VLTI and extragalactic science

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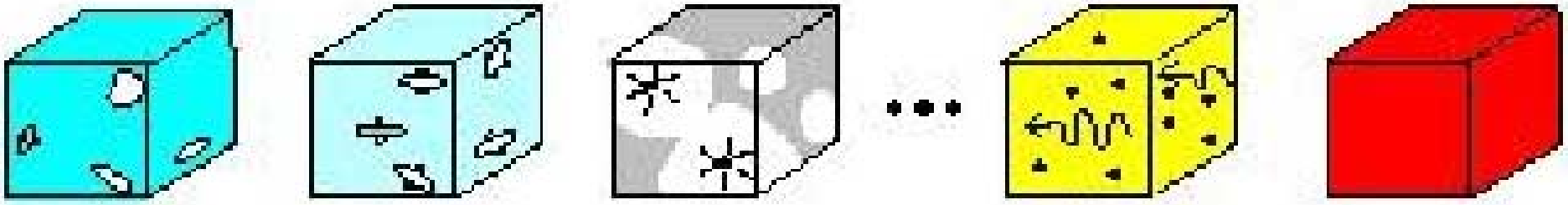
Overview

- Observations and theories
  - Galaxies
  - Active galaxies
- 10 micron MIDI observations of nearby AGN
- Prima observations of distant radio loud and radio quiet ellipticals
- Conclusions

Complexity

TIME

Simplicity



z=0
Intelligent Life

z=3
galaxy formation

z=10
reionization
first stars and quasars

z =1000
recombination

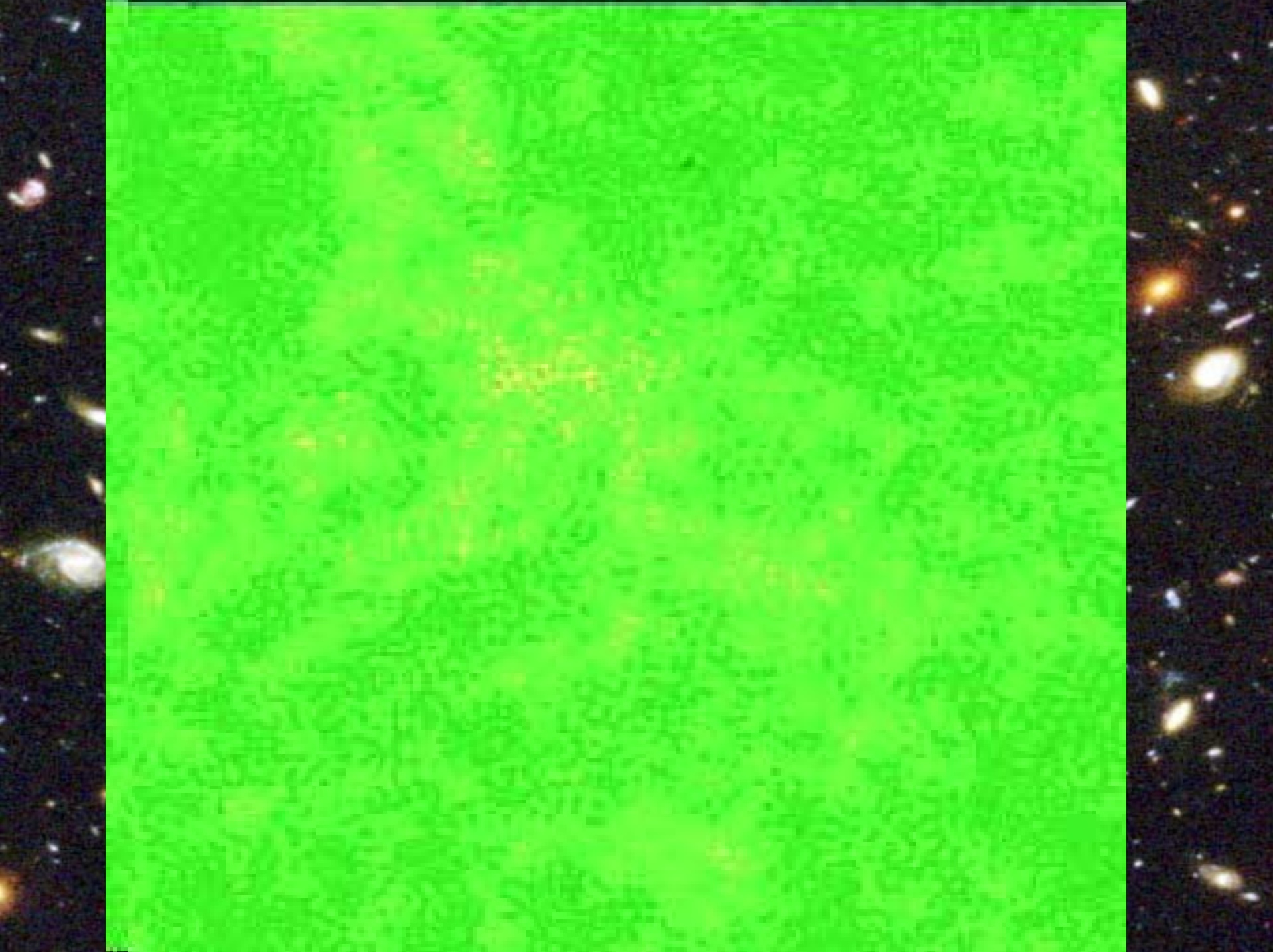
z=infinity
inflation

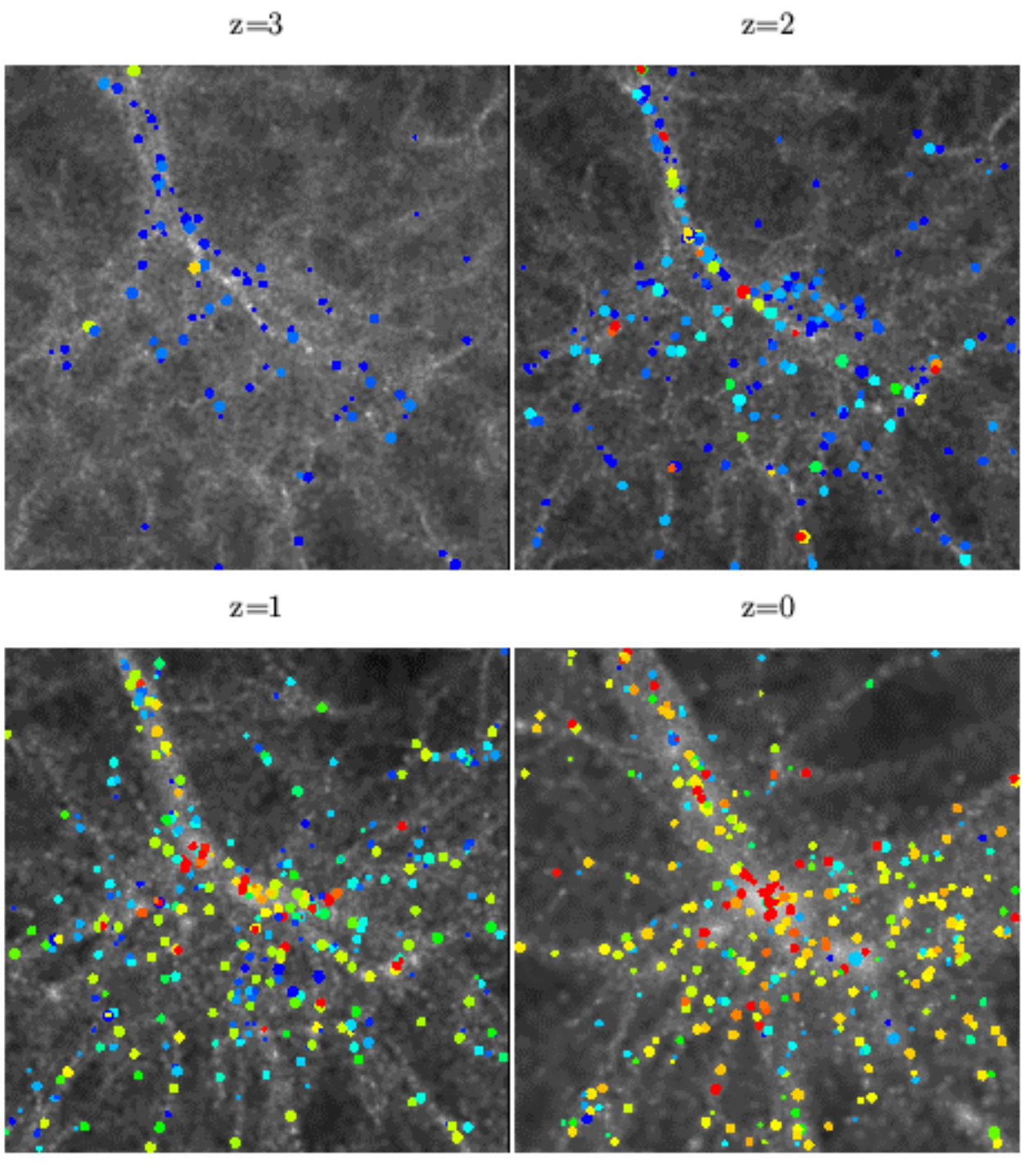
Issues related to galaxy formation

- How do galaxies work?
  - Dynamics of the gas (cold, warm and hot), dust, magnetic fields and stars
  - Distribution of starformation
- When and how do galaxies form?
- Why are there elliptical galaxies and spiral galaxies?
- How and why are these galaxies clustered?

Ingredients for a proper theory

- Gravitational collapse of dark matter halos
- Gas cooling in dark matter halos
- Star formation in dense regions with cool gas
- Feedback from supernove
- Merging of dwarf galaxies to form bigger galaxies

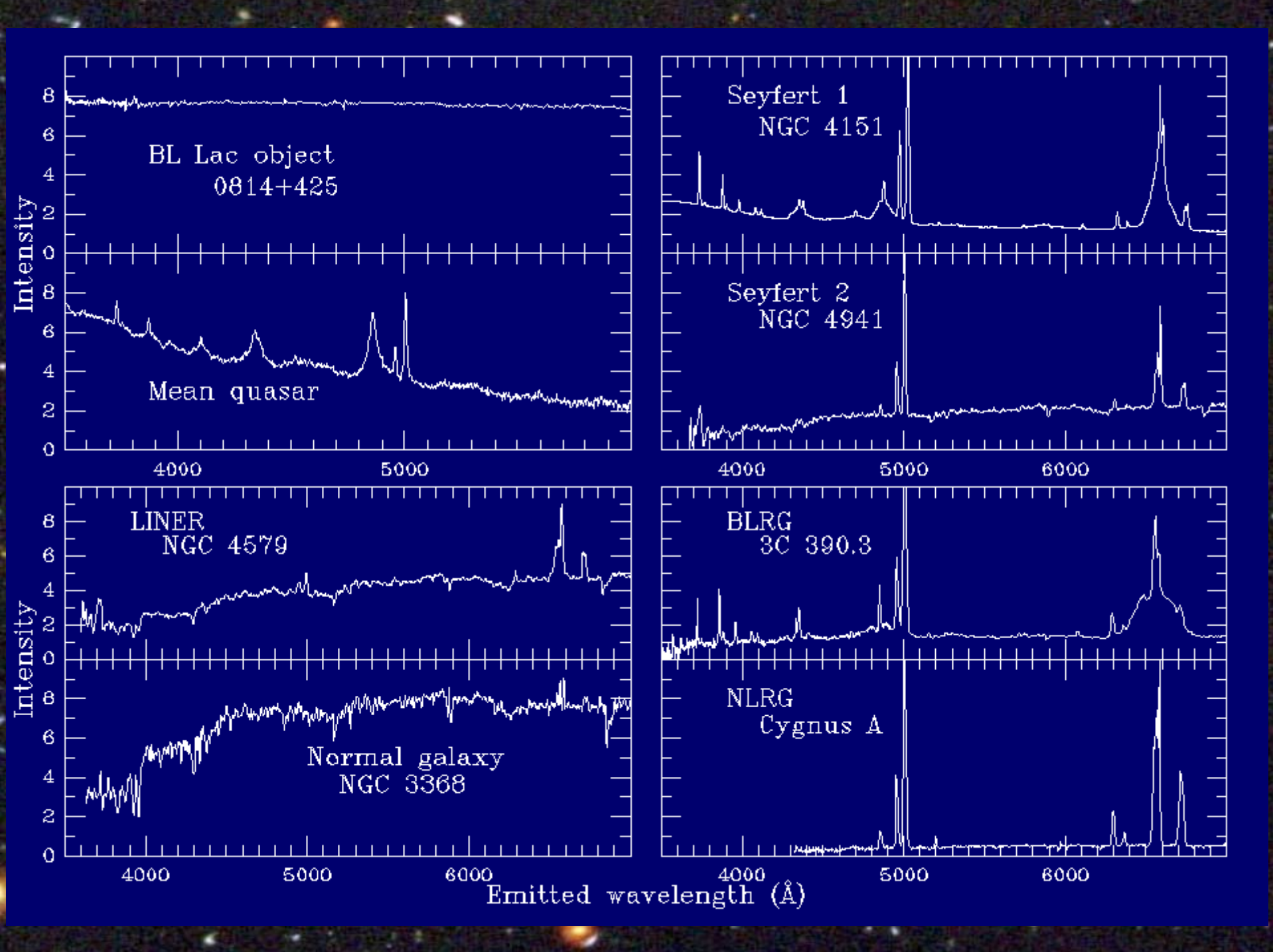




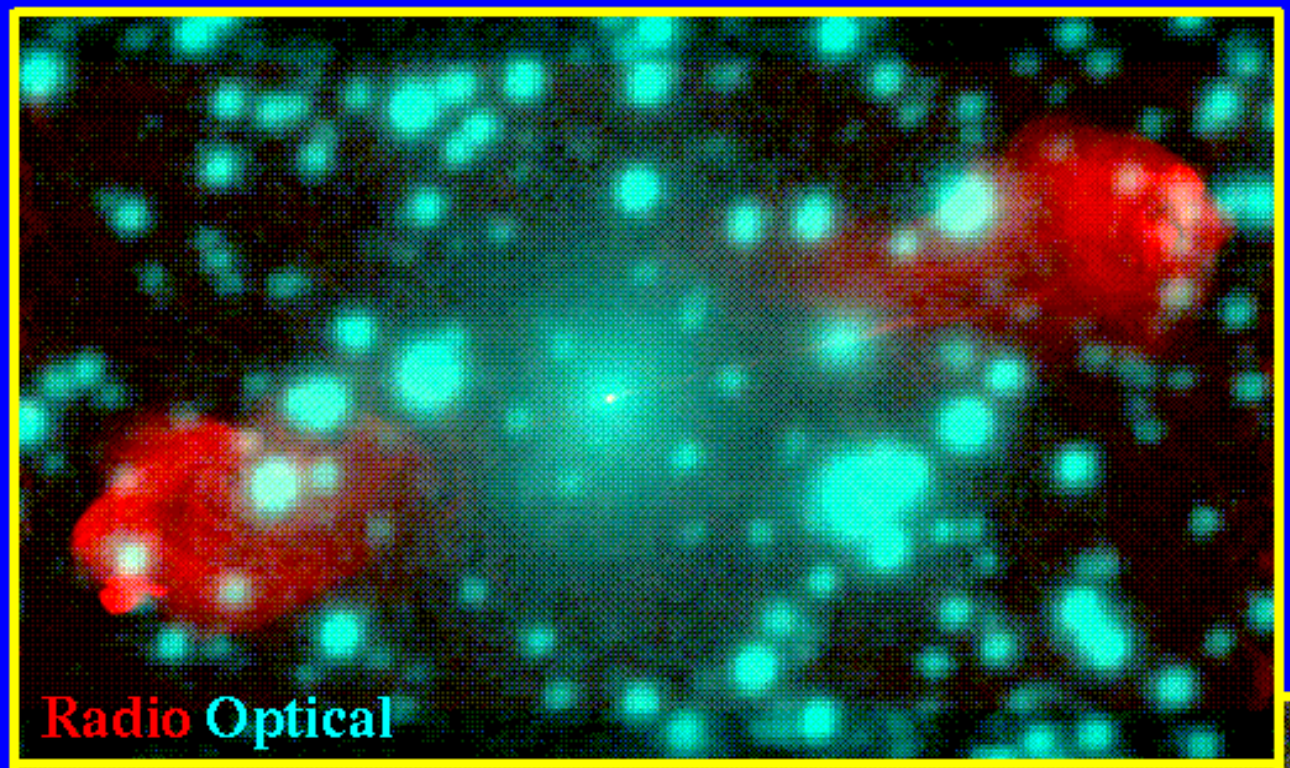
Greyscale
Dark matter population

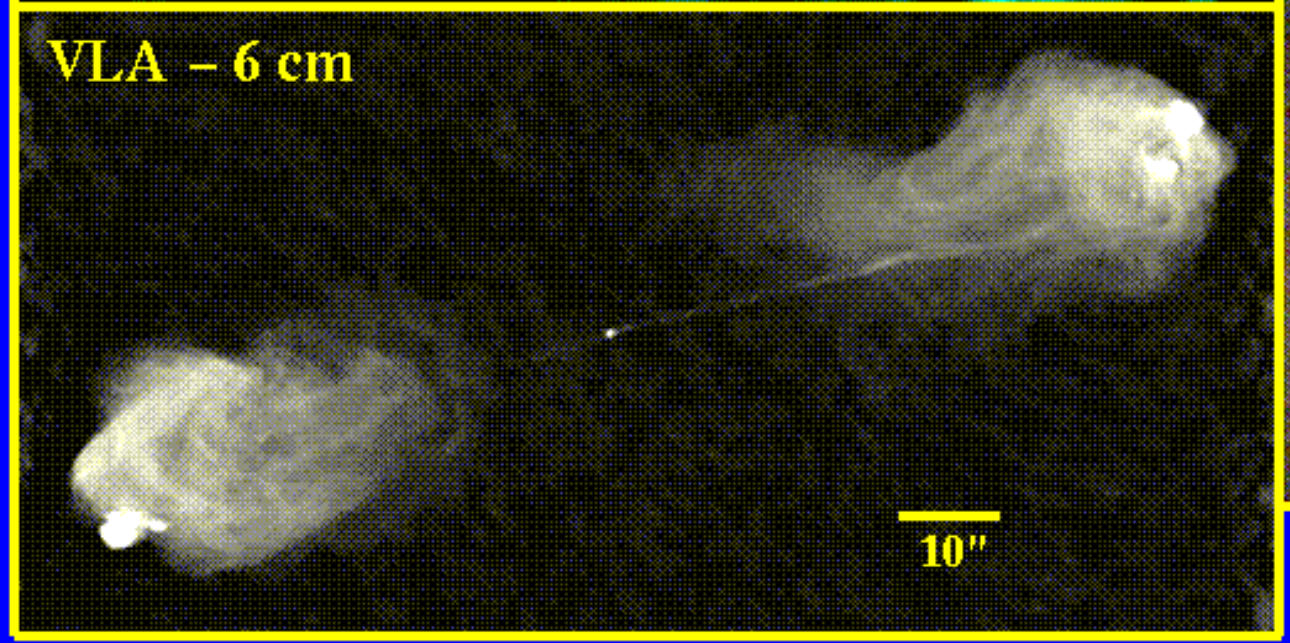
red, yellow,
green and blue dots
Galaxies with
increasing
rate of star formation

Seyfert Galaxies

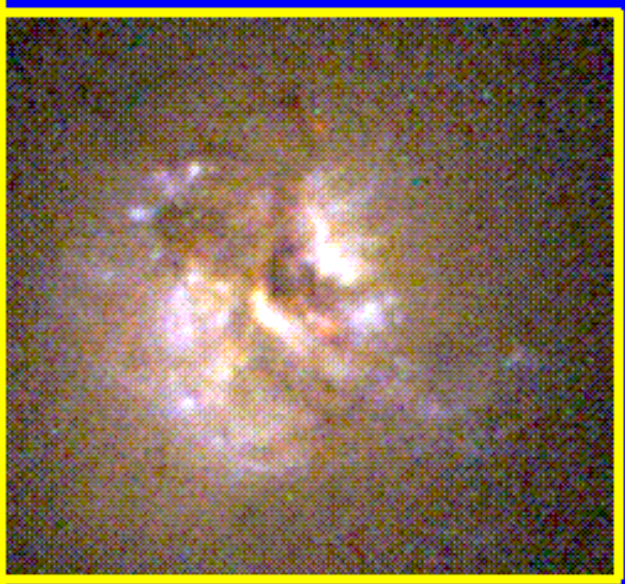

BL Lac object
0814+425
Mean quasar
Seyfert 1
NGC 4151
Seyfert 2
NGC 4941
LINER
NGC 4579
Normal galaxy
NGC 3368
BLRG
3C 390.3
NLRG
Cygnus A
Intensity
Emitted wavelength (Å)
0
2
4
6
8
4000
5000
6000

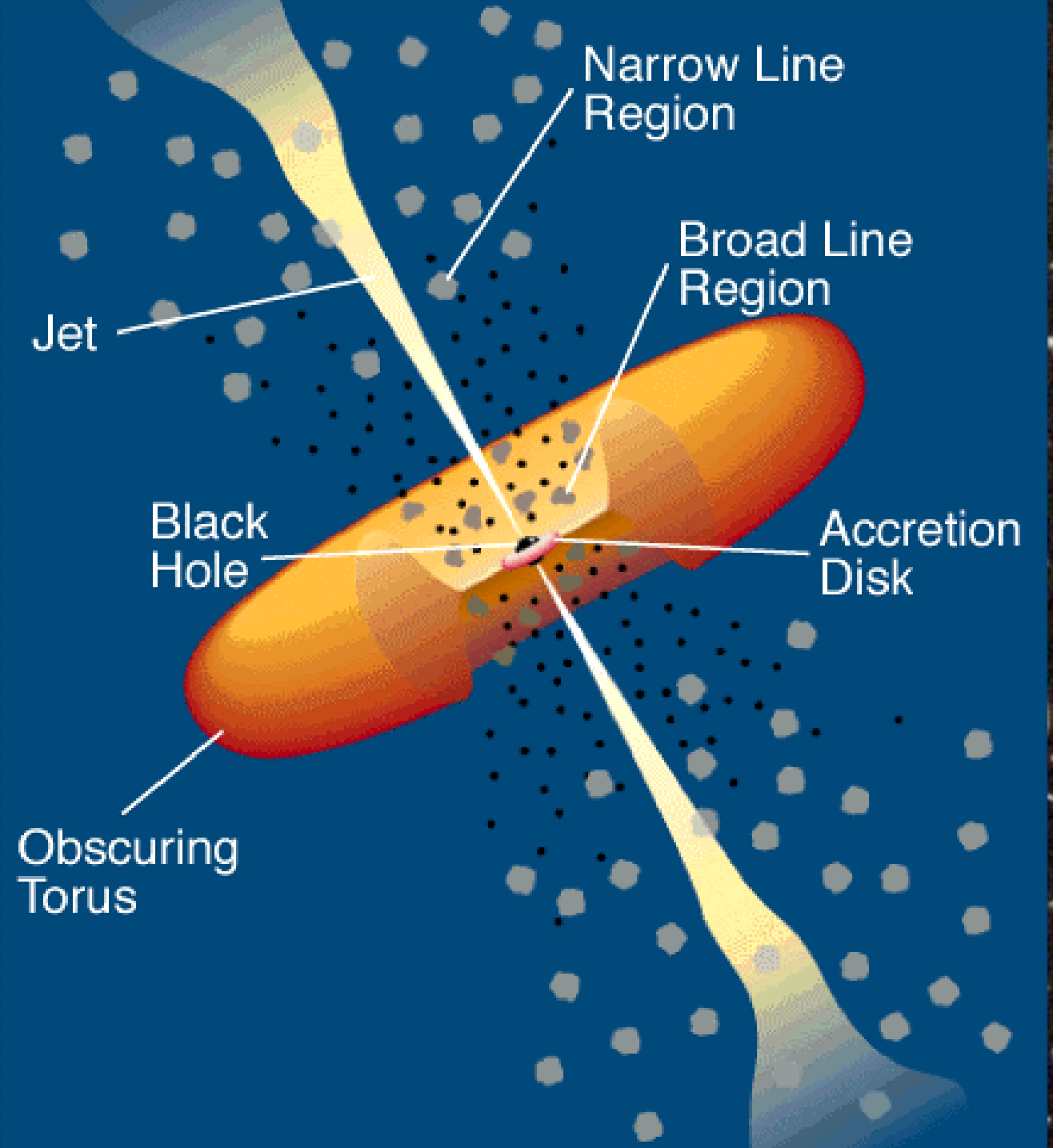
Cygnus A (3C 405)





HST closeup





Issues

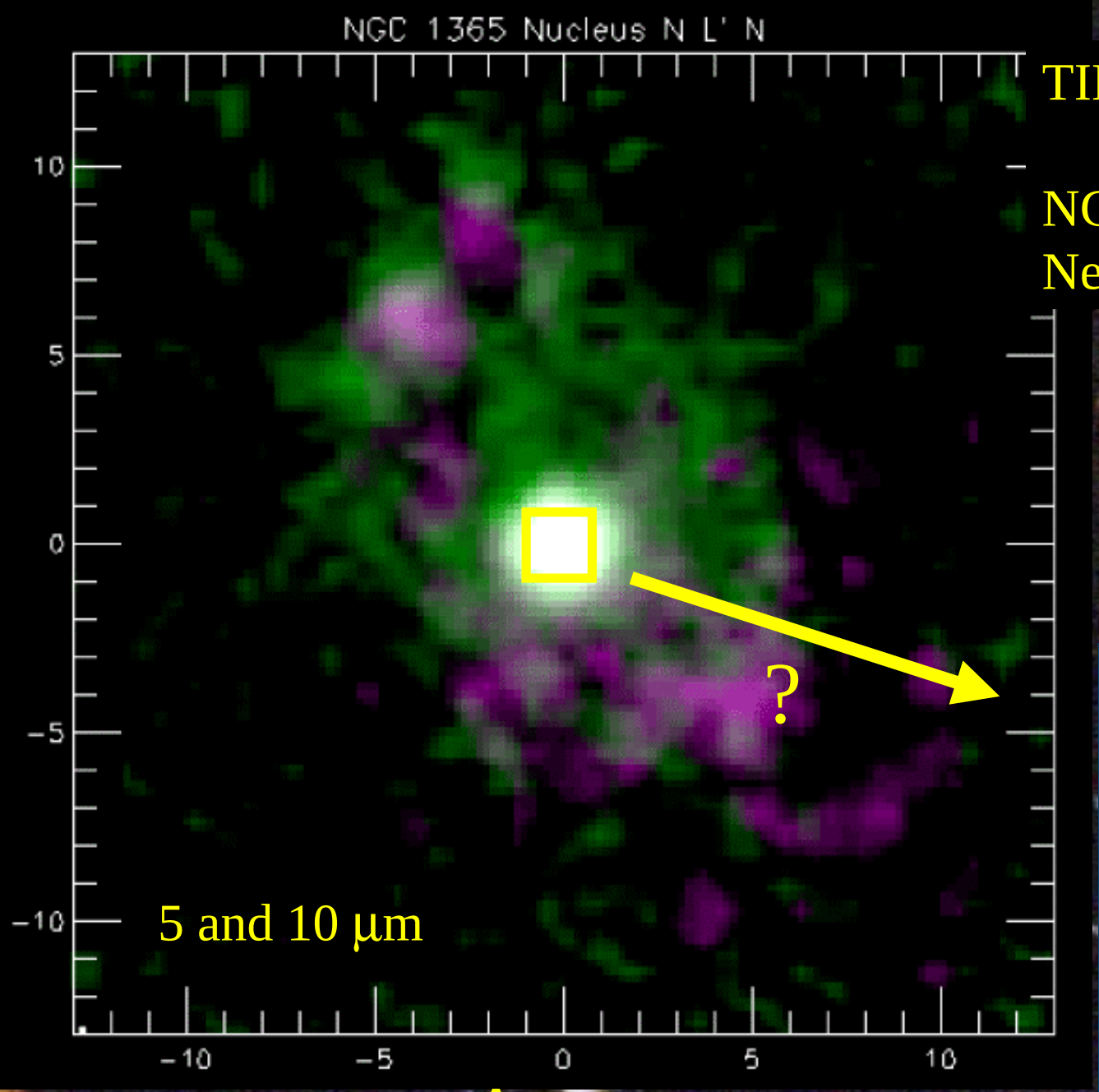
- How and when do massive black holes form?
- Why does every galaxy seem to have a massive central blackhole?
- Physics of active galaxies?

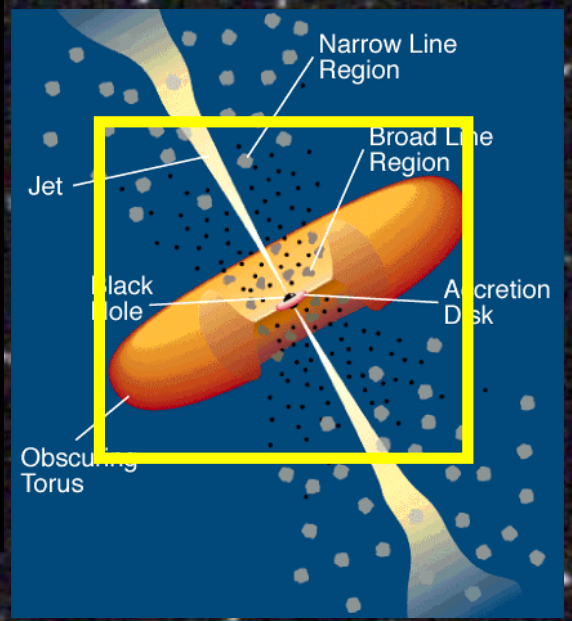
MIDI observations of nearby Active galaxies

- MIDI: 10 micron VLTI instrument
- Observe emission from the few 100 K dust torus to constrain size and orientation of tori
- Work plan (PhD Bjorn Heijligers)
  - Compile a list of candidates
  - Imaging at 10 micron using TIMMI2: resolution of 0.5 arcsec
  - VLT AO imaging at 5 micron using NAOS: resolution 0.1 arcsec
  - Using these observations to constrain torus models
  - Pick best candidates for MIDI observations

TIMMI observations

NGC 1365
Nearby spiral with AGN

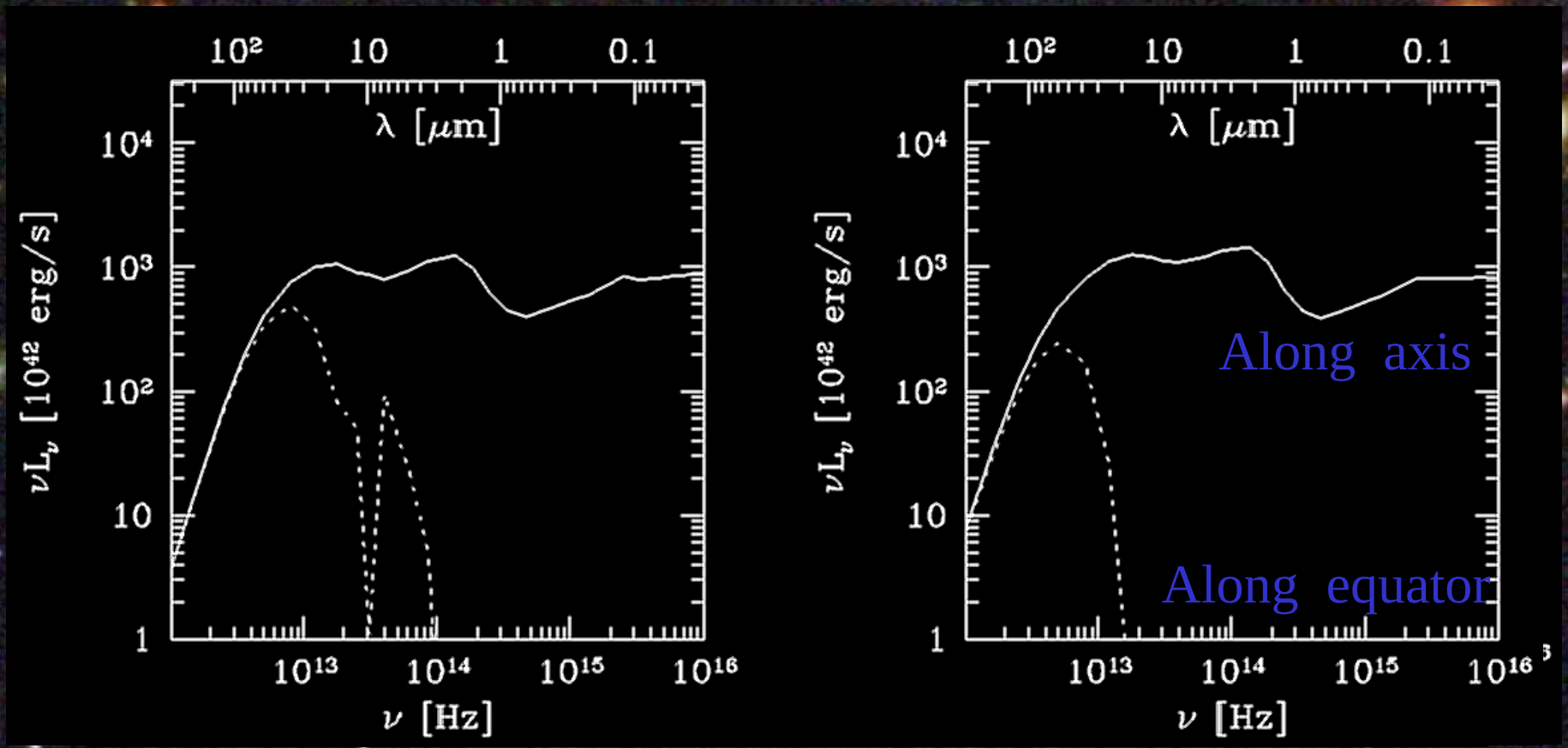


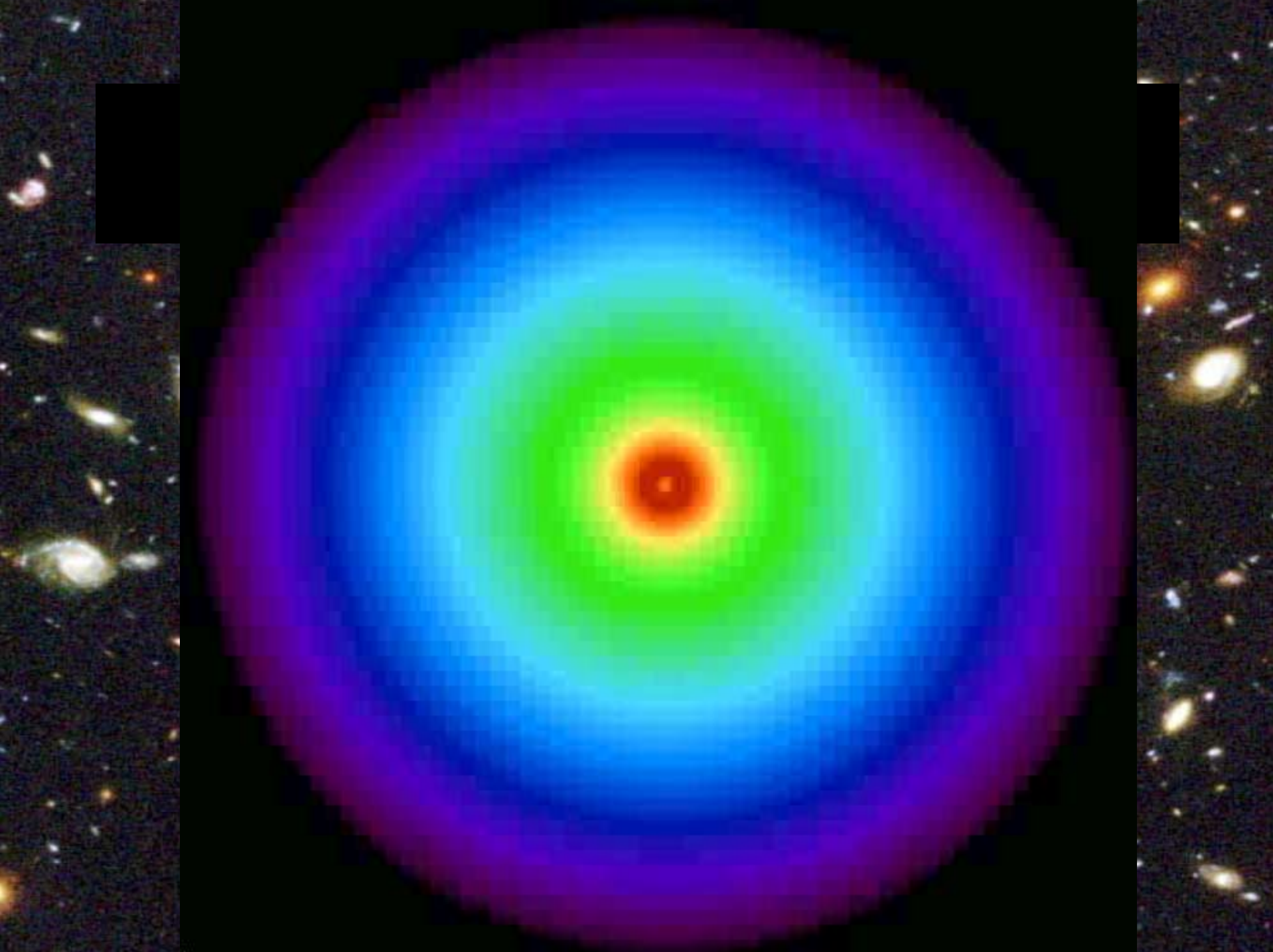


Models of dusty tori

- Radiative transfer model (Granato and Danese)
  - Axially symmetric toroidal Structure
  - Composed of Galactic dust
  - Radiative transfer for Emission, Absorption, Scattering and grain destruction
- Input
  - Luminosity of the central quasar
- Output
  - Spectral energy distribution
  - ``Maps''

Spectral energy distribution



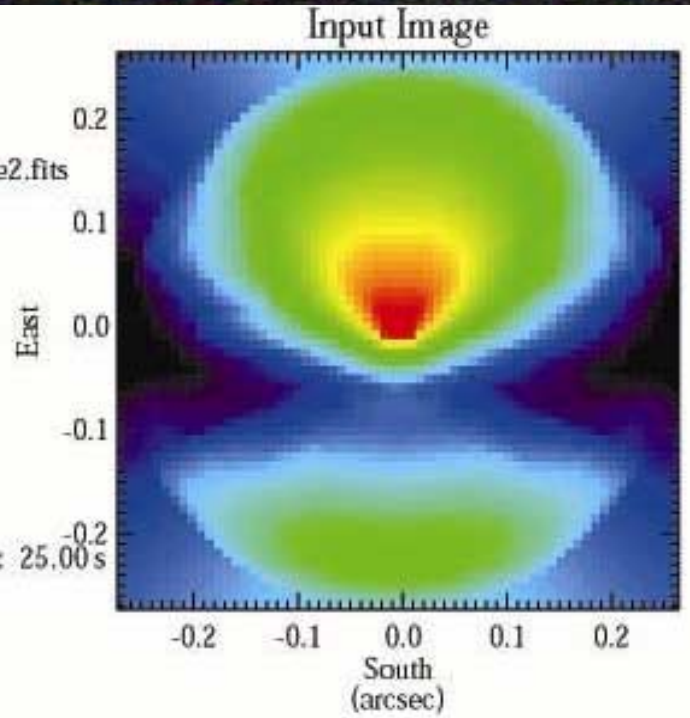


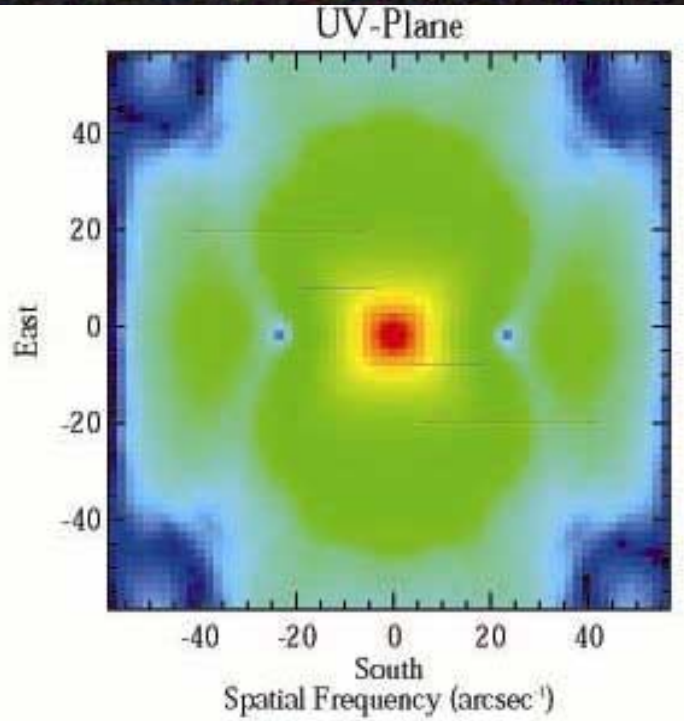
Input File Name:
C:\users\Phd\AGN\nice2.fits

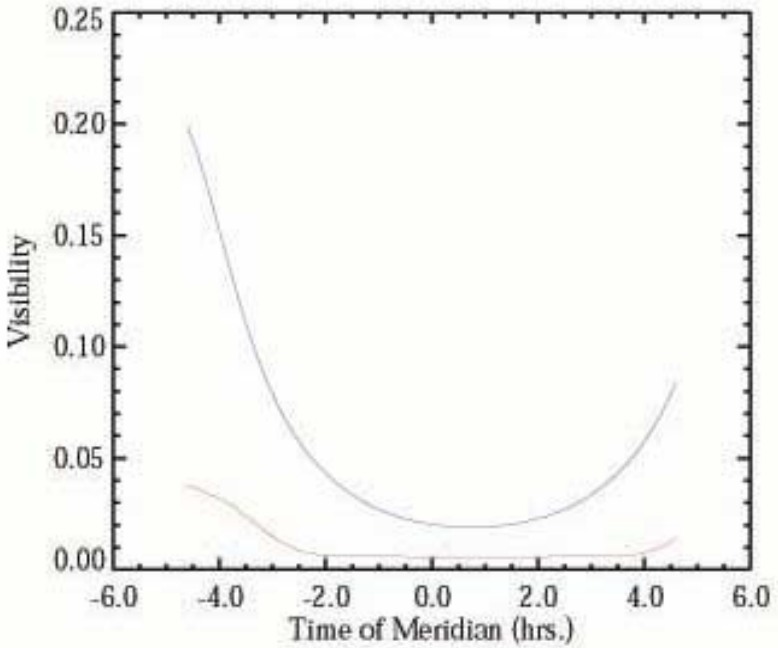
Frame: 1 (10.0 um)

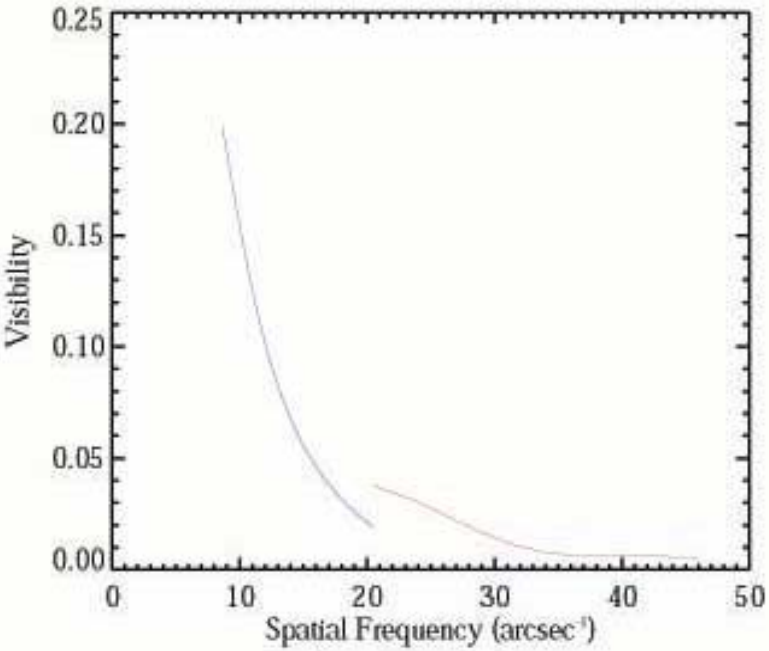
Baseline Key:
UT1 -- UT2
UT1 -- UT3

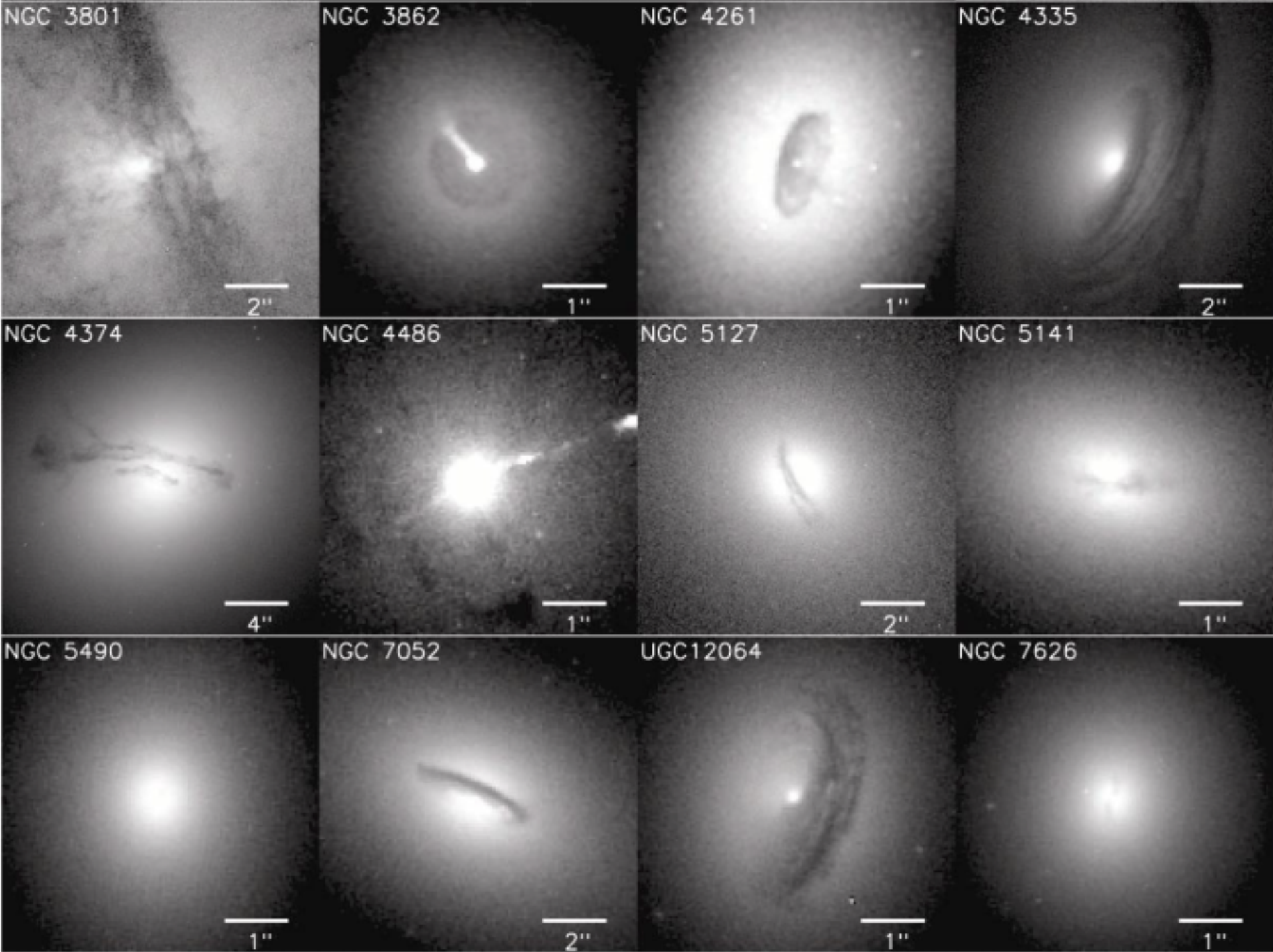
Total Integration Time: 25.00 s



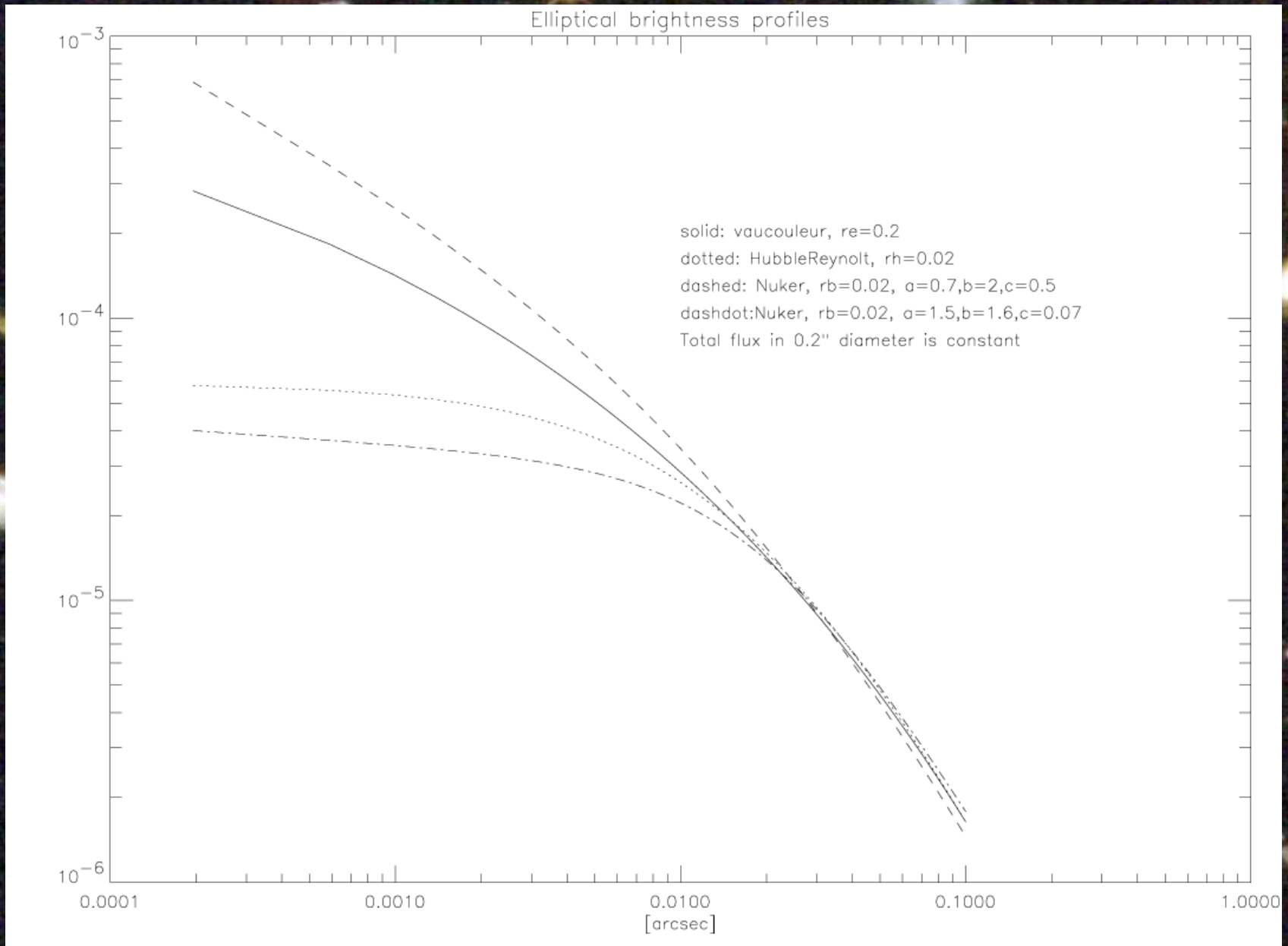






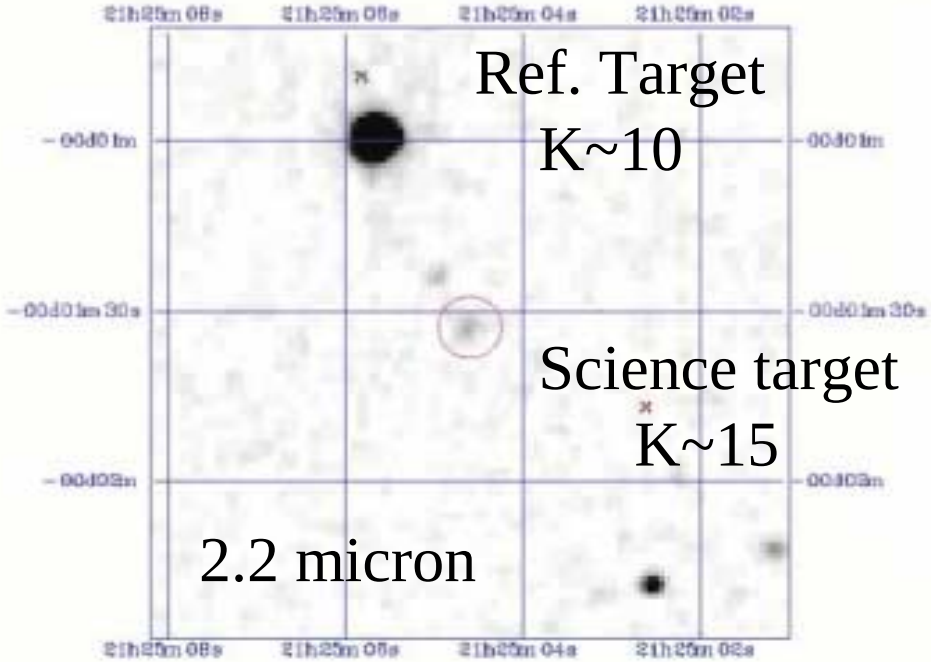

NGC 3801
2''
NGC 3862
1''
NGC 4261
1''
NGC 4335
2''
NGC 4374
4''
NGC 4486
1''
NGC 5127
2''
NGC 5141
1''
NGC 5490
1''
NGC 7052
2''
UGC12064
1''
NGC 7626
1''

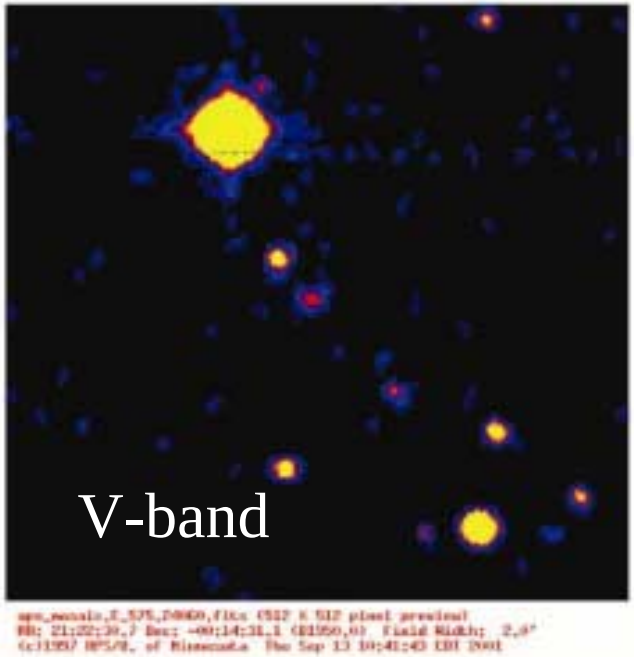
Models of radial profiles of elliptical galaxies

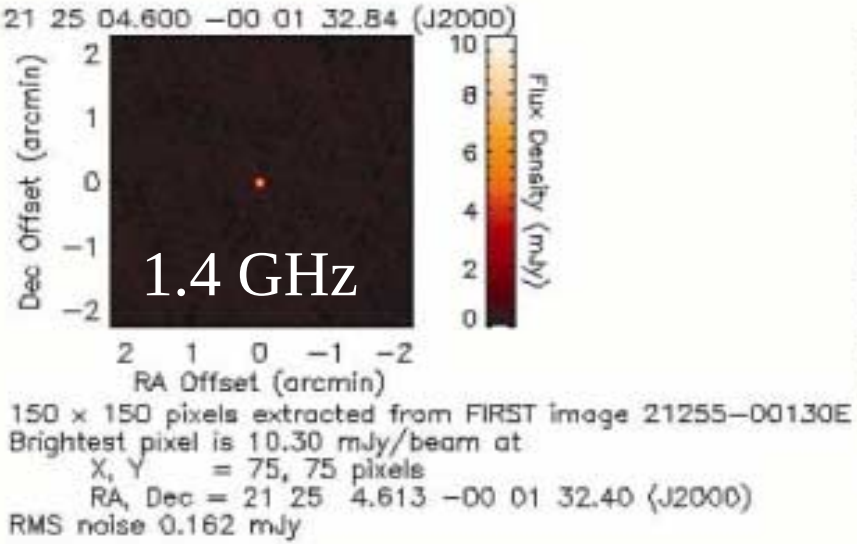


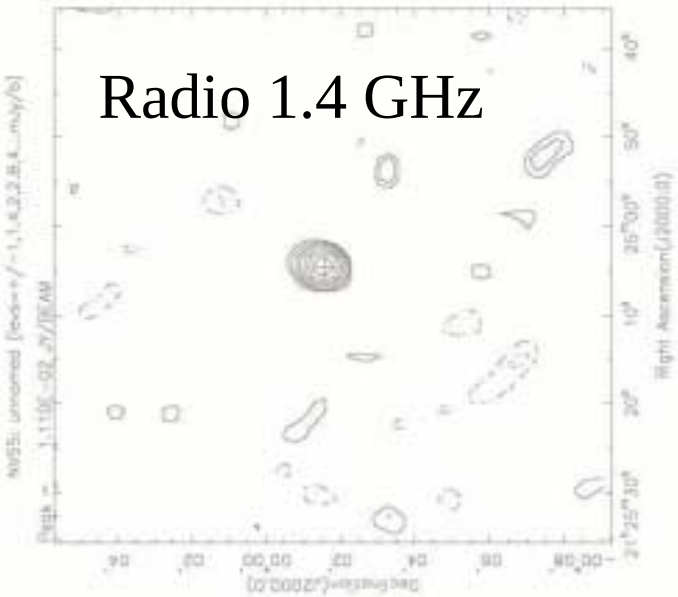
Profiles of cores of ellipticals

- Why such a rich variation of these profiles ?
  - Dynamics stars ?
  - Formation history ?
  - Presence of massive black-hole ?
  - Presence radio source?
- VLTI: measure accurately inner profiles of radio loud and radio quiet ellipticals
  - Range of galaxy type and redshifts
  - Near IR:
    - Interferometry relatively easy
    - Peak of the spectral energy distribution of stars
  - Surface brightness of (distant) galaxies faint: Use PRIMA+ VLT
    - Define a samples of galaxies close to bright stars


Ref. Target
K~10
Science target
K~15
2.2 micron


V-band


21 25 04.600 −00 01 32.84 (J2000)
Dec Offset (arcmin)
RA Offset (arcmin)
Flux Density (mJy)
1.4 GHz
150 × 150 pixels extracted from FIRST image 21255−00130E
Brightest pixel is 10.30 mJy/beam at
X, Y = 75, 75 pixels
RA, Dec = 21 25 4.613 −00 01 32.40 (J2000)
RMS noise 0.162 mJy


Radio 1.4 GHz

Conclusion

VLTI will be the first instrument to carry out high resolution optical interferometry on extragalactic objects