Embedded star clusters

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Project Description

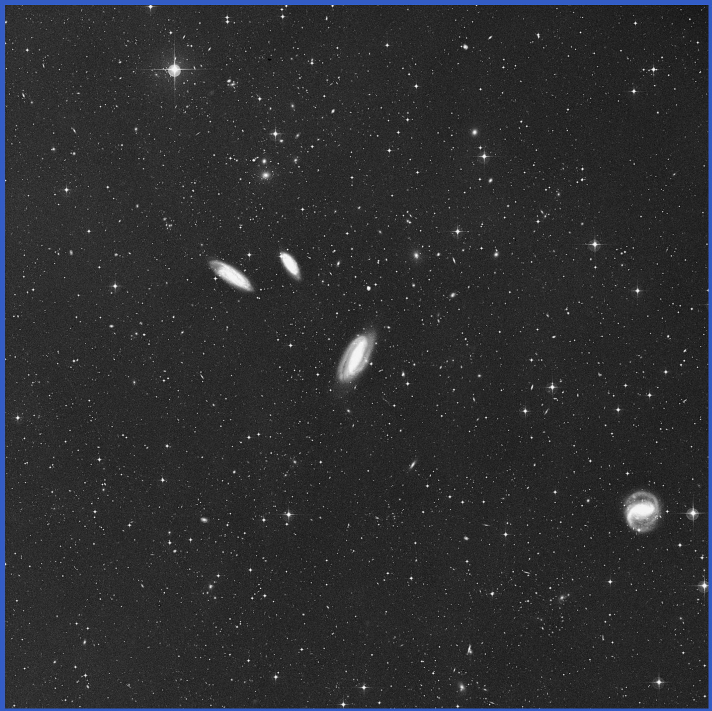
The task of this project is to study the starformation in the nucleus of NGC7582 and estimate the mass of several components of this galaxy revealed in the NeII emission line.

Outline

1. Object description
2. Mid-Infrared observing techniques
3. VISIR instrument
4. Data processing
5. Results
6. Conclusions

Object: NGC 7582

- Seyfert2 galaxy, supermassive blackhole
- starburst activity, heavily dust enshrouded
- SBab, member of Grus quartet, D=22.5Mpc



Data from other wavelengths

Data from HST

- WFPC2 F606W - 0.6μm - 0.046”
- NICMOS F106W - 1.6μm - 0.075”

Infrared observing techniques

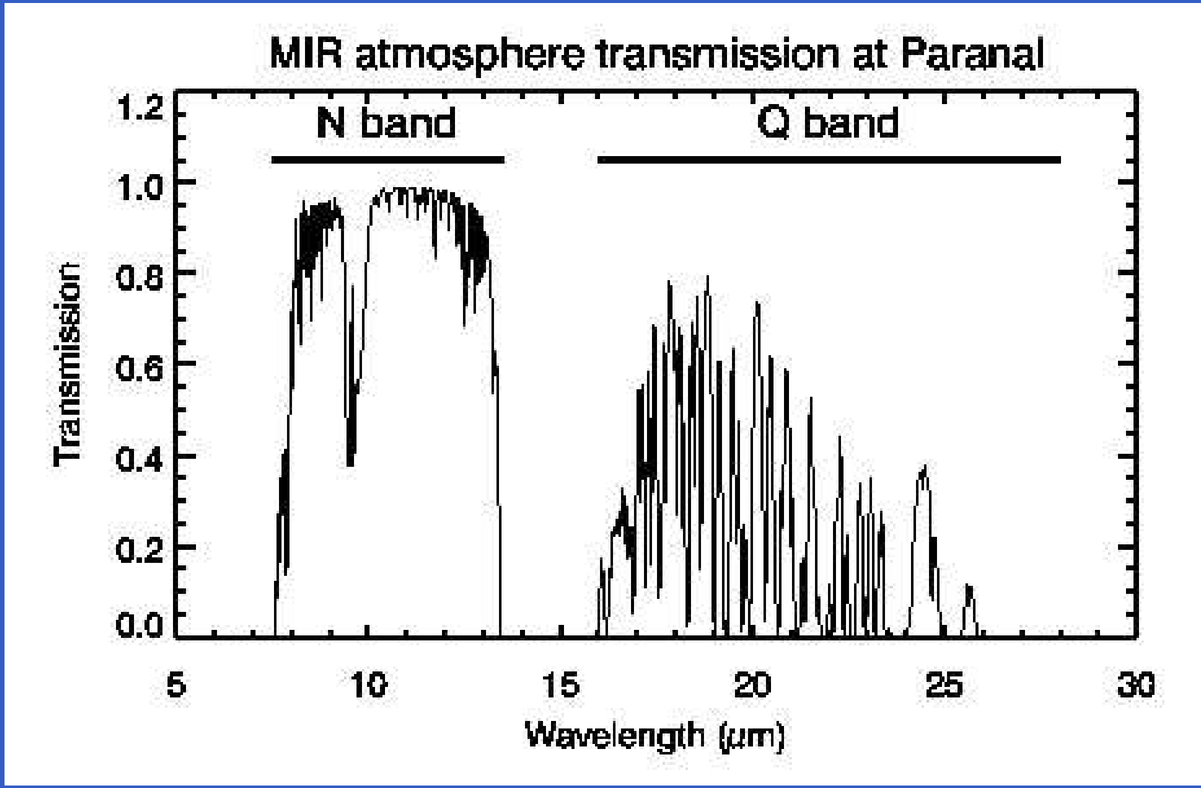
In the infrared we have to deal with special problems:

- high absorption by the atmosphere
- high background
  - atmosphere
  - telescope

Infrared observing techniques

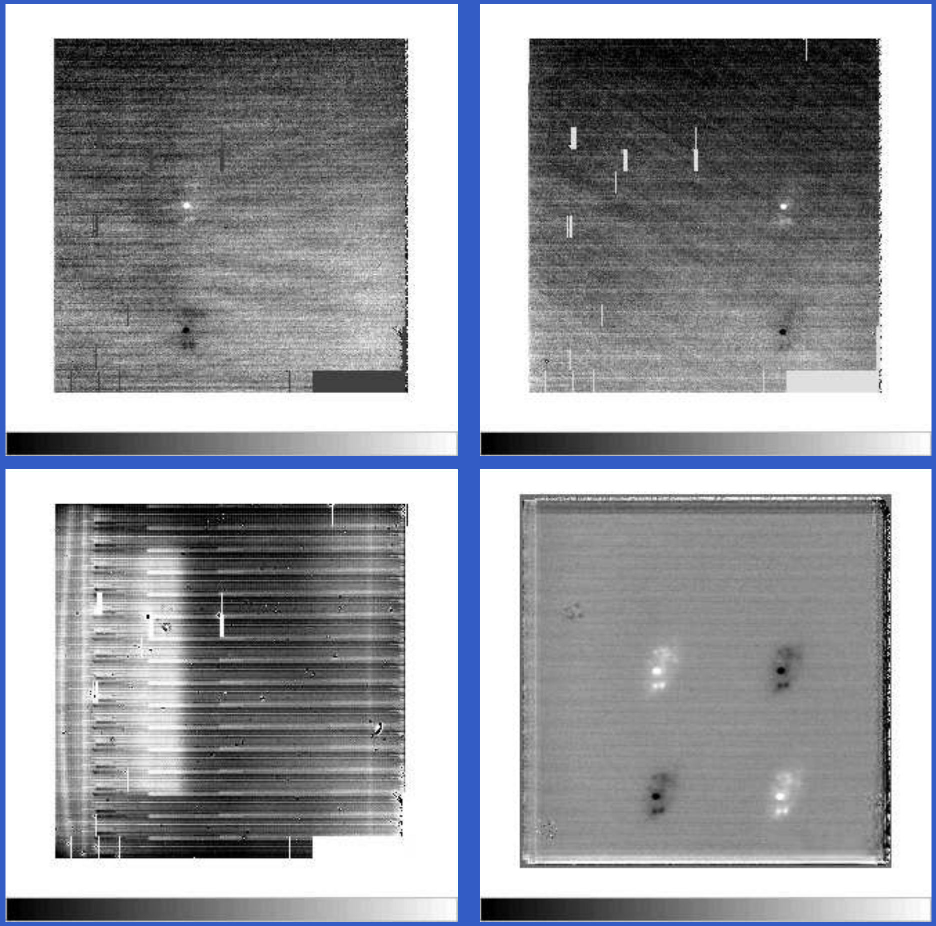
Dealing with absorption of the atmosphere

- N-band and Q-band mid-infrared window



Infrared observing techniques

Dealing with the background: chop & nod



VISIR instrument

VLT Imager and Spectrometer for the mid-InfraRed (VISIR)

- UT3 Melipal telescope (8.2m)
- diffraction limit at 12.8μm: 0.39 arcsec
- 256 $\times$ 256 px, 0.127 arcsec
- filters NeII, $\lambda_c = 12.8\mu$m, $\Delta\lambda = 0.21\mu$m
- T = 5 - 6 K
- noise level: 10^8 ph / s $\rightarrow$ DIT $\sim$ 0.01s

Data Processing

Dataset taken from ESO Archive

- NGC 7582: 122 files
- calibrating star: 4 files

Each file consists of

- 17 frames
- odd (1, 3, .. 15): single exposure
- even (2, .. 16): chopped image, cumulative
- 17th frame = 16th, product

Data Processing

datasets

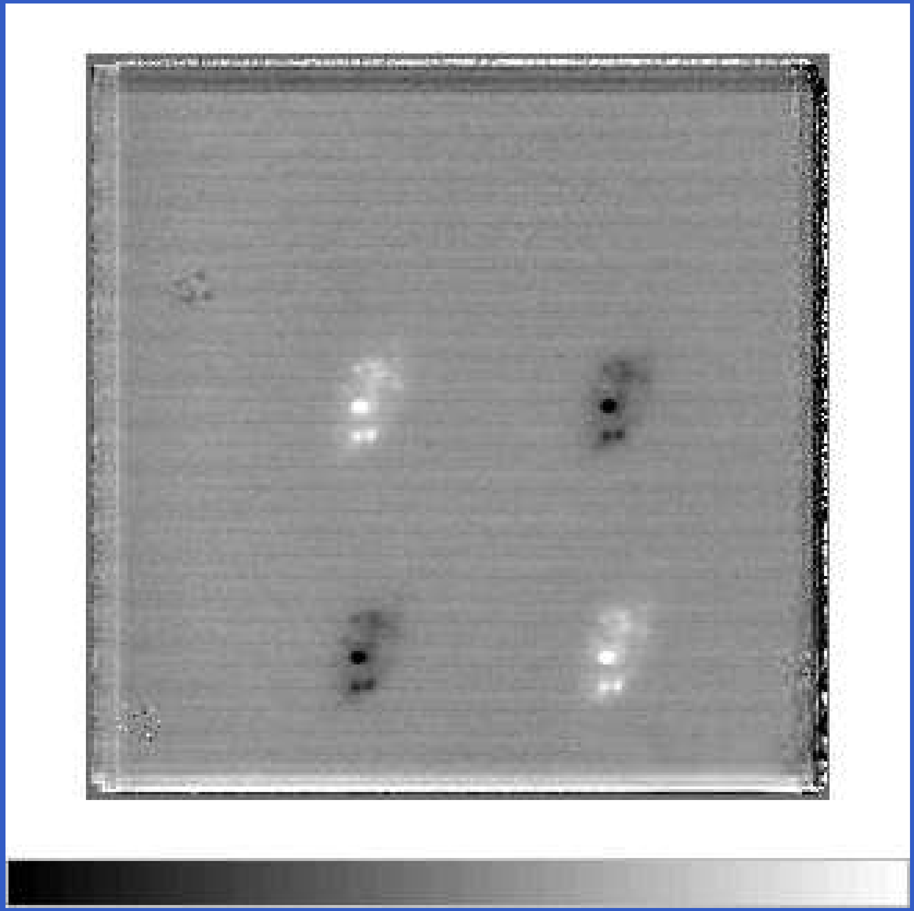
$\Downarrow$

VISIR pipeline

$\Downarrow$

combined frame

Combined frame



Data Processing

datasets

$\Downarrow$

VISIR pipeline

$\Downarrow$

combined frame

$\Downarrow$

IRAF (imcopy, imalign, imcombine)

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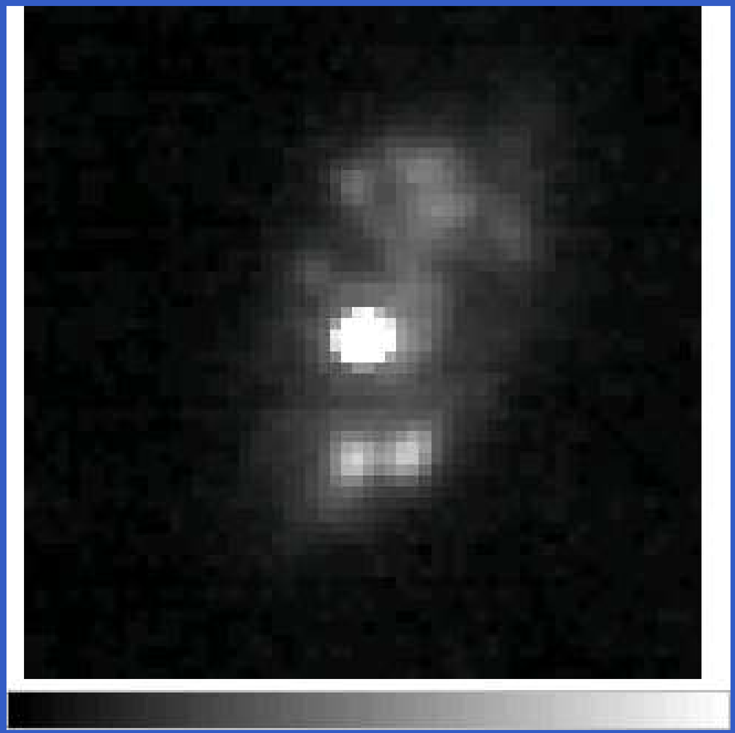
stacked single frame

Processed Image

- 10 arcsec $\times$ 10 arcsec ($\sim$ 1kpc $\times$ 1kpc)
- resolution 0.39 arcsec



Data Processing

Calibration using the HD224630

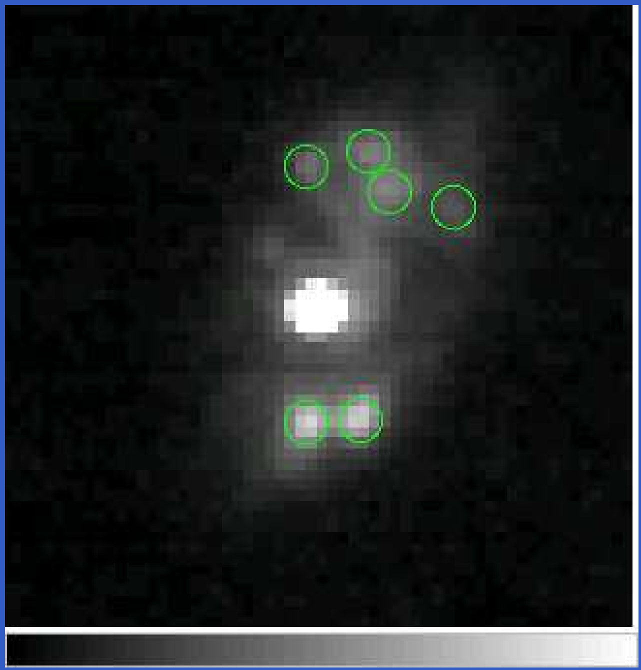
- Reduction as the science image
- Photometry using IRAF(apphot)
- Derive conversion factor from ADU to Jy

  $CF = 4.51 \cdot 10^{-4} \frac{Jy}{ADU}$

Photometry

Flux estimation out of the science image

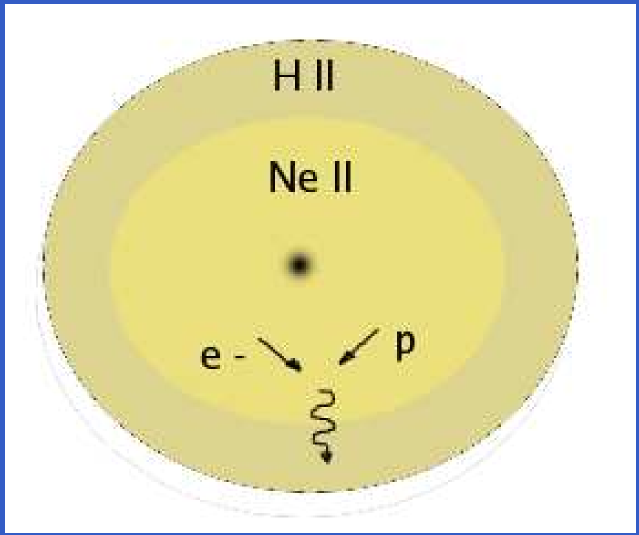
#	F_{NeII} [ADU]	F_{NeII} [Jy]
1	219.7	0.099
2	221.8	0.100
3	118.0	0.053
4	163.4	0.074
5	168.4	0.076
6	99.8	0.045



Scheme of the emitting region

What is the reason for the emission?
$\Rightarrow$UV–flux of hot stars ionising the Ne (21.6eV)

[NeII]12.8μm line: fine structure line
$^2\mathrm{P}_{3/2} \rightarrow {}^2\mathrm{P}_{1/2}$



Some equations

Task: Estimate numbers of UV photons and deduce embedded stellar masses

First step: Calculate emission measure

$$I_{\rm NeII} \approx 3 \cdot 10^{-8} \cdot \left(\frac{10^4 {\rm K}}{T_e}\right)^{1/2} \cdot \exp\left(-\frac{h\nu}{kT_e}\right) \int \gamma_{\rm Ne}\, n_e^2 \,{\rm d}l$$

$I_{\rm NeII}$: derived from image

$\int \cdots$: to be determined

$$EM = \int n_e^2 \,{\rm d}l$$

Some equations

Second step: Derive optical depth of region

$$\tau_{ff} = 8.2 \cdot 10^{-2} \cdot (\frac{T_e}{\mathrm{K}})^{-1.35} \cdot (\frac{\nu}{\mathrm{GHz}})^{-2.1} \cdot EM$$

Third step: Calculate Radio flux of ff–continuum

$$S_\nu = \tau_{ff} \cdot \frac{2\,k\,T_e\,\nu^2}{c^2}$$

Fourth step: Estimate number of ionizing photons

$$N_{\mathrm{UV}} = 7.49 \cdot 10^{48} \cdot (\frac{\nu}{\mathrm{GHz}})^{0.1} \cdot (\frac{T_e}{\mathrm{K}})^{-1/2} \cdot (\frac{S_\nu}{\mathrm{Jy}}) \cdot (\frac{D}{\mathrm{kpc}})^2$$

Properties of YMC - results (1)

#	$F_{\nu=5\mathrm{GHz}}$ [mJy]	N_{UV} [10^{52} ph/s]
1	1.46	6.47
2	1.47	6.53
3	0.78	3.48
4	1.09	4.81
5	1.11	4.96
6	0.66	2.94

For comparison: an O star has $N_{\mathrm{UV}} \sim 10^{49} ph/s$

Properties of YMC - results (2)

#	N_{stars}	$M_{\mathrm{O4\,III}}$ $[10^4 M_\odot]$
1	1664	8.12
2	1680	8.20
3	893	4.36
4	1237	6.04
5	1274	6.22
6	755	3.69

Conclusions

Combination of data in the three wavelengths