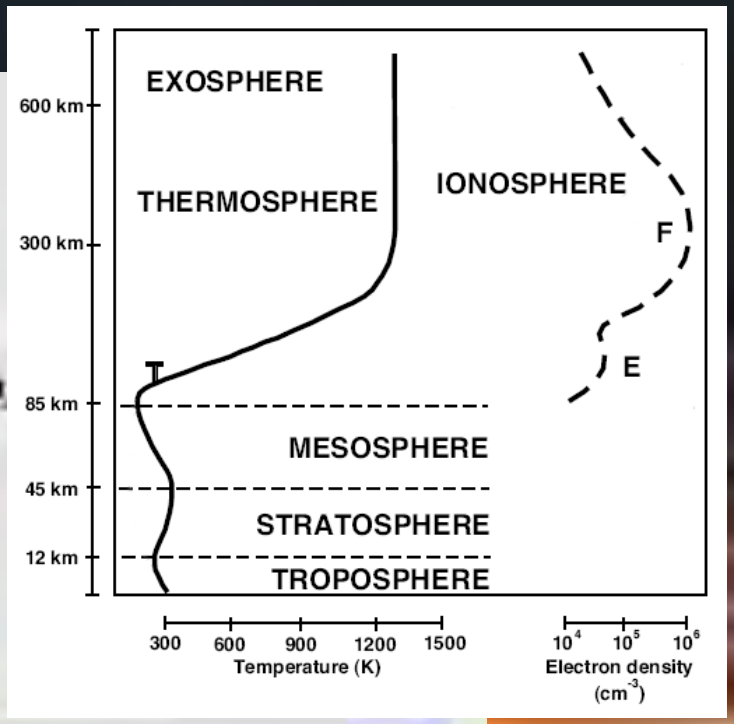


1 arcmin=γυμνό μάτι-οπτικό

Radio Telescope

100 km-1mm





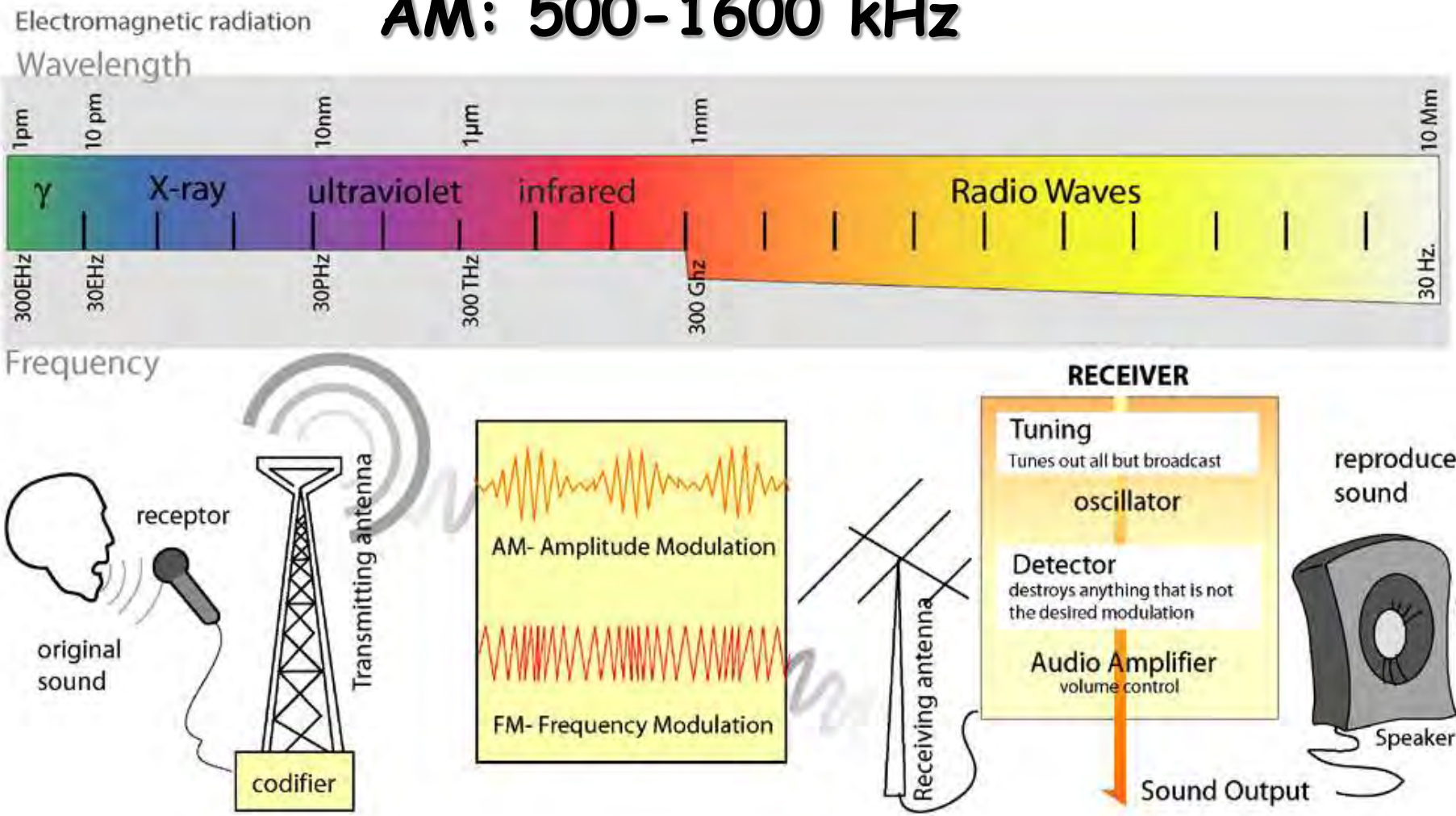
Radio waves reflect off the dish and focus at the tip.

Receivers amplify and detect radio signals.

VLBA

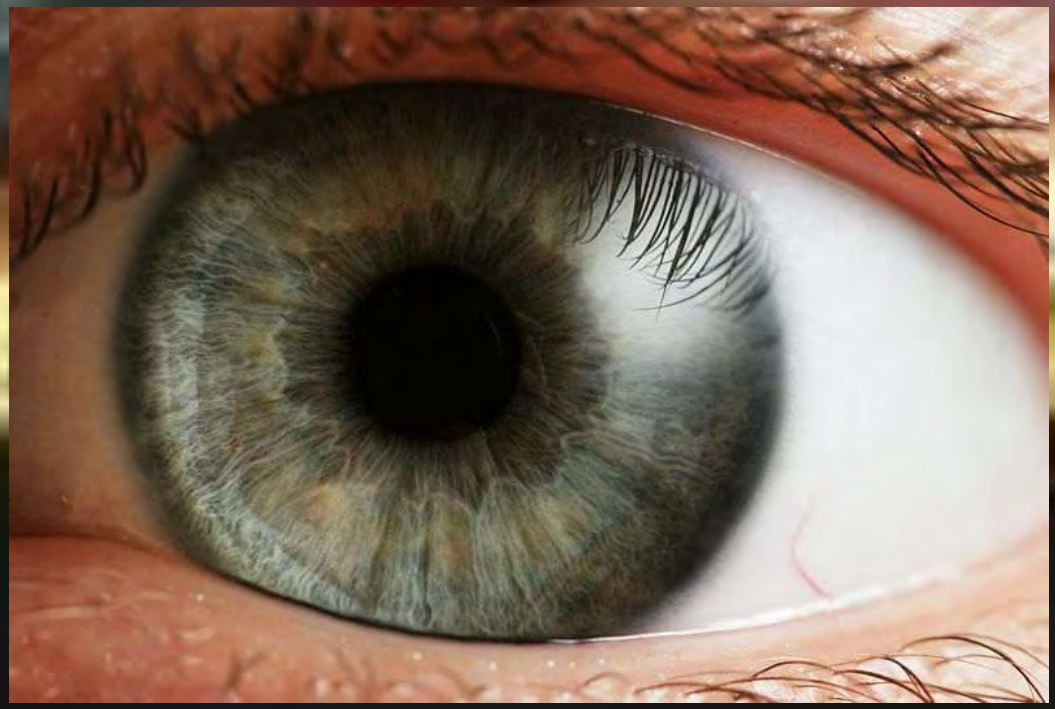
Ακούμε?

AM: 500-1600 kHz



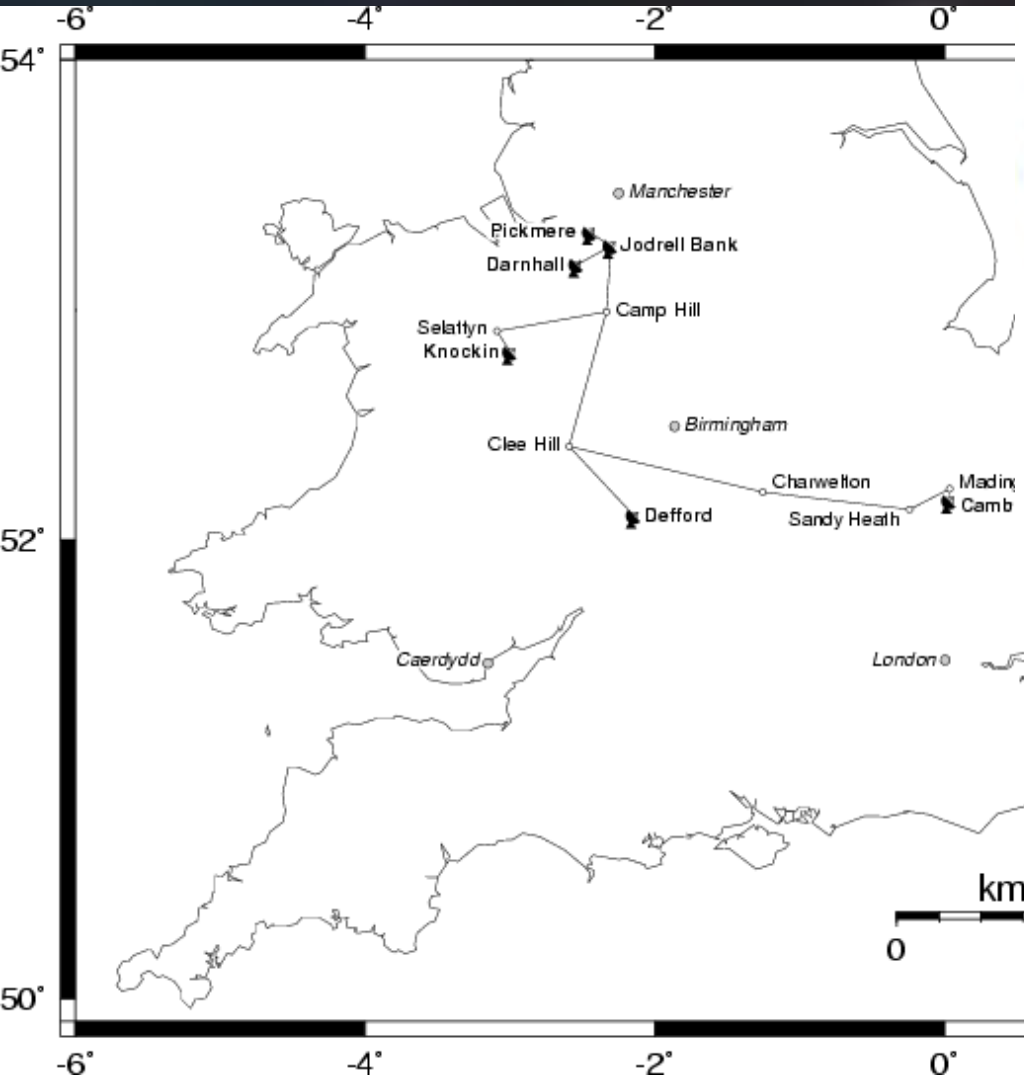
FM: 86-107 MHz

ΟΧΙ !!!!

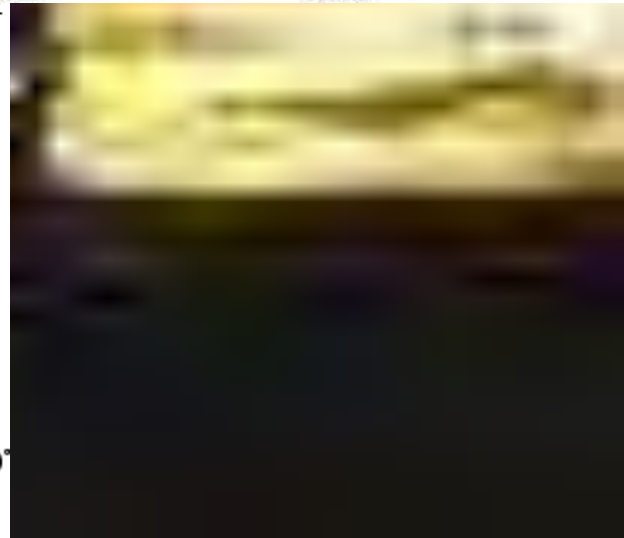


Jodrell Bank Observatory

ΜΕΡΛΙΝ


-6°
-4°
-2°
0°
54°
52°
50°
Manchester
Pickmere
Jodrell Bank
Darnhall
Camp Hill
Selatlyn
Knockin
Birmingham
Clee Hill
Charwelton
Defford
Sandy Heath
Caerdydd
London
km
0
100
2°


Jodrell Bank Lovell
Pickmere
Jodrell Bank Mk2
Darnhall
Cambridge
Knockin
Defford



Μεγαλύτερο τηλεσκόπιο στον κόσμο (305 m)
Φυσική κοιλάδα Puerto Rico


VLA

Australia Telescope Compact Array

Image Gallery - World Radio Telescopes

This gallery contains thumbnail images of some of the world's most important radio telescopes. Click on an individual image for the full size version.


VLBA Mauna Kea


VLBA Brewster


Owens Valley 130-ft


VLBA Owens Valley


DSN Goldstone


VLBA Kitt Peak


VLBA Pie Town


VLA


VLBA Los Alamos


VLBA Fort Davis


VLBA North Liberty


NRAO 140-ft


VLBA Hancock


Haystack


VLBA St Croix


Yebes


Jodrell Bank Lovell


Jodrell Bank Mk2


Cambridge 32-m


Westerbork Array


Effelsberg


Medicina


Onsala 25-m


Wettzell


Noto


Torun 32-m


Metsahovi


Hartesbeesthoek


Simeiz


Urumqi


Ceduna

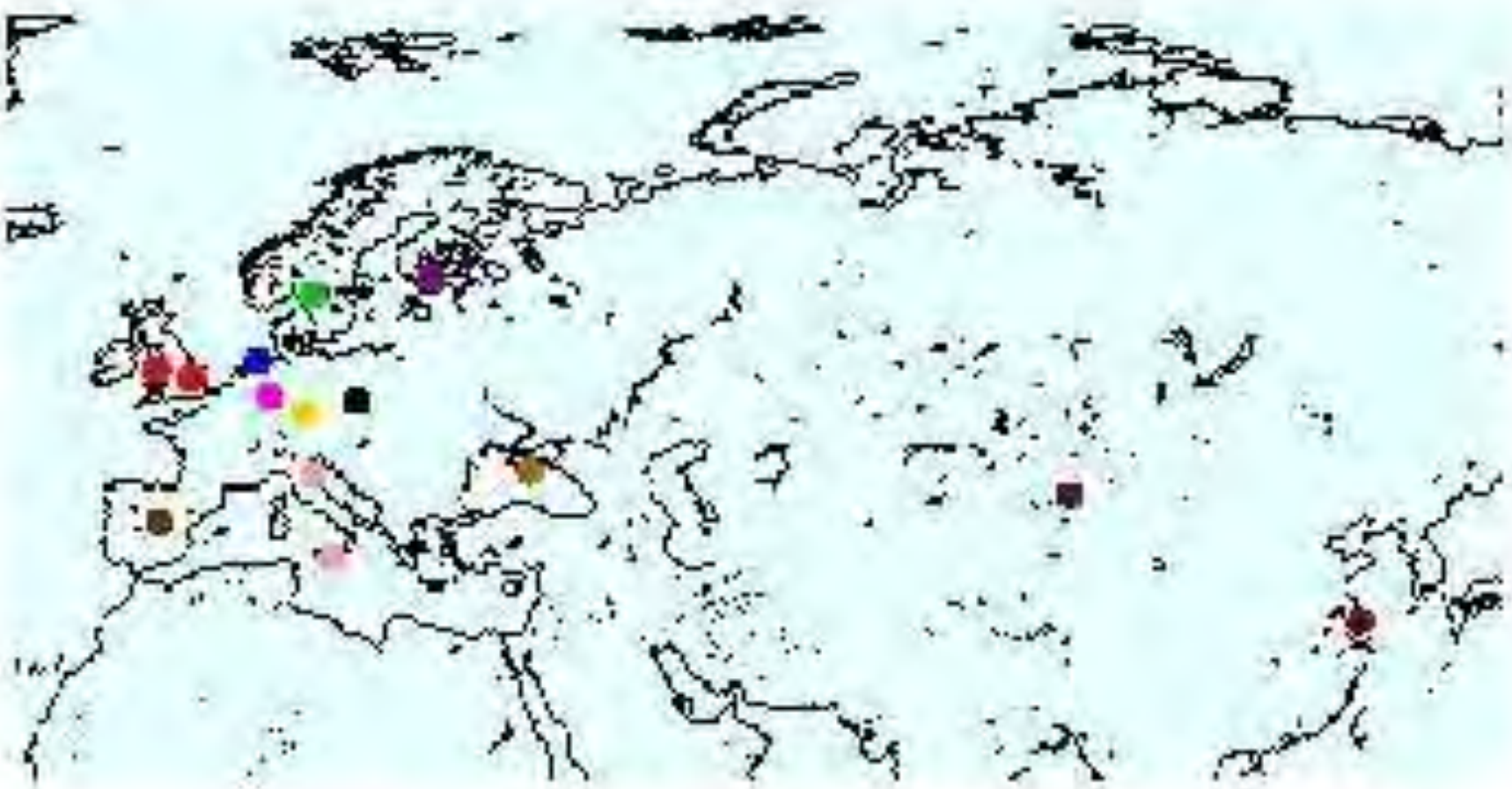

Usuda


Nobeyama


Kashima


Hobart

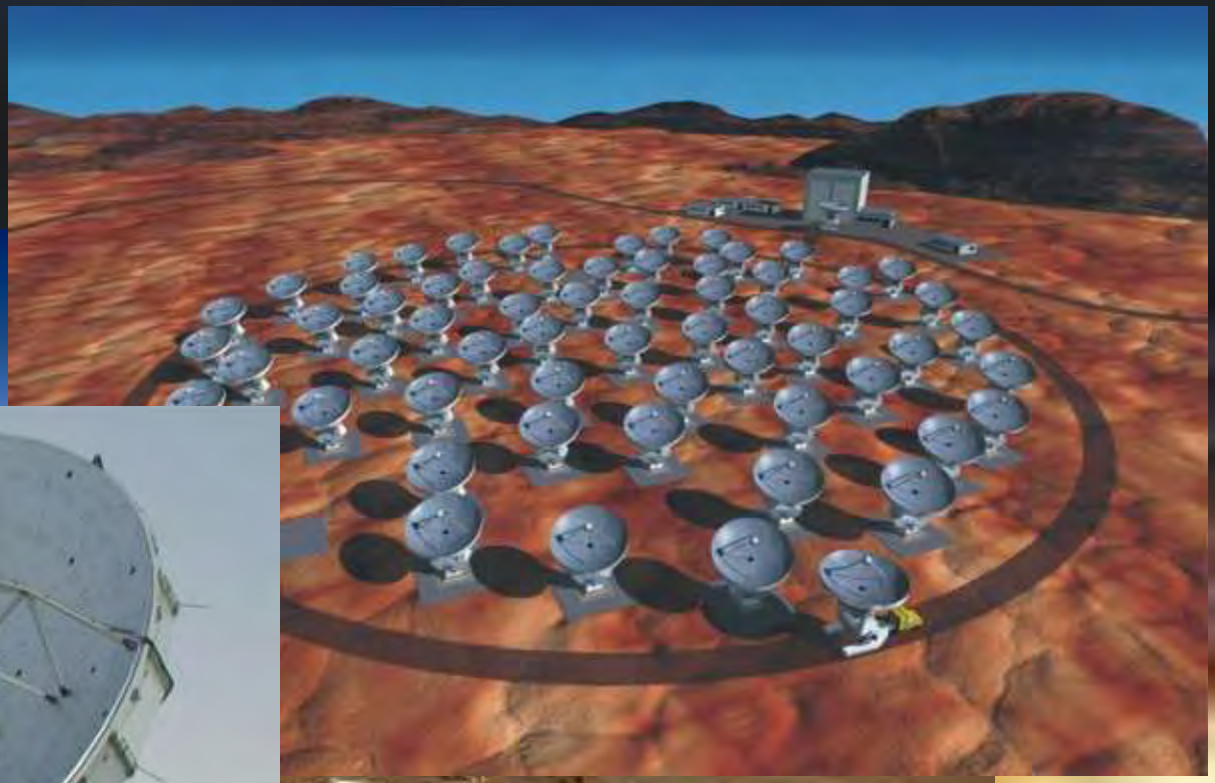
The European VLBI Network



HALCA

X
Bistatic Radar
X = (to date)
Mercury
Venus
Mars
Ganymede
Callisto
Saturn
Titan
Asteroids
VSOP

ALMA

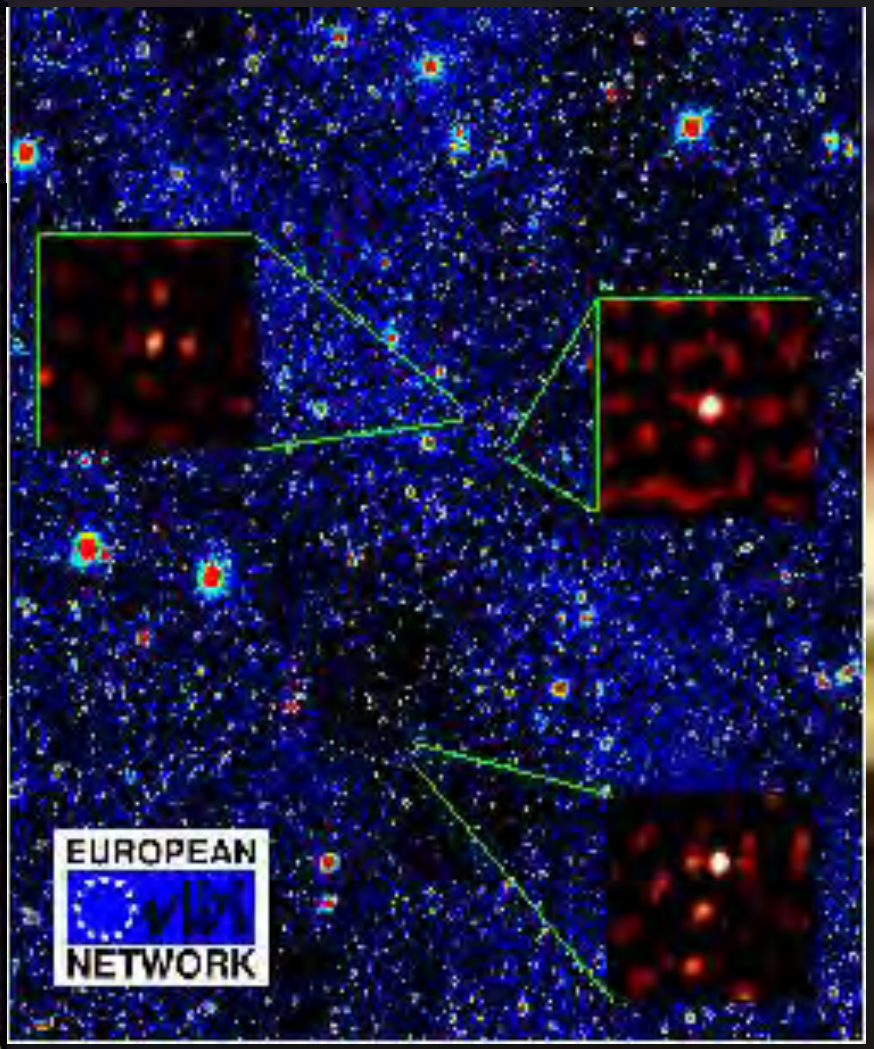


Atacama Large Millimeter/
Submillimeter Array

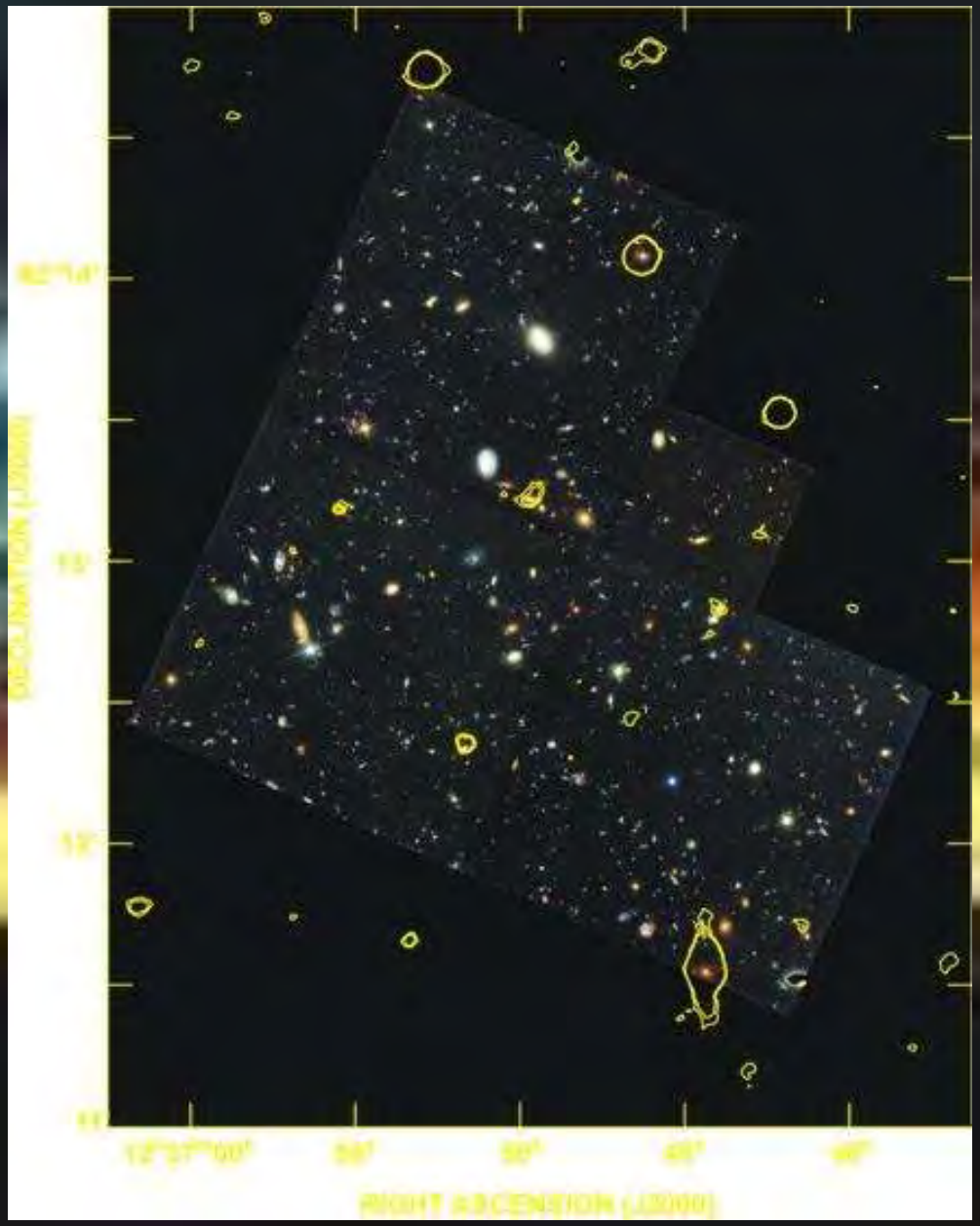
Глубокое поле Хаббла

Hubble Deep Field HST · WFPC2

PRC96-01a · ST ScI OPO · January 15, 1996 · R. Williams (ST ScI), NASA

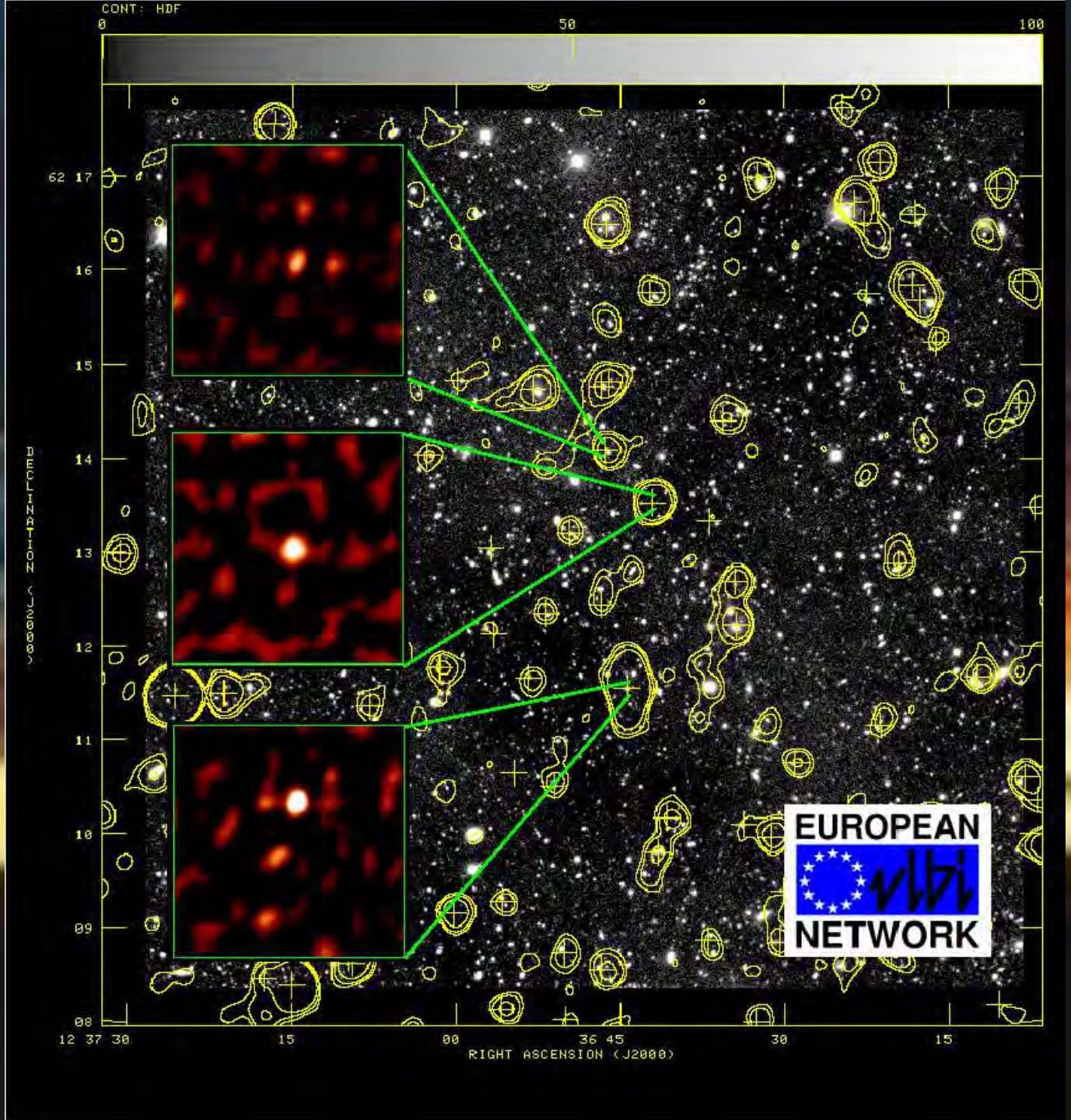


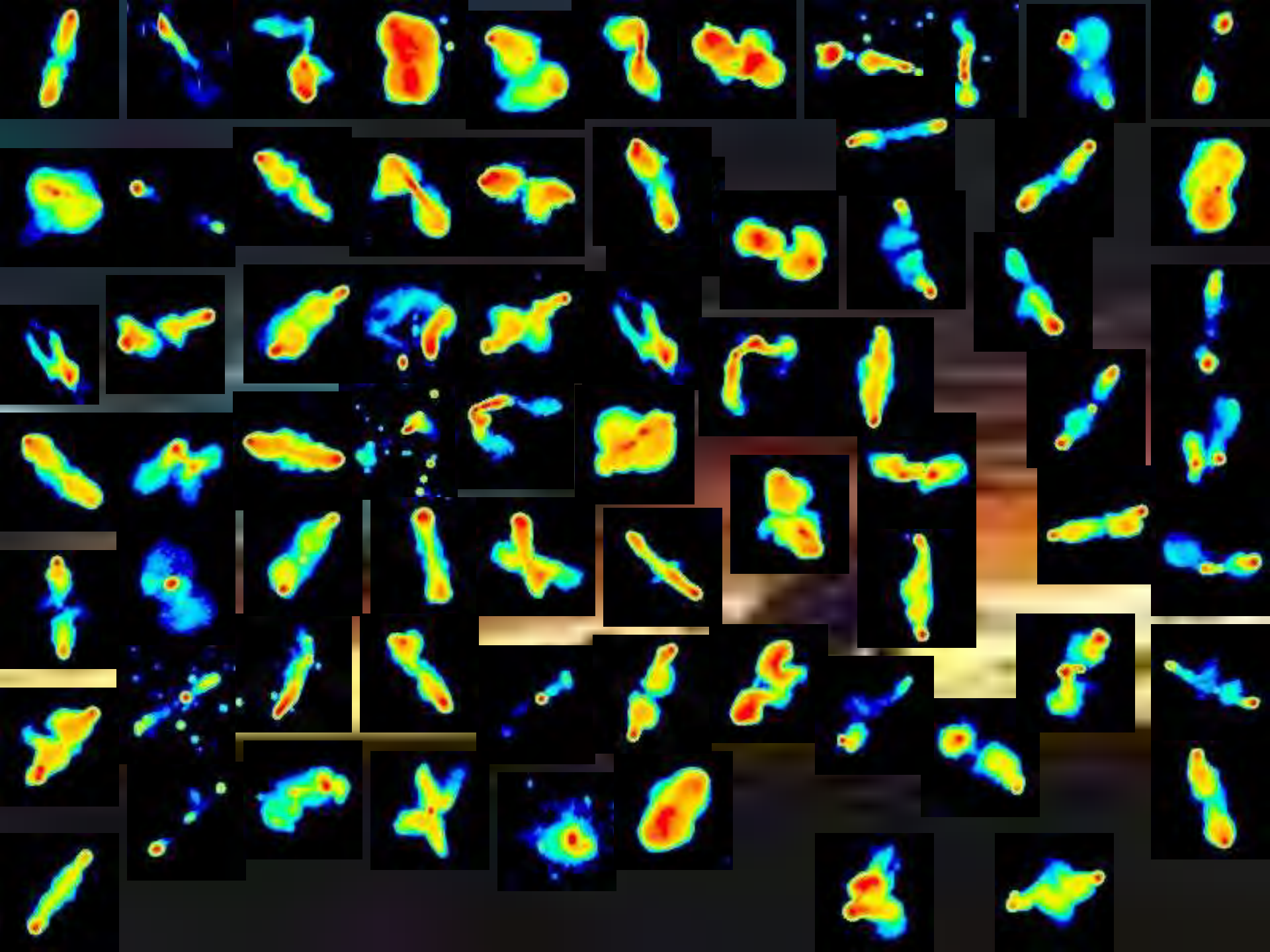
VLA Observations of the Hubble Deep Field



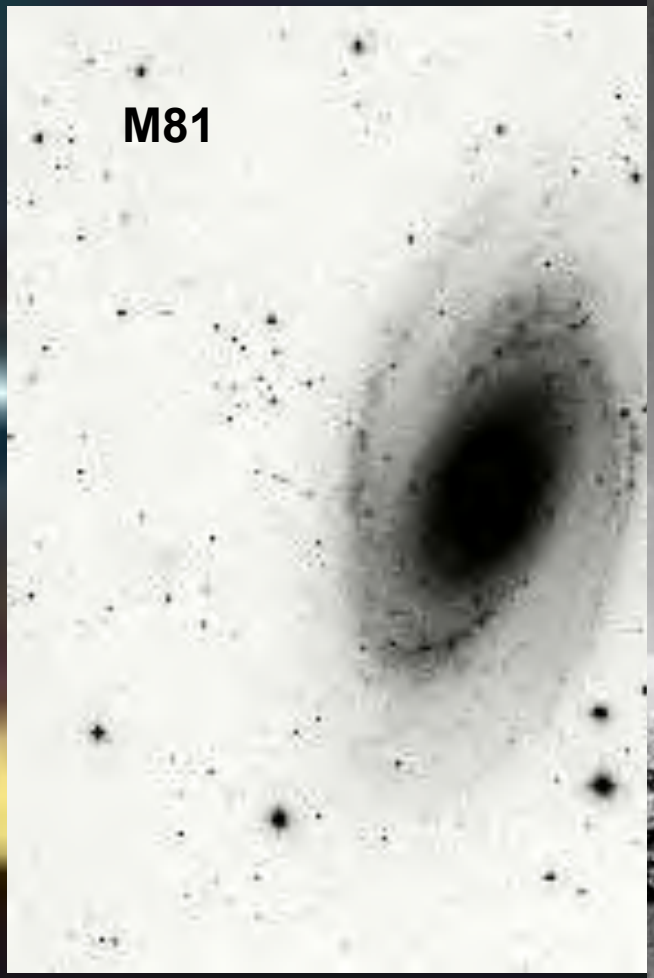

ALMA
NEARBY
DISTANT
HUBBLE

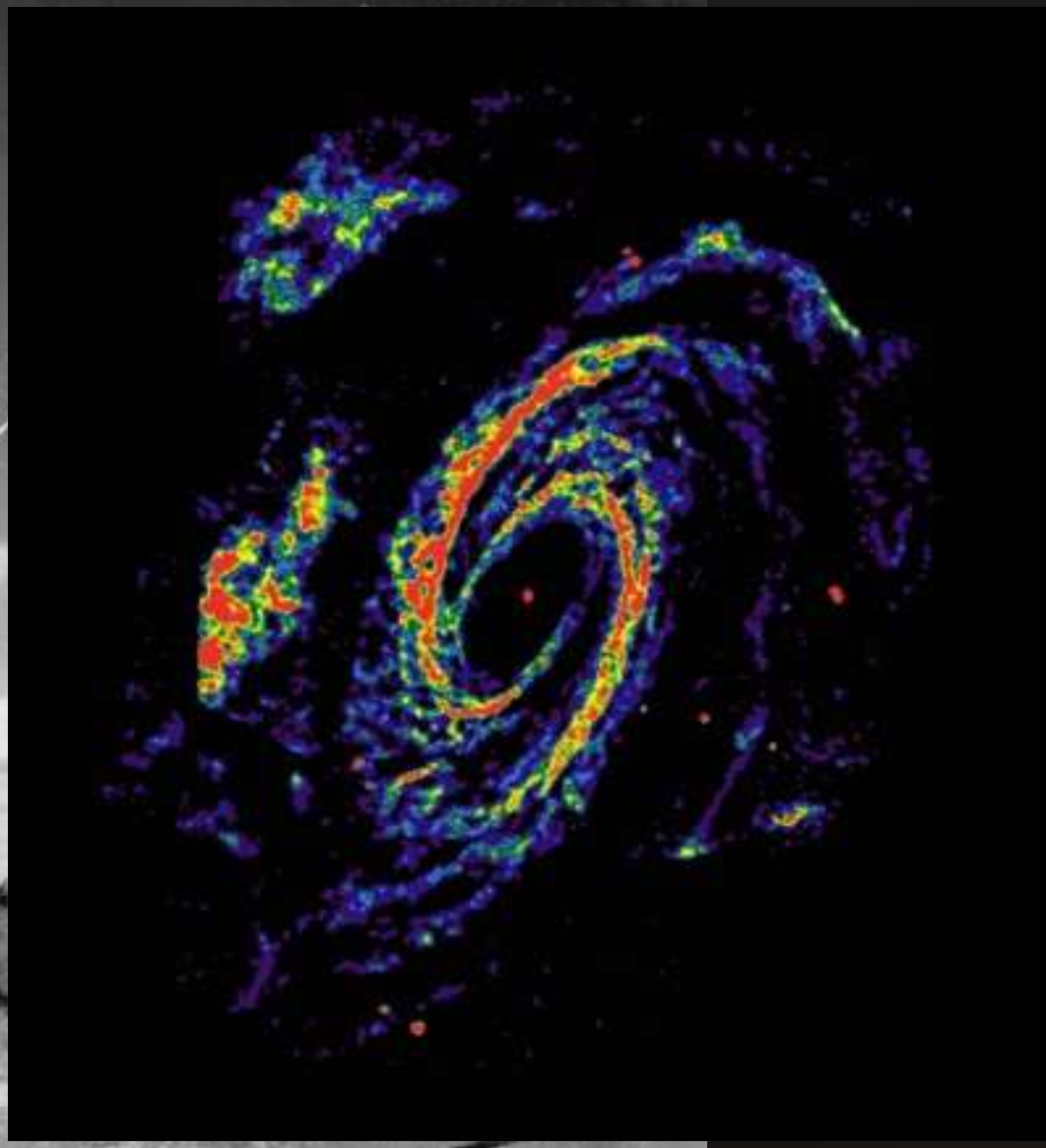
Ουρανός στα ραδιοκύματα


CONT: HDF
0
50
100
62 17
16
15
14
13
12
11
10
09
08
DECLINATION (J2000)
12 37 30
15
00
36 45
30
15
RIGHT ASCENSION (J2000)
EUROPEAN
NETWORK



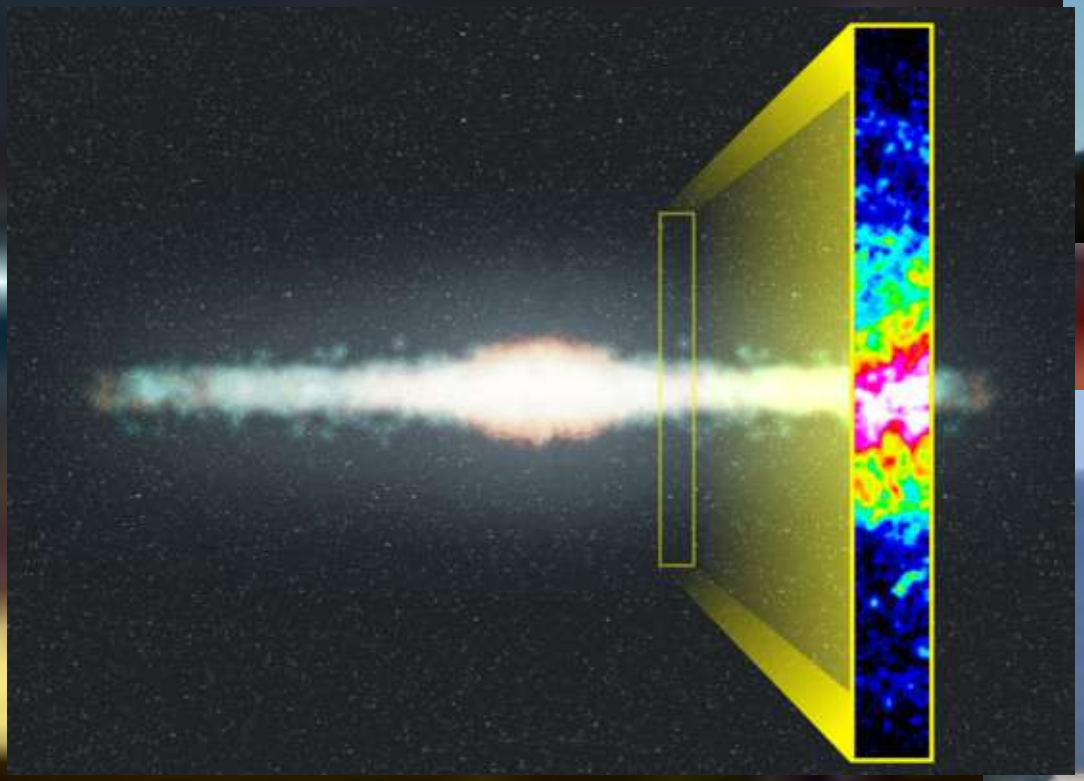
Galaxies in the radio





Spiral

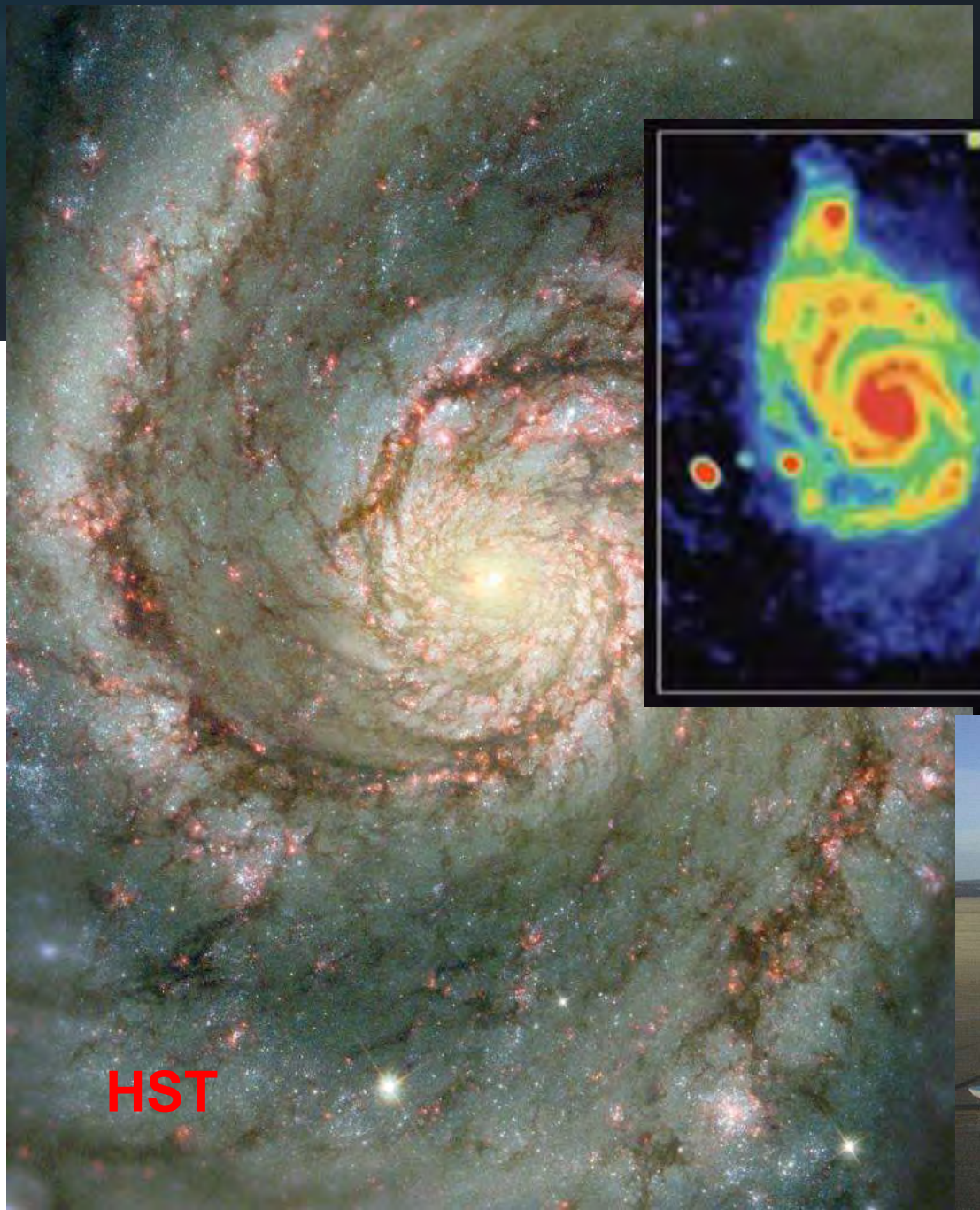
Milky Way

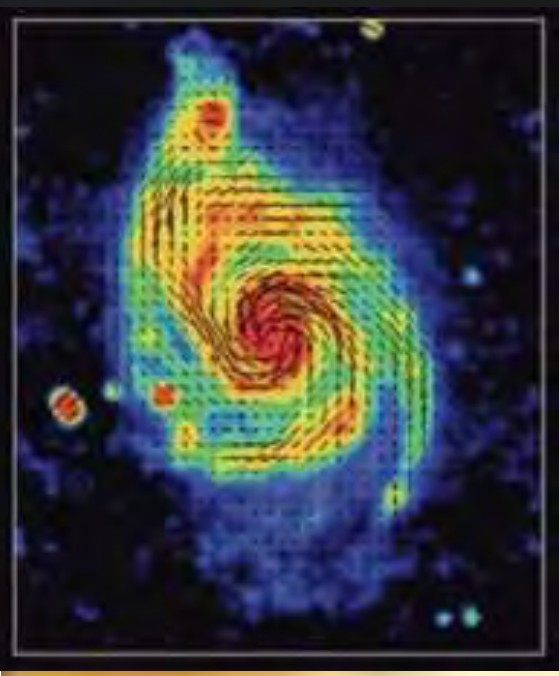


HI Observations

Green Bank RT

M51





M33 ράδιο+ορατό

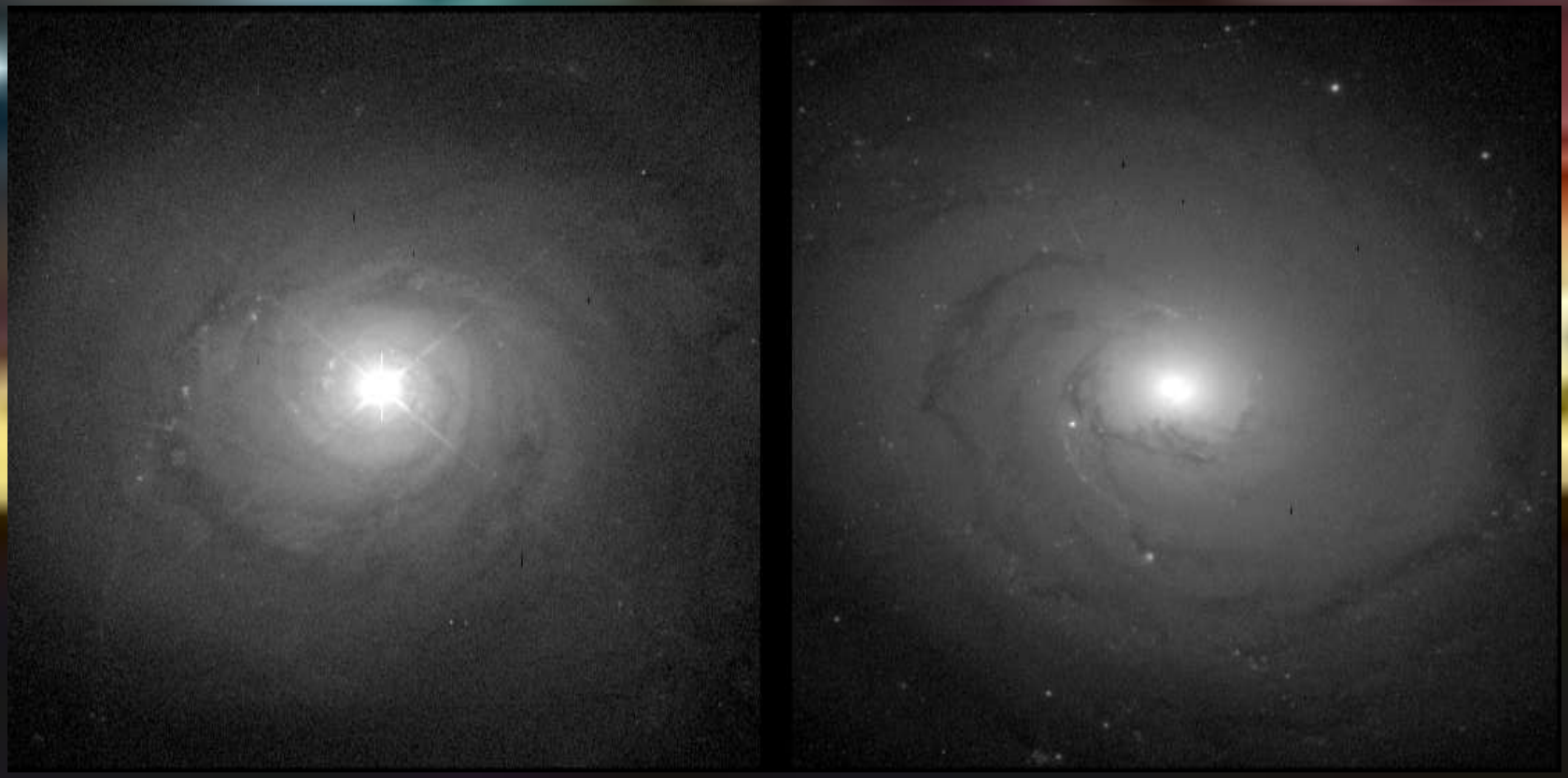
Local group

$>2 \cdot 10^6$ l.y.

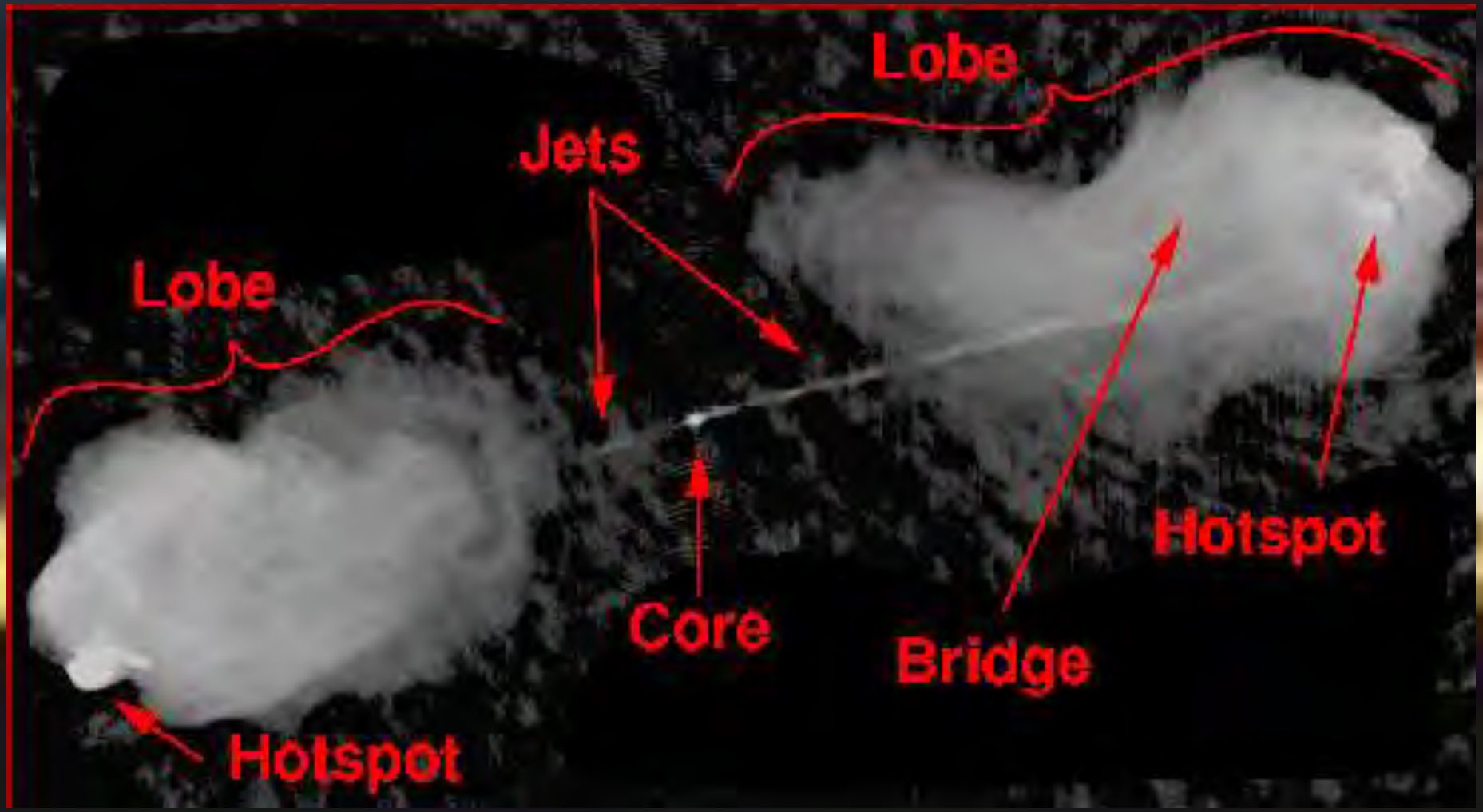

Actividad Nº 1

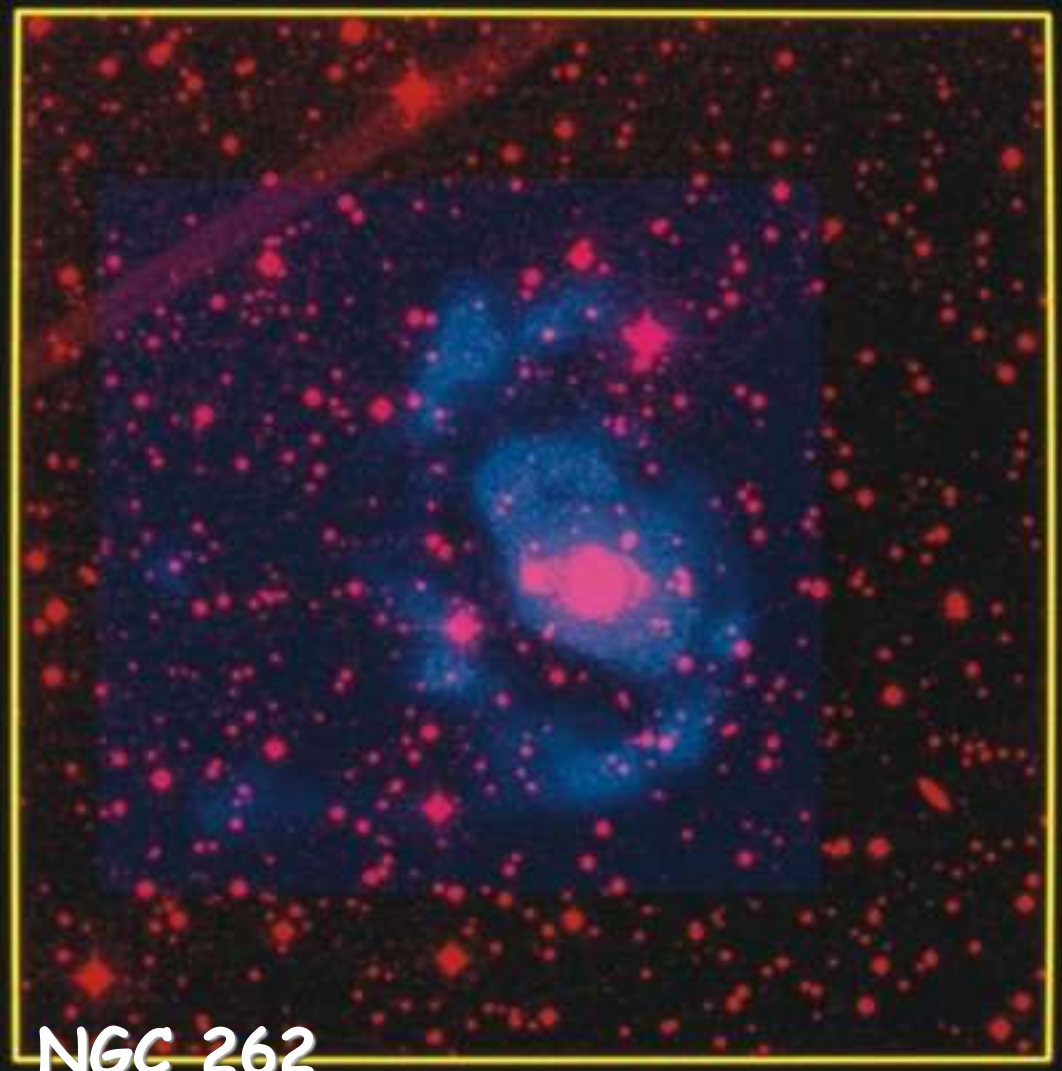
AGNs ≠ Κανονικούς Γαλαξίες!!

- ΜΙΚΡΟΣ, πολύ λαμπρός πυρήνας, παραγωγή ακτινοβολίας >>> ολόκληρο το γαλαξία
- $E_{tot}^{normal} = \sum$ stars
- Μεγάλη μεταβλητότητα -> μικρό μέγεθος
- Φαρδιές γραμμές εκπομπής -> υπάρχει ιονισμένο αέριο



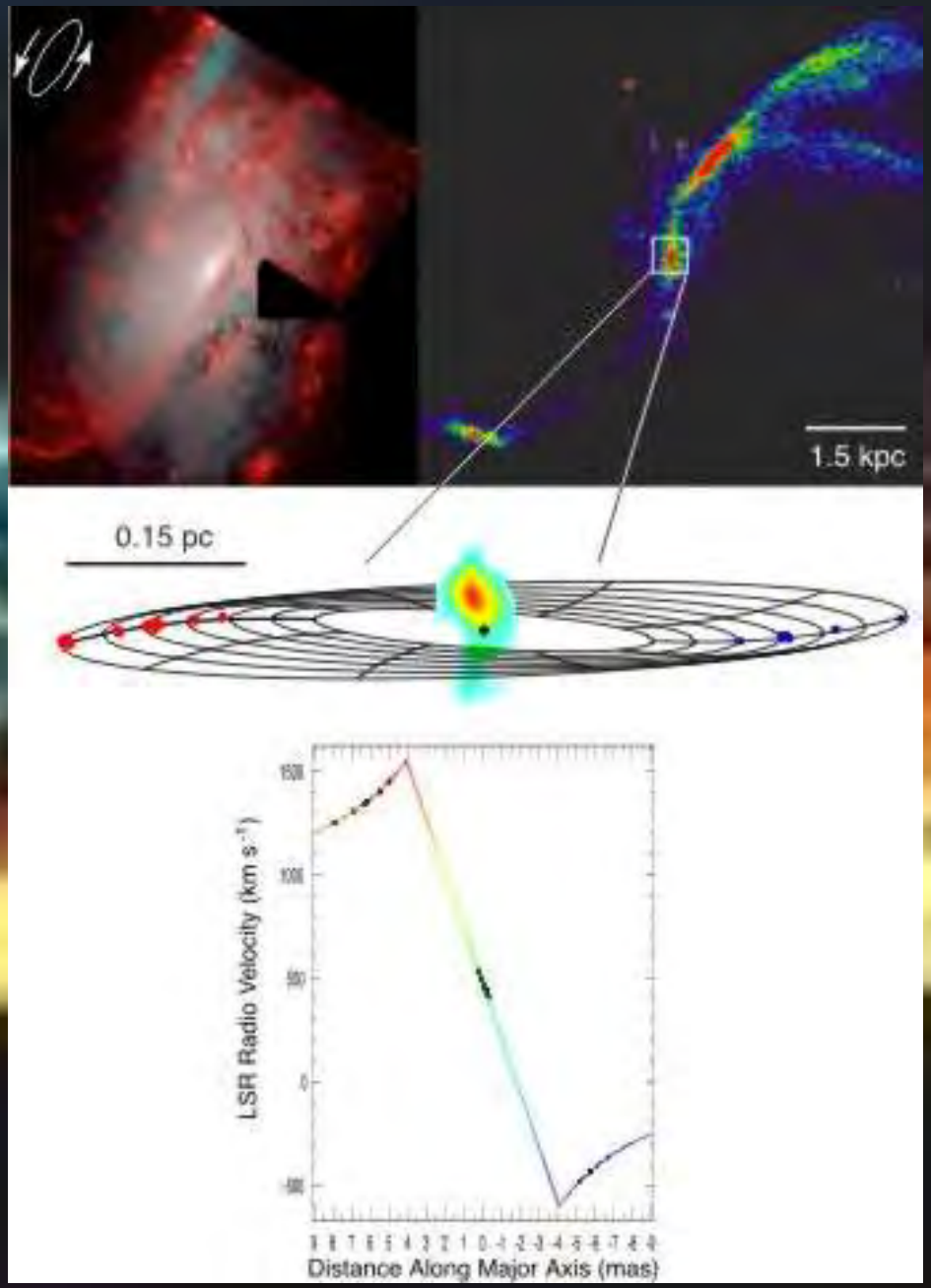
ΡΑΔΙΟ ΑΝΑΤΟΜΙΑ





SEYFERTS

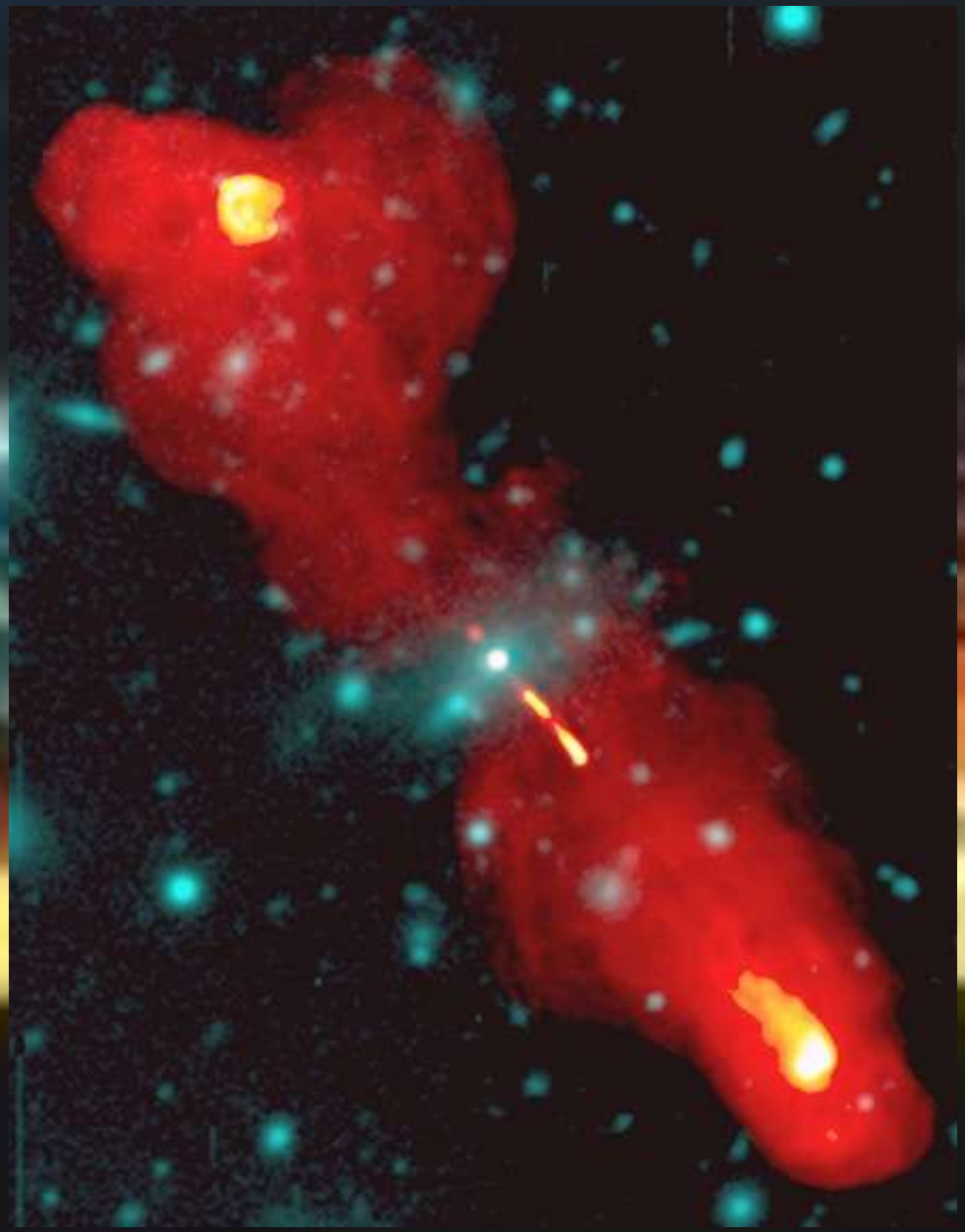
NGC 4258



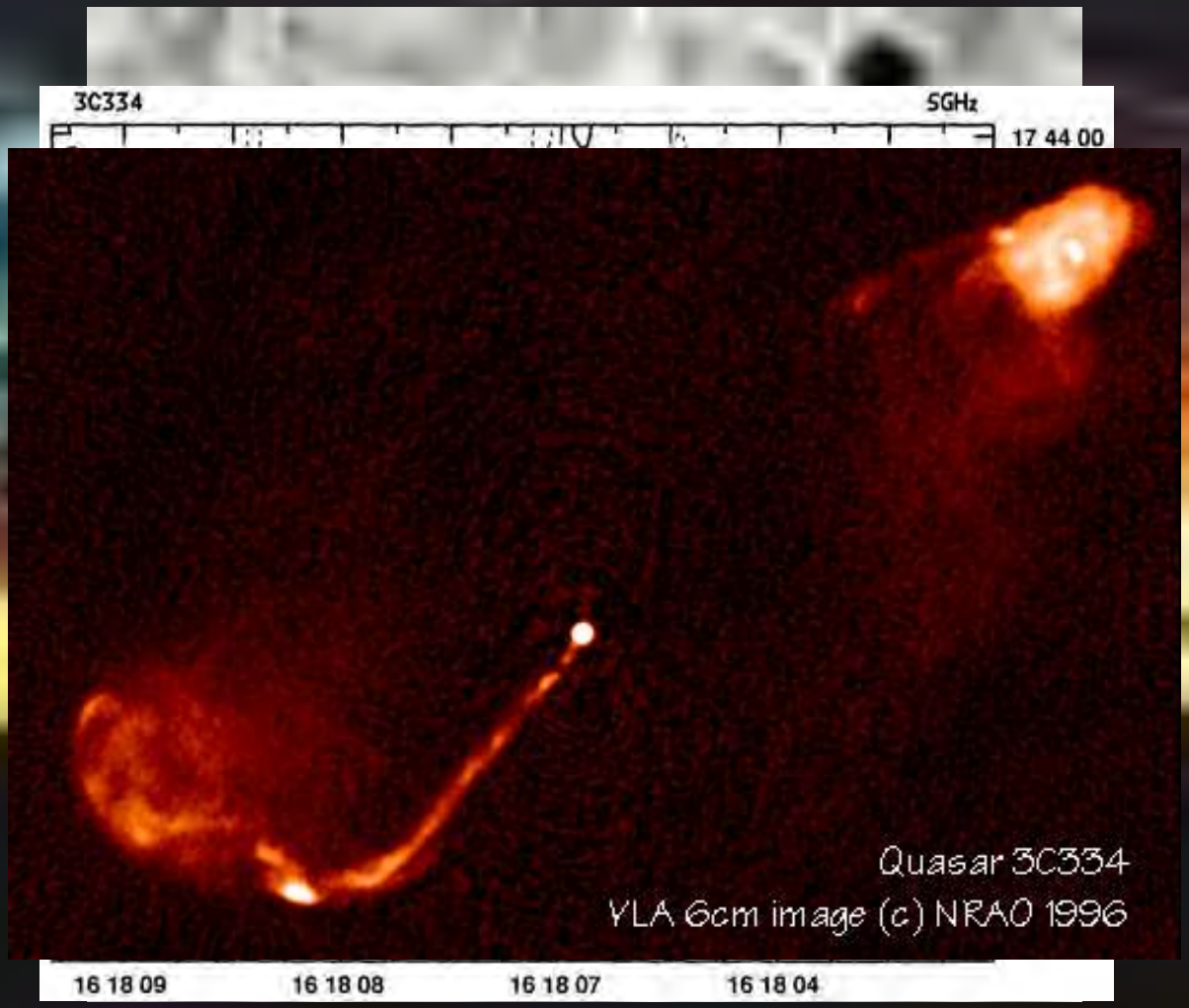
Στη μεγαλη

άρκτο

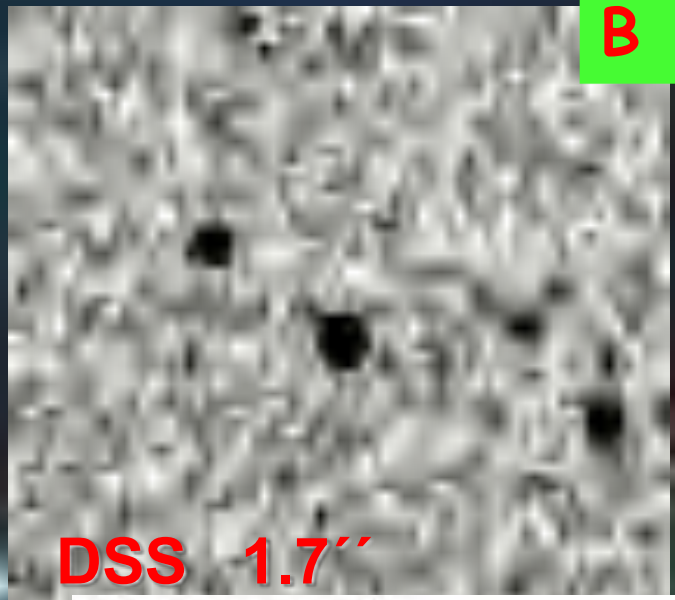
3C 219



QUASARS


3C334
5GHz
17 44 00
Quasar 3C334
VLA 6cm image (c) NRAO 1996
16 18 09
16 18 08
16 18 07
16 18 04

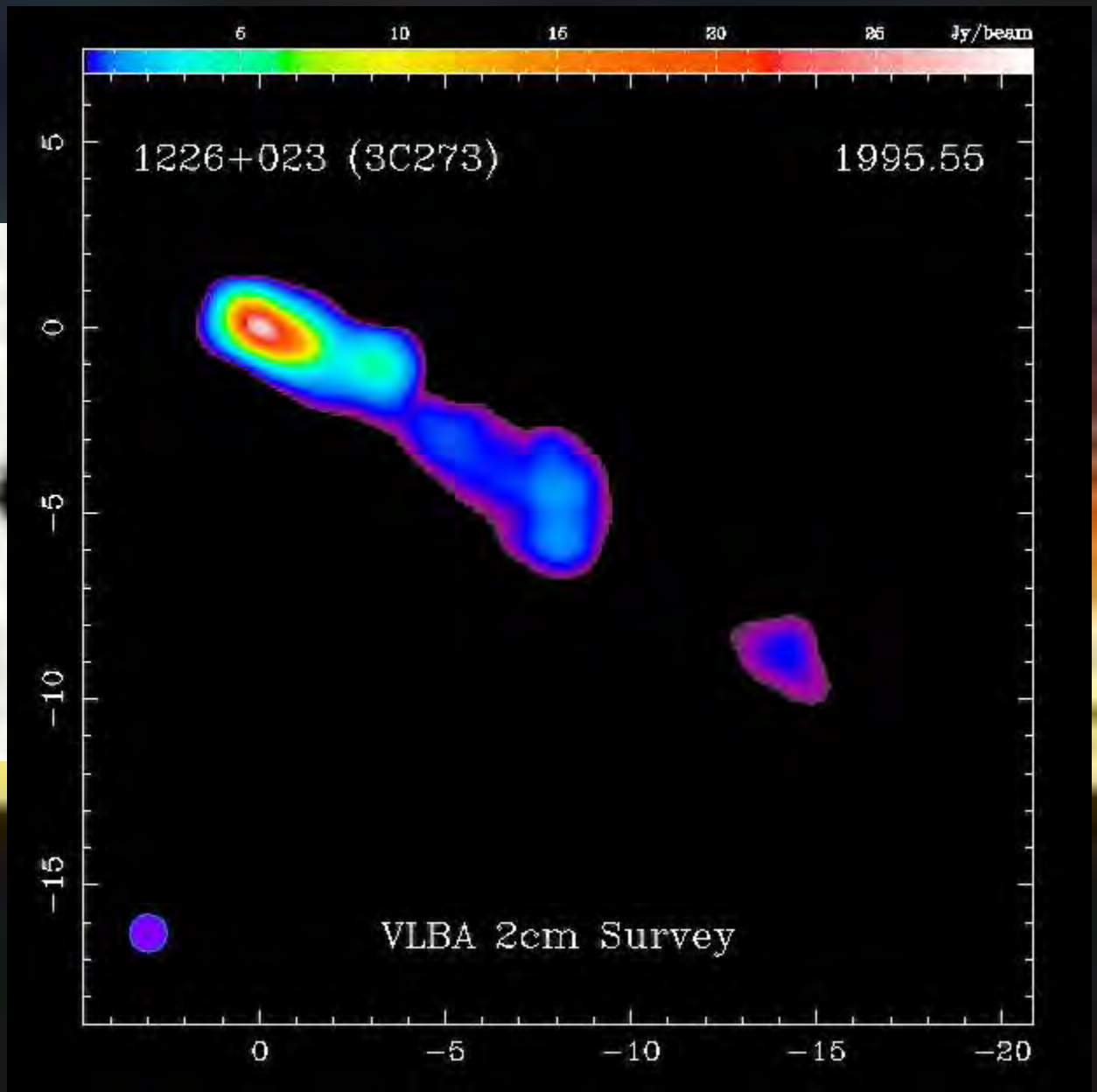
B 1156+295



DSS 1.7´´

VLBA 0´´.001

VLBA στα 2 cm, 3C 273

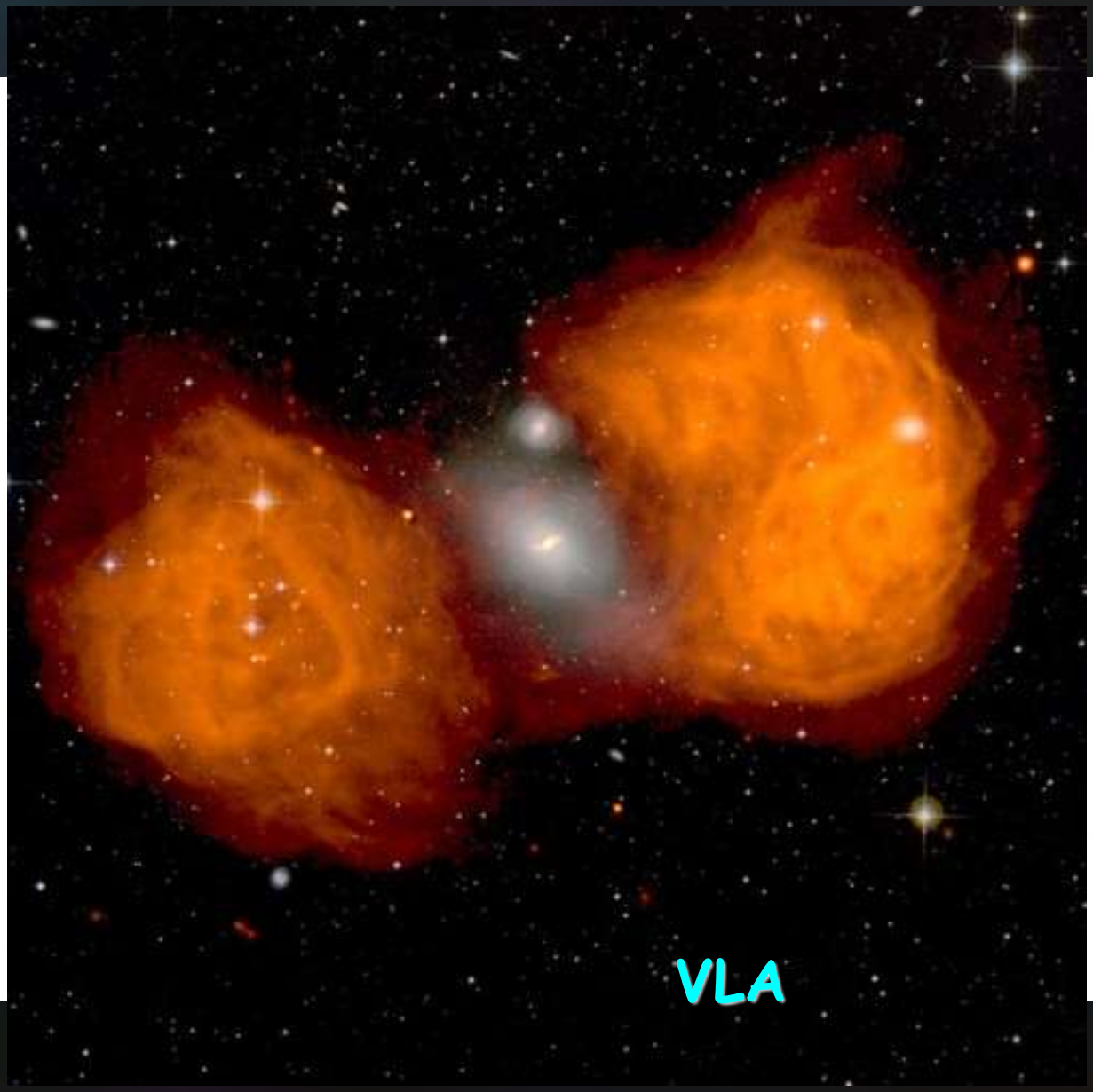


RADIOGALAXIES

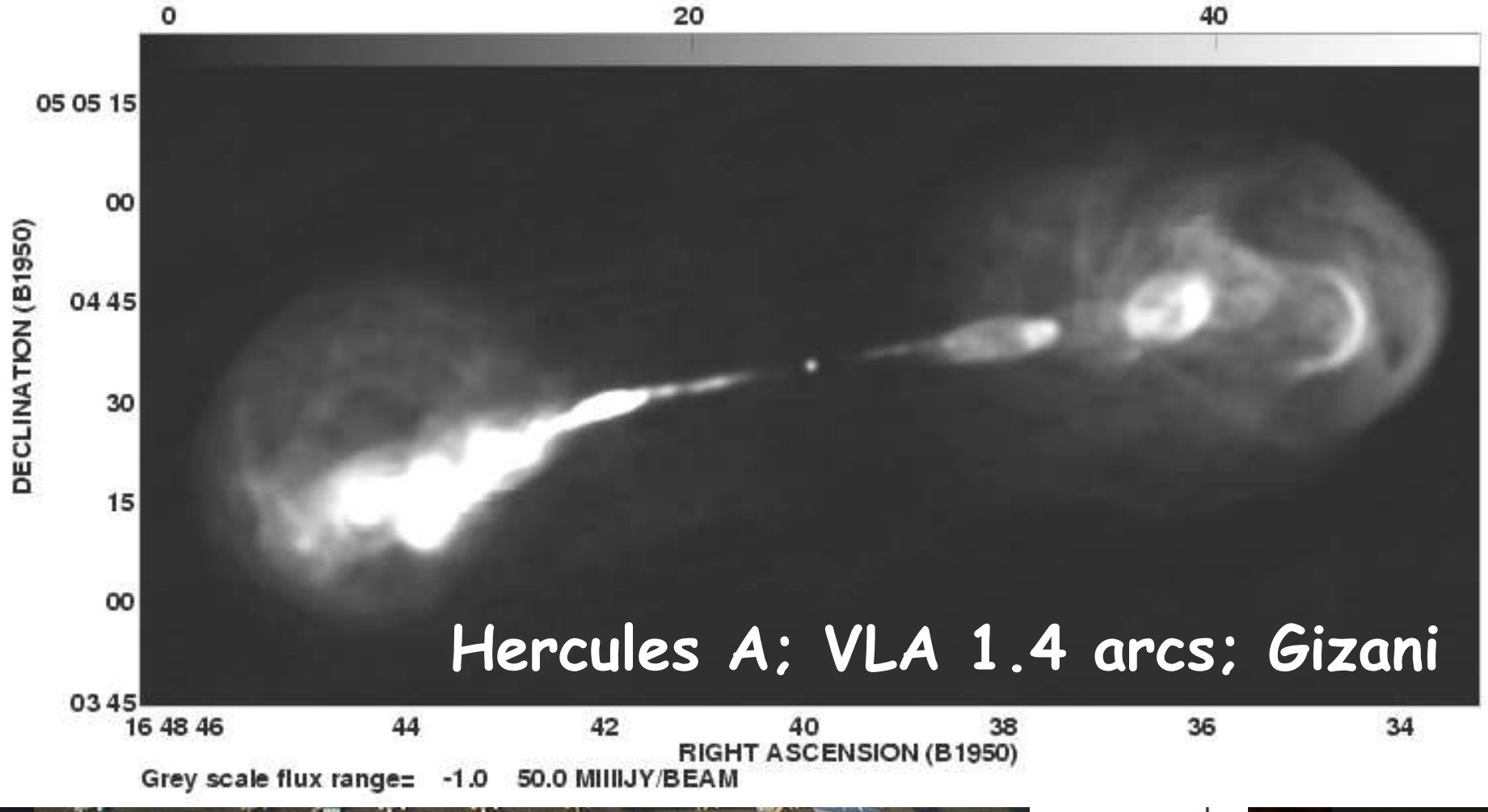
Virgo A

HST

Fornax A

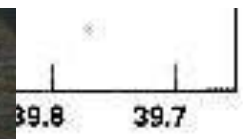


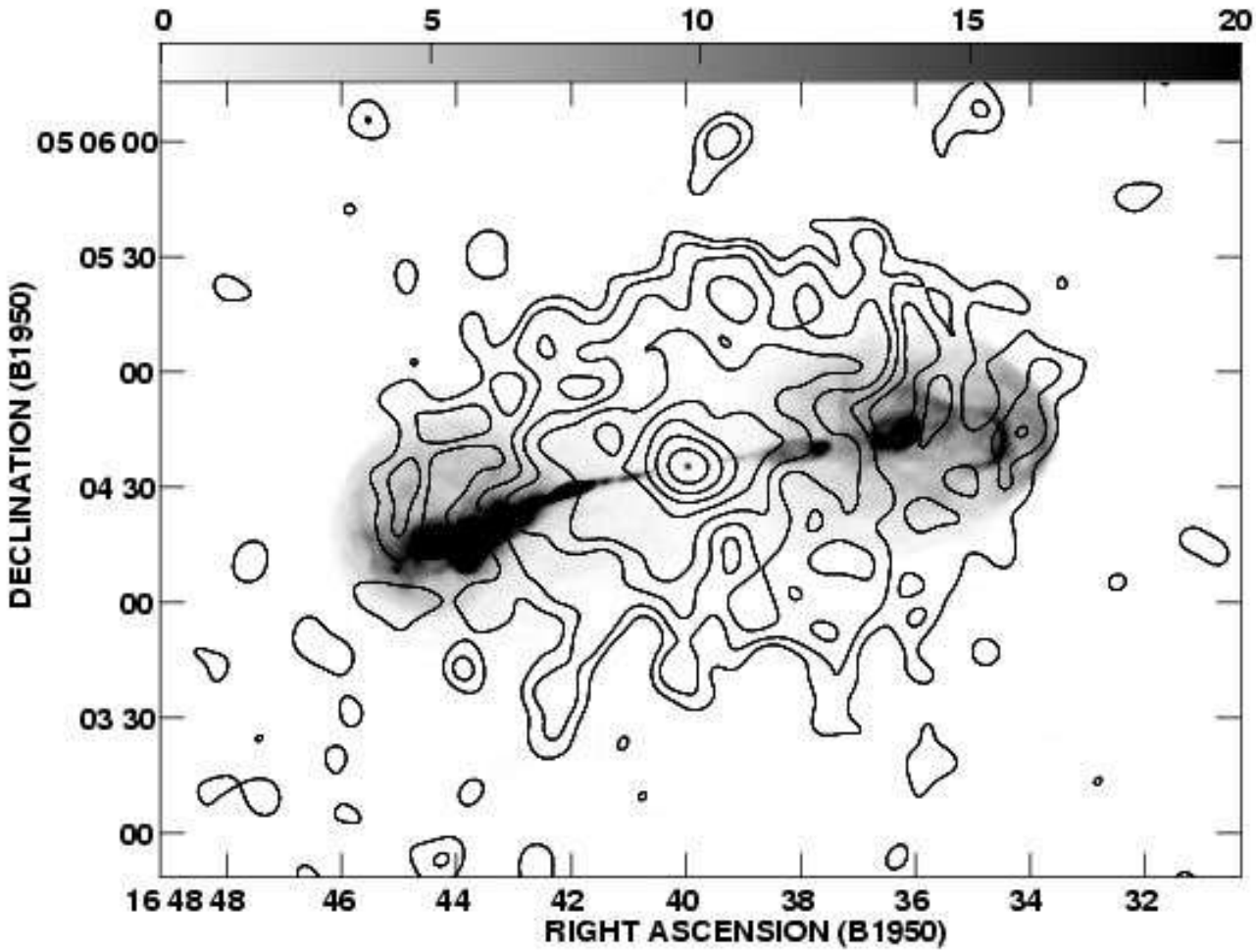
HST, Baum et al.



Hercules A; VLA 1.4 arcs; Gizani

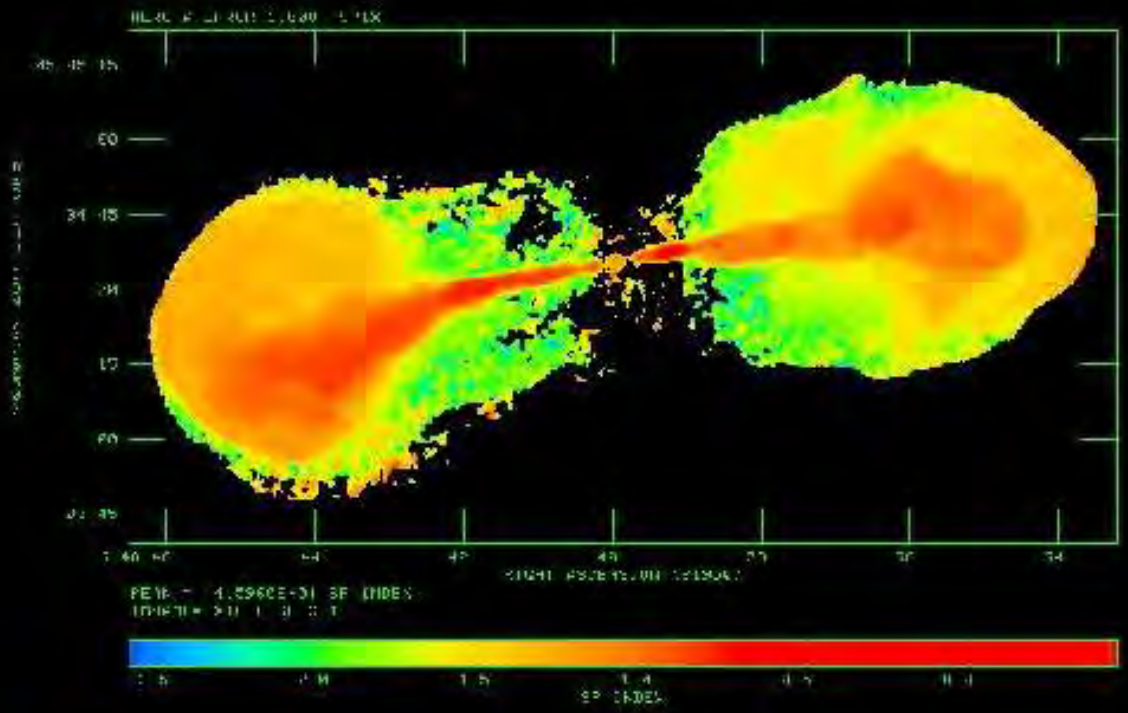
VLA



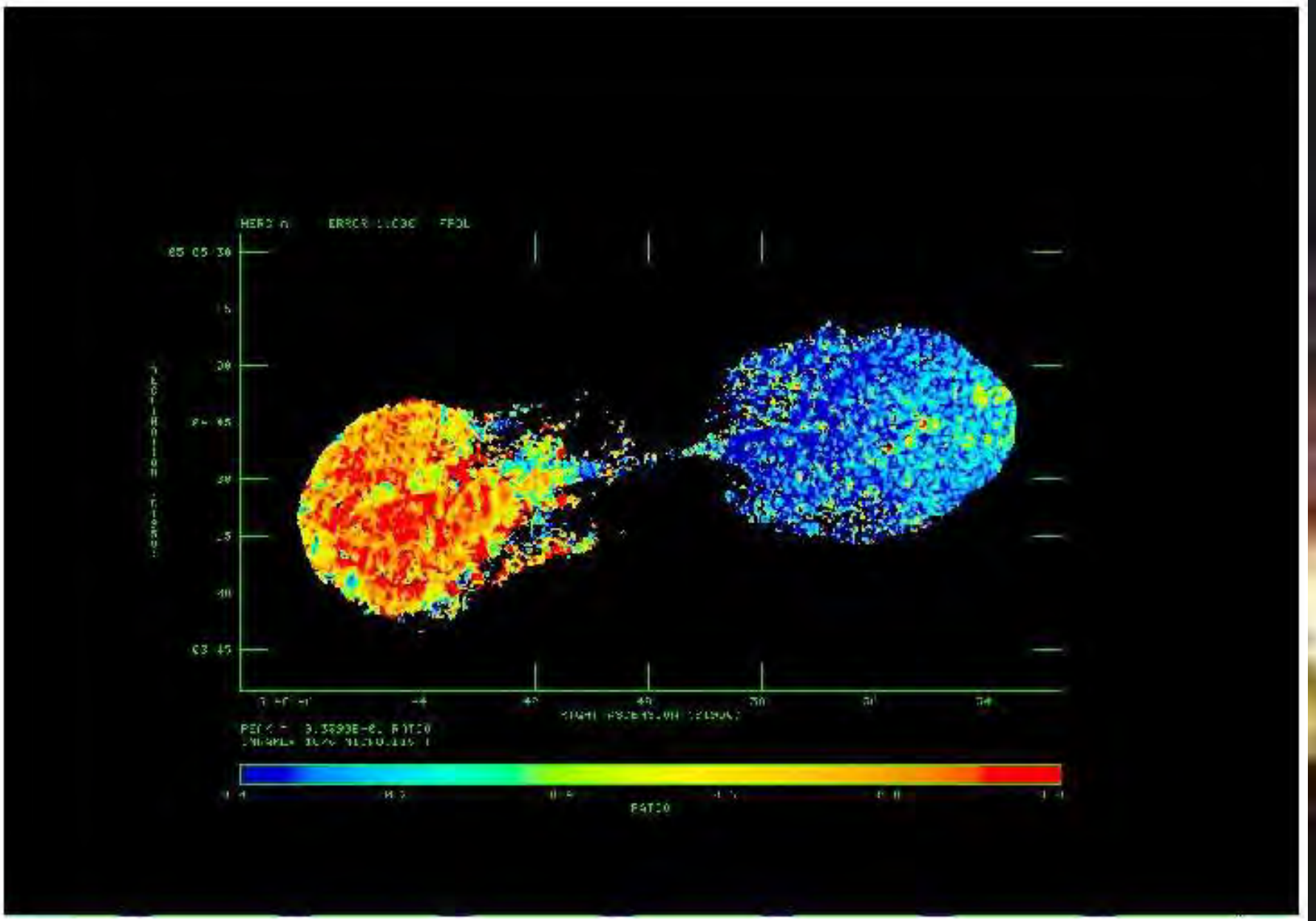


ROSAT (PSPC+HRI, 32", Gizani & Leahy)

$S_\nu \propto \nu^\alpha$, $\alpha<0$

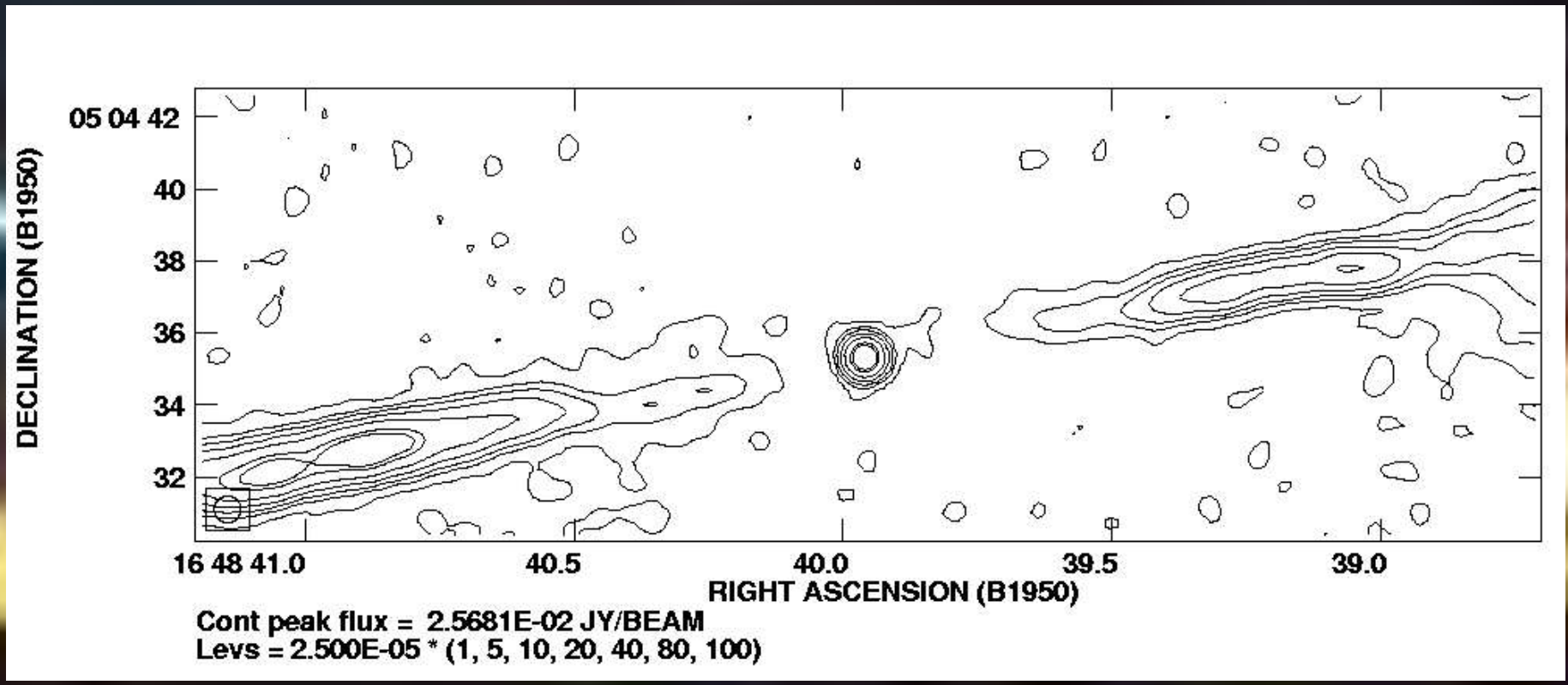


AIPS User 1020 A MAP AT 1.4 ARCS, X,C,L


RATIO

Hercules A

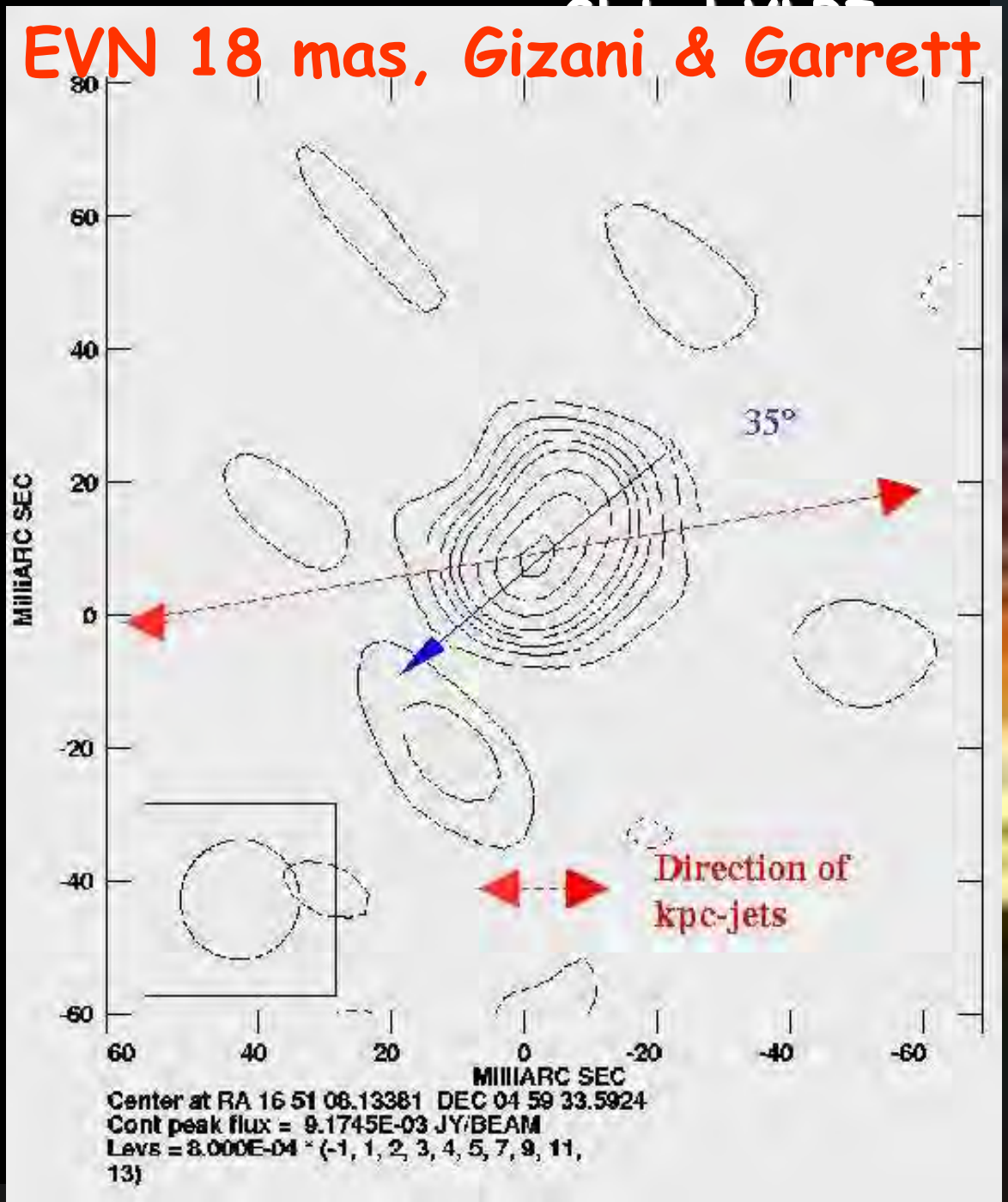
VLA B+C+D , 3.6 cm, 0.74 asec, rms ~ 11 μJy



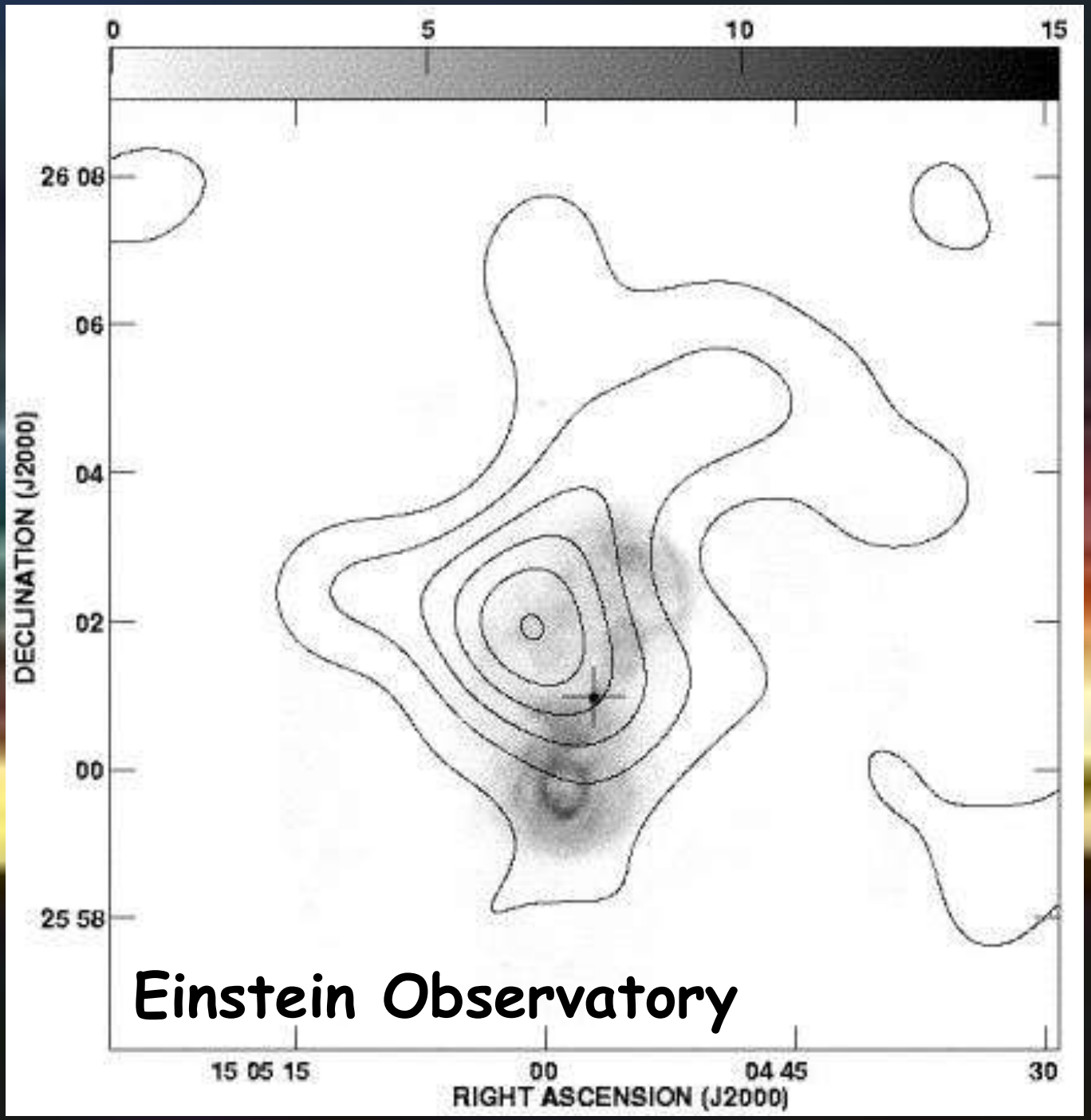
~ 6.0 mJy

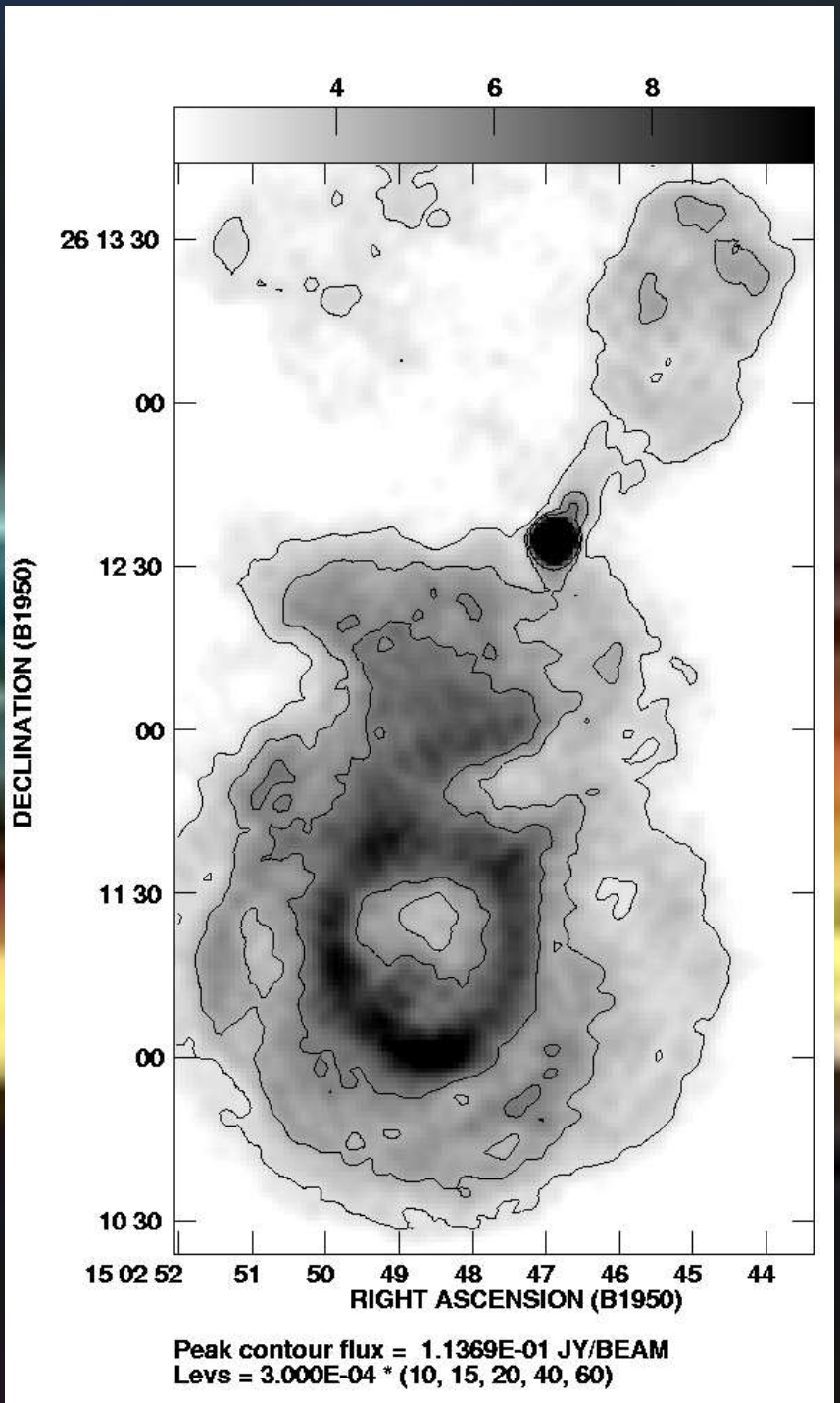
18 cm: ~41 mJy

EVN 18 mas, Gizani & Garrett

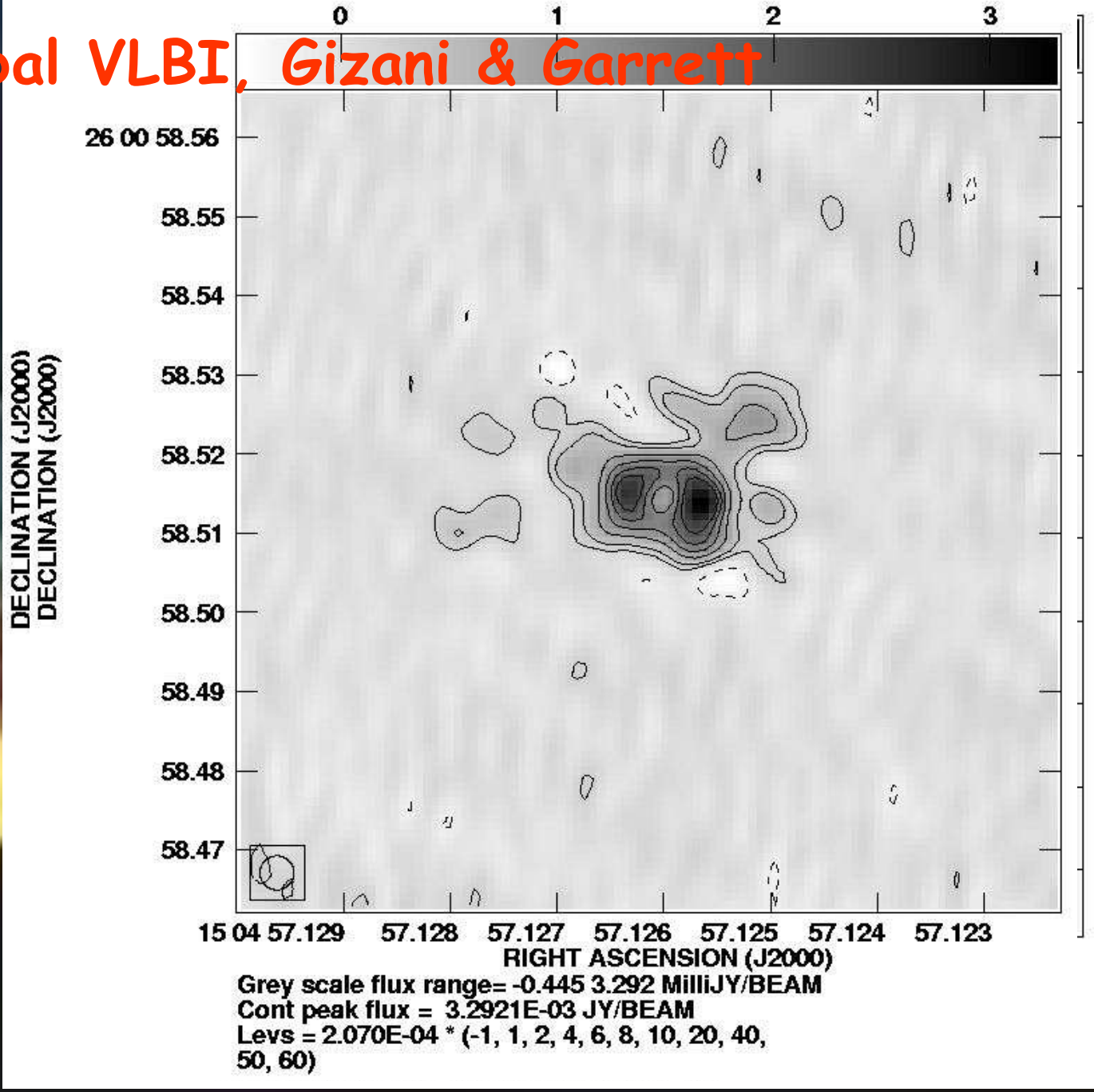



HST
VLA 4 arcsec (Feigelson et al.)


0
5
10
15
26 08
06
04
02
00
25 58
DECLINATION (J2000)
15 05 15
00
04 45
30
RIGHT ASCENSION (J2000)
Einstein Observatory


4
6
8
26 13 30
00
12 30
00
11 30
00
10 30
DECLINATION (B1950)
15 02 52
51
50
49
48
47
46
45
44
RIGHT ASCENSION (B1950)
Peak contour flux = 1.1369E-01 JY/BEAM
Levs = 3.000E-04 * (10, 15, 20, 40, 60)

Global VLBI, Gizani & Garrett

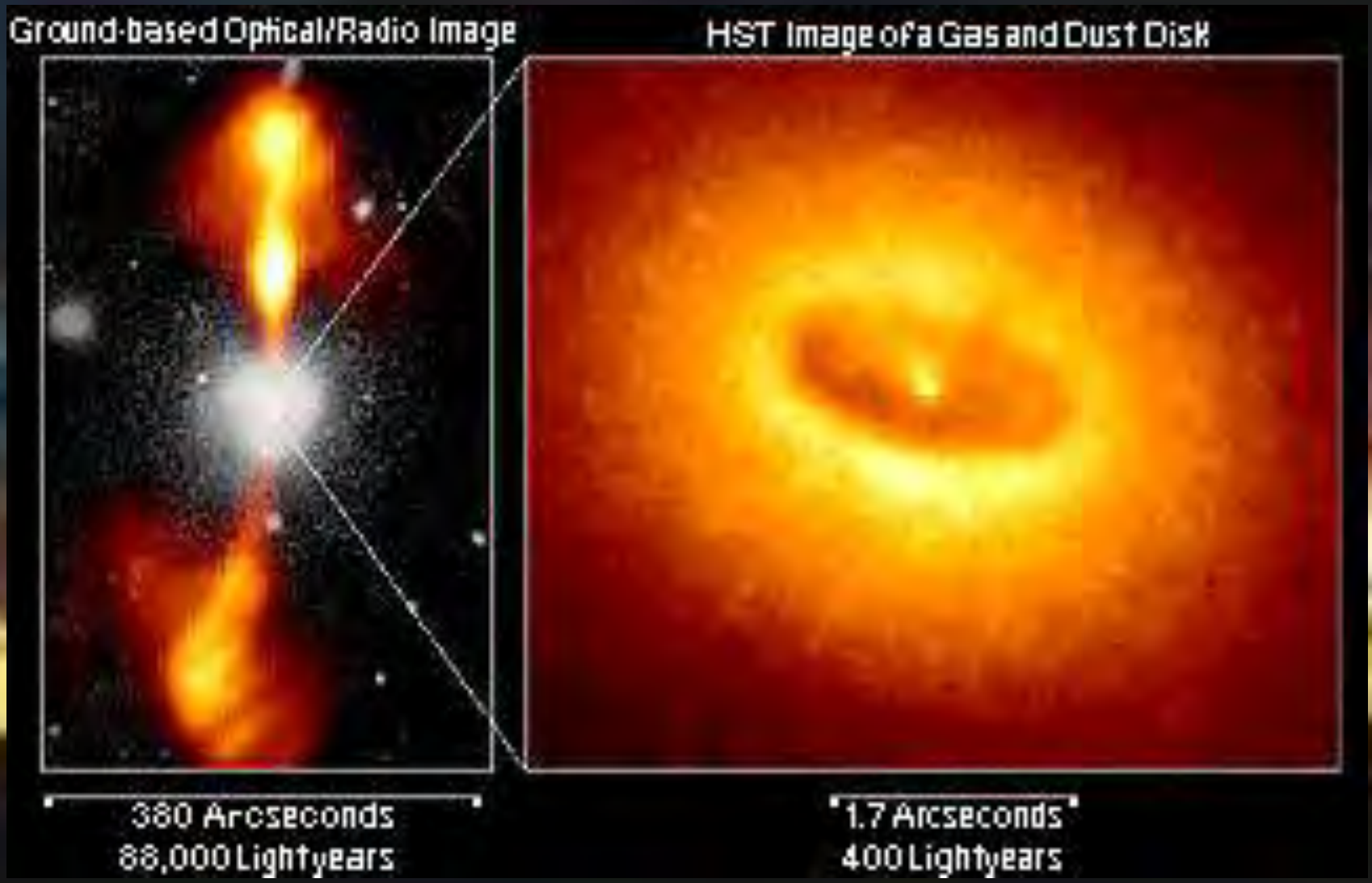



X-AIPS tv Screen Server 98 - INET
Gizani & Garrett

NGC 4261

RADIO+OPT

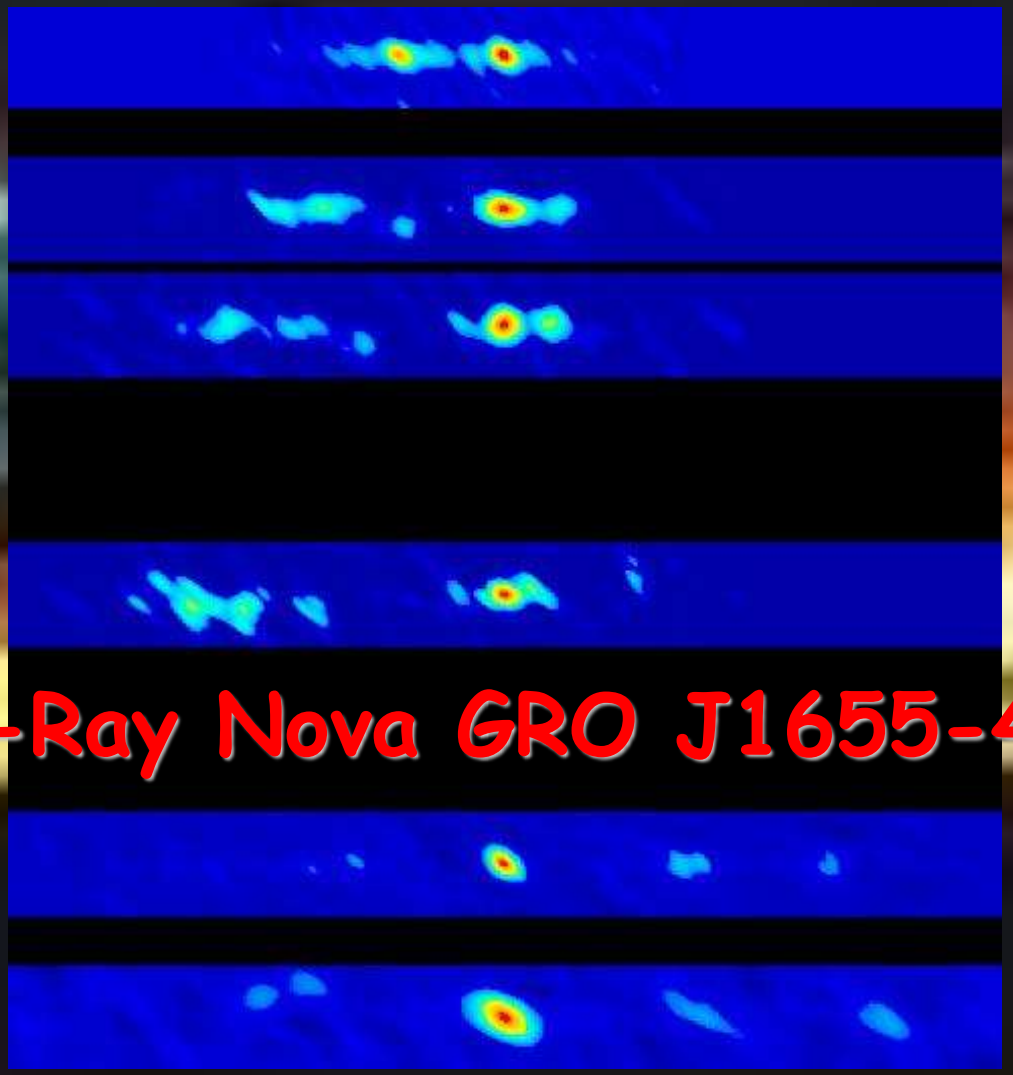
HST



Different AGN types = variations of this

Galactic Objects

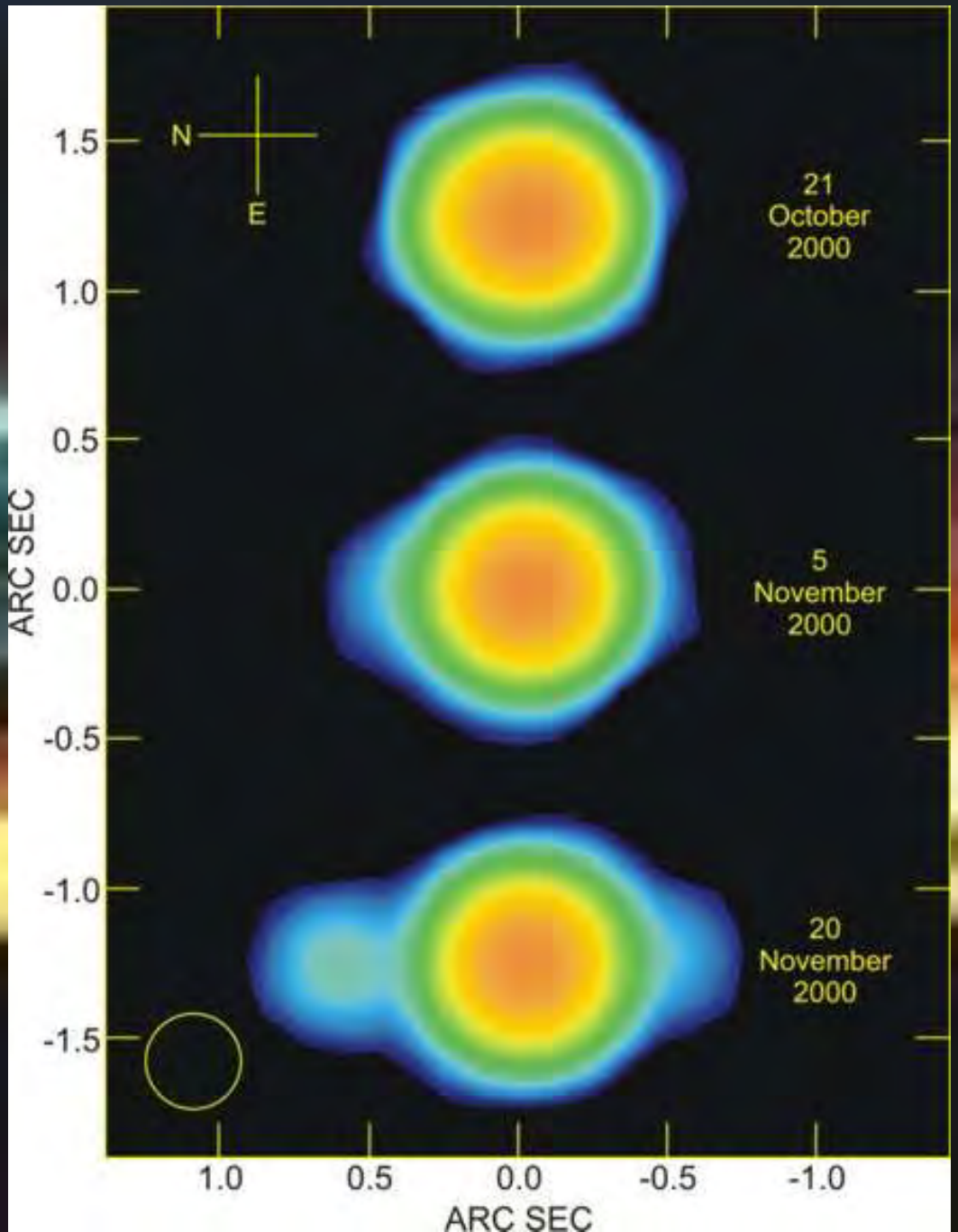
Black Holes



X-Ray Nova GRO J1655-40

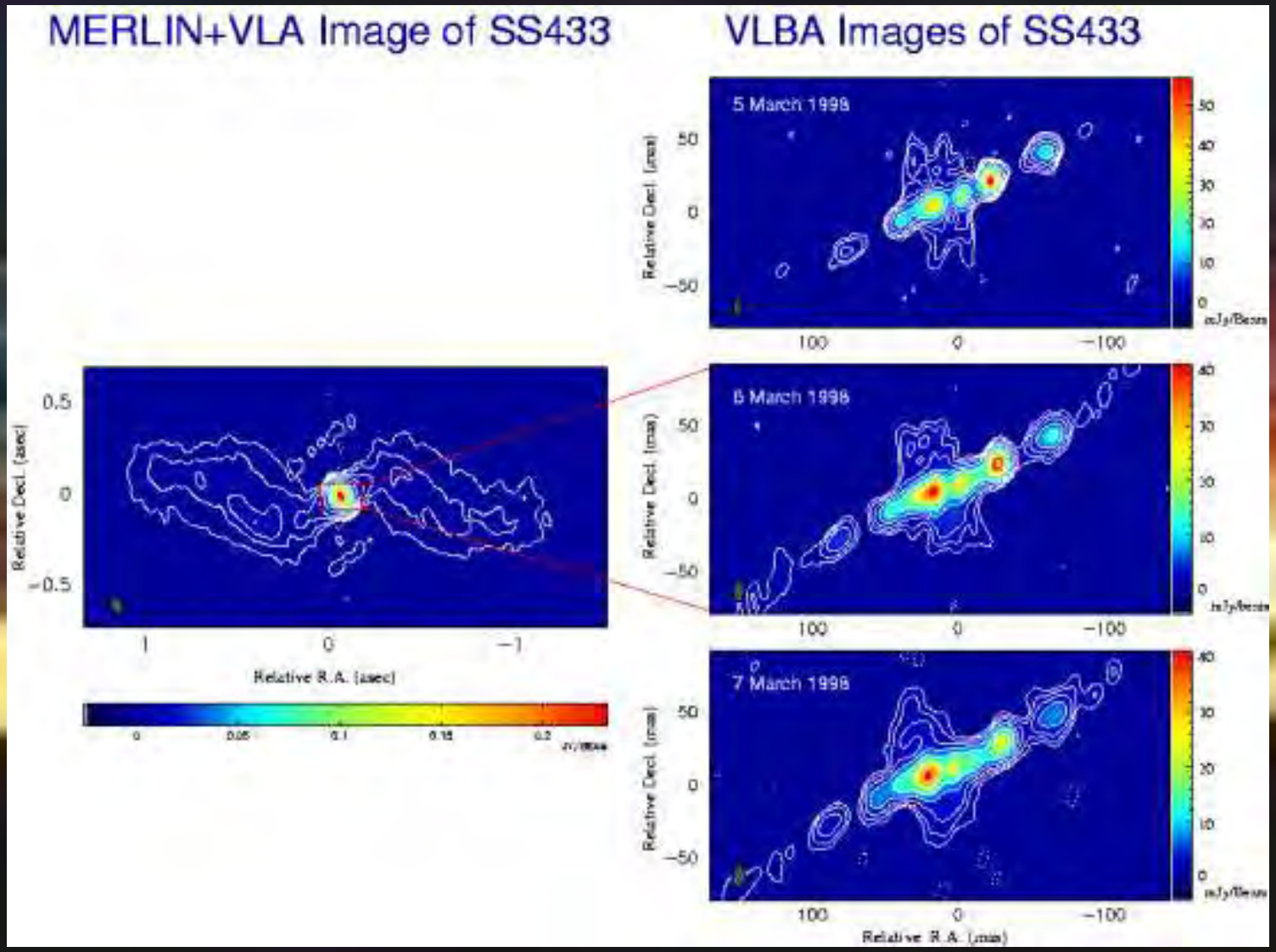
time

Cygnus X-3

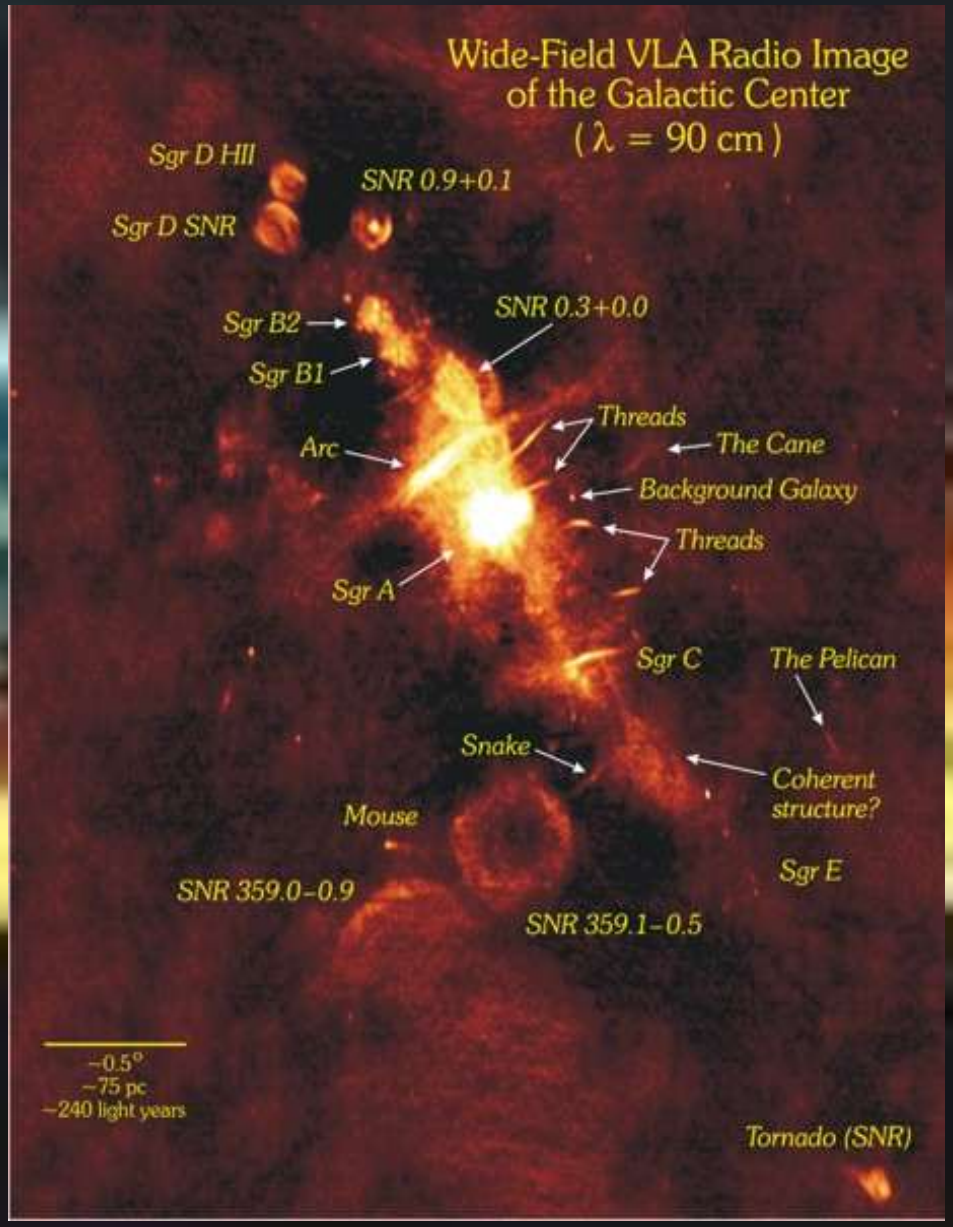

N
E
21
October
2000
5
November
2000
20
November
2000
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
ARC SEC
1.0
0.5
0.0
-0.5
-1.0
ARC SEC

Microquasar GRS 1915+105

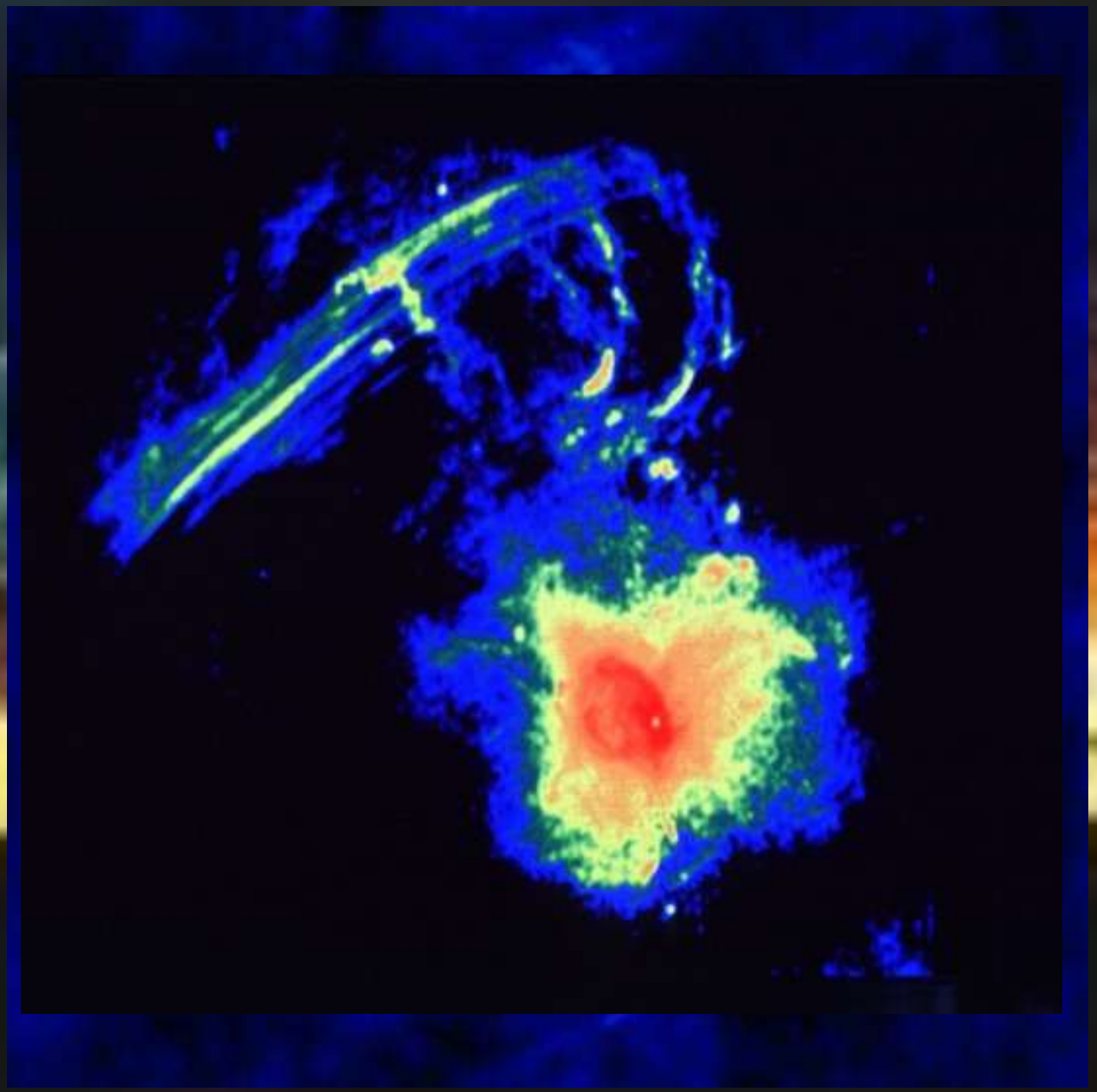
SS433 X-ray Binary



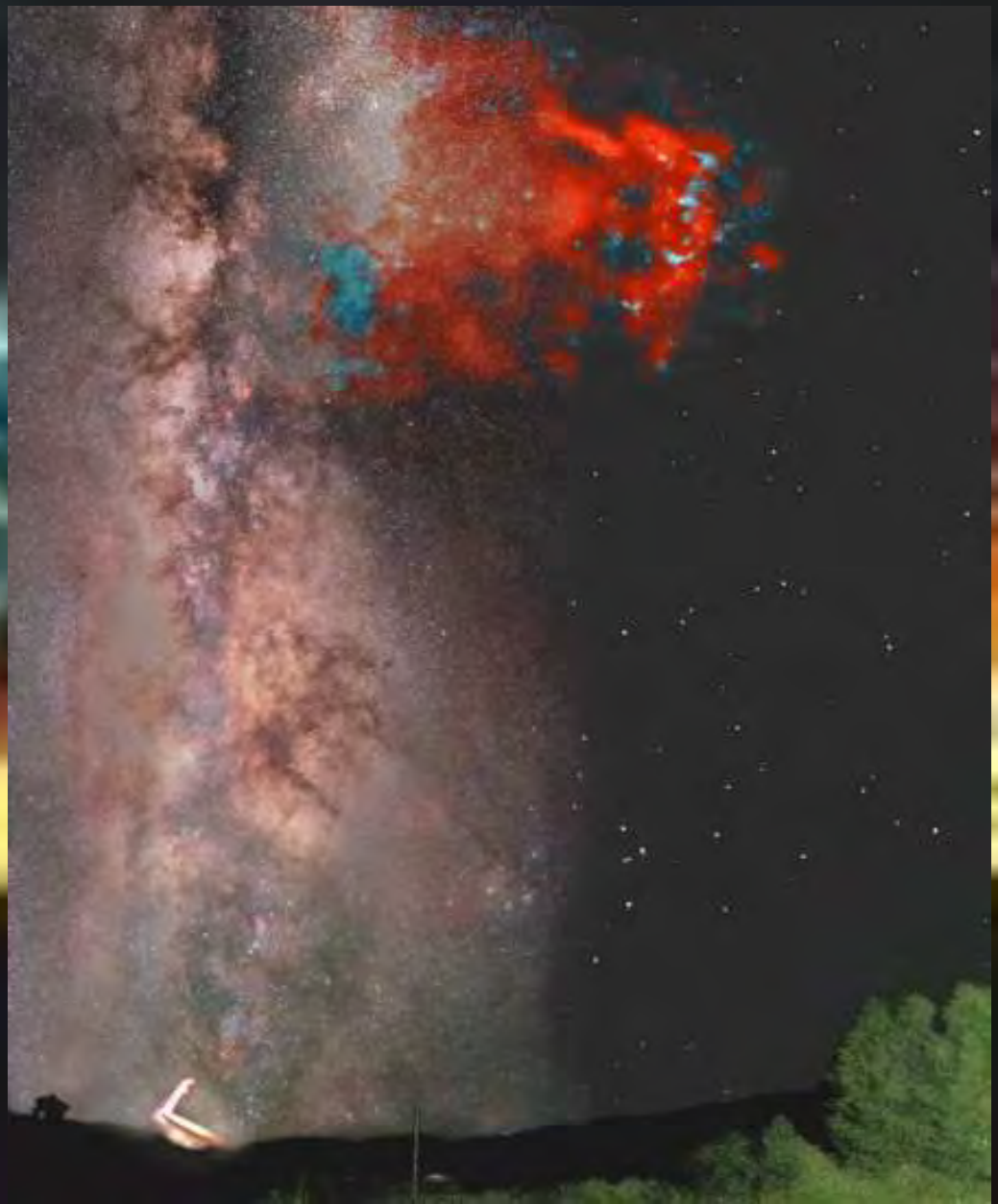
Γαλαξιακό Κέντρο με VLA



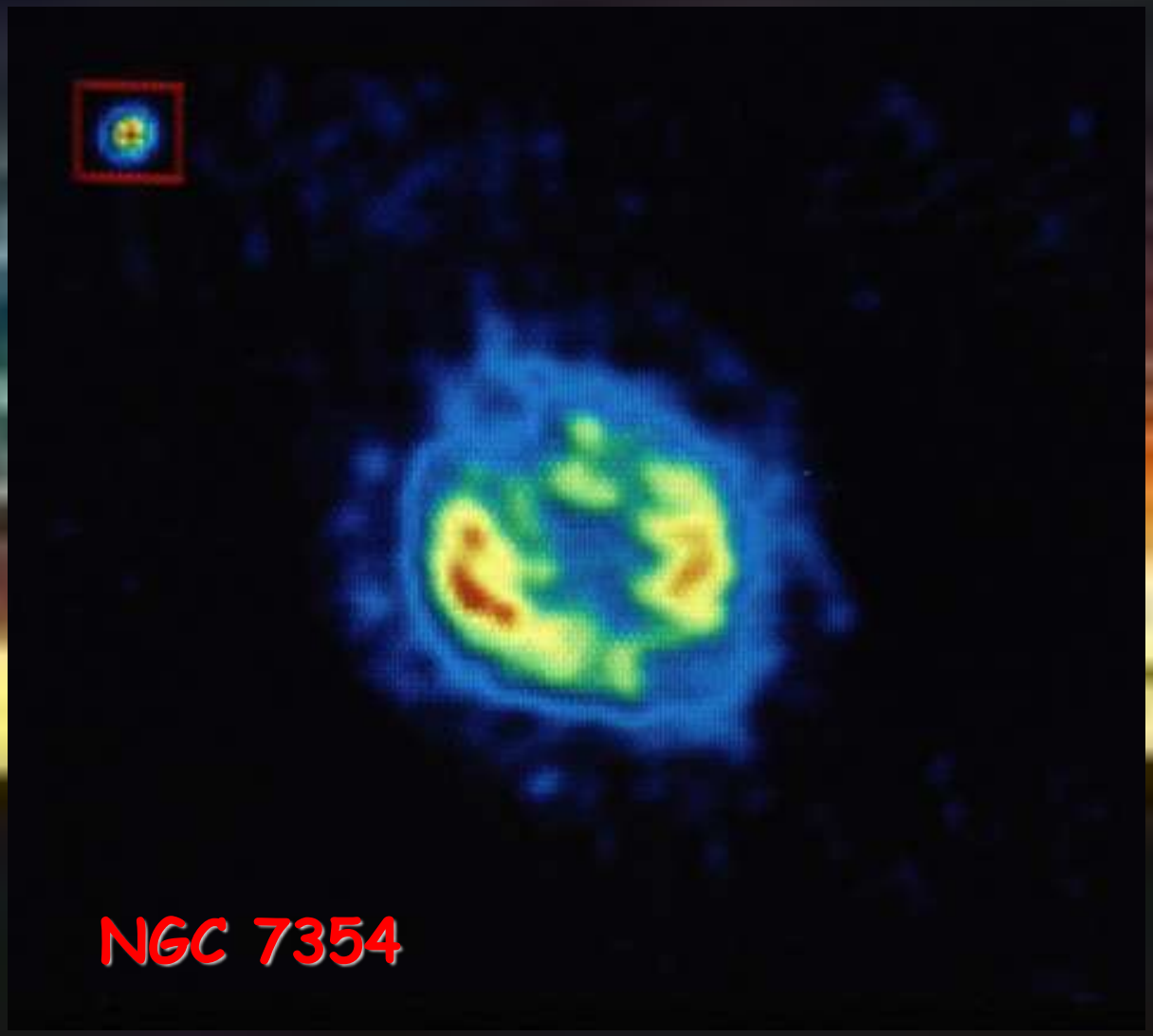
Sagittarius A

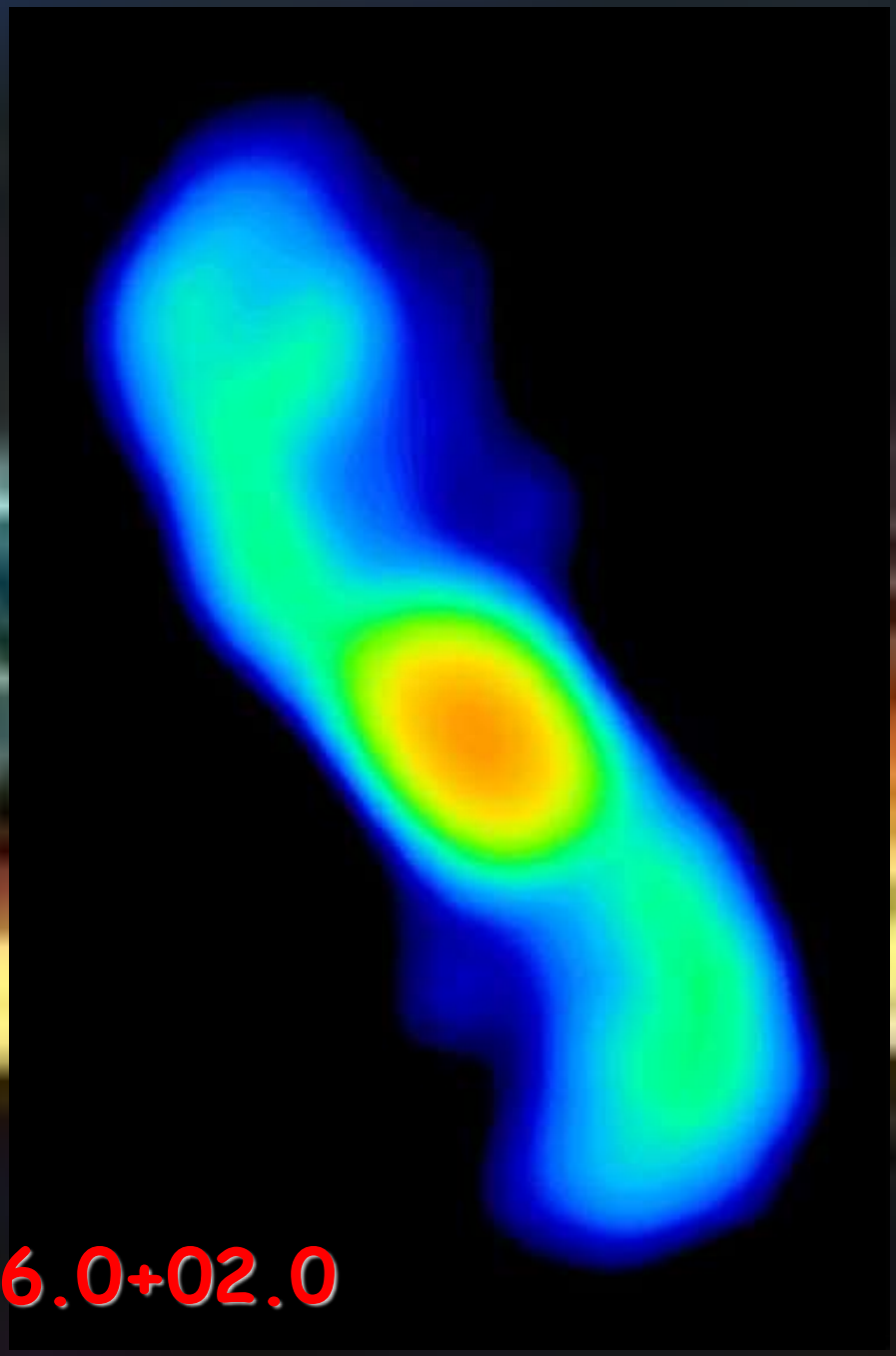


Γαλαξιακή Άλως

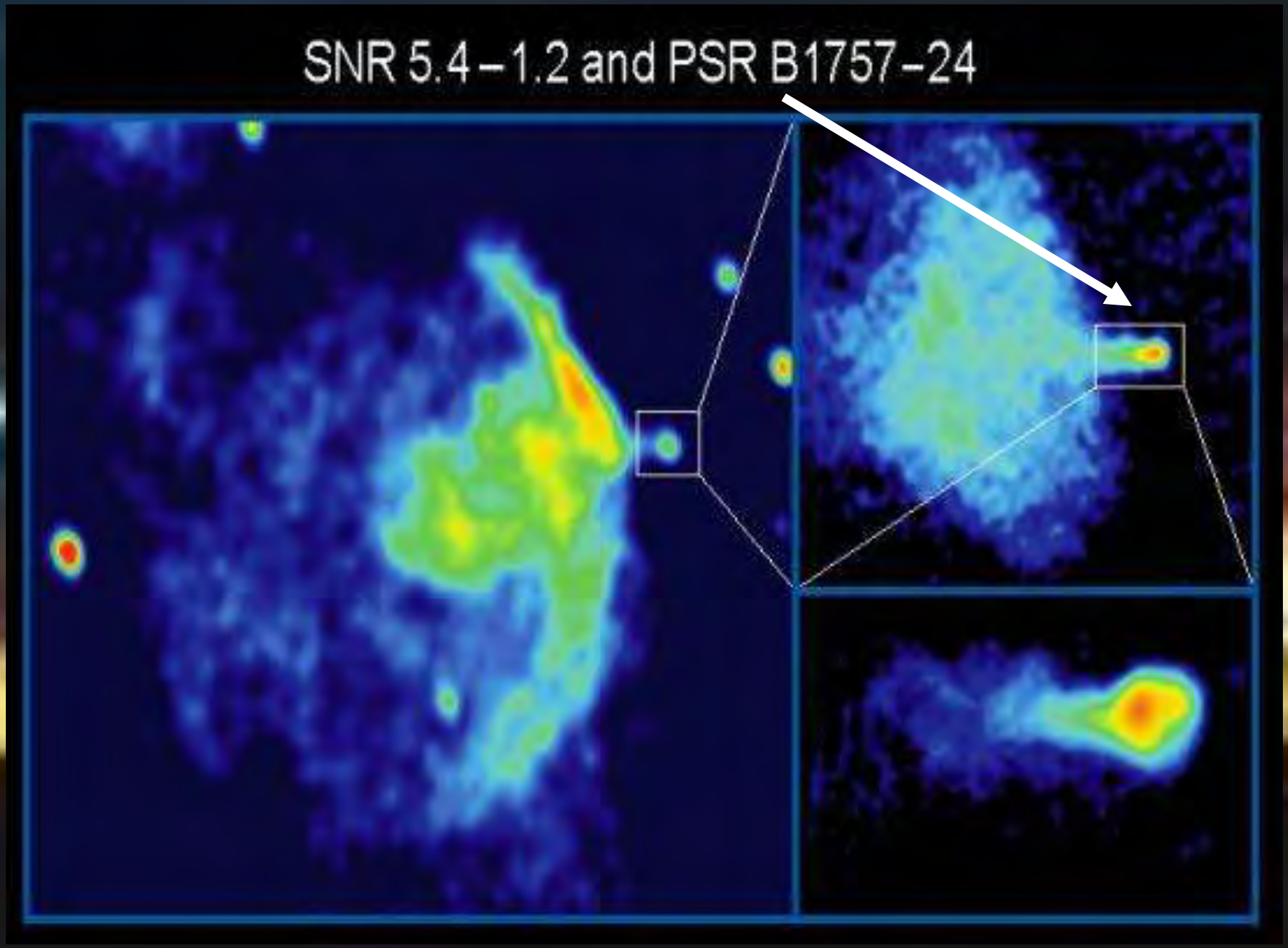


Πλανητικό Νεφέλωμα

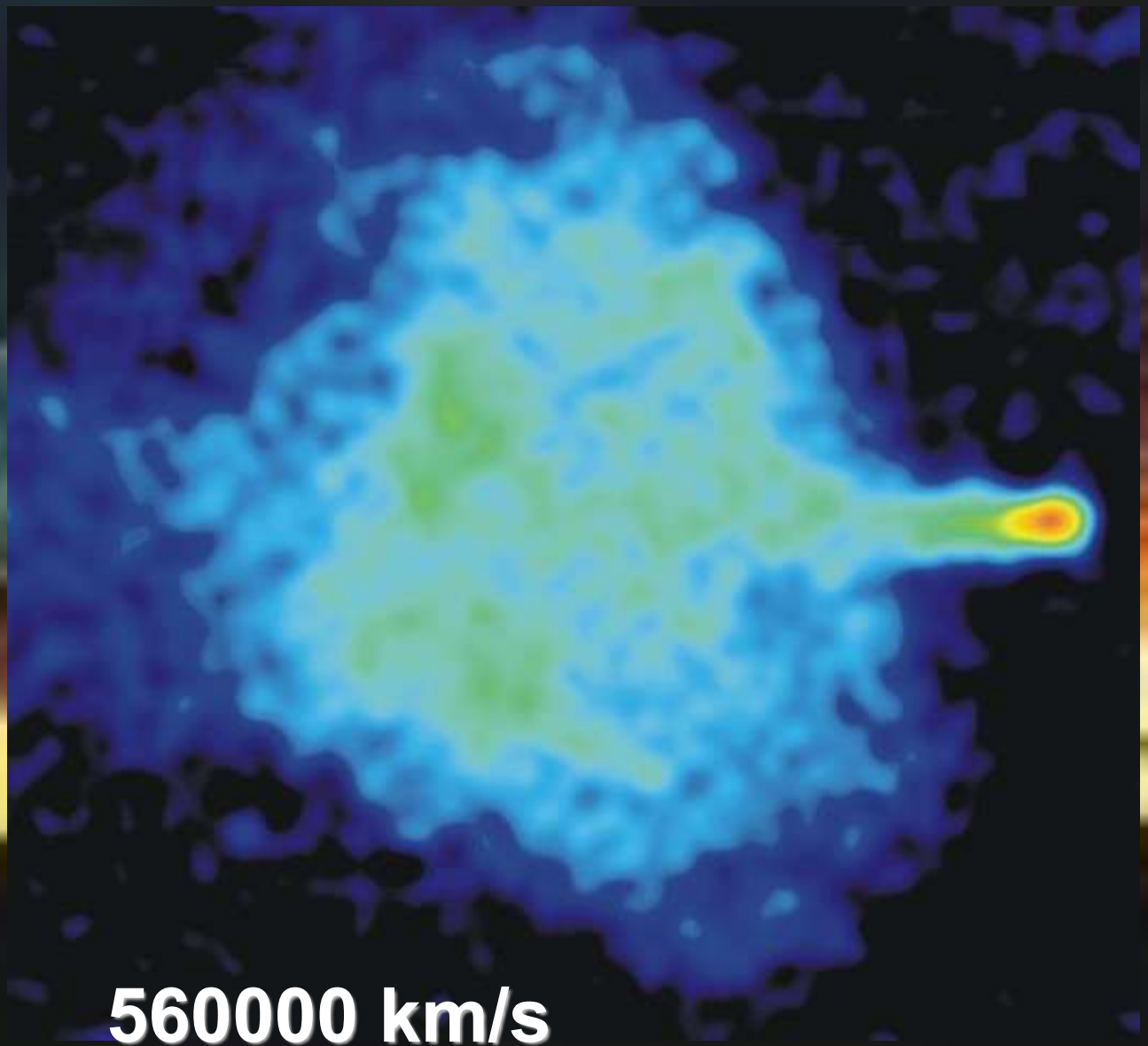




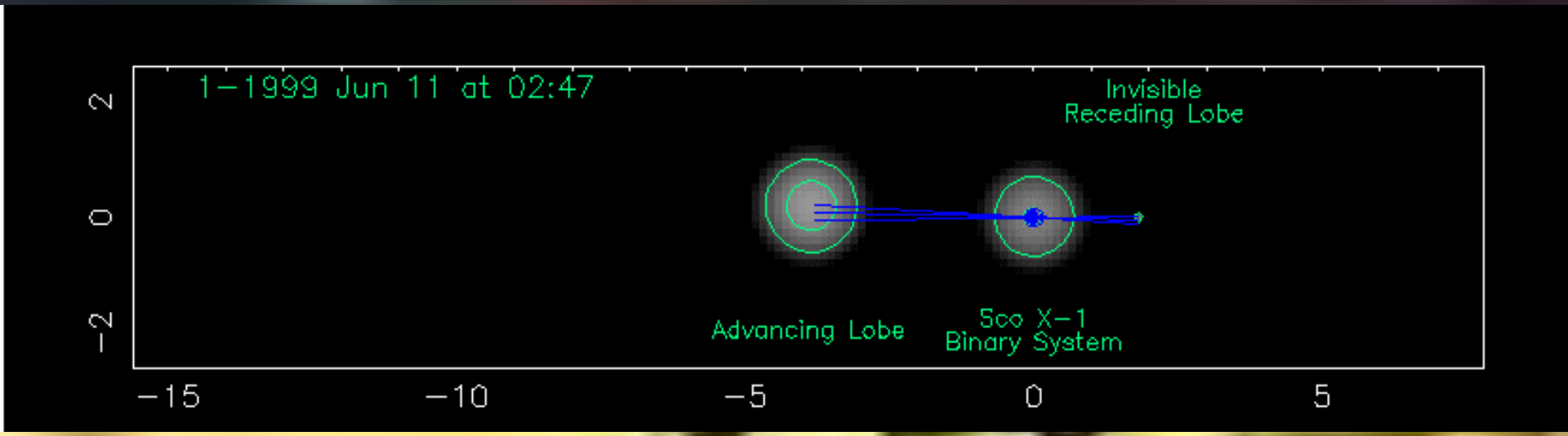
PN G056.0+02.0


SNR 5.4 – 1.2 and PSR B1757 – 24

Pulsar B1757-24

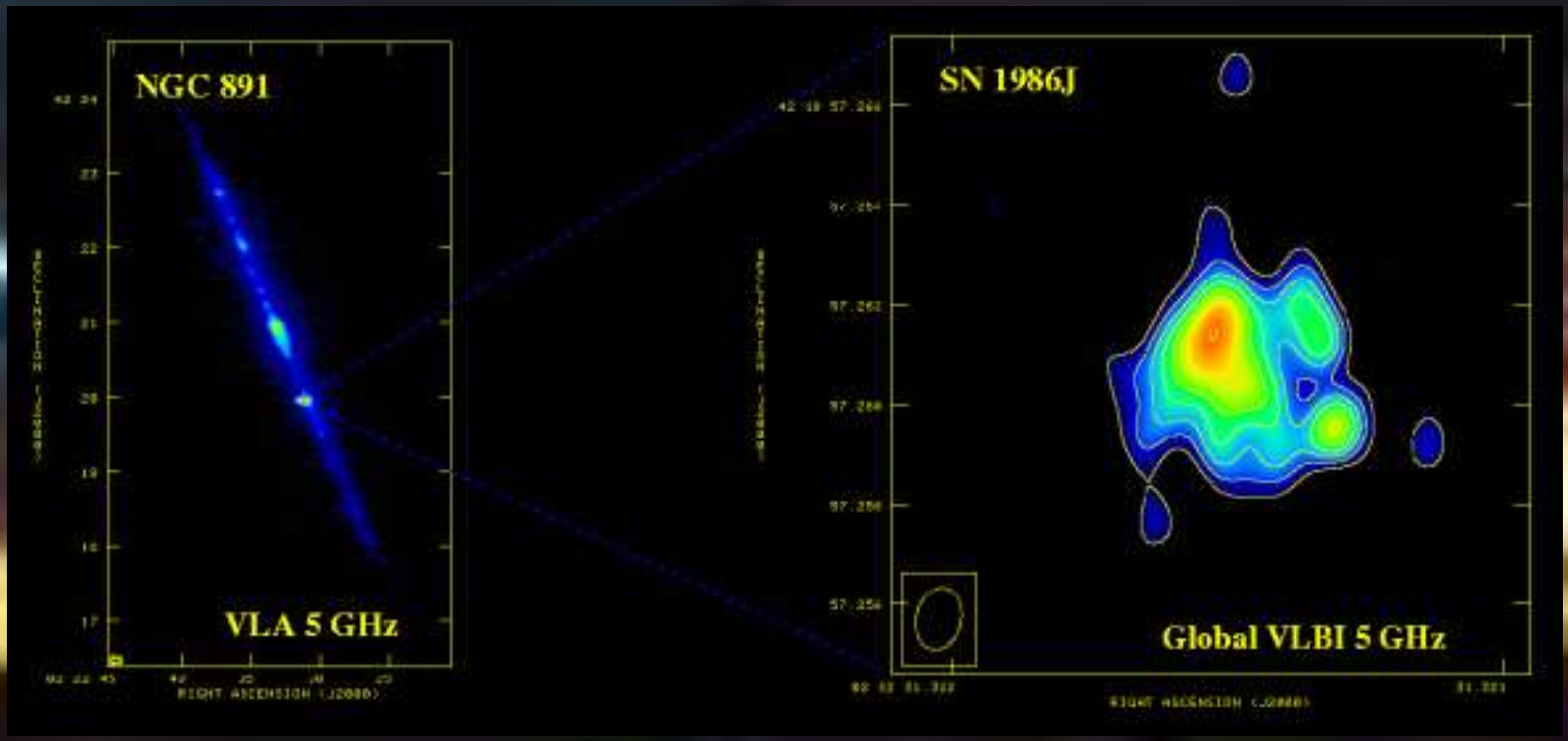


Scorpius X-1



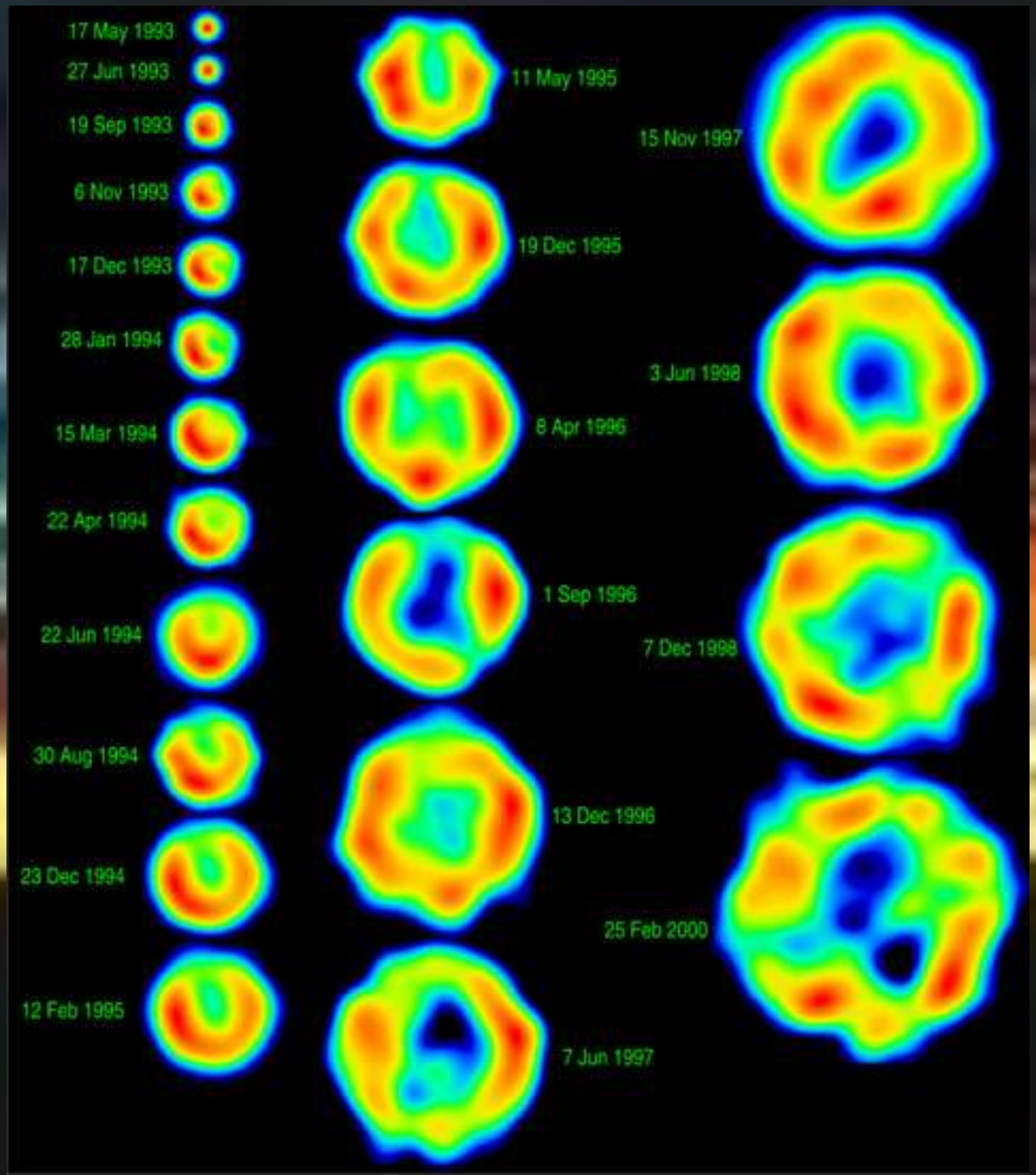
Απόσταση σε 10^9 μίλια

Supernovae



Κέντρο έκρηξης?

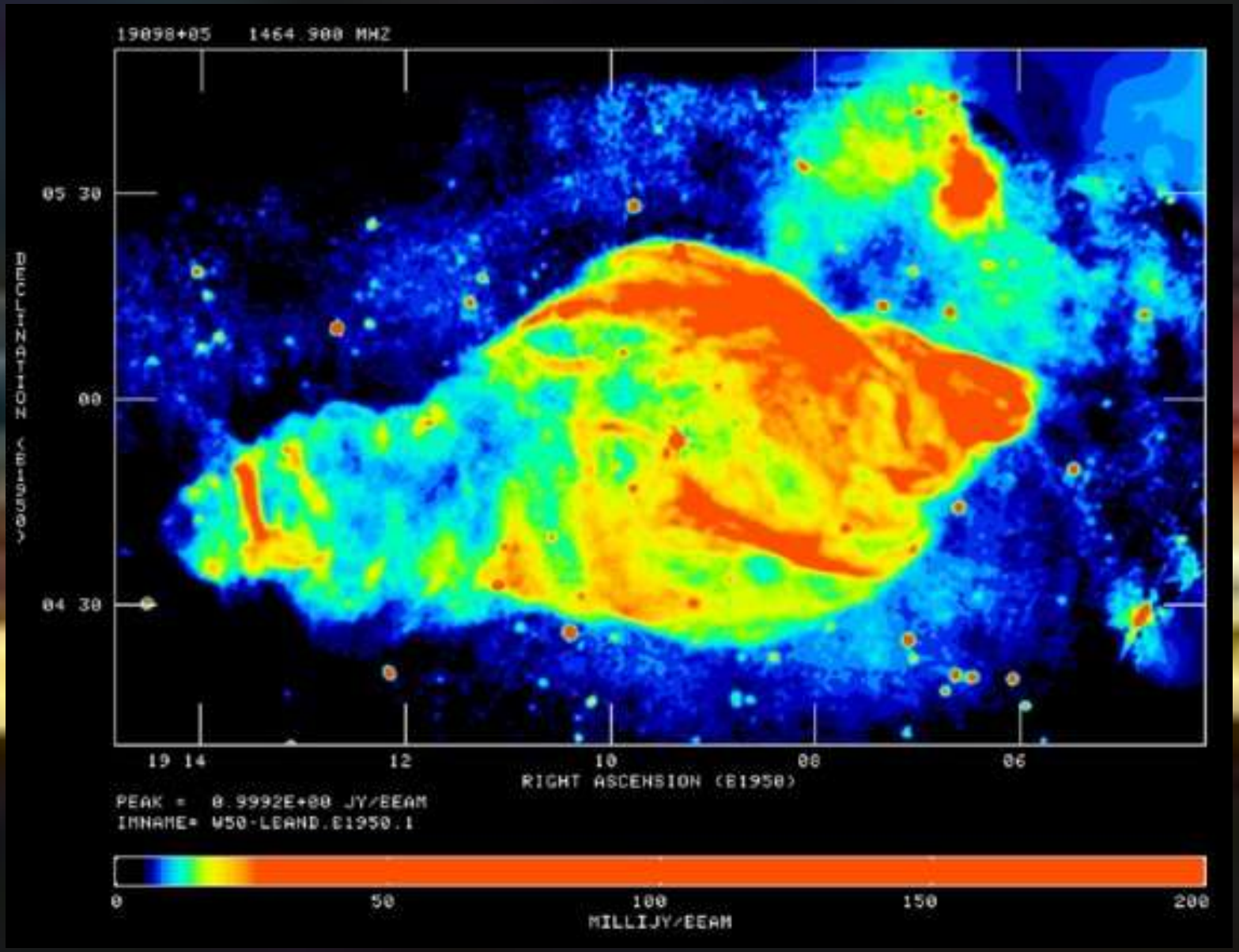
Supernova 1993J



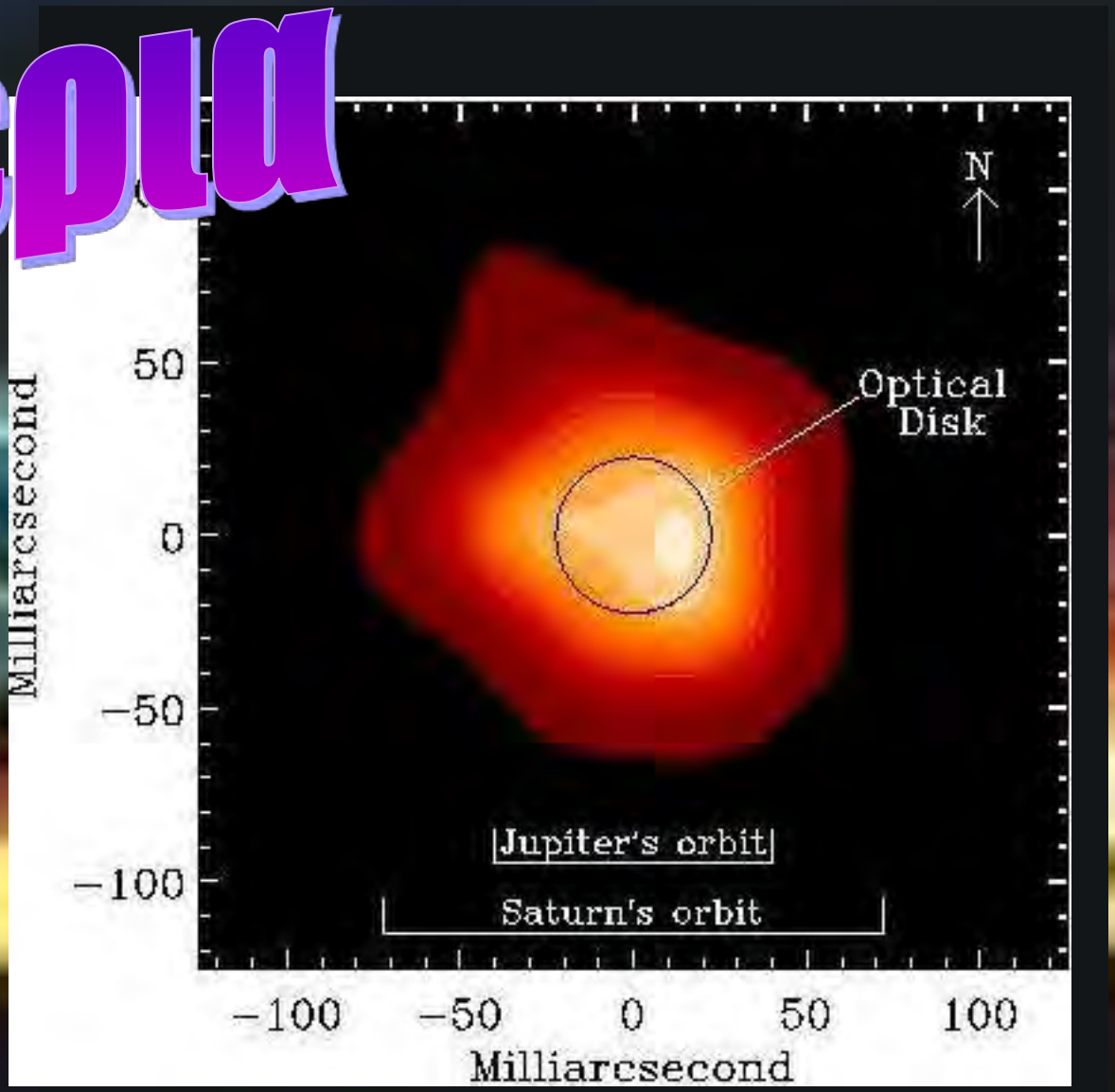
Supernova Remnant

Cassiopeia A

W50A

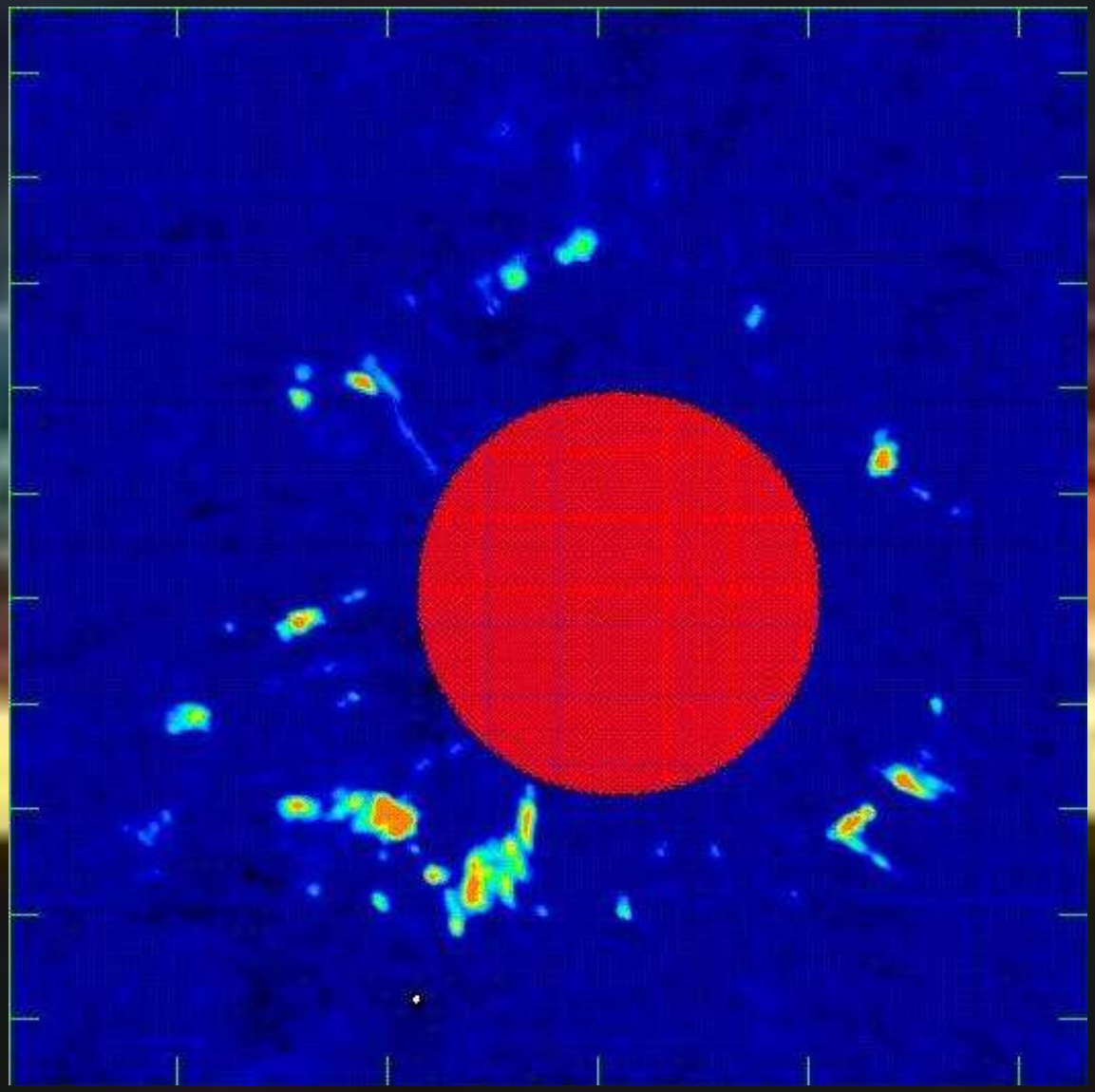

19098+05 1464.900 MHZ
05 30
00
04 30
DECLINATION (B1950)
19 14
12
10
08
06
RIGHT ASCENSION (B1950)
PEAK = 0.9992E+00 JY/BEAM
IMNAME= W50-LEAND.B1950.1
0
50
100
150
200
MILLIJY/BEAM

Αστέρια

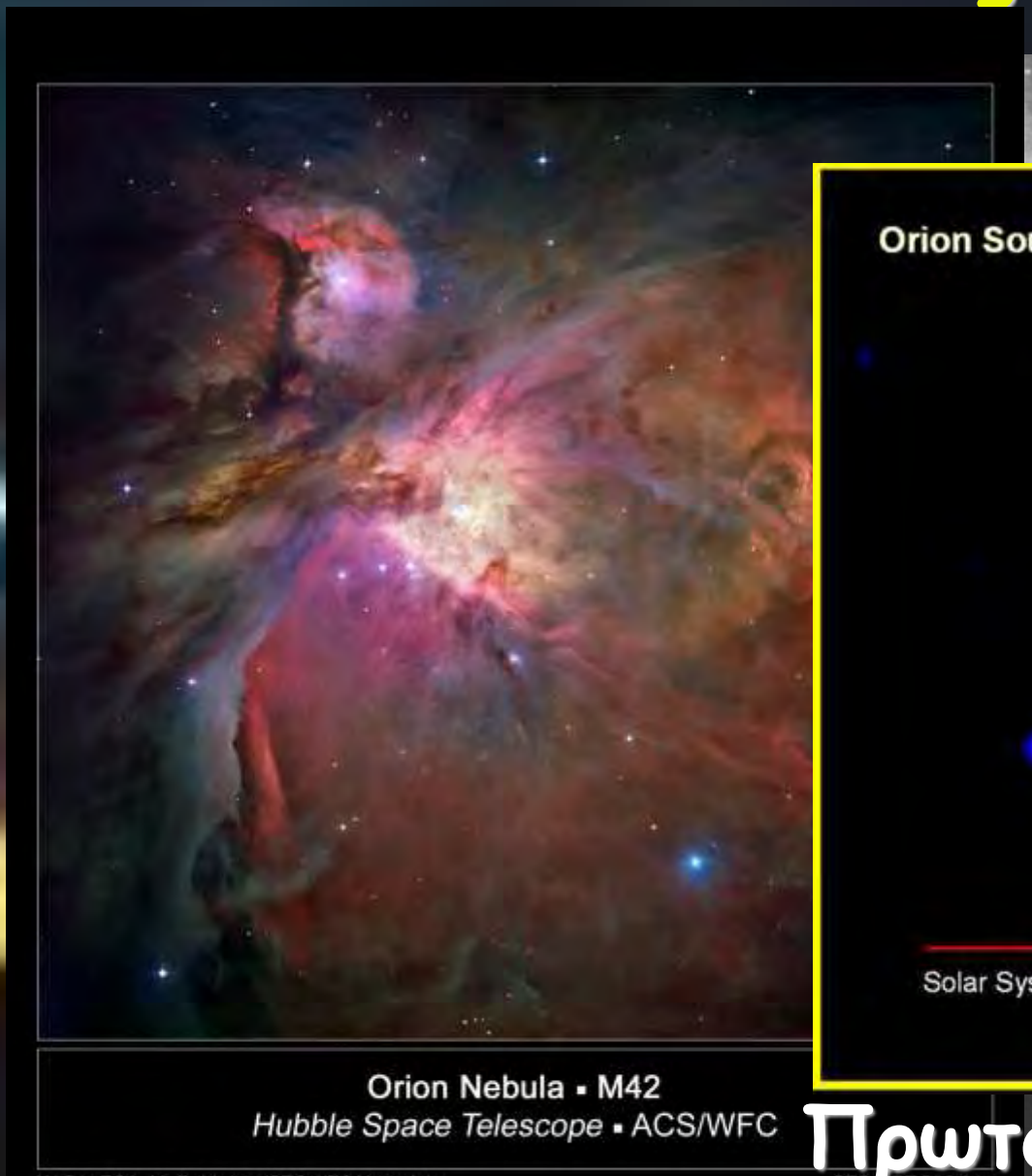


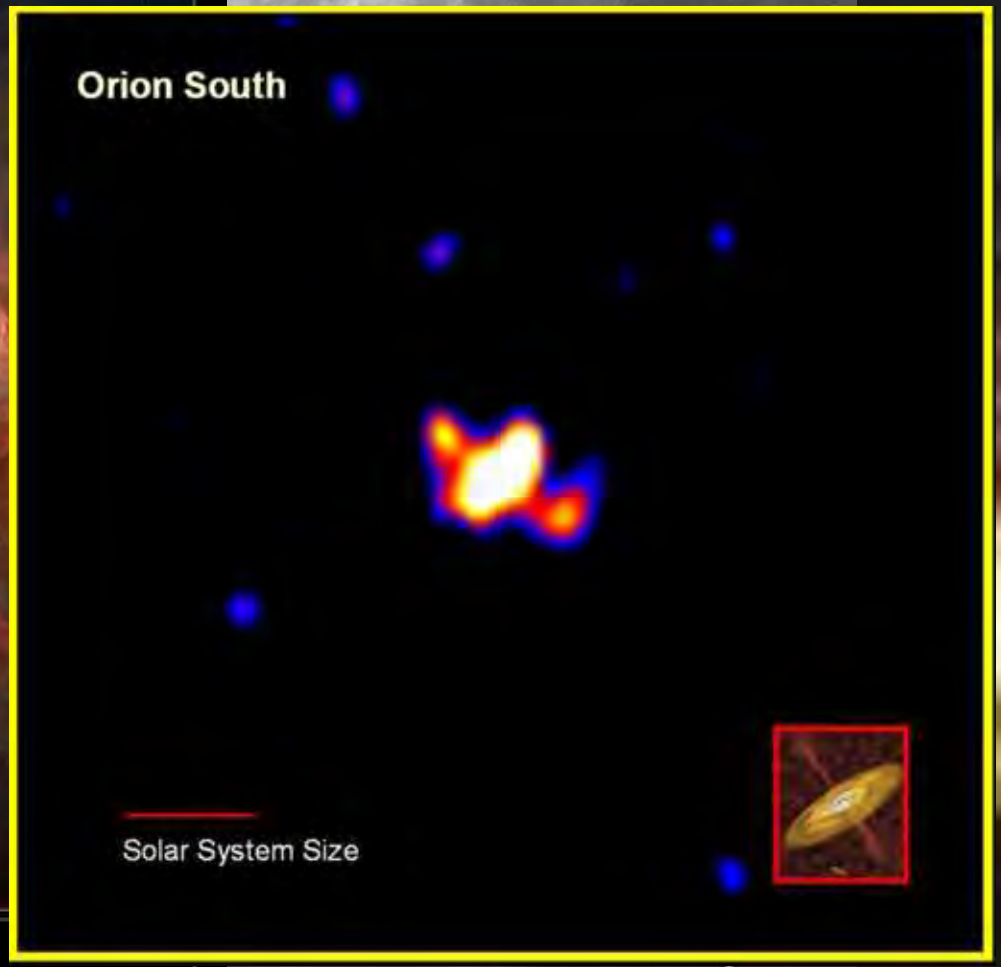
Betelgeuse

TX Cam - Masers



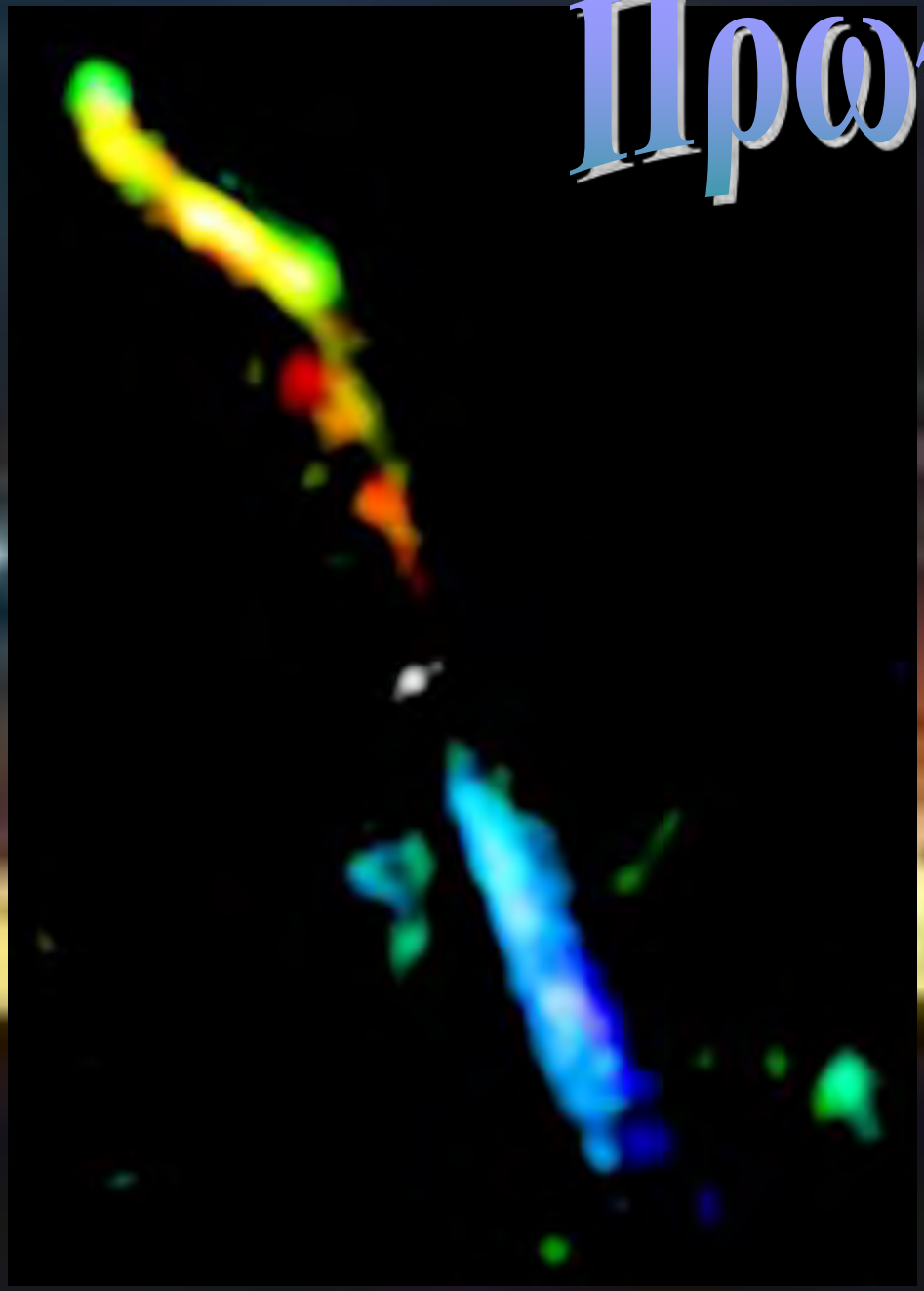
Star forming regions





Πρωτοπλανητικος δίσκος + outflow

Πρωτοαστέρας

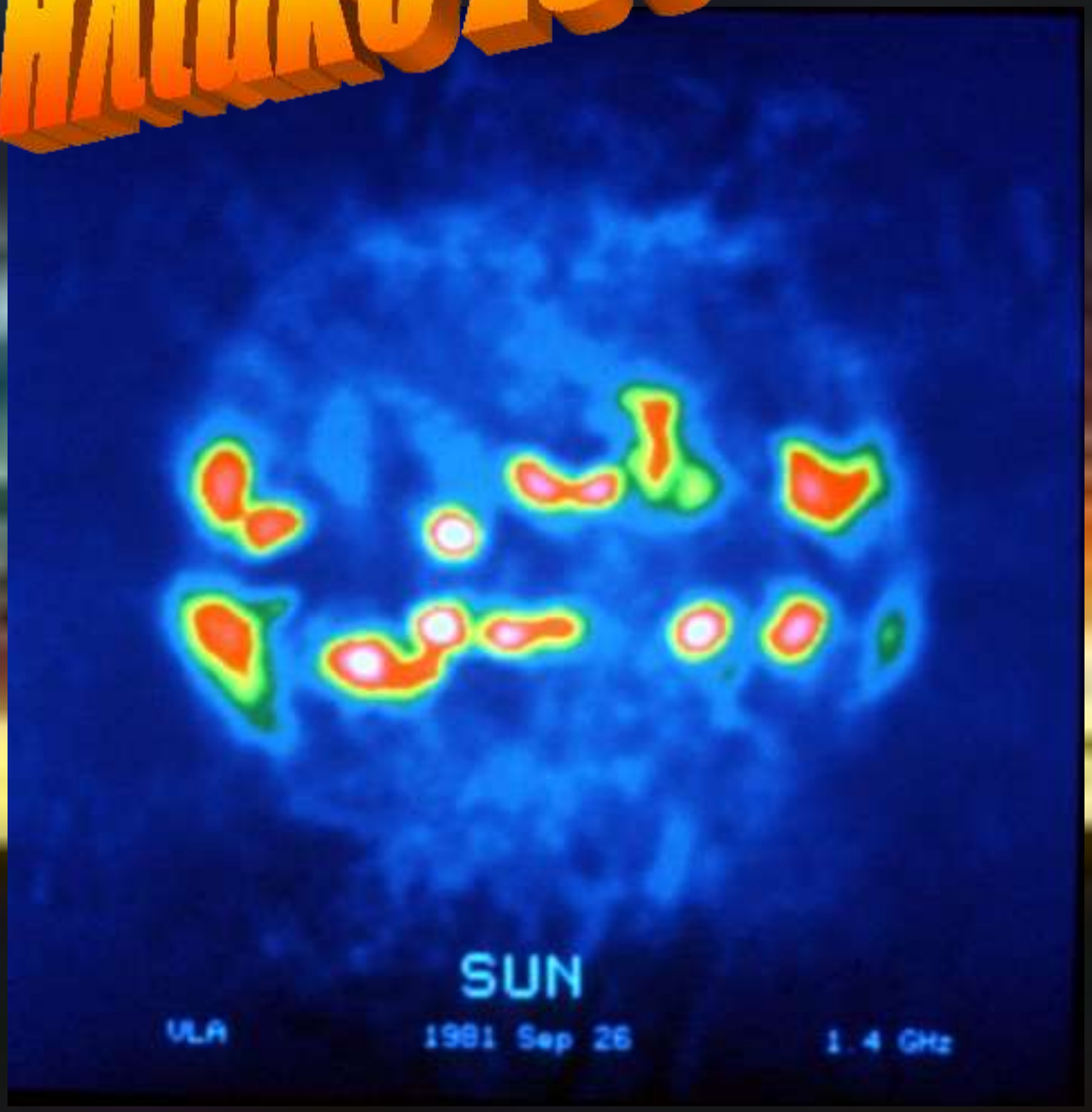


NGC 1333
Εκτρεπόμενα jets

γ—ray bursts

Radio + optical + X-ray

Ηλιακό Σύστημα

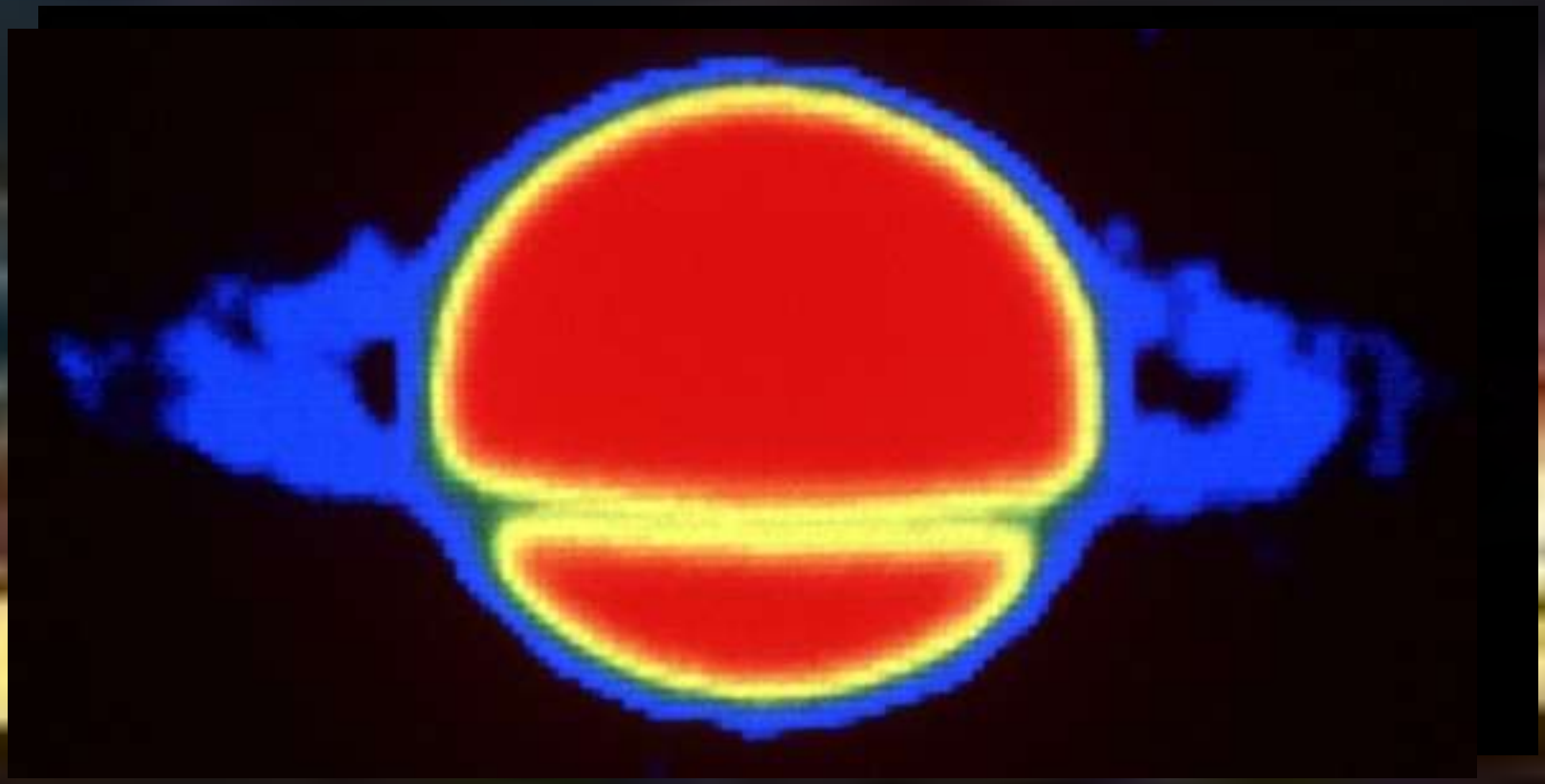


Σελήνη

Radar

ΔΙΑΣ

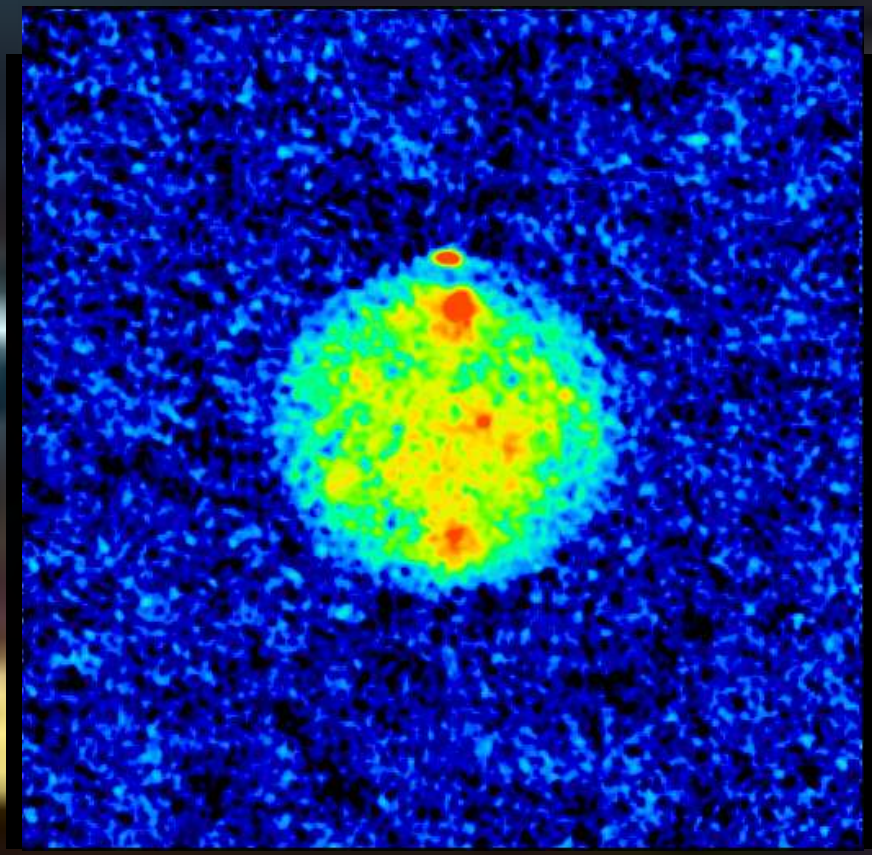
Κρόνος

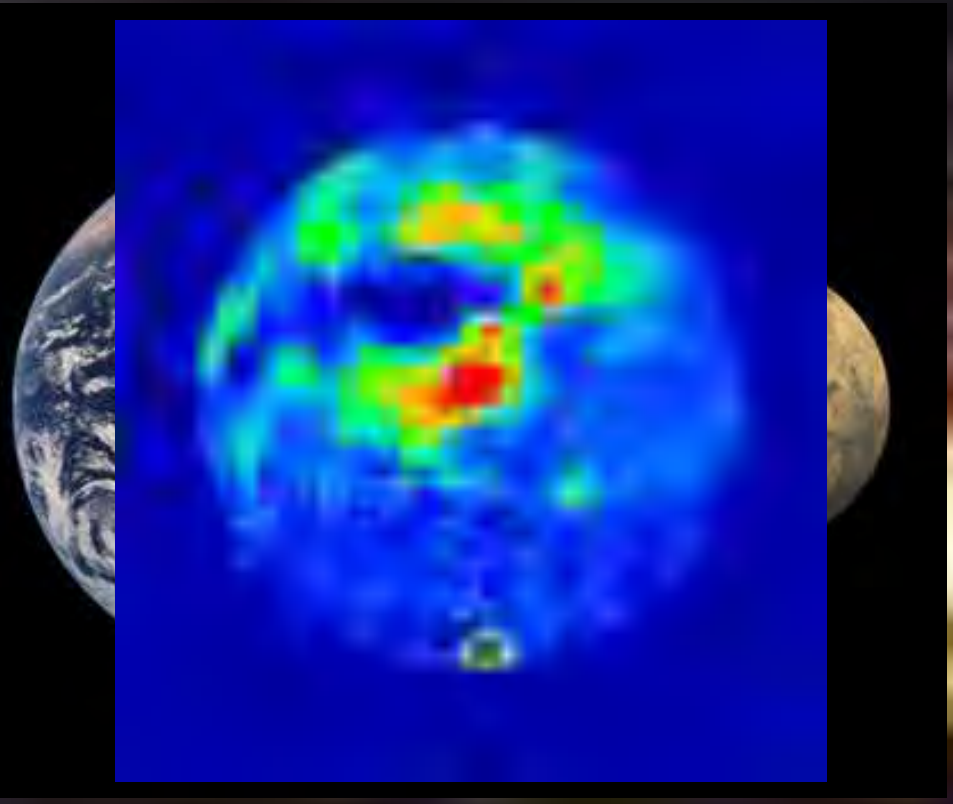


Αφροδίτη

Radar

Ερμής και Αφροδίτη



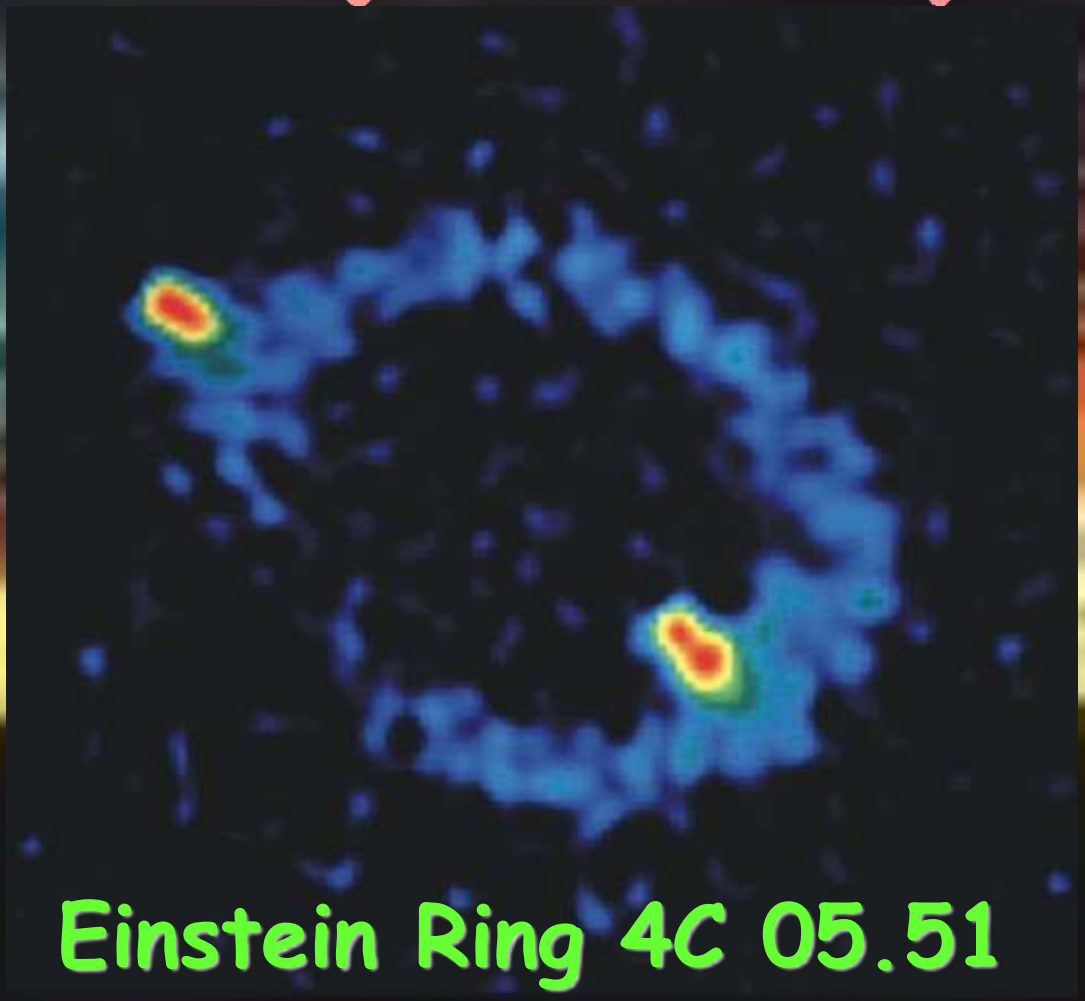


Radar

Αστεροειδής EC 16

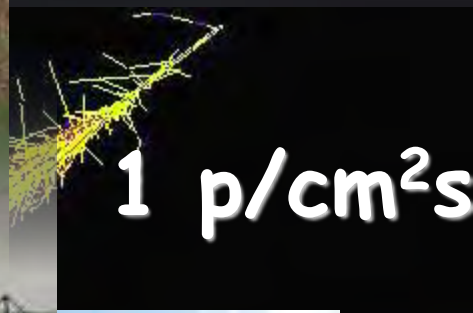
Radar

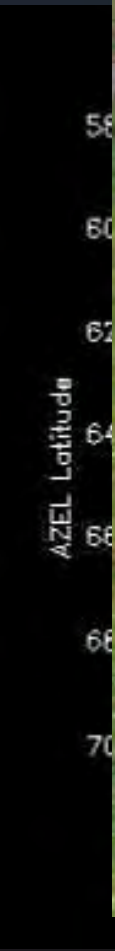
Κοσμολογία



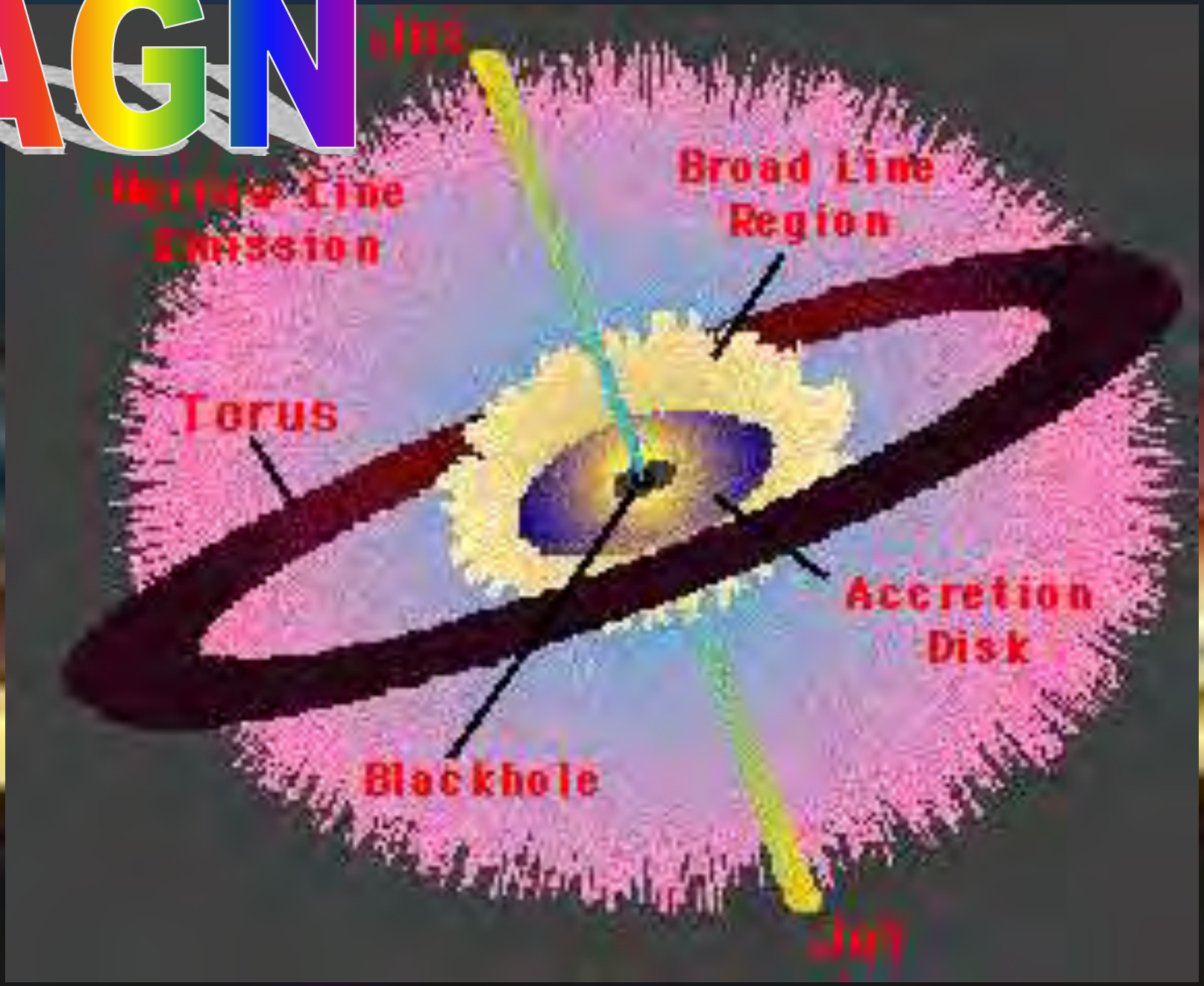
Einstein Ring 4C 05.51

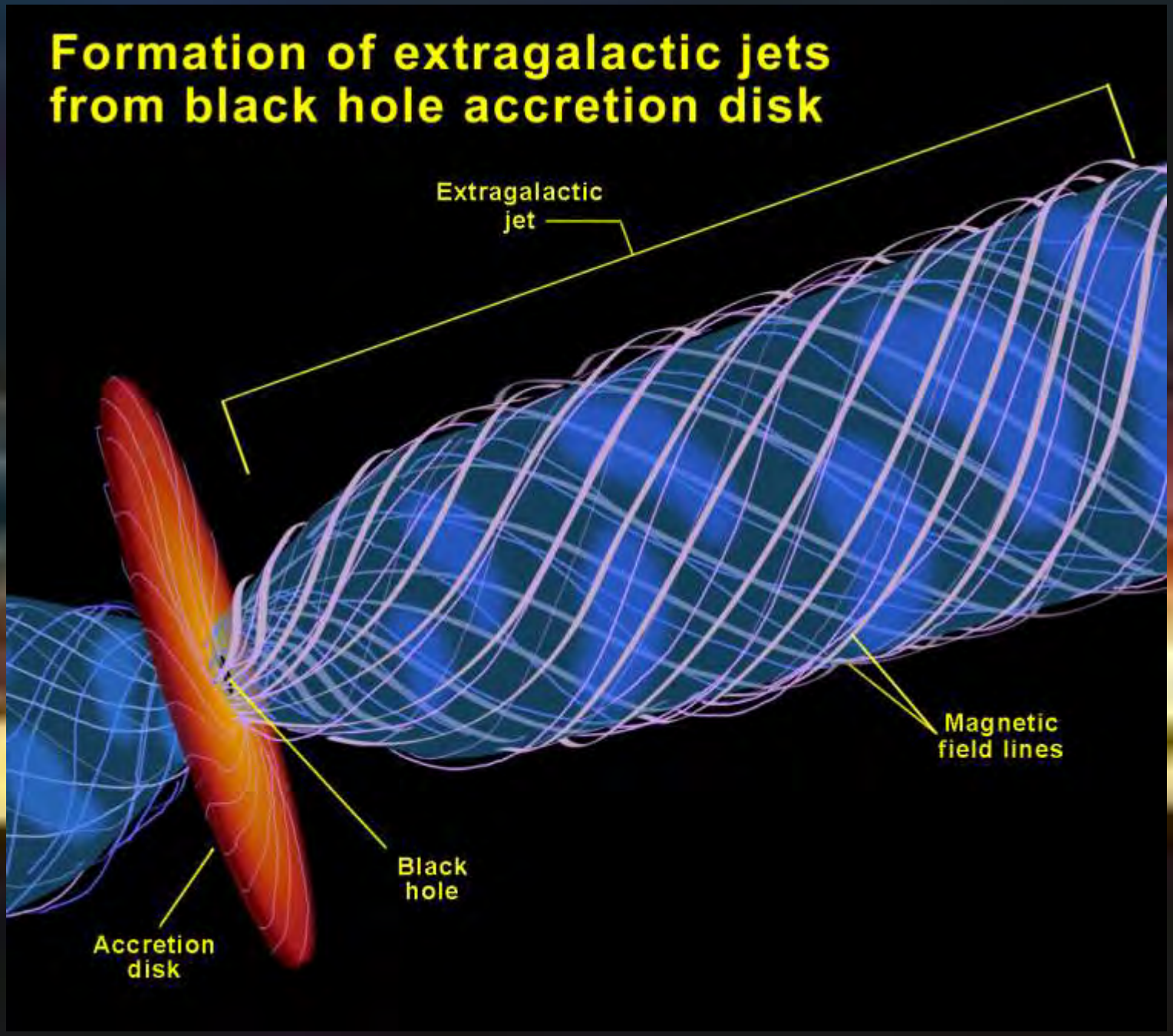
Αστροσωματιδιακή

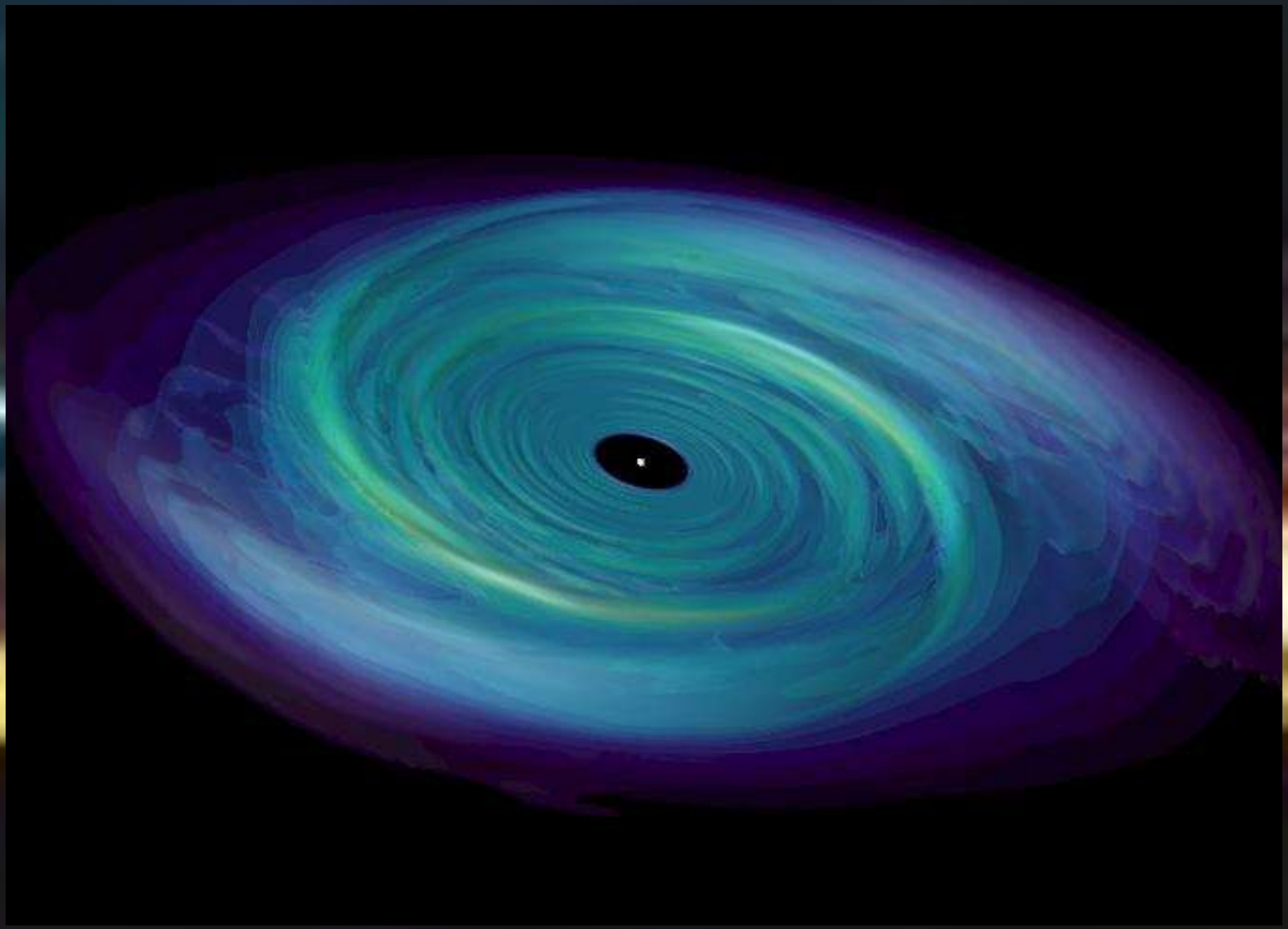


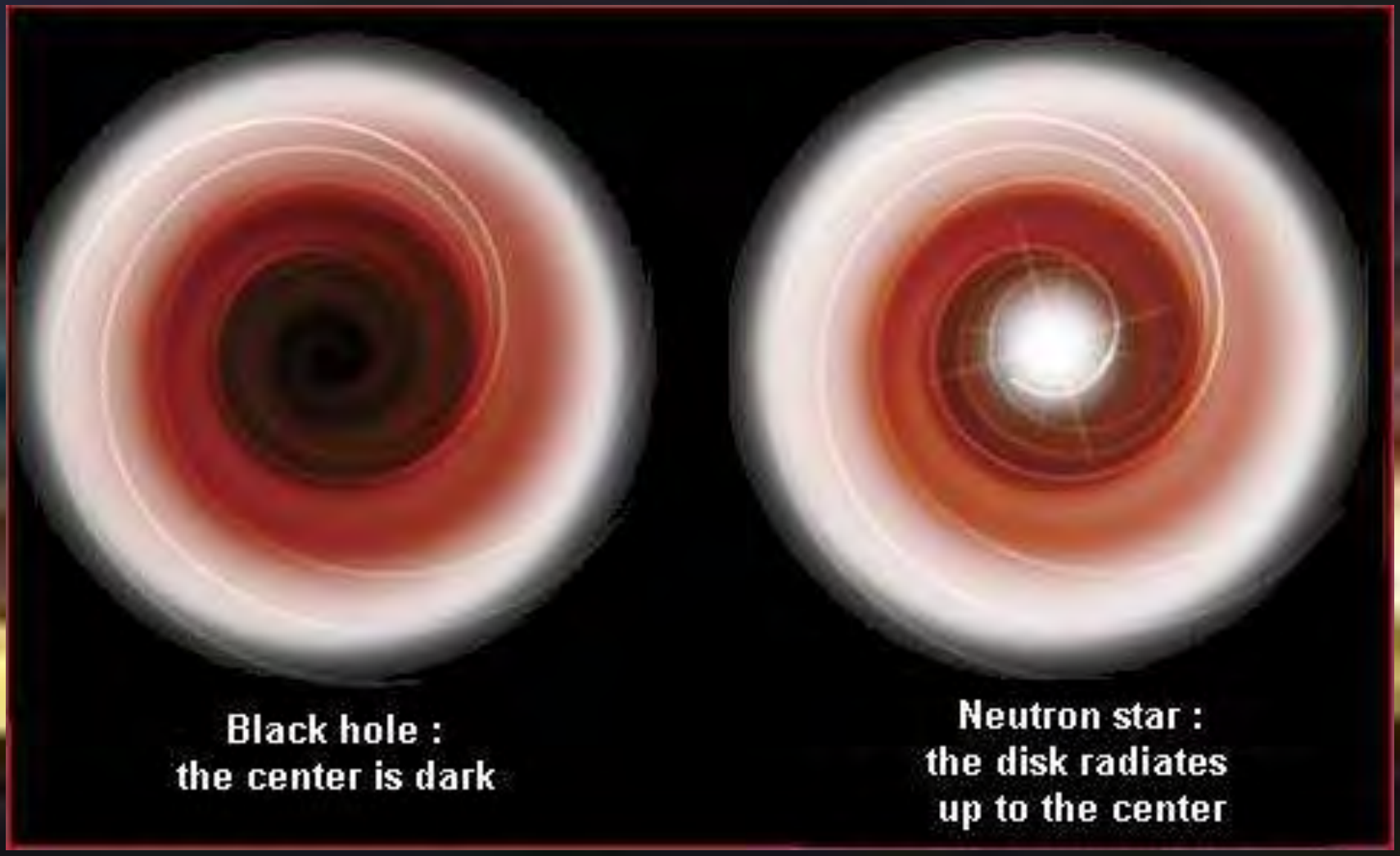


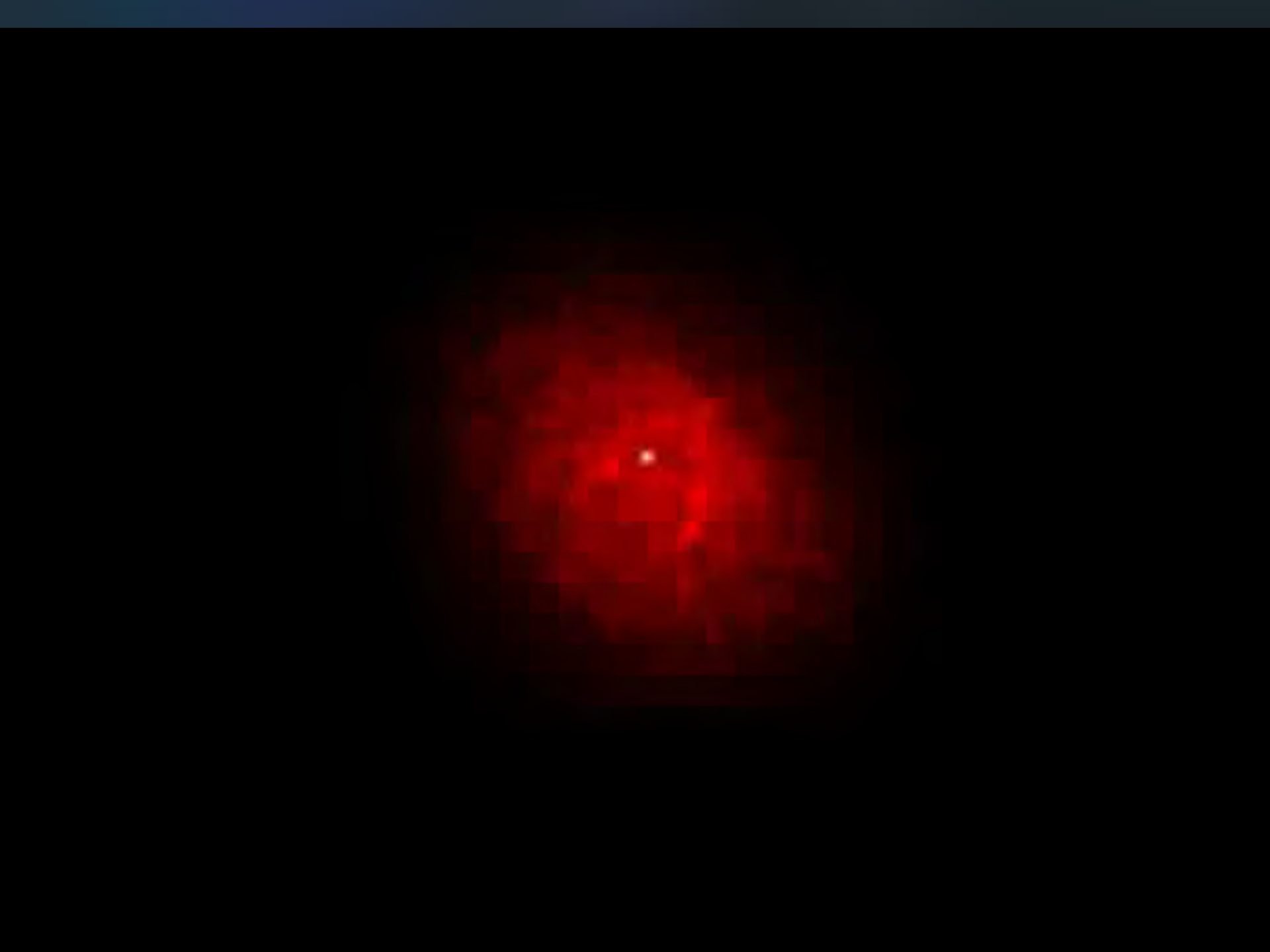
AGN




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

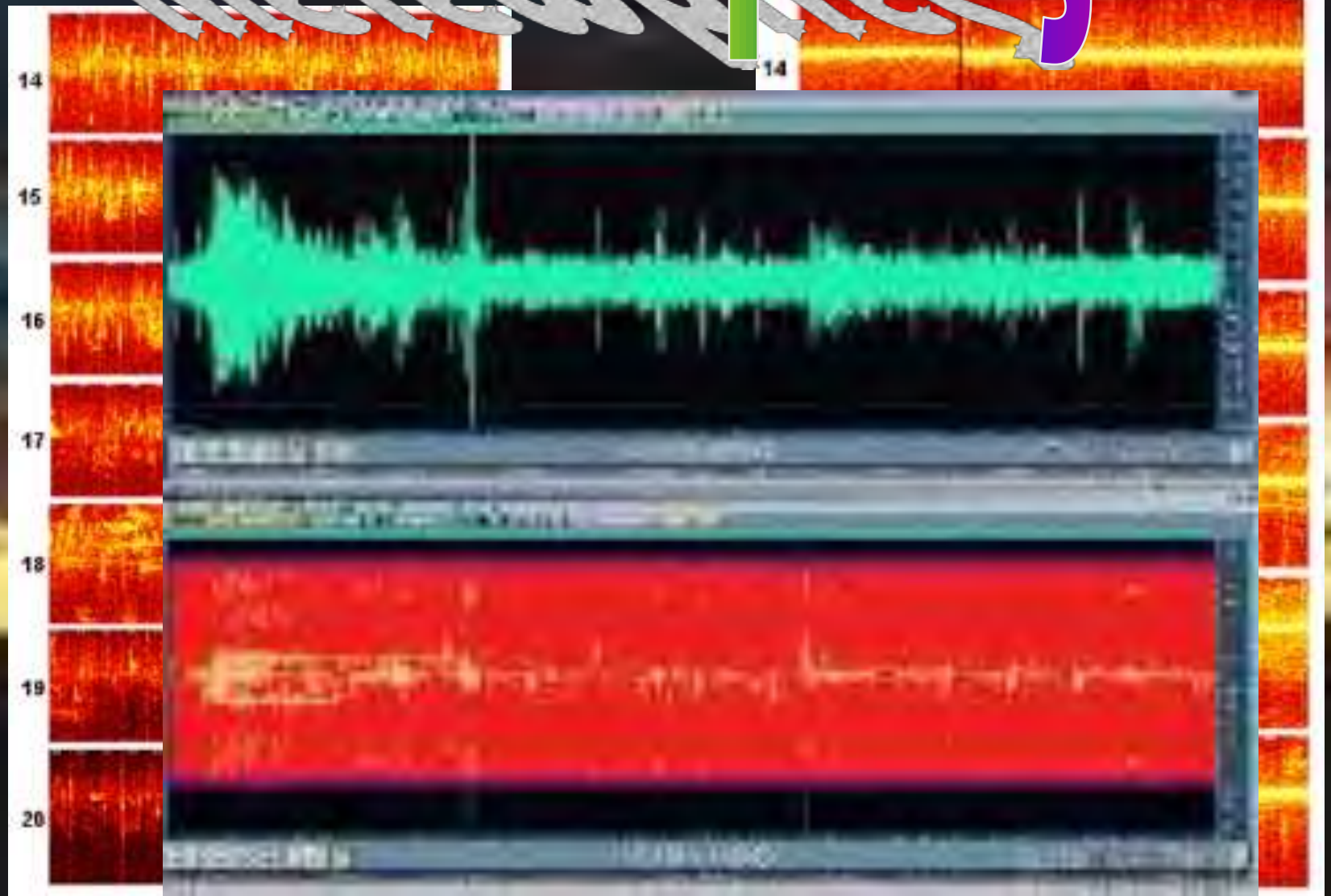



Black hole :
the center is dark
Neutron star :
the disk radiates
up to the center



Φως + Θερμότητα από ΒΗ, αλλά και … ήχος

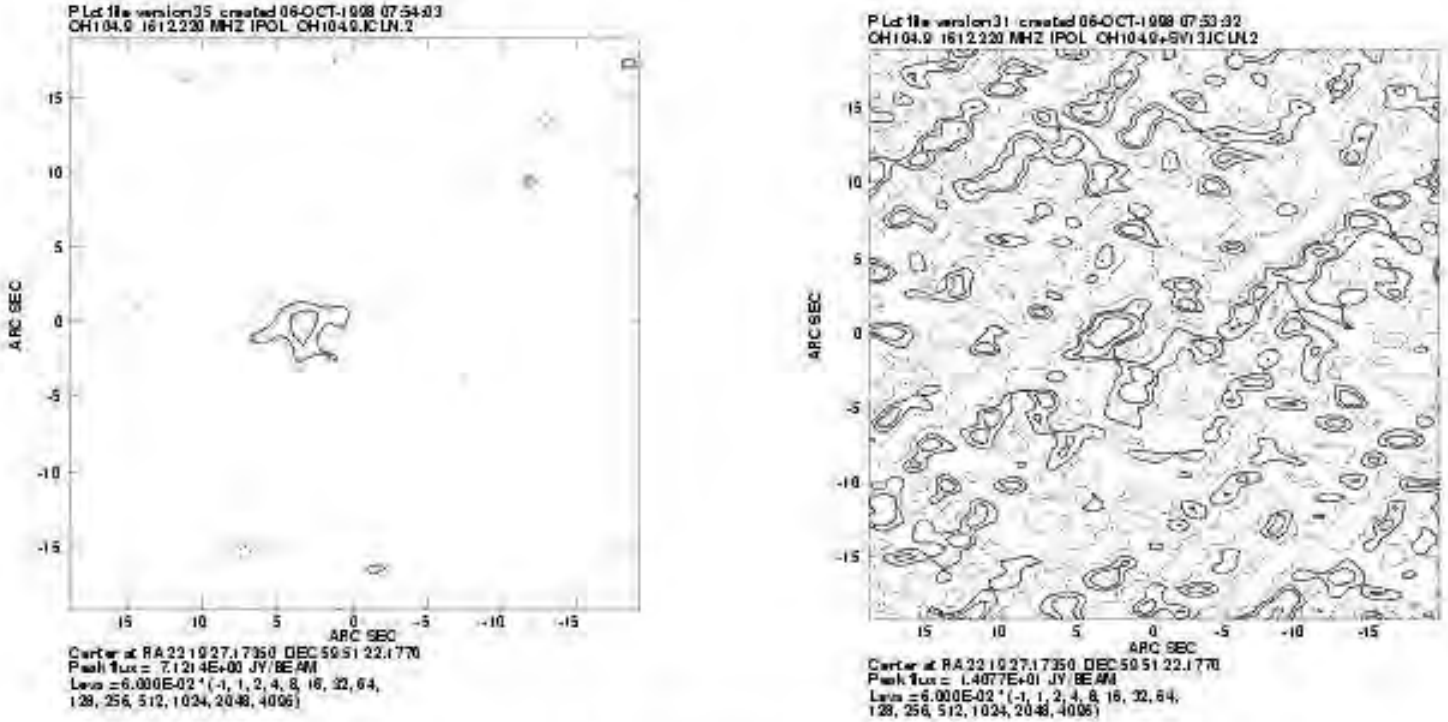
Μετεωρίτες



"Spillover" Into a Radio Astronomy

Interference

Effect of Radio Interference On Astronomical Observations

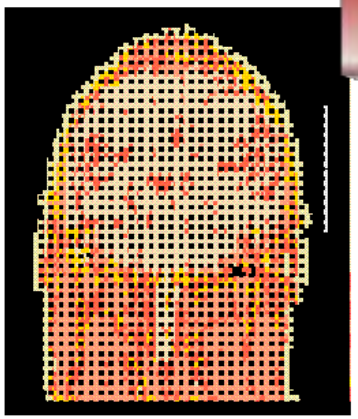


VLA Images of OH/IR Star at 1612 MHz: No satellite present (left) and satellite ~22 degrees from star (right)

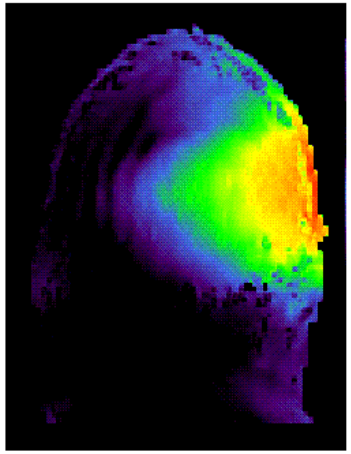
(From G.B. Taylor, NRAO)

range, this transmitter spreads radio emissions over a very wide range of frequencies, far beyond its ITU-authorized range.

KINAYNOI



Tissues: muscle & high water content tissue-light red, fat and bone-dark yellow, blood-dark red, brain -light yellow, skin-ligh yellow



Radiated power from antenna = 125 mW

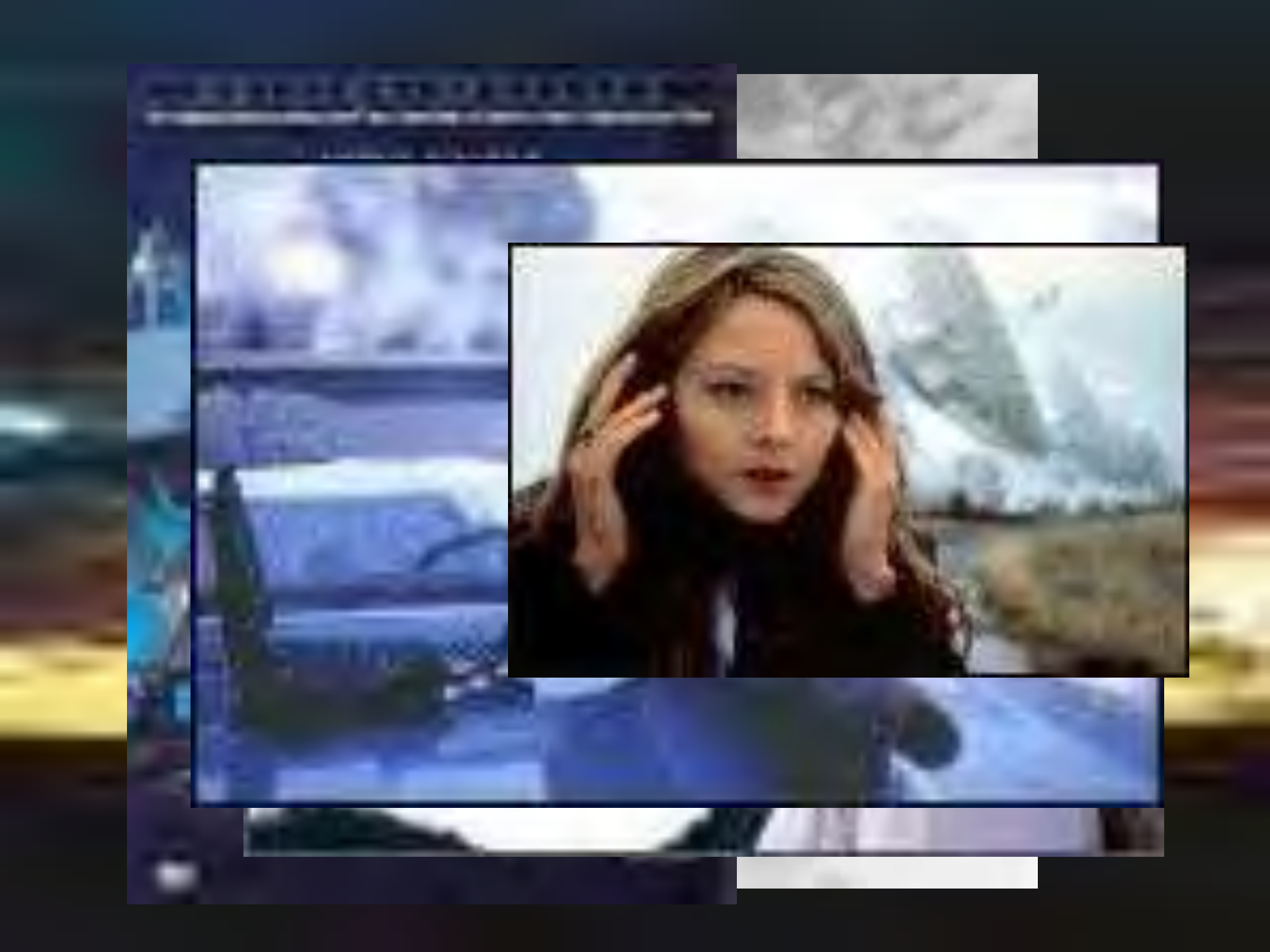
0 db = 9.50 W/kg

0 -9 -18 -27 -36

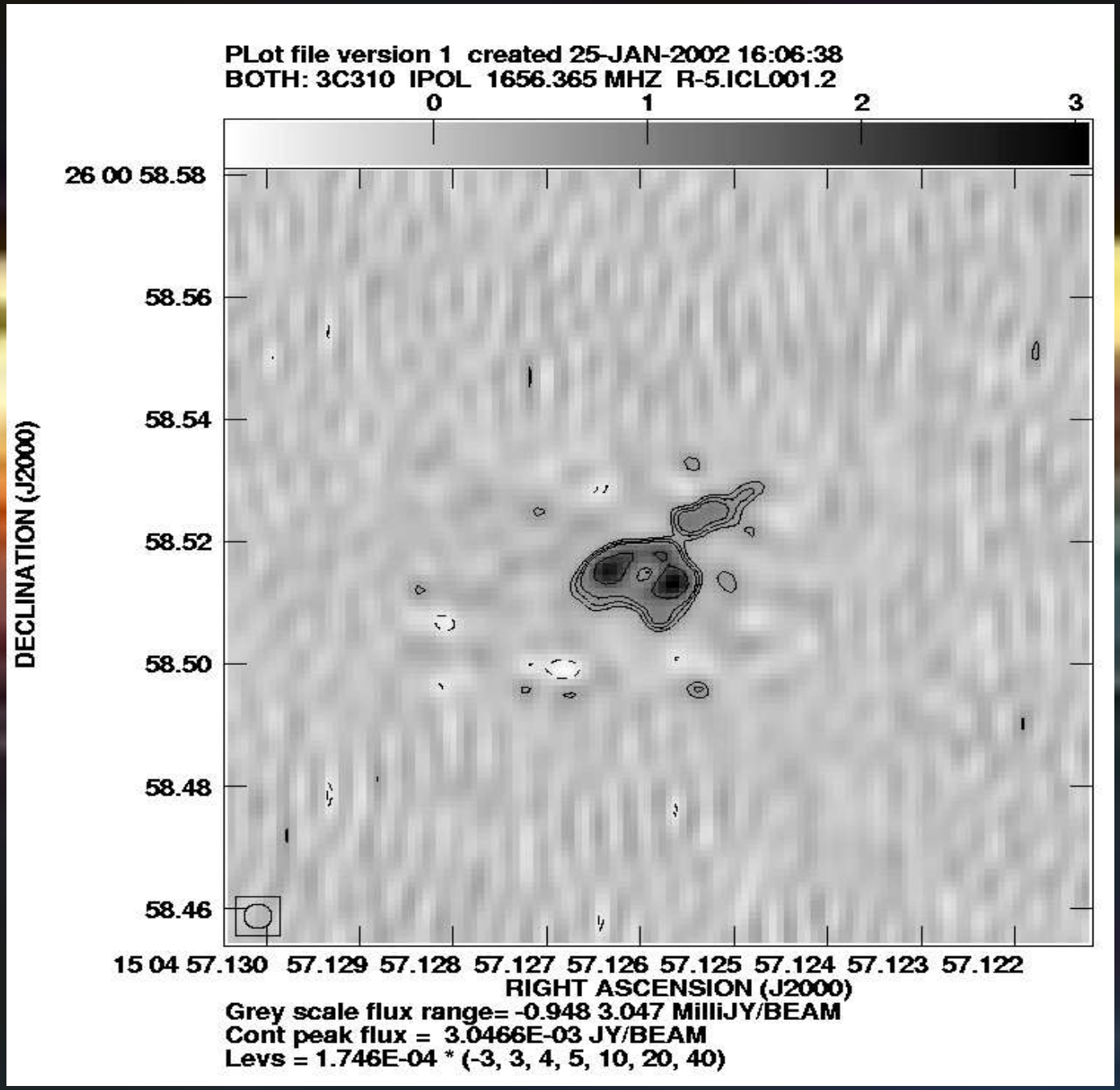
Figure 5a. Geometry of (top) and SAR distribution in phantom human head model exposed to 1900 Mhz dipole antenna.

Είμαστε Μόνοι

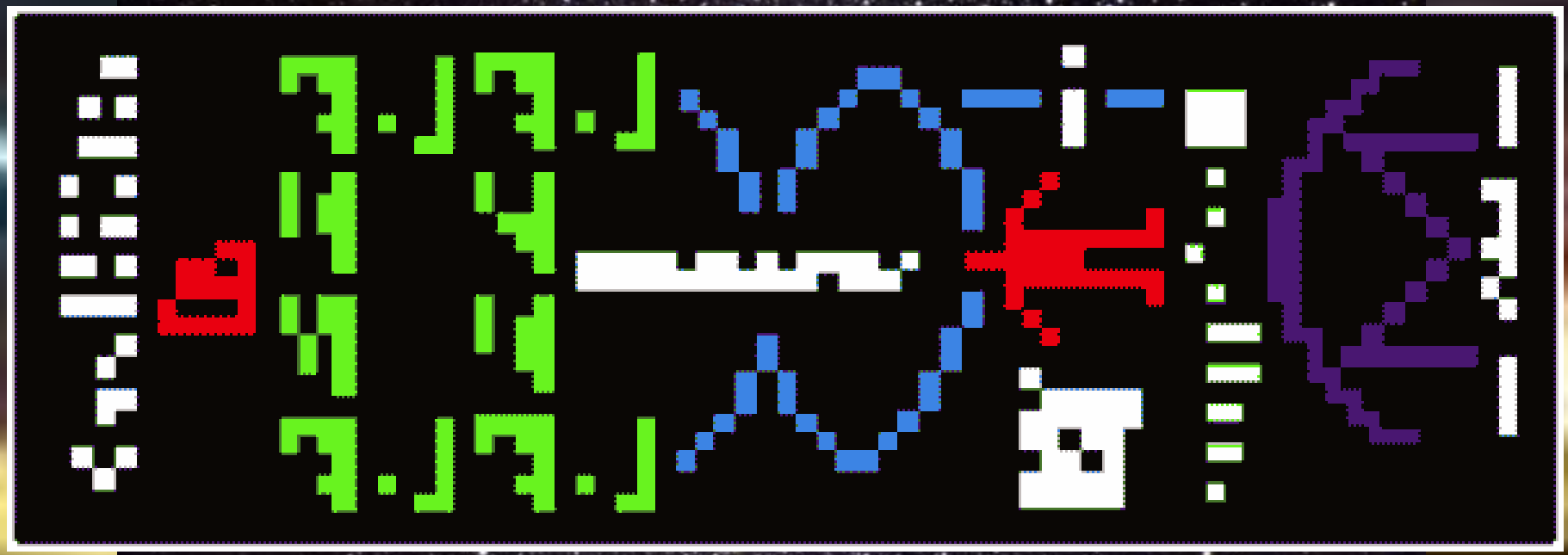

SETI



Υπάρχουν εξωγήινοι?

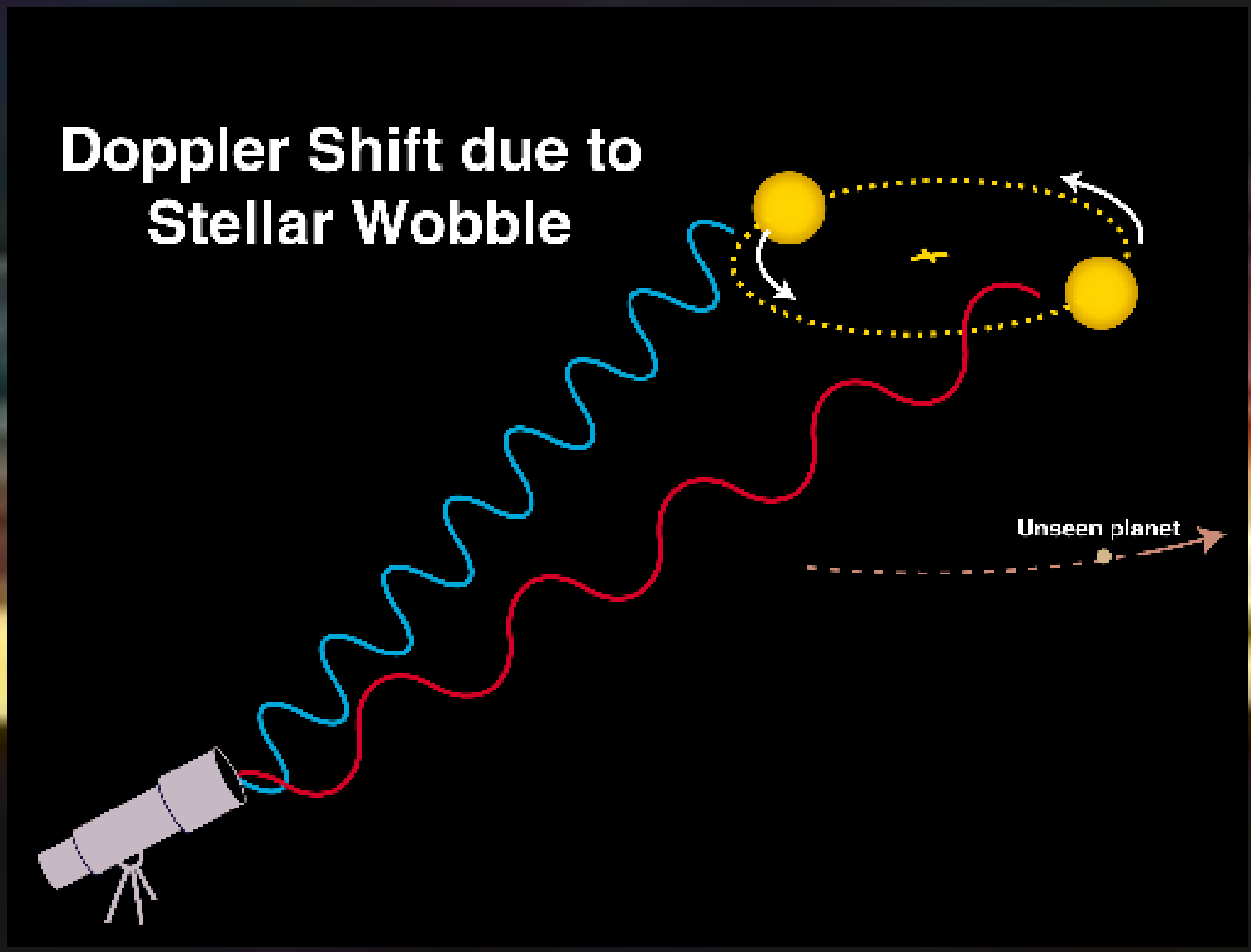

PLot file version 1 created 25-JAN-2002 16:06:38
BOTH: 3C310 IPOL 1656.365 MHZ R-5.ICL001.2
0
1
2
3
26 00 58.58
58.56
58.54
58.52
58.50
58.48
58.46
DECLINATION (J2000)
15 04 57.130
57.129
57.128
57.127
57.126
57.125
57.124
57.123
57.122
RIGHT ASCENSION (J2000)
Grey scale flux range= -0.948 3.047 MilliJY/BEAM
Cont peak flux = 3.0466E-03 JY/BEAM
Levs = 1.746E-04 * (-3, 3, 4, 5, 10, 20, 40)

Το μήνυμα



M13

ΑΜΕΤΡΗΤΟΙ ΠΛΑΝΗΤΕΣ



$$N_T = R_* \cdot f_p \cdot f_h \cdot f_s \cdot f_i \cdot f_t \cdot t_l$$

N_T = Number of technological civilizations in the galaxy.

R_* = Rate at which stars are born, averaged over the lifetime of the galaxy. (Stars/year)

f_p = Fraction having planetary systems.

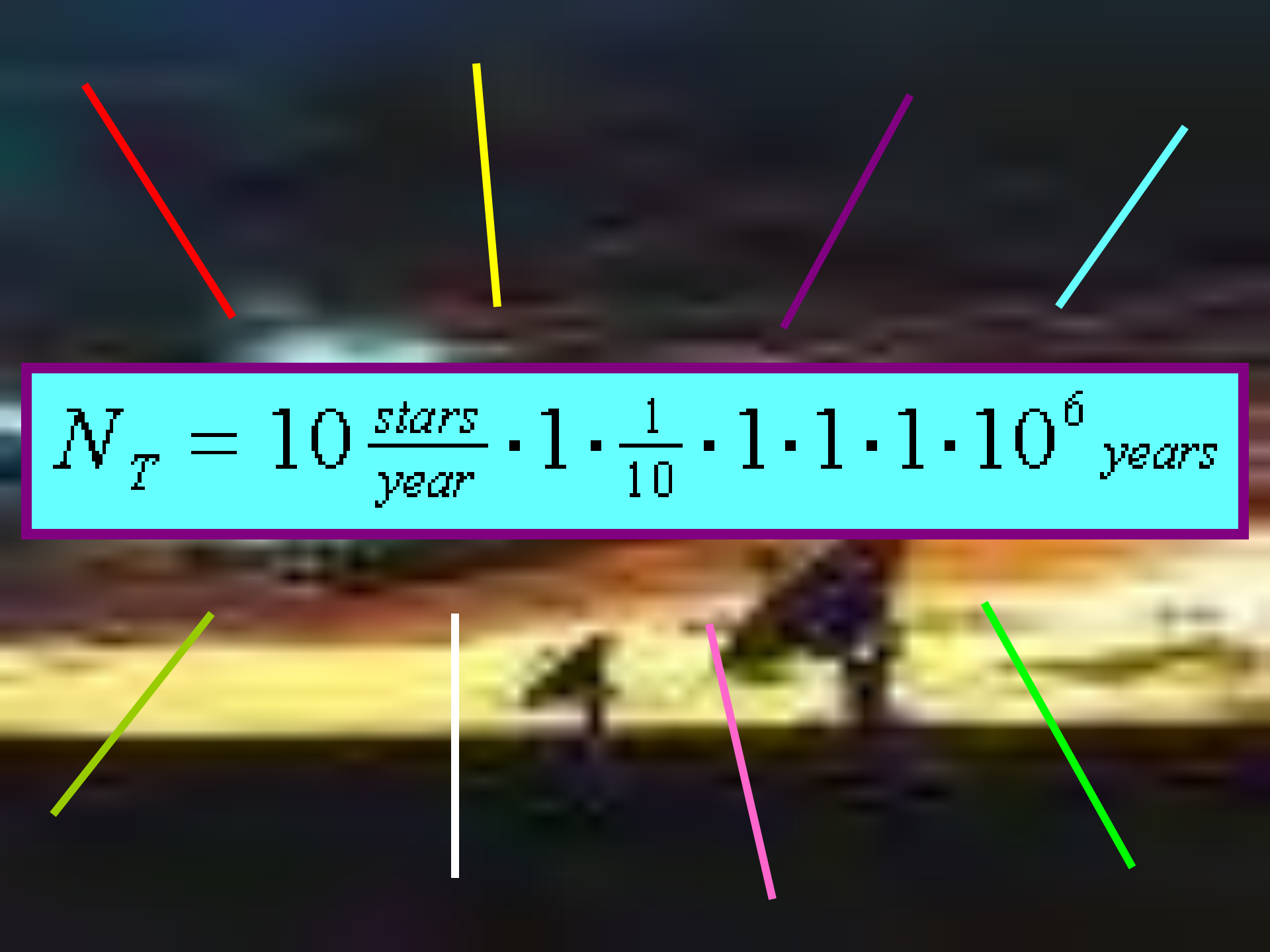
f_h = Average number of life-suitable (habitable) planets within those systems having planets.

f_s = Fraction of habitable planets on which at least simple life arises.

f_i = Fraction of life-bearing planets on which intelligence evolves.

f_t = Fraction of those intelligent life planets that develop a technological society.

t_l = Average lifetime of a technological civilization. (years)


$N_T = 10 \frac{stars}{year} \cdot 1 \cdot \frac{1}{10} \cdot 1 \cdot 1 \cdot 1 \cdot 10^6 \, years$

Ενδιαφέροντα SITES

Εικονικό συμβολόμετρο
http://www.jb.man.ac.uk/vri/vri/intro.html

Εξω-πλανήτες http://exoplanet.eu/
http://exoplanets.org/
http://techinfo.jpl.nasa.gov

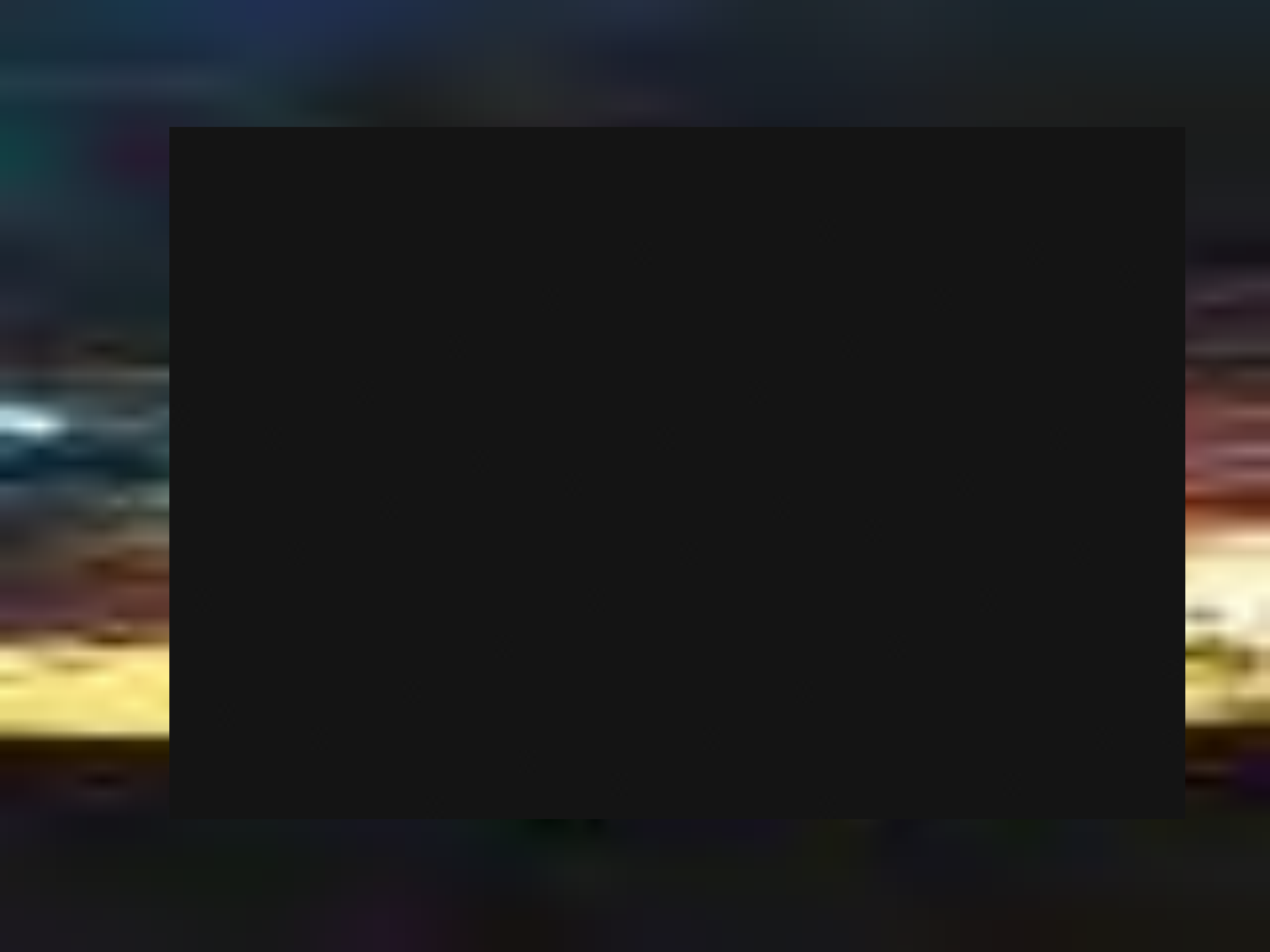
http://setiathome.berkeley.edu/

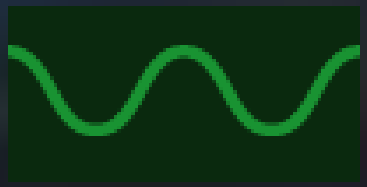
http://hubblesite.org/newscenter/archive/releases/2006/01/image/a/format/zoom/

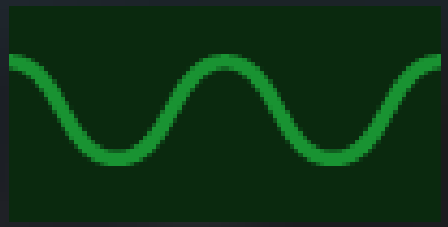
http://www.jb.man.ac.uk/atlas/

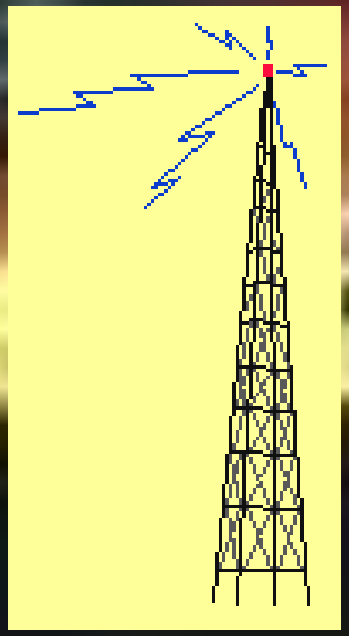
Ερασιτέχνες ραδιο:http://radio-astronomy.org/

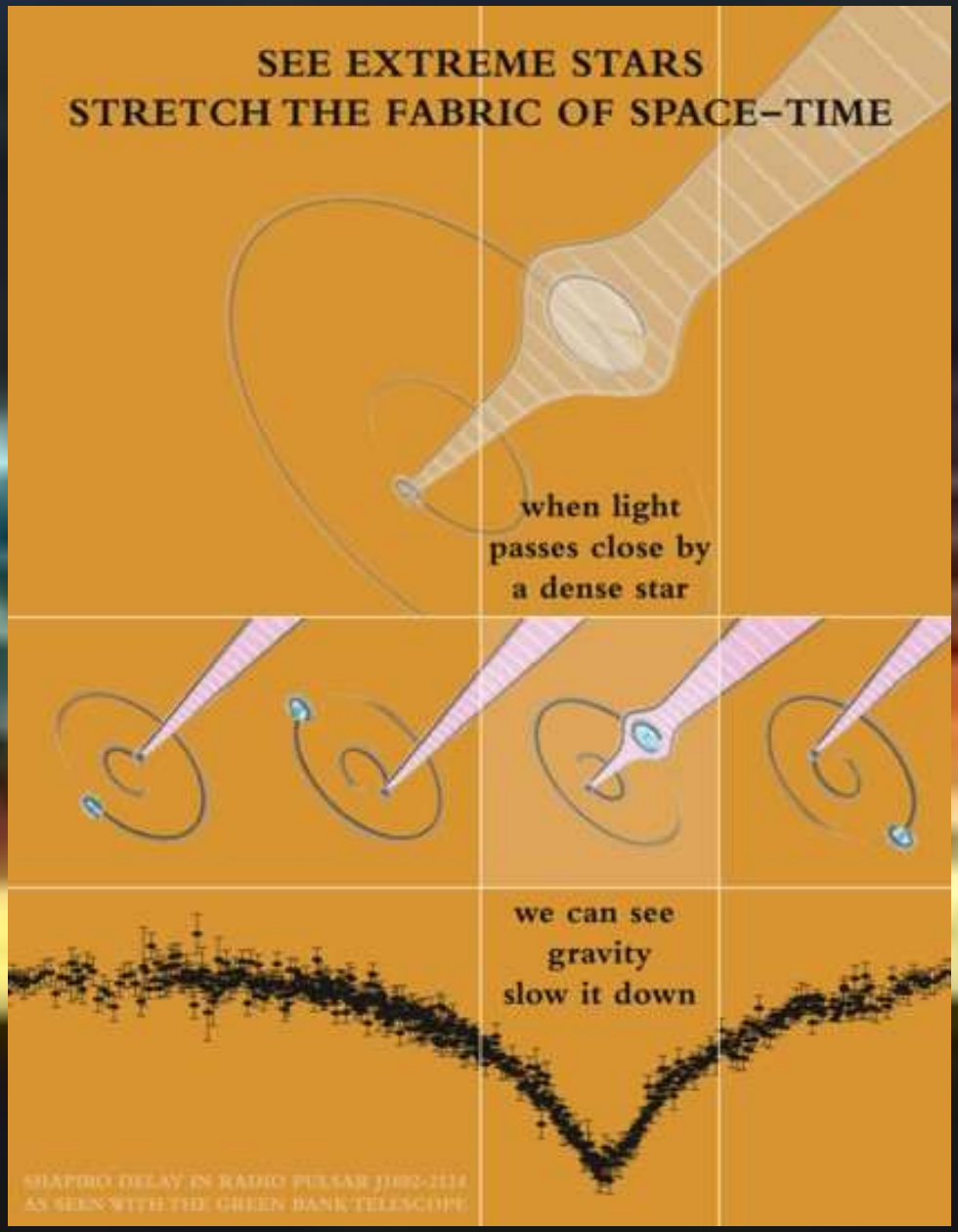
Σας ευχαριστώ

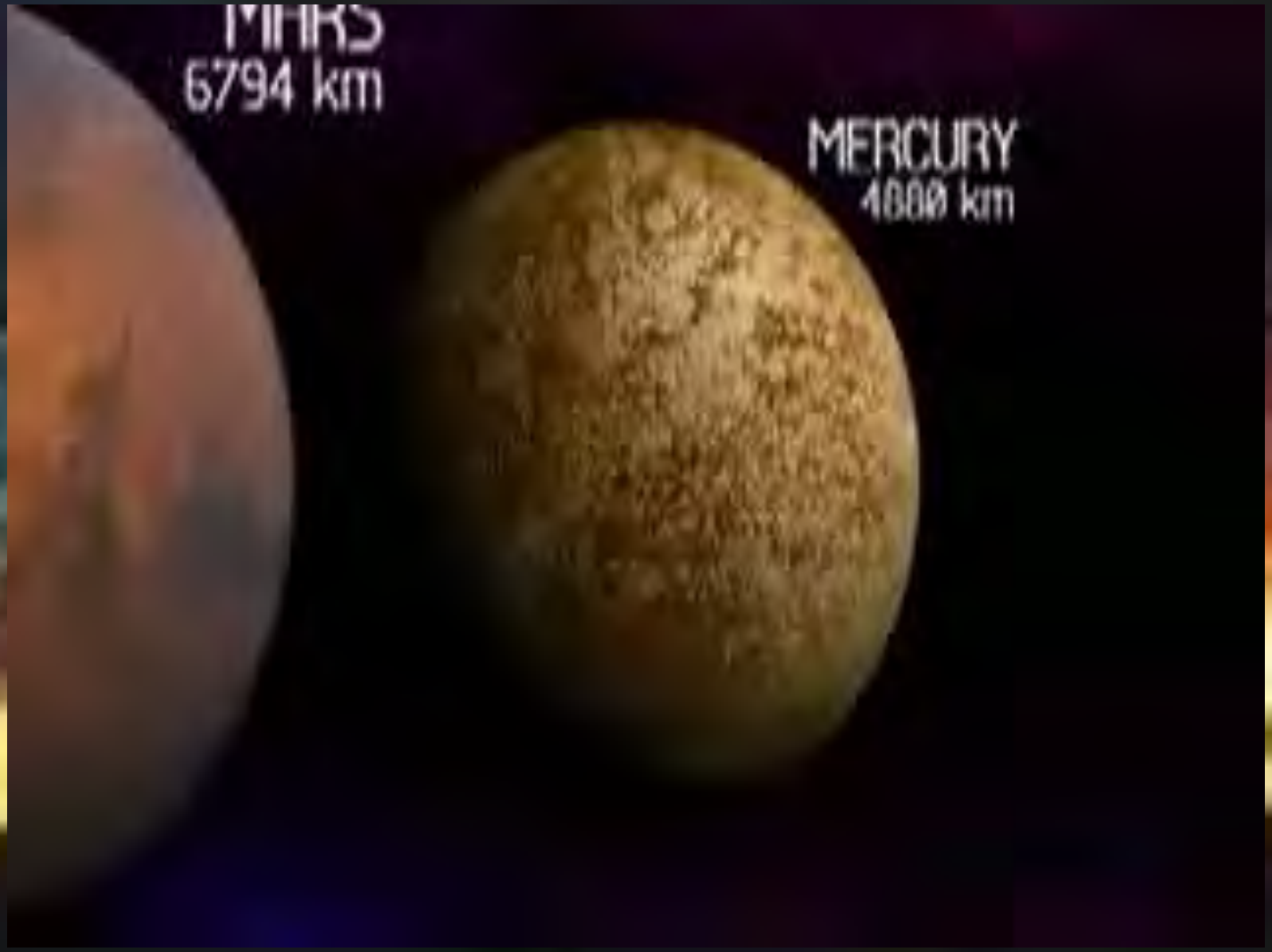




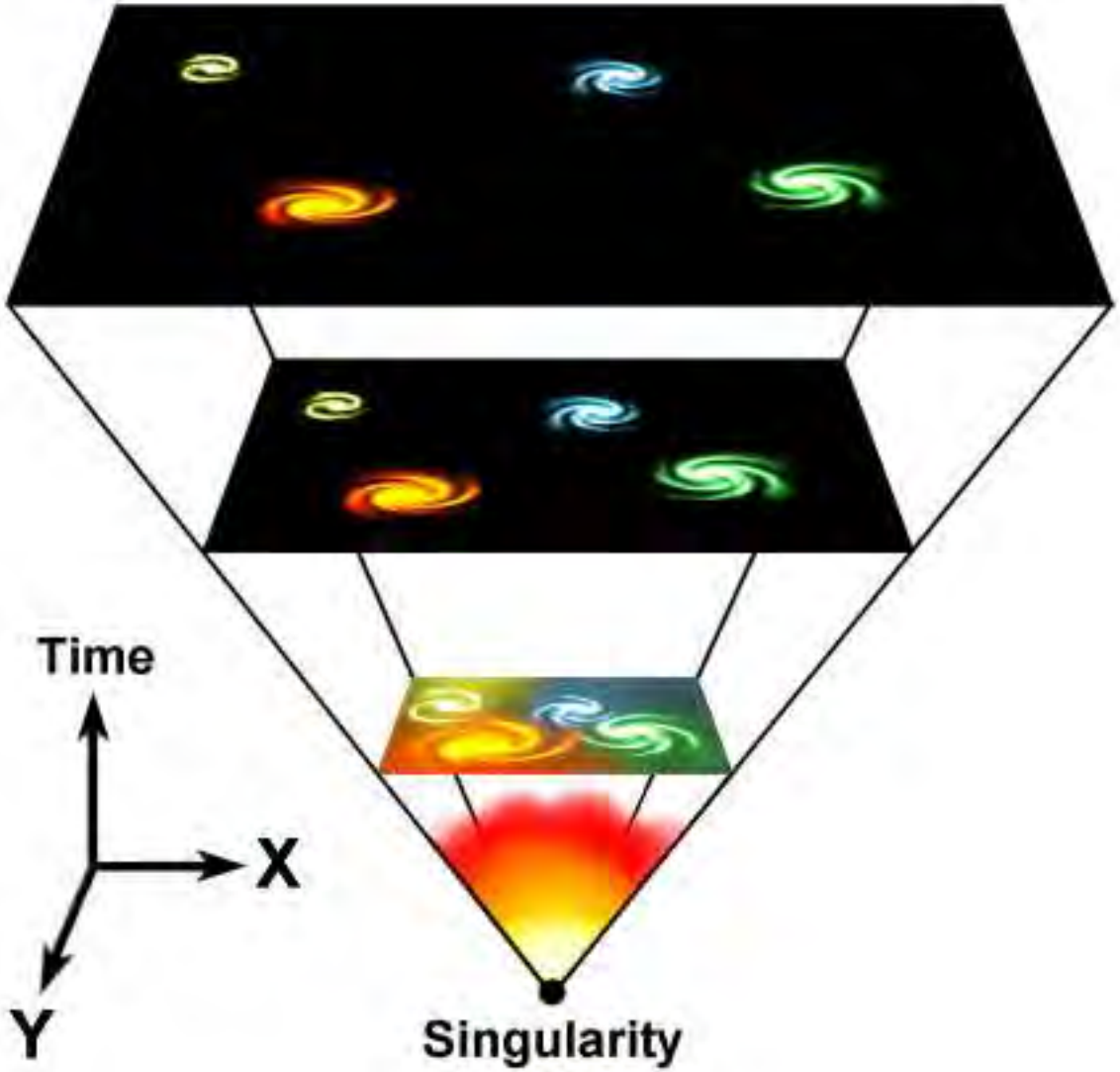




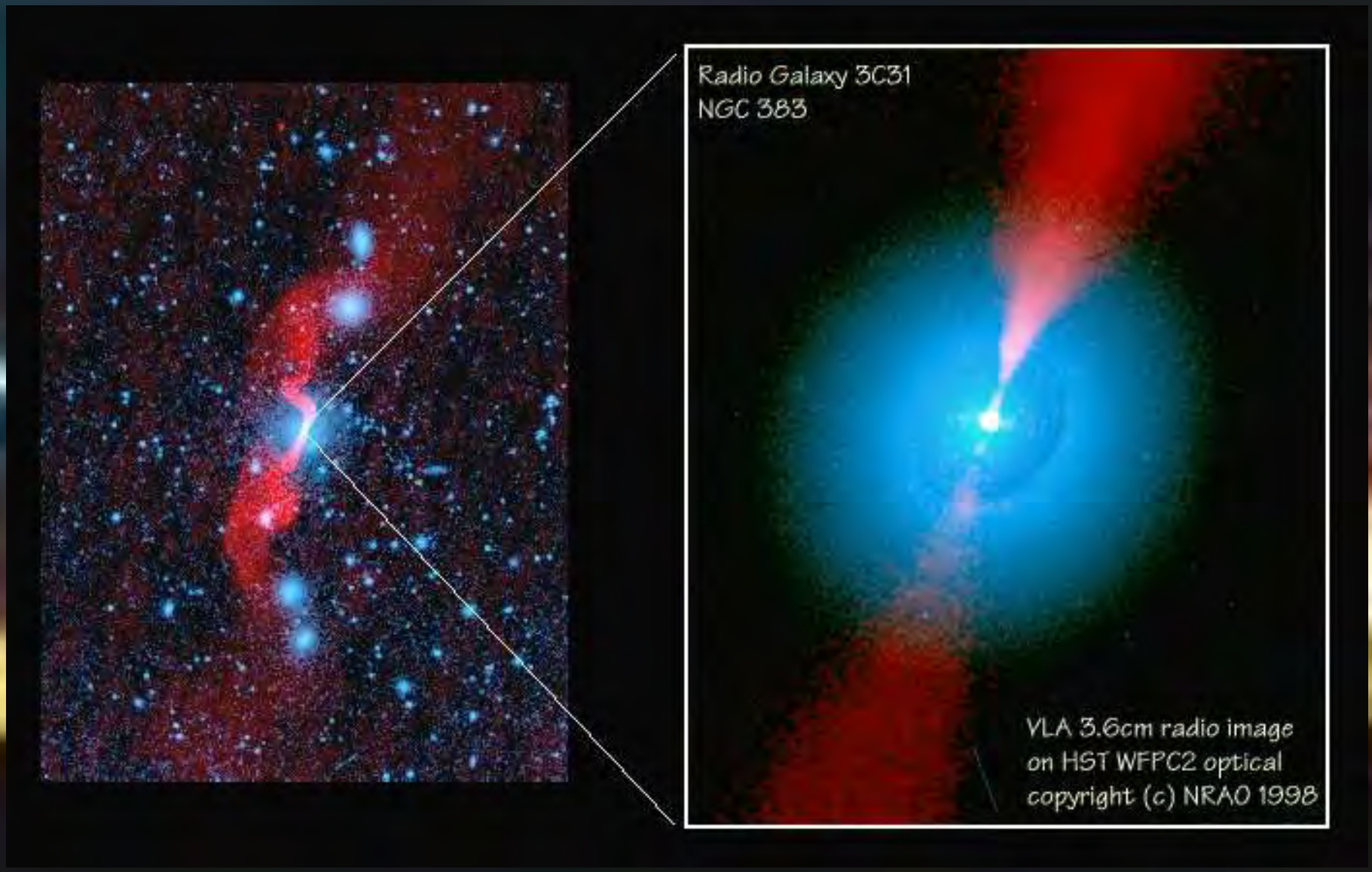

SEE EXTREME STARS
STRETCH THE FABRIC OF SPACE-TIME
when light
passes close by
a dense star
we can see
gravity
slow it down


MARS
6794 km
MERCURY
4880 km

Singularity



Sobrero Galaxy


Radio Galaxy 3C31
NGC 383
VLA 3.6cm radio image
on HST WFPC2 optical
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Hawking radiation