

VLBI for Astronomy

Cristina García Miró

Madrid Deep Space Communications Complex

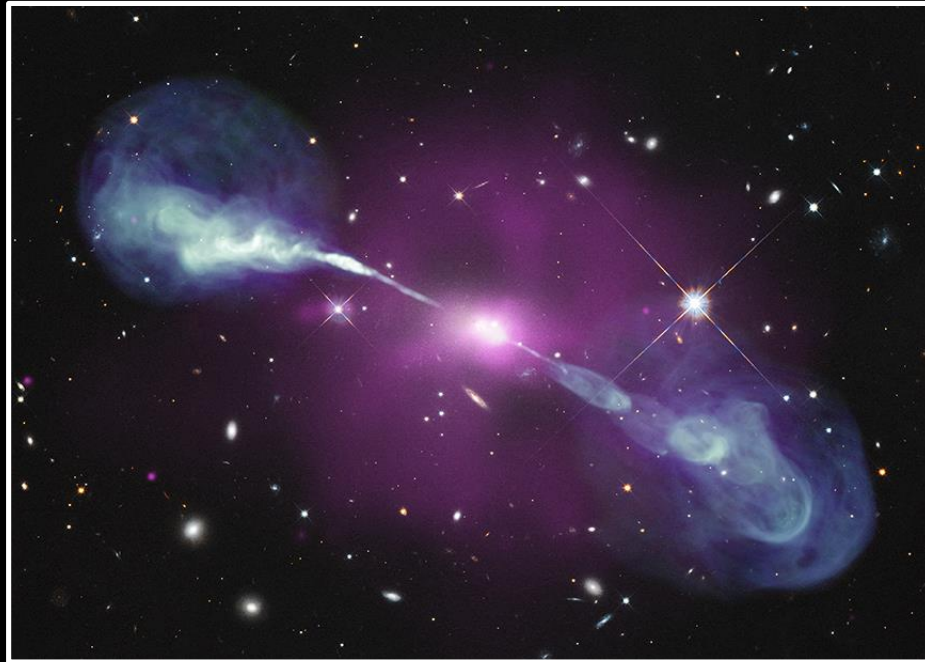
NASA/INTA

AVN Training School

HartRAO, March 2017



VLBI for Astronomy



Radio emission mechanisms
The radio sky: galactic and extragalactic
Different science cases for VLBI

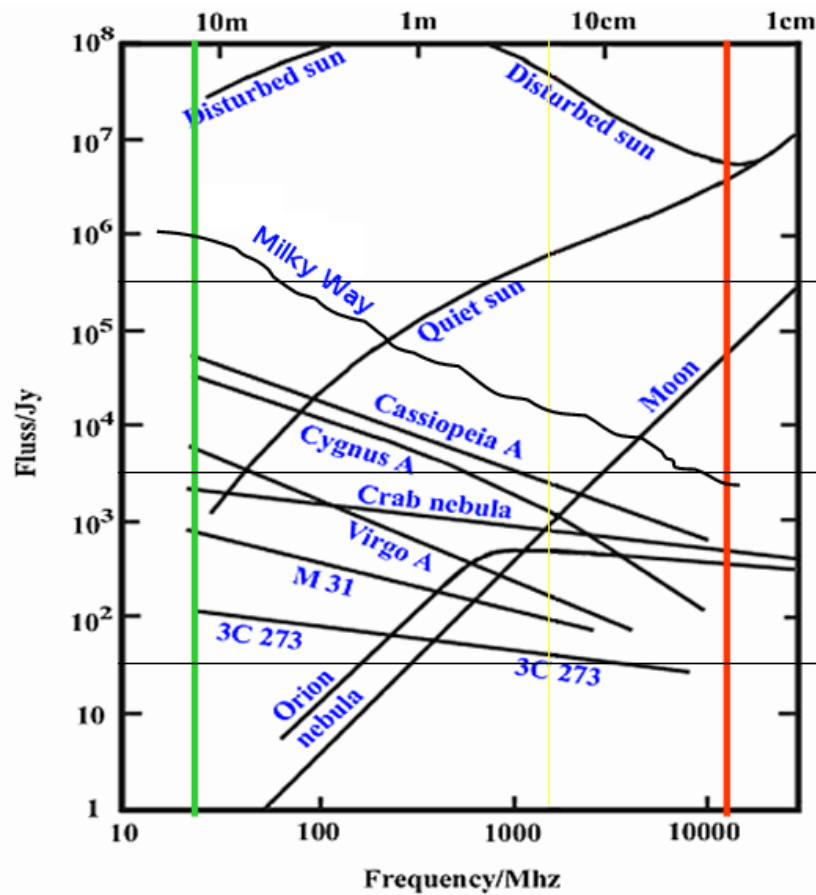
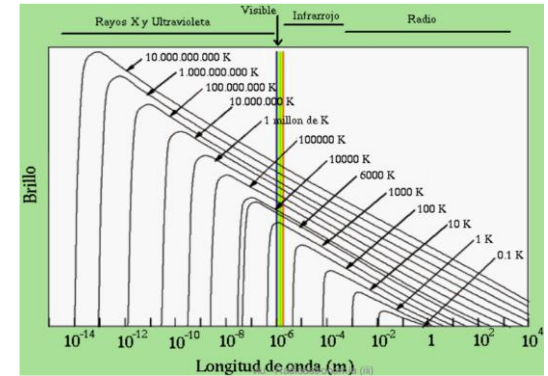
RADIO SKY (night and day)



RADIO SKY (night and day)

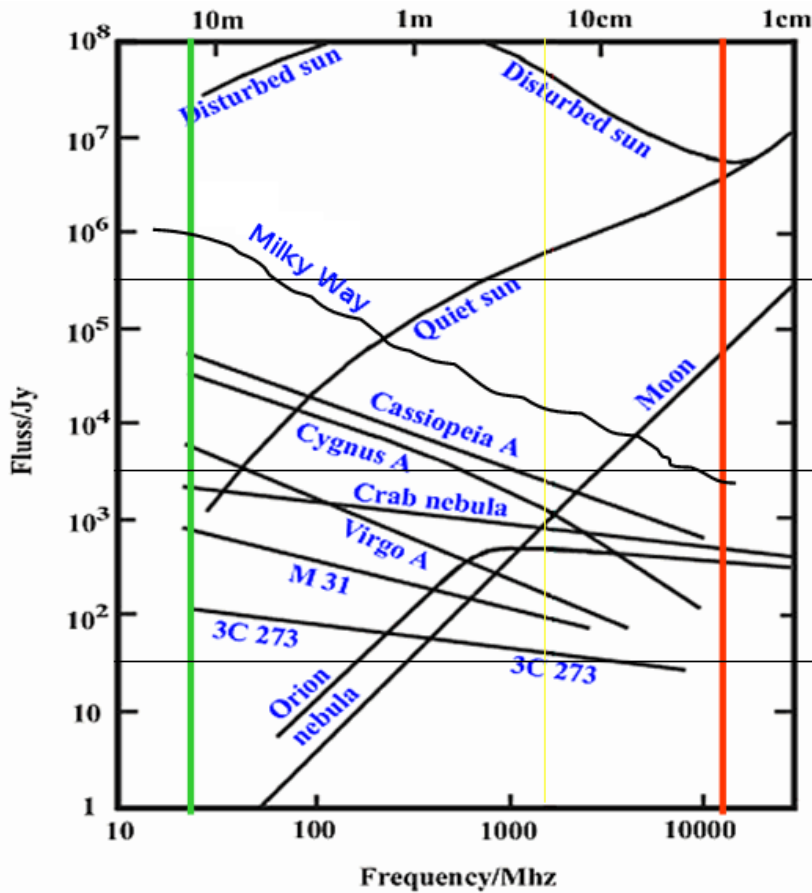
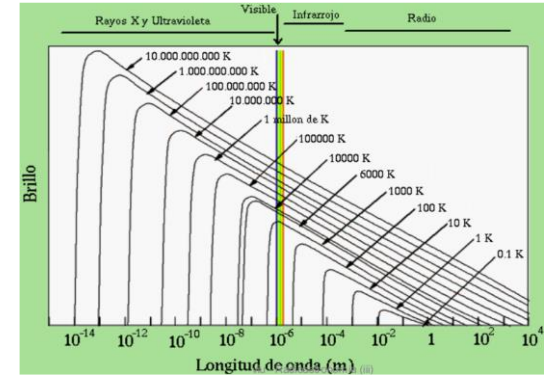


Emission mechanisms: continuum emission



BLACK BODY THERMAL EMISSION

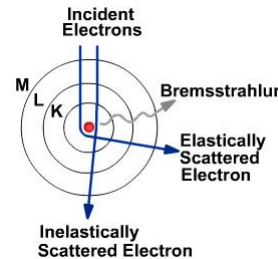
Emission mechanisms: continuum emission



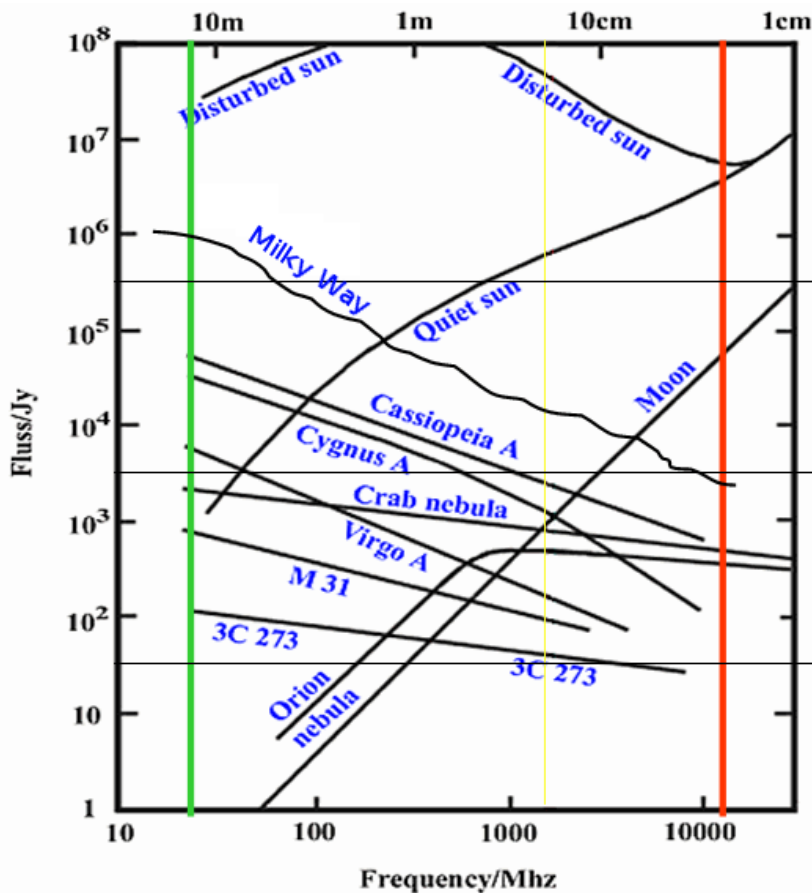
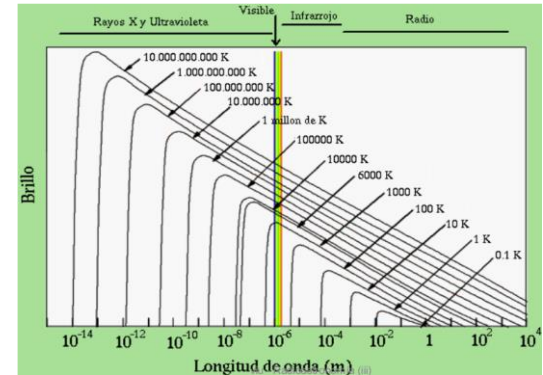
BLACK BODY THERMAL EMISSION



IONIZED GAS EMISSION
(FREE-FREE)



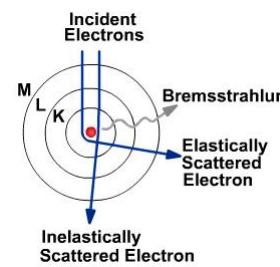
Emission mechanisms: continuum emission



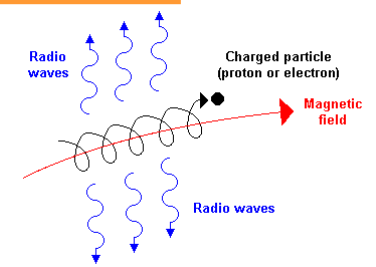
BLACK BODY THERMAL EMISSION



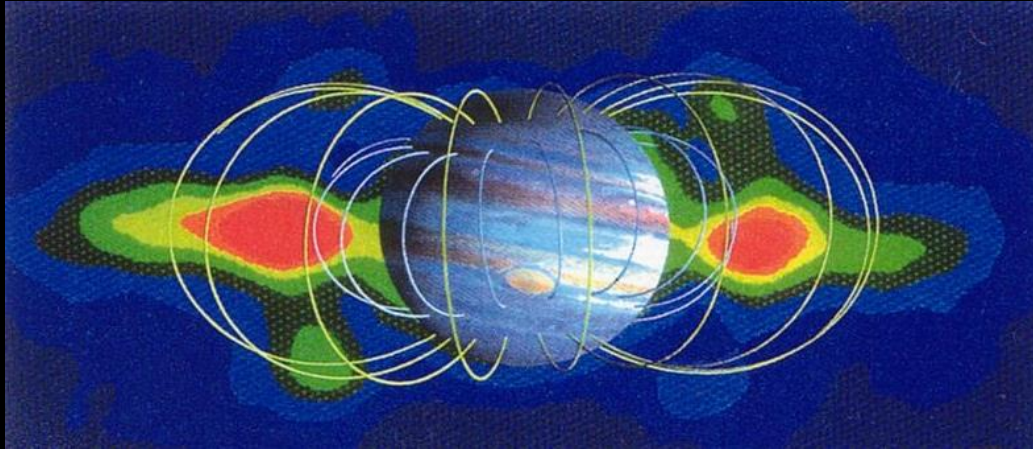
IONIZED GAS EMISSION
(FREE-FREE)



NON THERMAL EMISSION
(SYNCHROTRON)

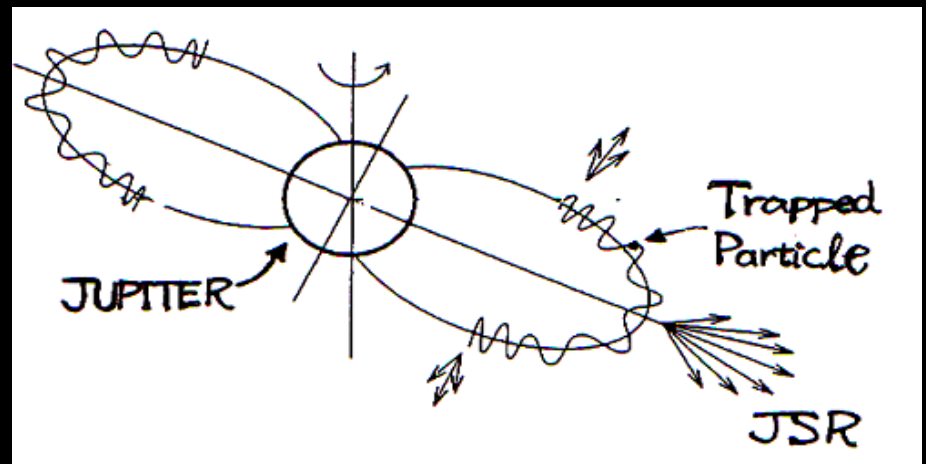
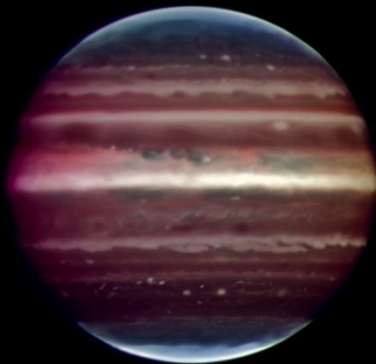


Jupiter continuum emission



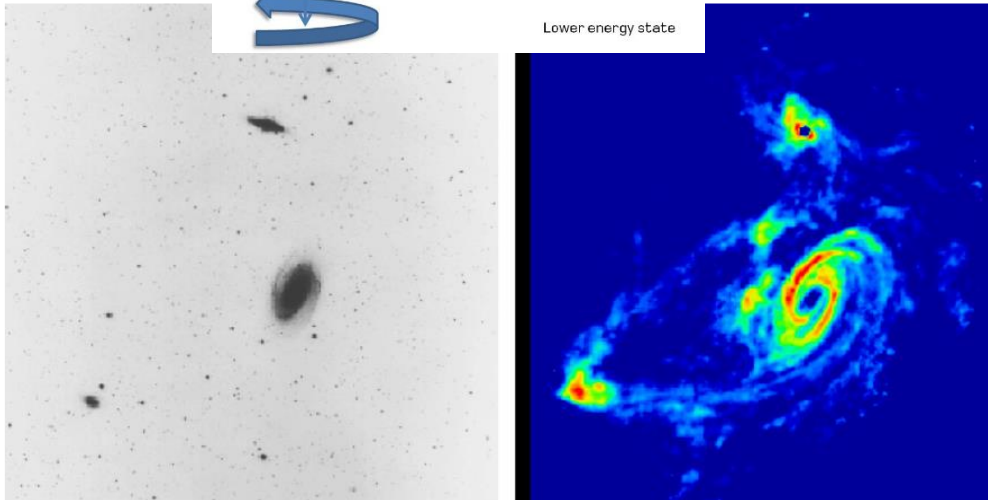
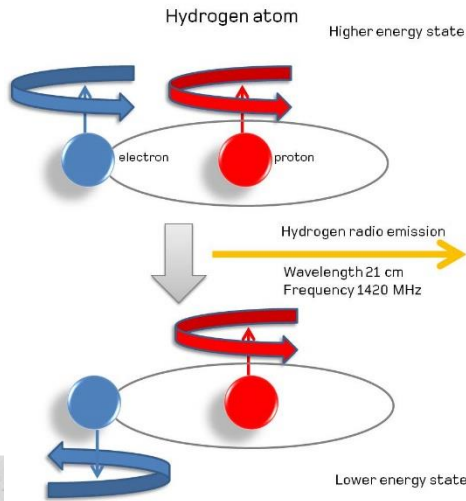
Black body thermal emission

Synchrotron non-thermal emission



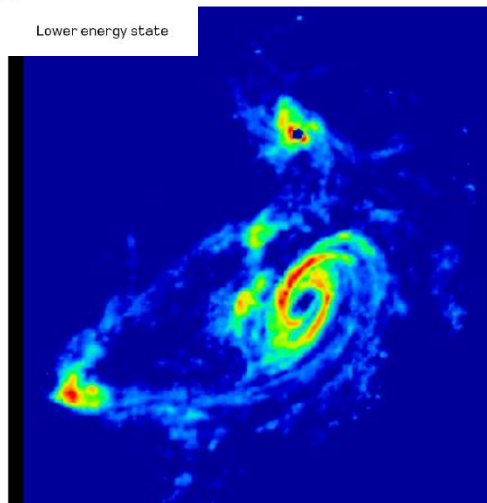
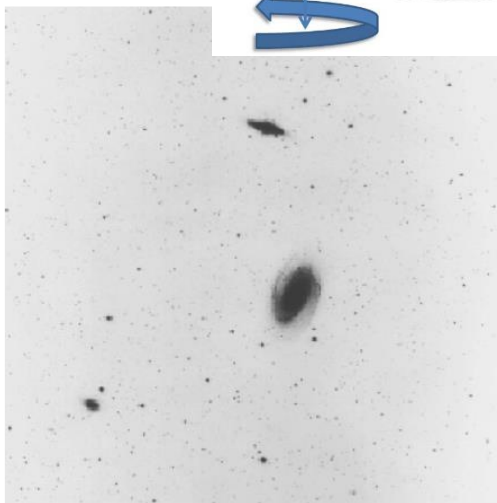
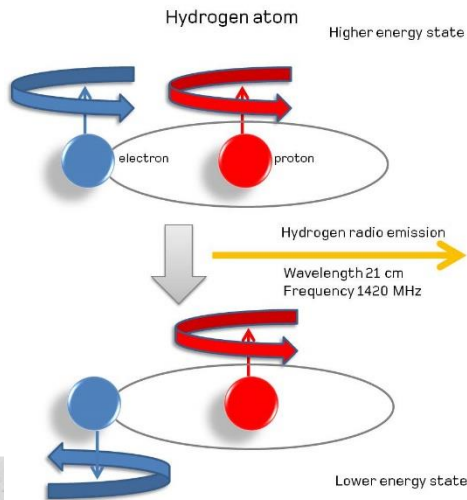
Emission mechanisms: spectral line emission

ATOMIC LINES: HI

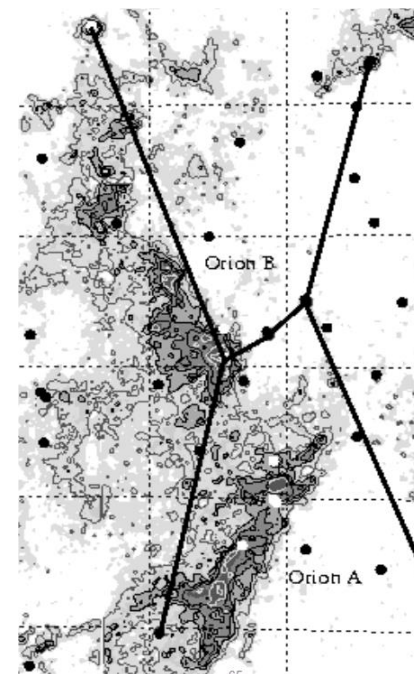
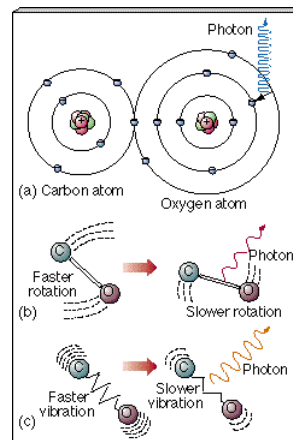


Emission mechanisms: spectral line emission

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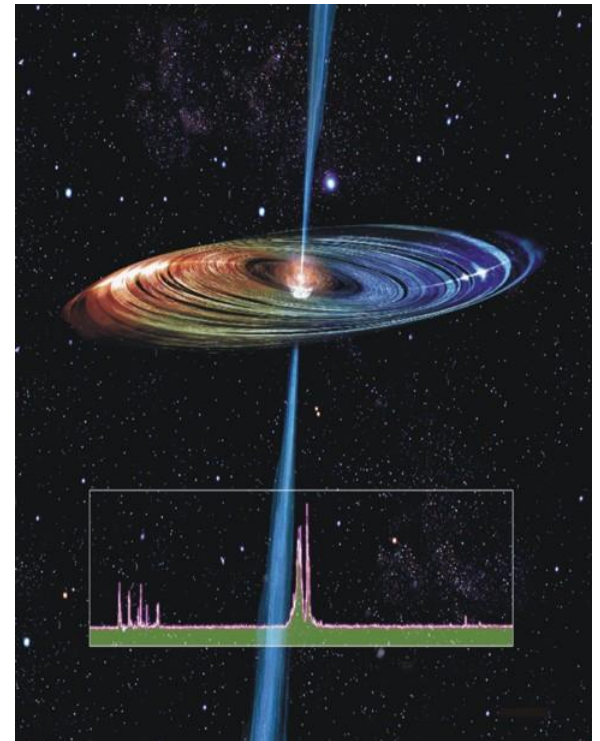
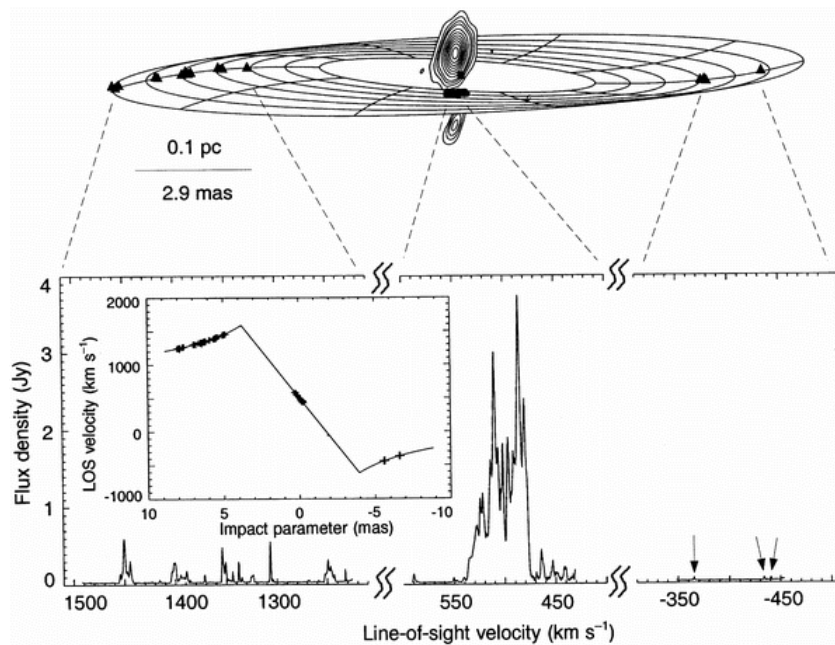
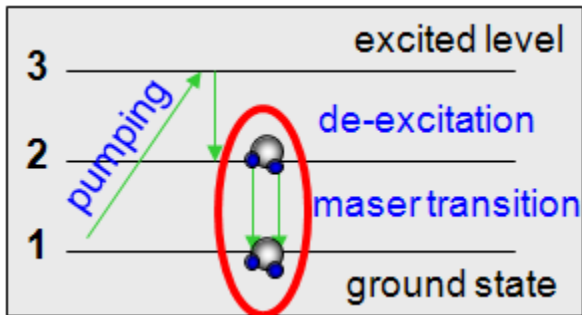


MOLECULAR LINES: CO

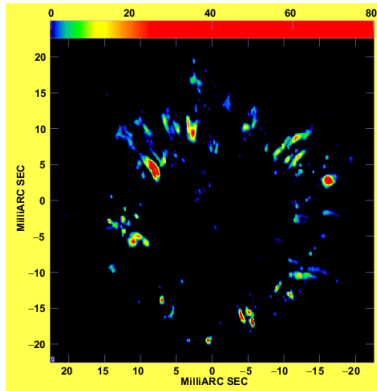


Emission mechanisms: spectral line emission

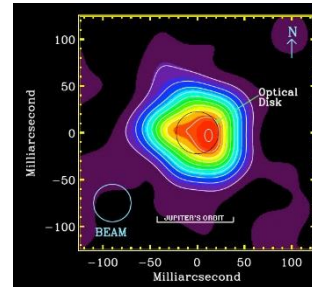
MASER EMISSION: H₂O



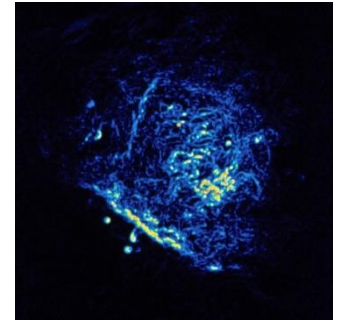
The radio sky: galactic objects



TX CAM SiO masers:
Pulsating Mira variable
(7mm VLBA)

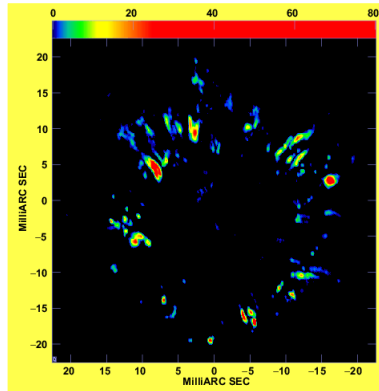
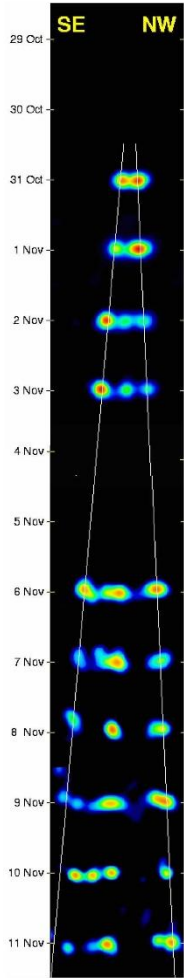


Betelgeuse red giant:
outer atmosphere activity
(7mm JVLA)

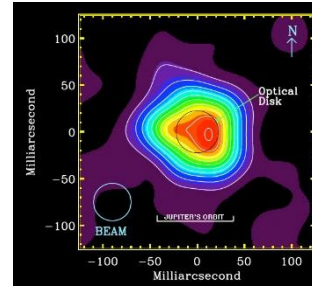


Orion nebula:
Filament structure
(20cm VLA)

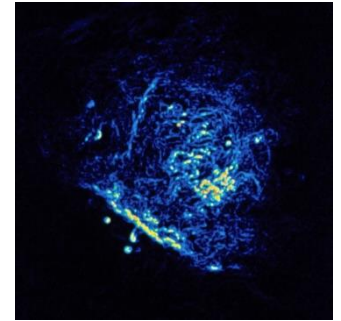
The radio sky: galactic objects



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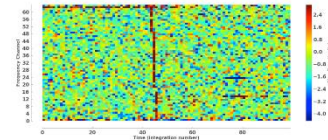


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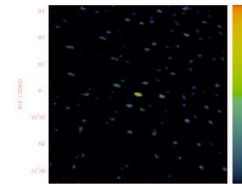


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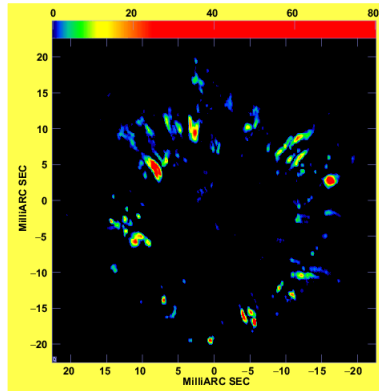
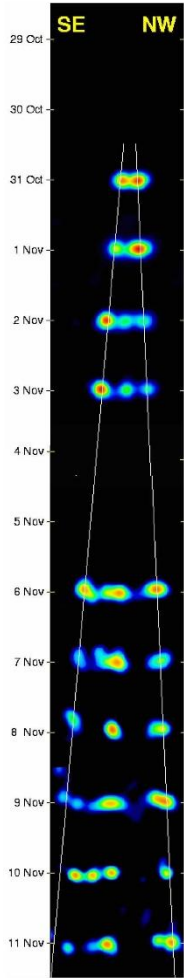
Microquasars:
GRS1915+105
Superluminal speed
(MERLIN)



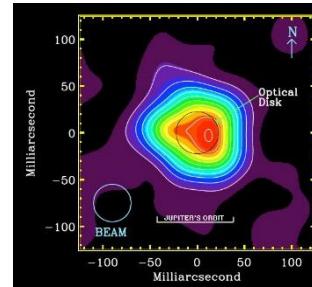
Pulsars: giant pulses
from Crab pulsar (JVLA)



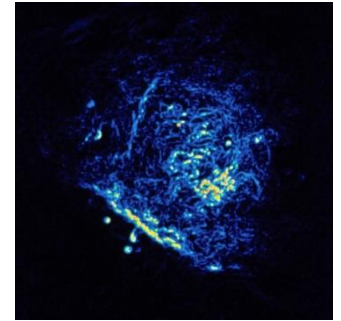
The radio sky: galactic objects



TX CAM SiO masers:
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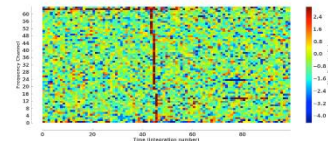


Betelgeuse red giant:
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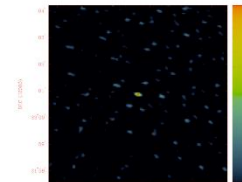


Orion nebula:
Filament structure
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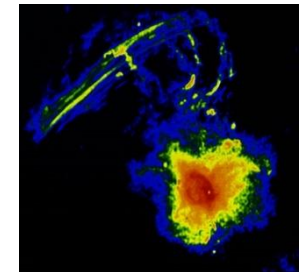
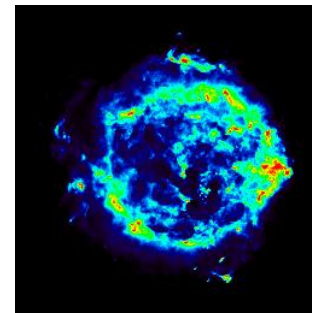
Microquasars:
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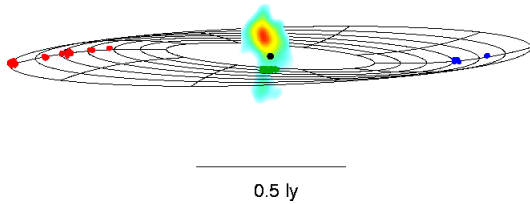


Supernova Remnants:
Cassiopeia A
(21cm JVLA)

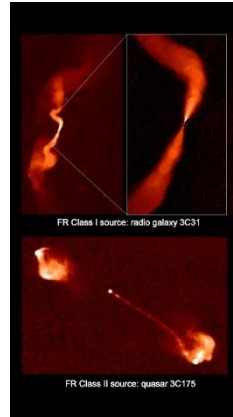


SMBH:
Sgr A*
(20 cm JVLA)

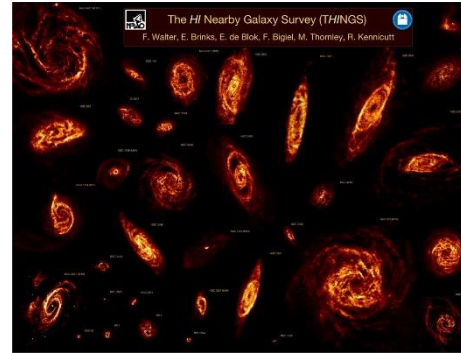
The radio sky: extragalactic objects



Water masers:
NGC4258
(1.3cm VLBA)

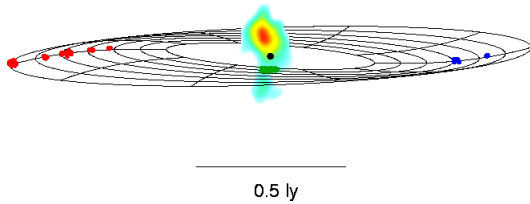


**Fanaroff-Riley
Galaxies (JVLA)**

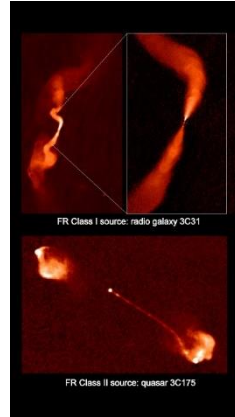


Neutral Hydrogen:
Nearby galaxies
(21 cm JVLA)

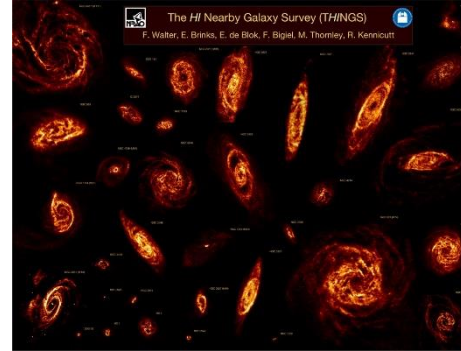
The radio sky: extragalactic objects



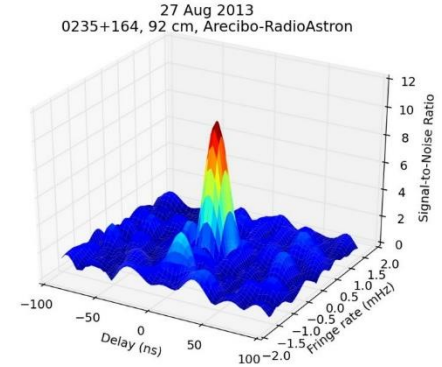
Water masers:
NGC4258
(1.3cm VLBA)



**Fanaroff-Riley
Galaxies (JVLA)**



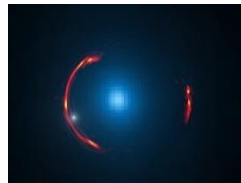
Neutral Hydrogen:
Nearby galaxies
(21 cm JVLA)



BL LAC object:
0235+164
(92 cm RadioAstron)

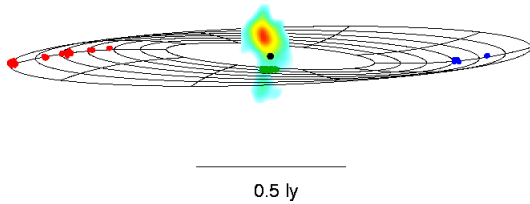


Fast Radio Burst:
FRB121102 from
distant dwarf galaxy
(JVLA)



Gravitational lenses:
SDP.81(ALMA)

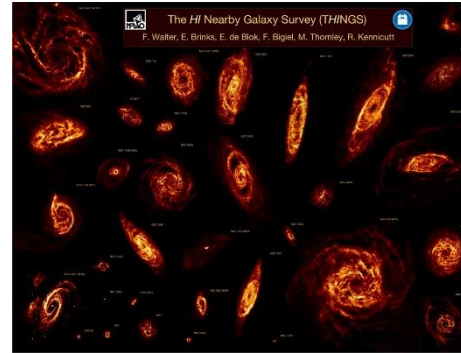
The radio sky: extragalactic objects



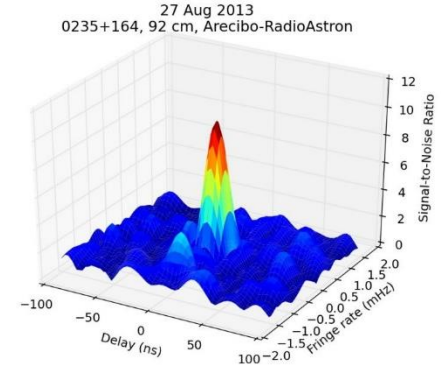
Water masers:
NGC4258
(1.3cm VLBA)



Fanaroff-Riley Galaxies (JVLA)



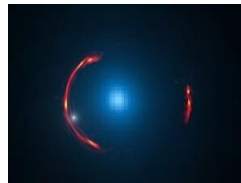
Neutral Hydrogen:
Nearby galaxies
(21 cm JVLA)



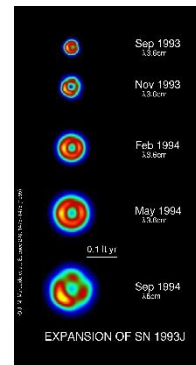
BL LAC object:
0235+164
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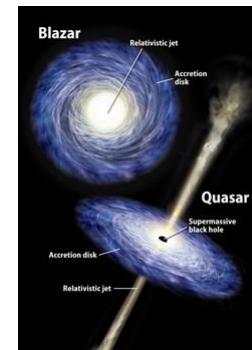
Fast Radio Burst:
FRB121102 from
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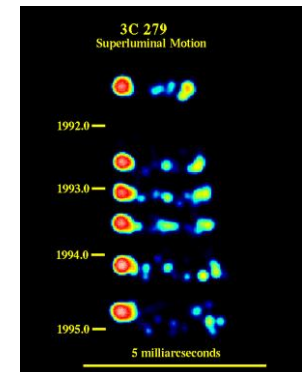
Gravitational lenses:
SDP.81(ALMA)



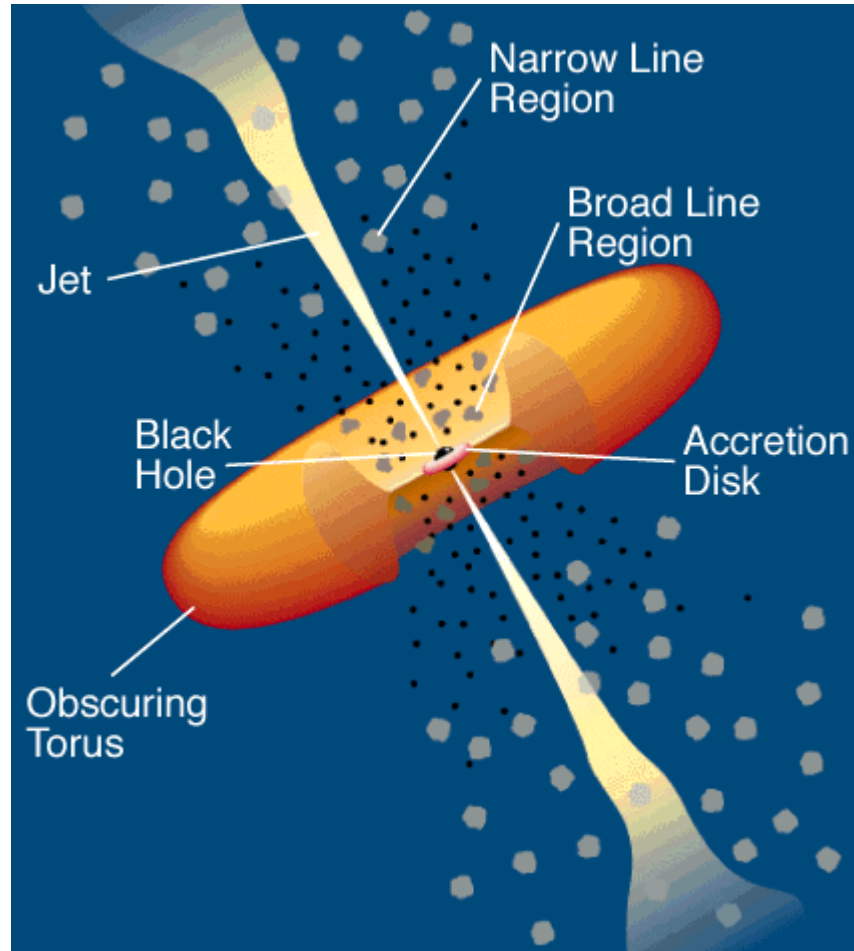
Supernovas:
SN 1993J (3.6 cm
VLBA+Global)



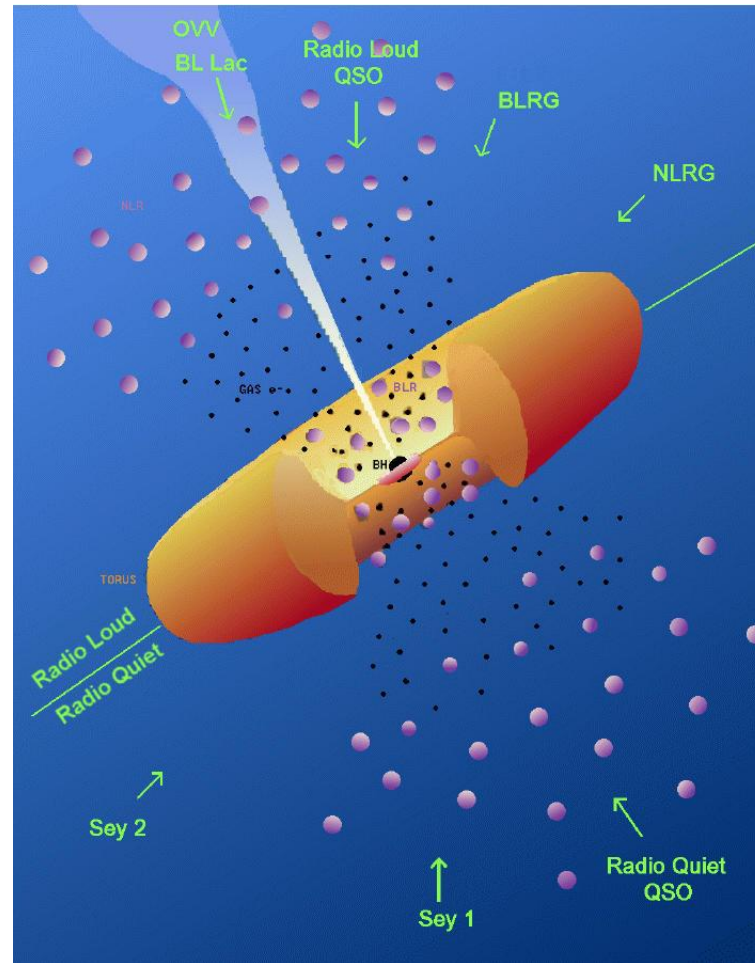
Quasars and Blazars:
3C279 (1.3 cm VLBA)



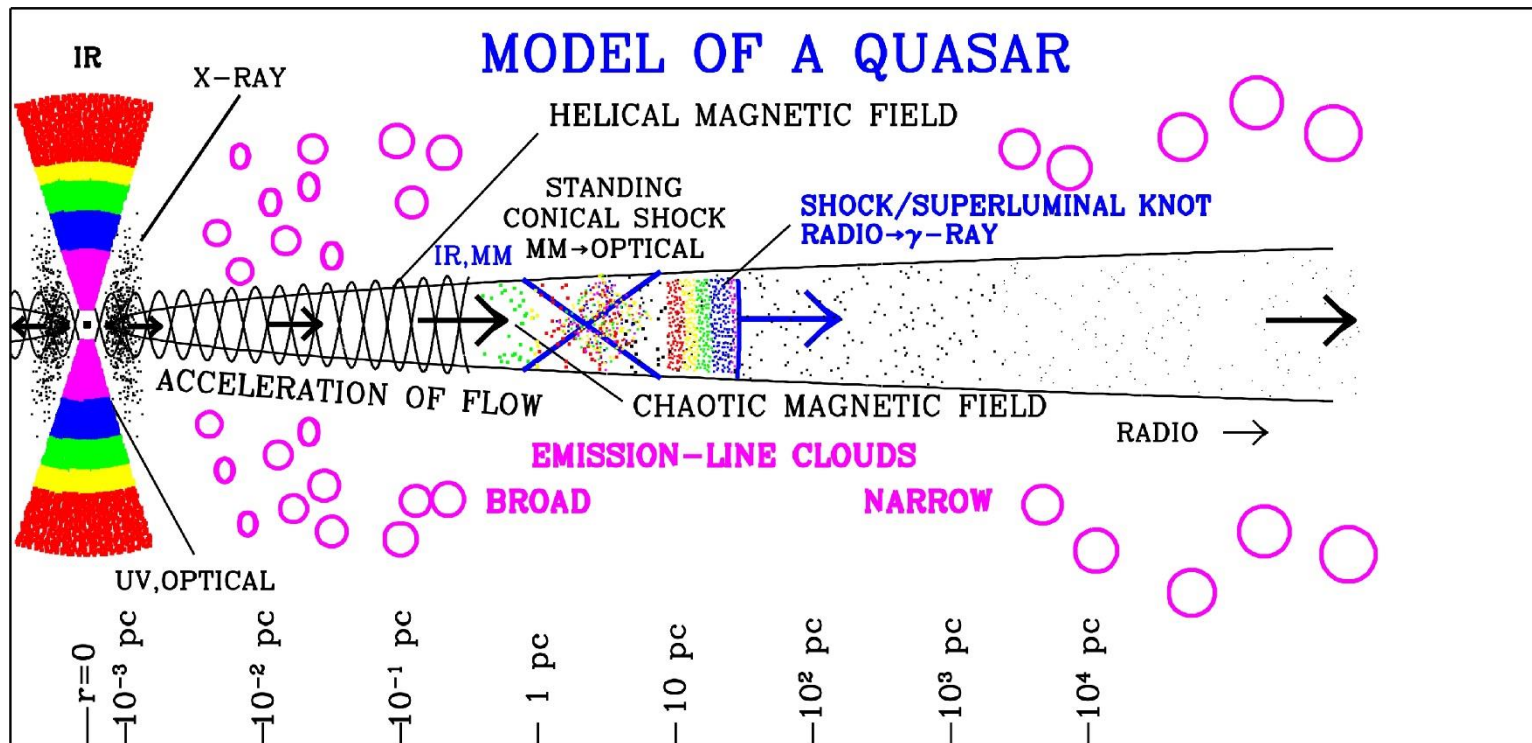
Active Galactic Nuclei: standard unified model



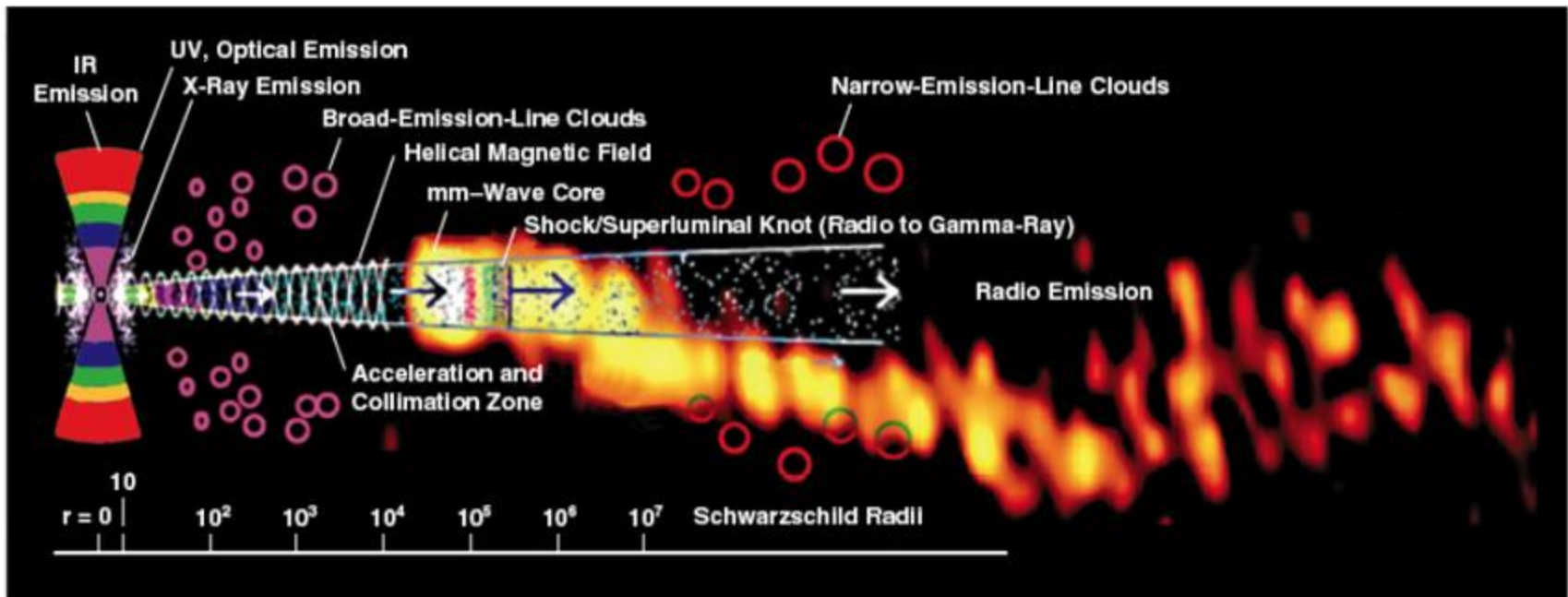
Active Galactic Nuclei: standard unified model



Active Galactic Nuclei: Quasar



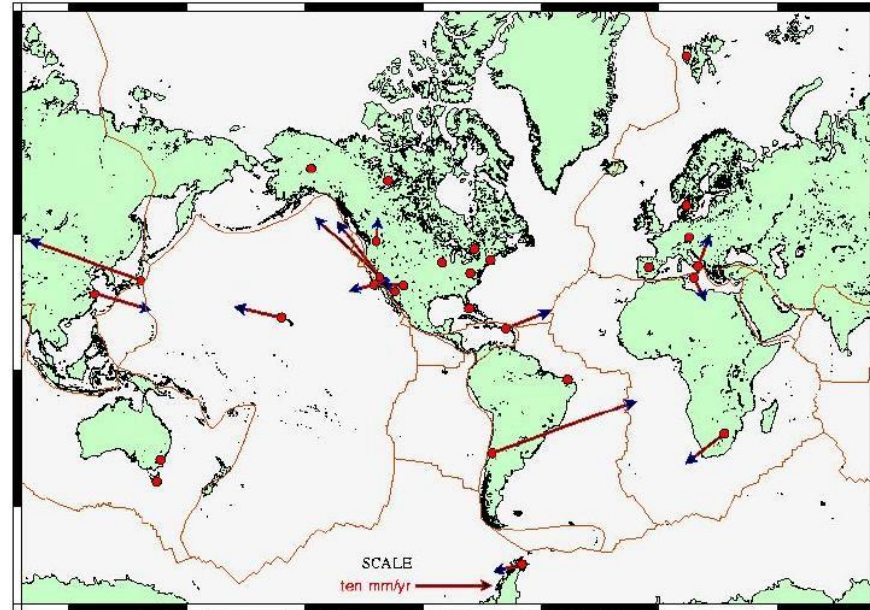
Active Galactic Nuclei: standard unified model



VLBI science cases: Geodesy



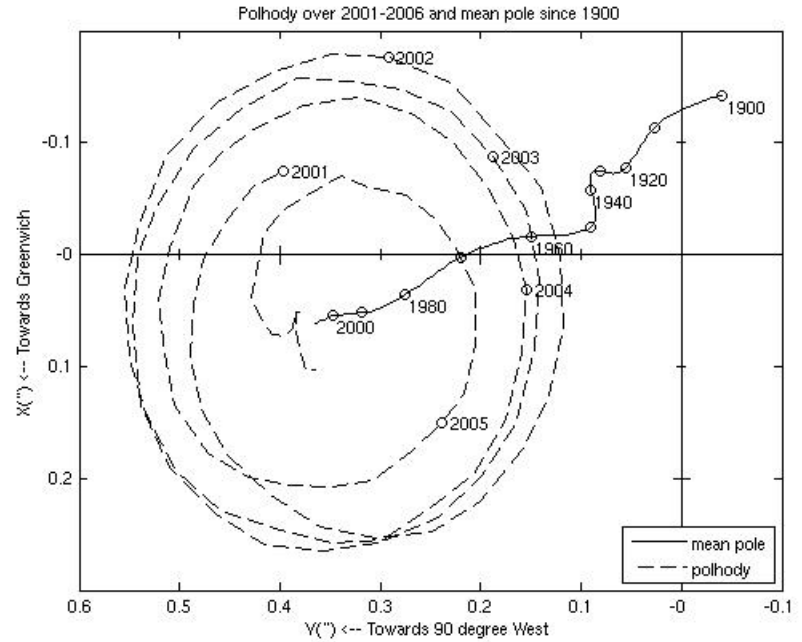
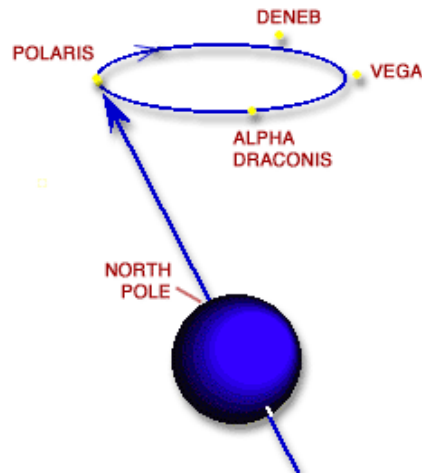
Differences between VLBI Velocities and Plate Model



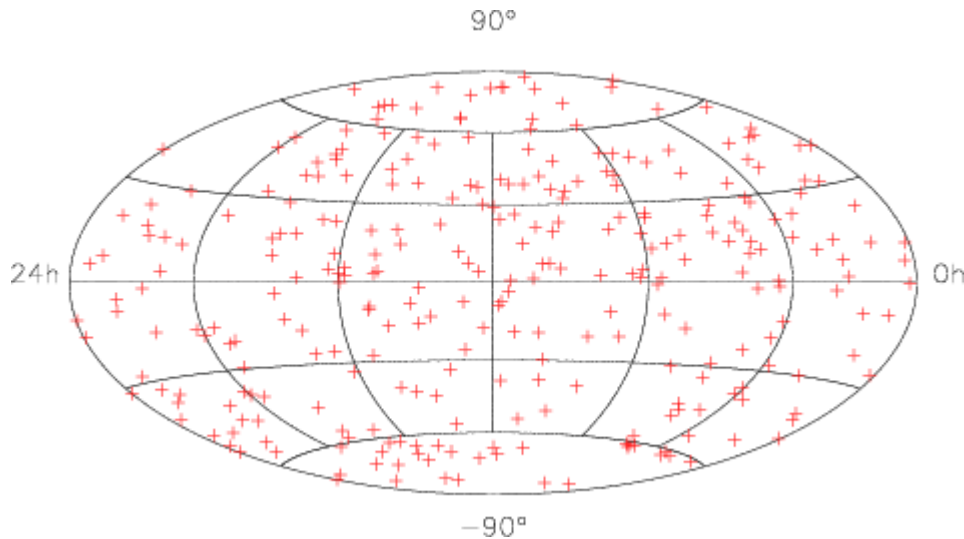
Goddard Space Flight Center VLBI solution KB 2003cn version 01
Velocity residuals < 2 mm/yr are not displayed. NUVEL1A-NNR reference frame.

<https://svs.gsfc.nasa.gov/10964>

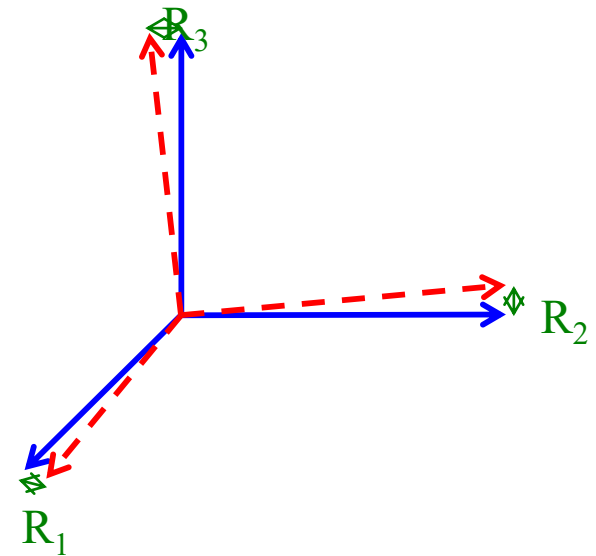
VLBI science cases: EOP



VLBI science cases: Celestial Reference Frames



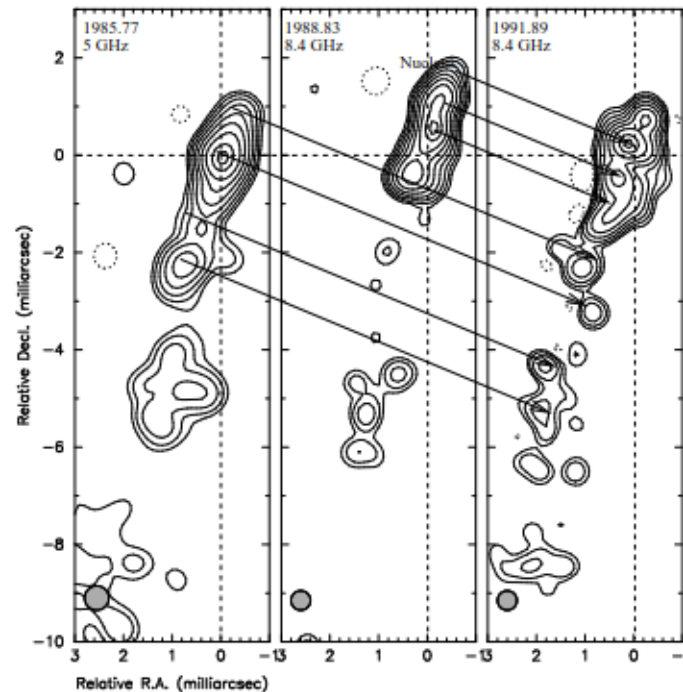
**ICRF2: 2nd realization International
Celestial Reference Frame**
295 defining sources



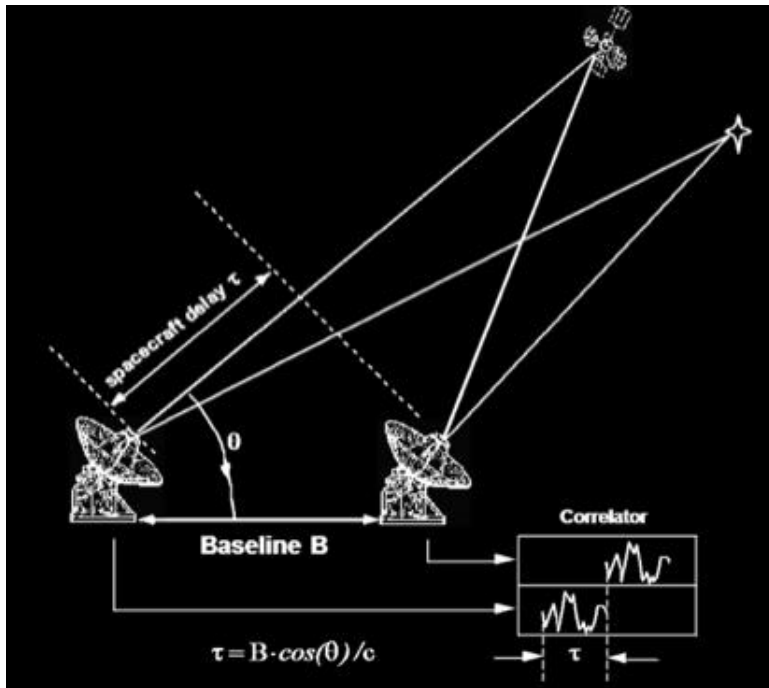
**Tie between reference frames, e.g.
radio and GAIA optical**

VLBI science cases: high precision astrometry

HIGH PRECISION ASTROMETRY WITH VLBI



VLBI science cases: Spacecraft tracking and Navigation



VLBI for Astronomy

MANY THANKS!!

Cristina García Miró

Madrid Deep Space Communications Complex

NASA/INTA

AVN Training School

HartRAO, March 2017

