Super Star Clusters in NGC 253

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Aims of the Thesis (I)

- We want to determine the parameters that define the fate of a nuclear starburst (SuperGalactic Winds (SGW)??)
- Prototype => M82
- We will study isolated galaxies: NGC253 y NGC4631 // Mrk921 y Mrk307
- The origin of gas at high latitudes (“clumps”)
- The origin of X-rays emission
- Hidrodynamic models for different cases
- Creation of an archive of candidates for future works

Aims of the Thesis (II)

- Resolve starburst core:
- Confinement of starburst
- The units of the starburst:

  Theory: G.Tenorio-Tagle, C.Muñoz-Tuñón & S. Silich

  Units: SSCs.

  Parameters: distributions, ages and luminosities.

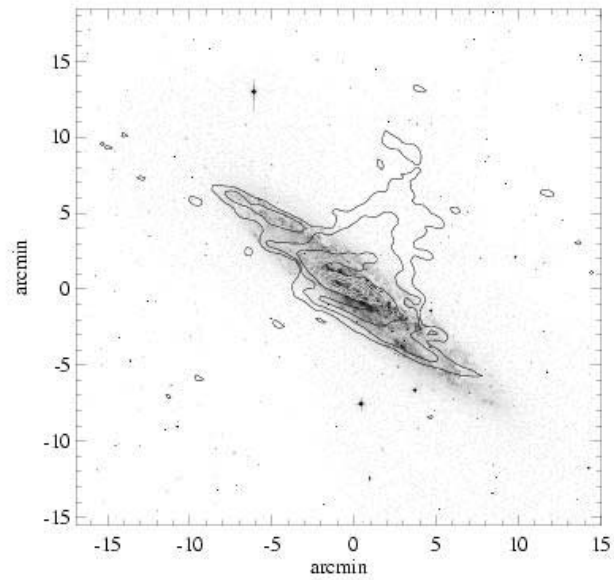
V.Melo, A.M.Pérez-García, J.A.Acosta-Pulido, C.Muñóz-Tuñón, J.M.Rodríguez-Espinosa, 2002 ApJ. 574, 709

NGC 253

- Has been proposed as SGWs candidate. Radovich et al (2001) proposed it with the IRAS observations.
- We have studied these images and we concluded that these structures are due to problems in the lower levels of maps :

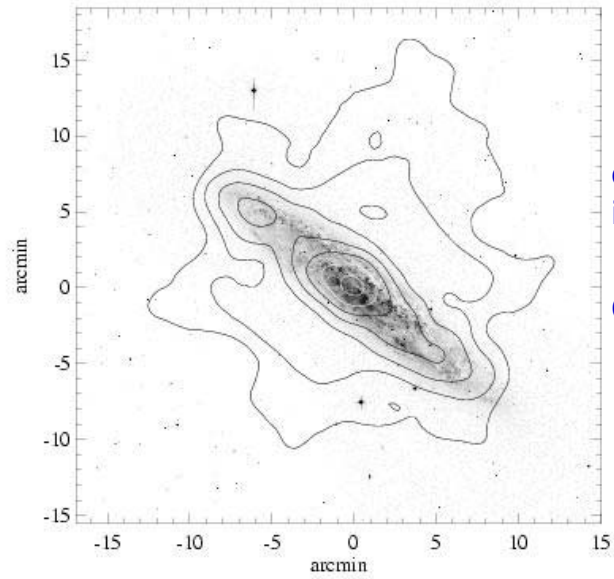
  -12 y 25 μm=> Detector hysteresis after crossing the bright nucleus (Rice 1993)

  -60 y 100 μm => Reflected emission of the IRAS secondary spider (Rice 1993)



optical image +

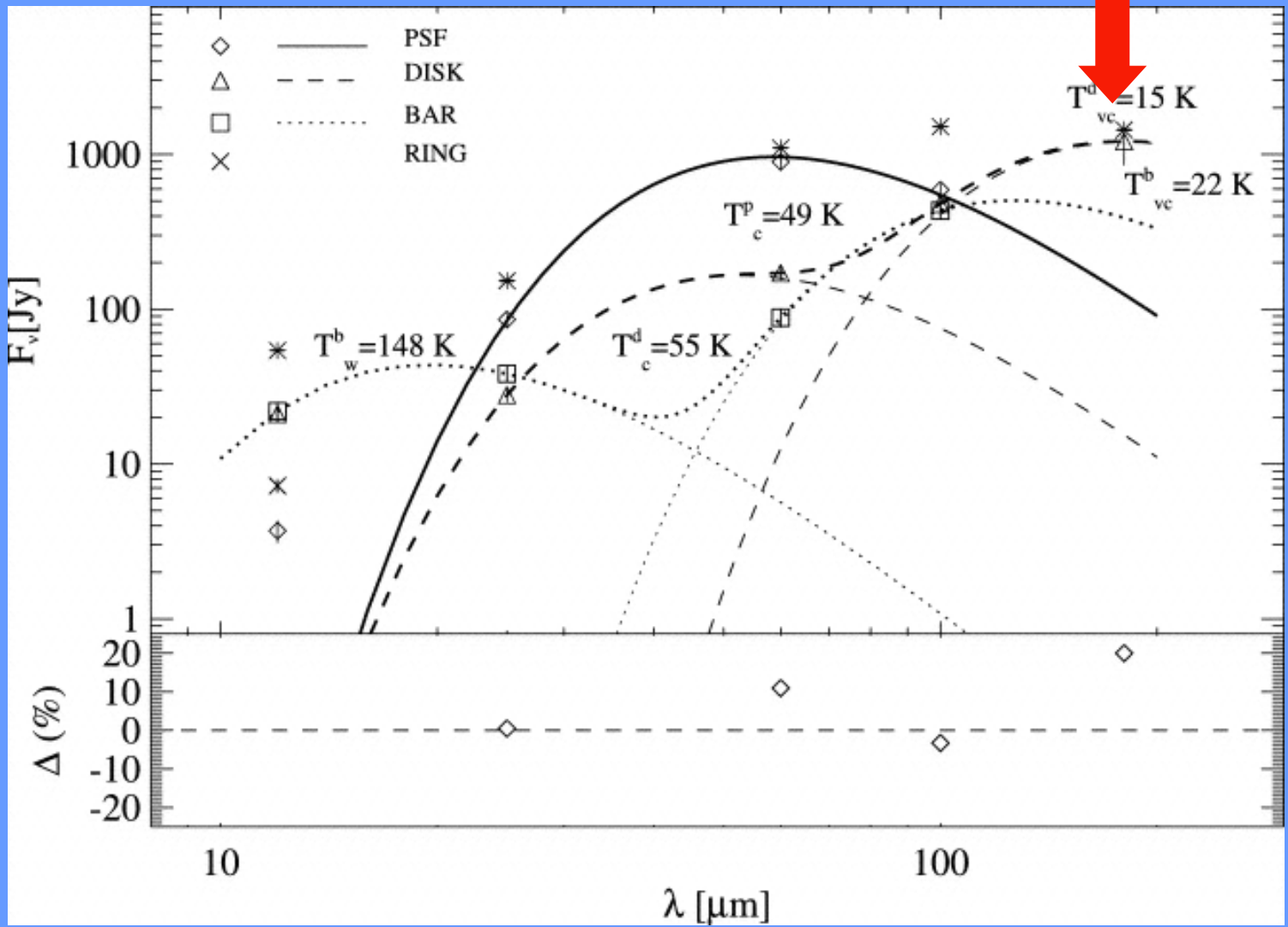
25 micron Contours



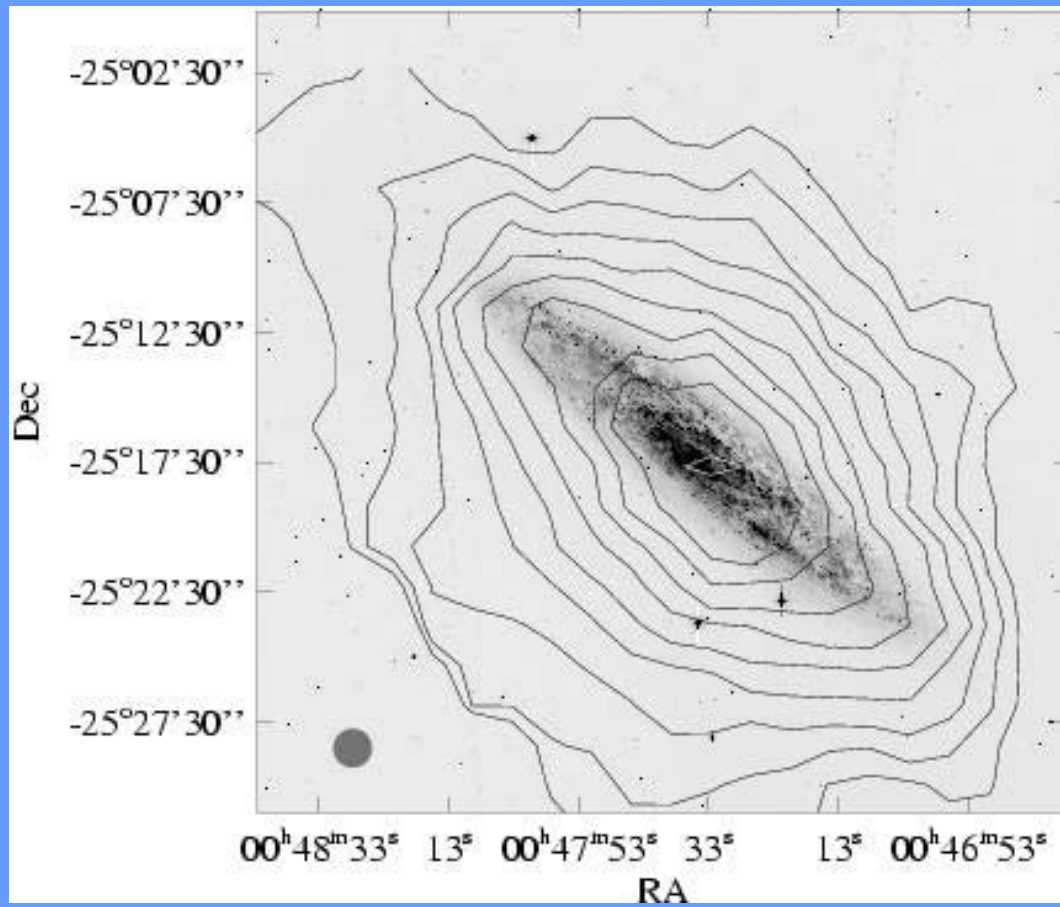
optical image +

100 micron Contours

We confirm the presence of a large amount of cold dust in the disk of NGC 253 => wich contains 94% of the overall dust mass (8.2 10^7 M_o). This dust mass have not been account until now

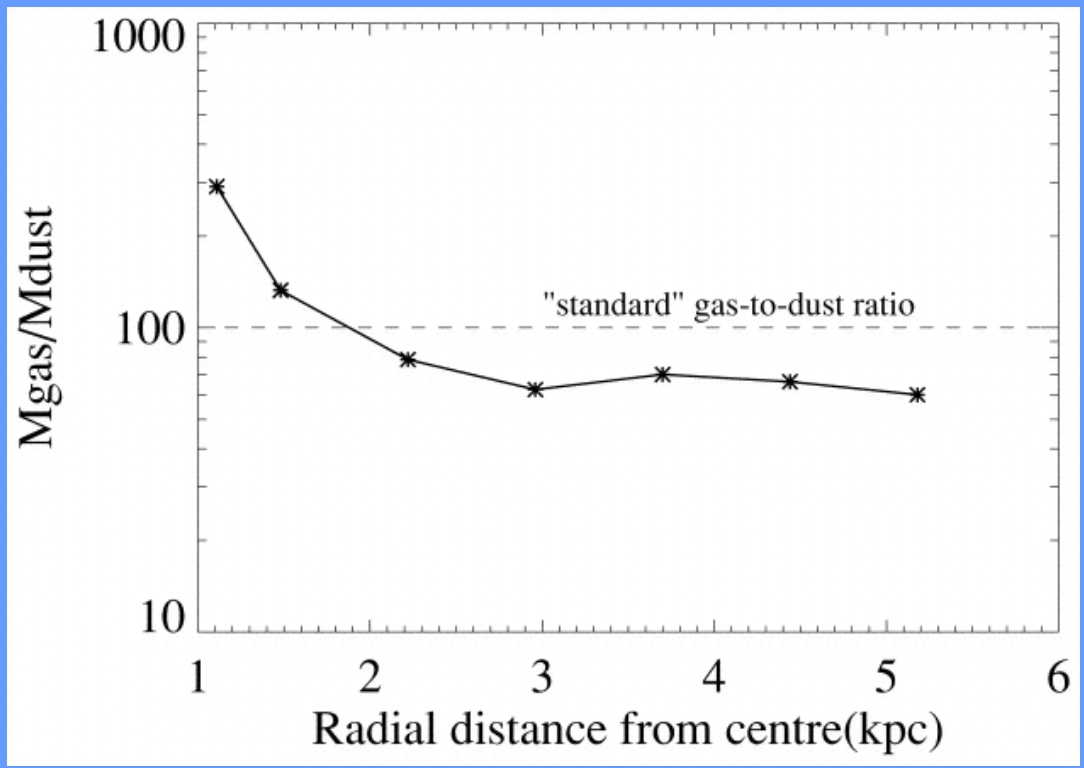


An extended cold dust halo is revelealed in the 180 microns map



Optical image + ISO-180 microns contours

M_{gas}/M_{dust}



For r = 5.2 kpc -- M_{gas}/M_{dust}= 64

- Gas mass take of Scoville et al(1985)
- Devereux et al(1990) had obtained (r=6.8kpc) M_{gas}/M_{dust}= 1070
- The problem of underestimation of dust have been resolved because:
  - data λ>100μm
  - Separation in structural components
- It is necesary to use far infrared observation to determine dust mass

NGC 253 starburst

- HST has resolved the starburst nucleus => showing that they are formed by a lot of very young and compact clusters with high luminosities => *Super Star Clusters (SSCs)* (Ho 1997)

SSCs main features are:

- High masses: 10^5 y 10^6 M_o
- Little size: R ~3 pc
- Very young: 1-10 Maños
- High luminosities: can surpass the luminosity of R136 cluster in the 30 Doradus complex

HST data

- We use HST observation taken from HST database (reduced with its pipeline)
- We are analysing the following images:

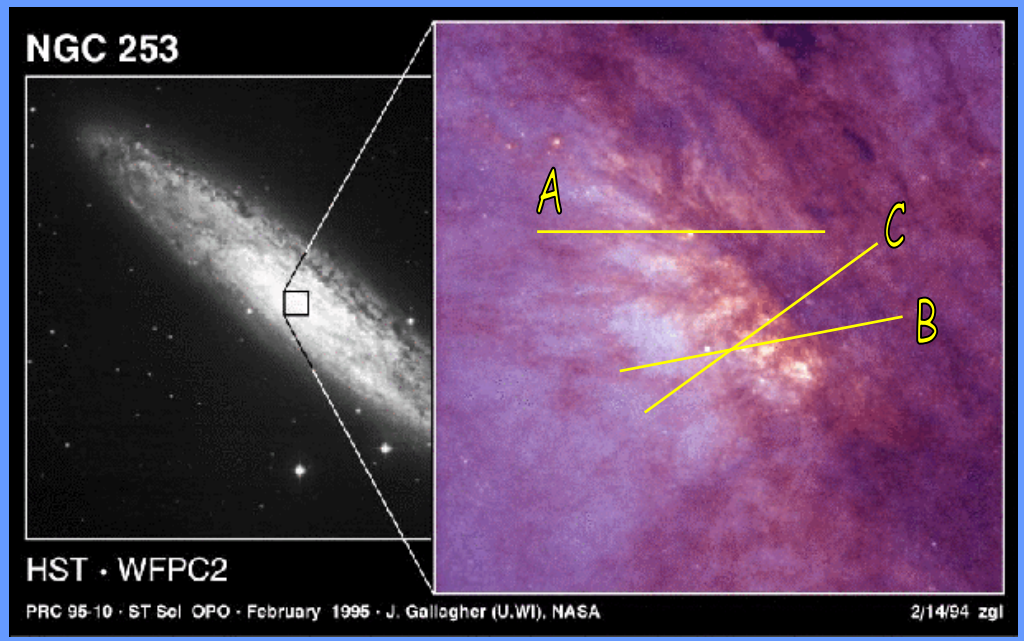
  - WFPC2: Hα, SII, SIII, OIII, OI

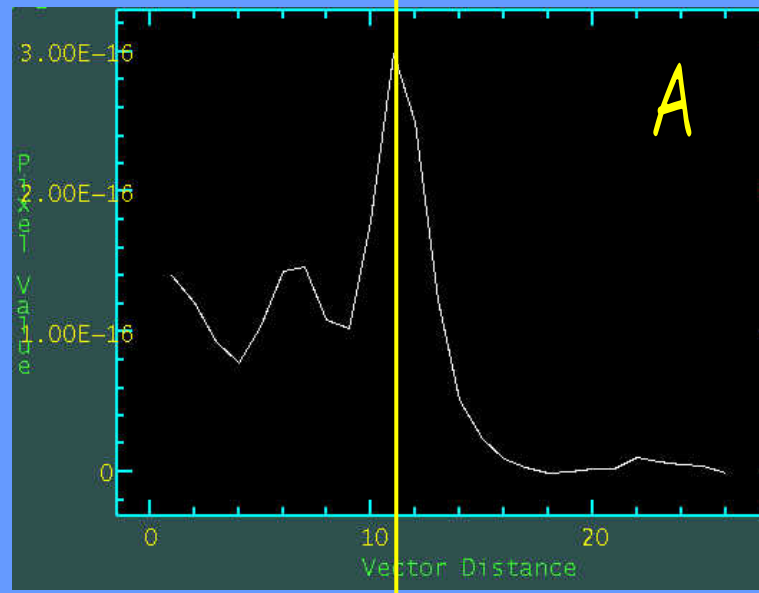
  - NICMOS: CO, FeII, H2, Paα
- Reduction and calibration => some problems that can influence in the results (instance in the estimation of equivalent width)

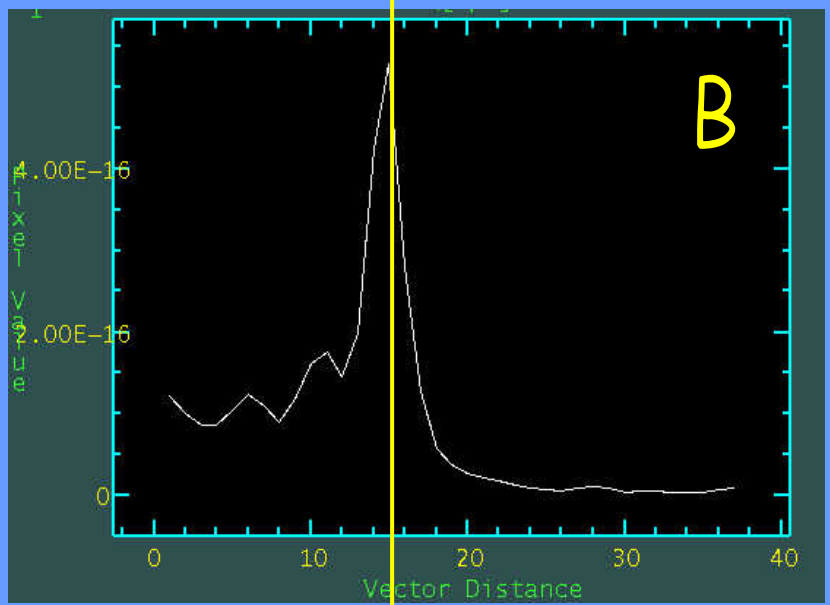
Characterize the SSCs candidates

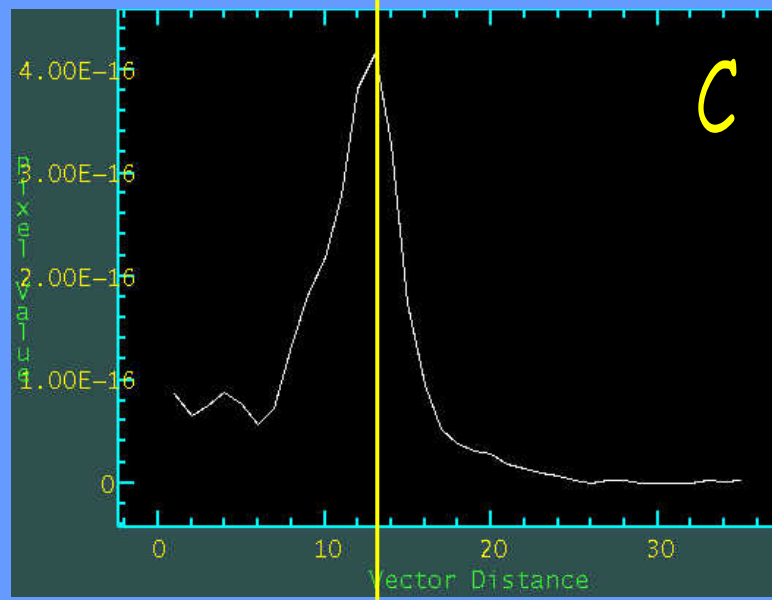
- Determination of the limits of regions with: FOCAS, luminosity profile gradients, daofind?
- Effective radius => region fluxes
- Extinction: we found in references Av = 4.5-24.

  BUT do we have a thin optically medium in all regions? => perhaps we have to fit the profiles for have a estimation of total flux
- First estimations: Luminosities and masses with Starburst 99 models (Leitherer et al,1999)


NGC 253
A
C
B
HST · WFPC2
PRC 95-10 · ST ScI OPO · February 1995 · J. Gallagher (U.WI), NASA
2/14/94 zgl


A
3.00E-16
2.00E-16
1.00E-16
0
Pixel Value
0
10
20
Vector Distance

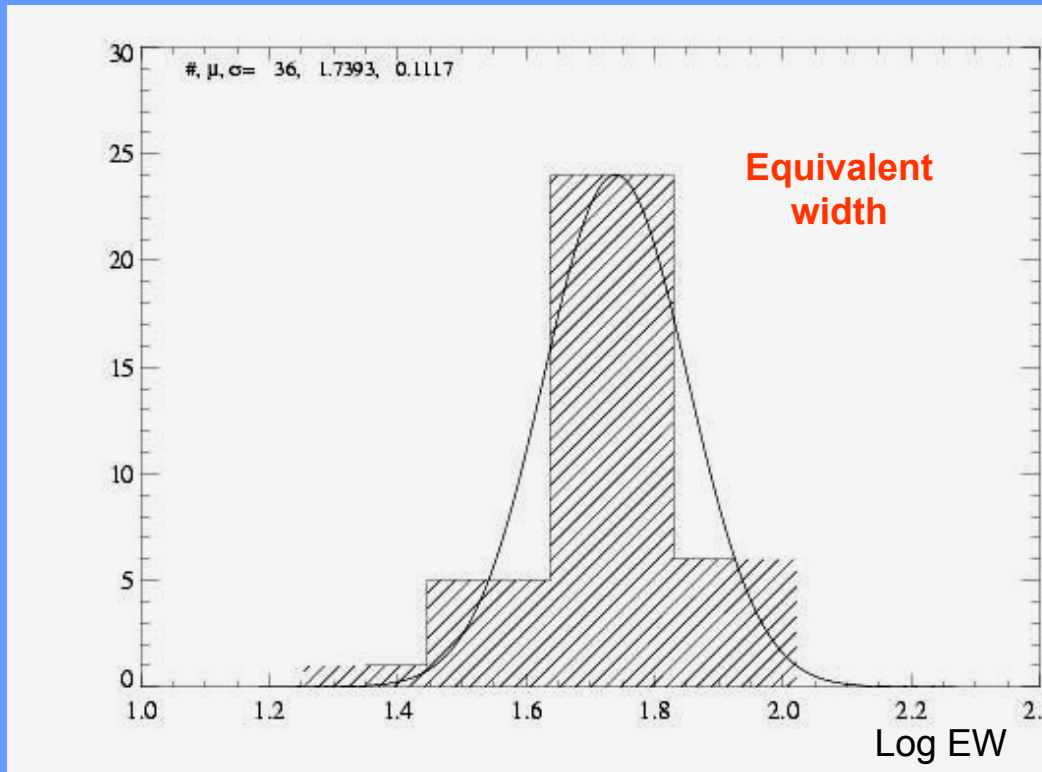

B
4.00E-16
2.00E-16
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10
20
30
40
Vector Distance


C
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Vector Distance

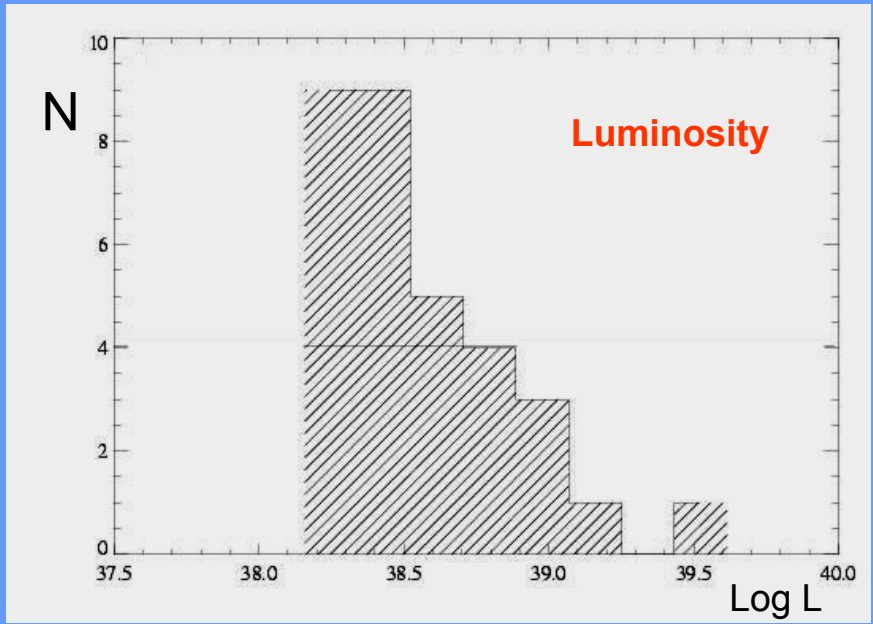
SSCs candidates

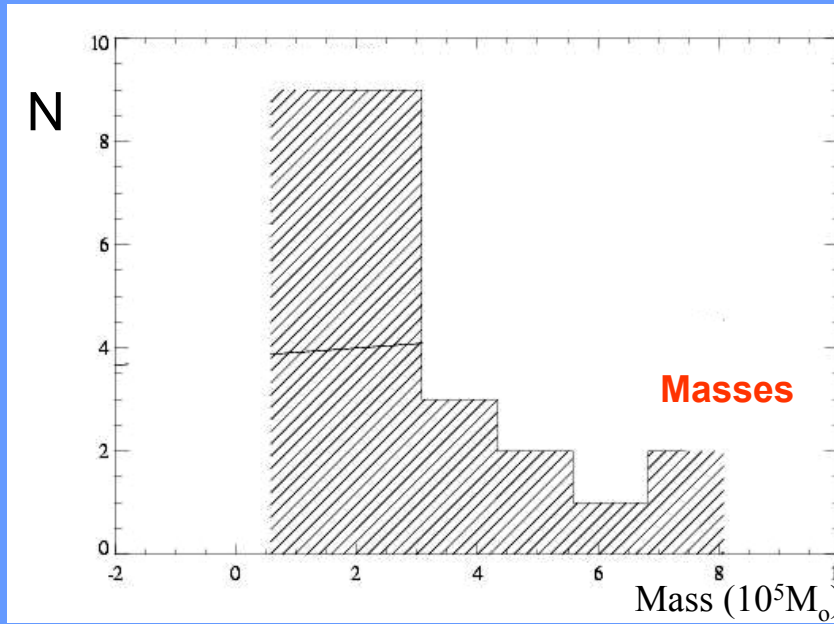
- Watson et al.(1996) proposed 4 SSCs in NGC253
- We have taken all the regions (FOCAS) with fluxes $\geq 5\ 10^{-15}$ erg/s/cm^2 and radius ≤ 4 pc

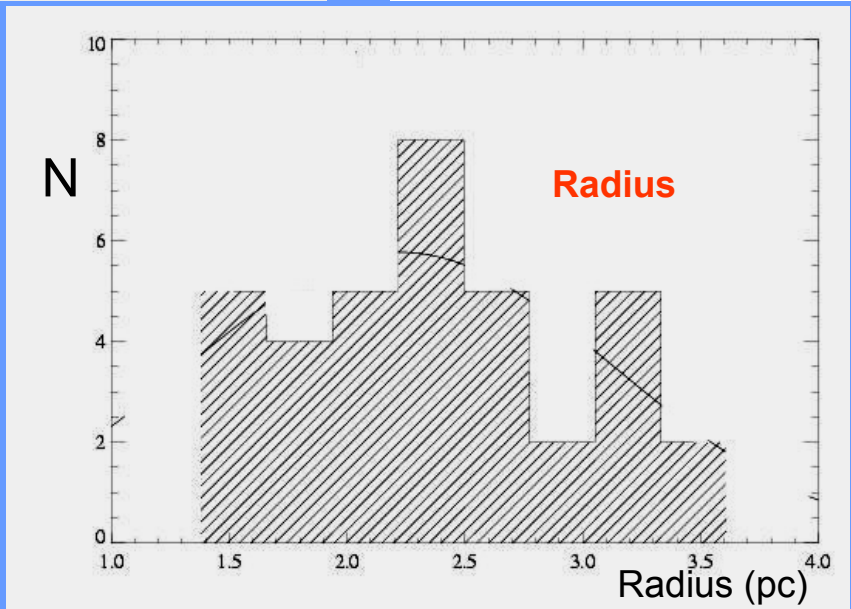
Equivalent width is a good indicator of cluster age (evolution)(Díaz et al. 2000)



Distribution functions





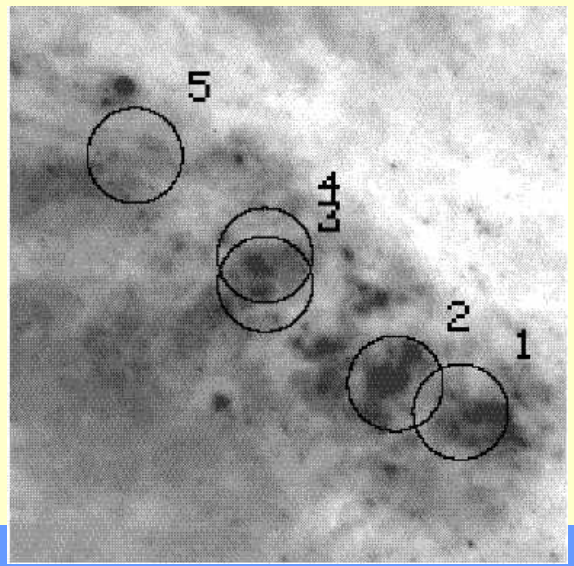


Can we see a continuum of similar objects? (SSCs IMF??)

In the past...

Ultradense HII regions

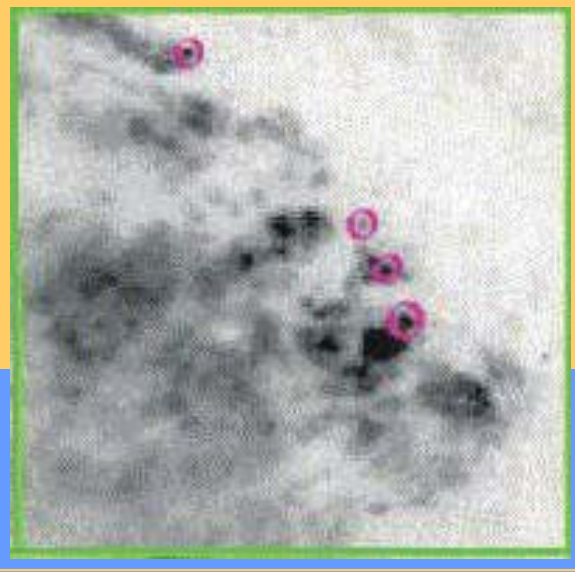
5 UDHII regions in NGC253 (Johnson et al. 2001)



In the present...

SuperStar Clusters

4 SSCs (Watson et al. 1996)



In the future...

Globular Clusters

UDHII characteristics:

Size: few parsecs

Stellar masses: few $10^{5\text{-}6} M_o$

Ionization luminosities: Q_{Lyc} ~ $10^{51\text{-}53}$ s

Ages: few 10^5 years

Which SSC "state" can be associate with the structures in halo? Are these structures fossil or very recent structures?

M82 shows us both active and evolve starburst environments at close range (de Grijs et al.,2001)

NºSSC/area

Number of SSCs per area:

M82 (Meurer 1995):

(175*450) pc and N > 50 SSCs

Nº SSC/area = 808 SSC/kpc²

NGC253:

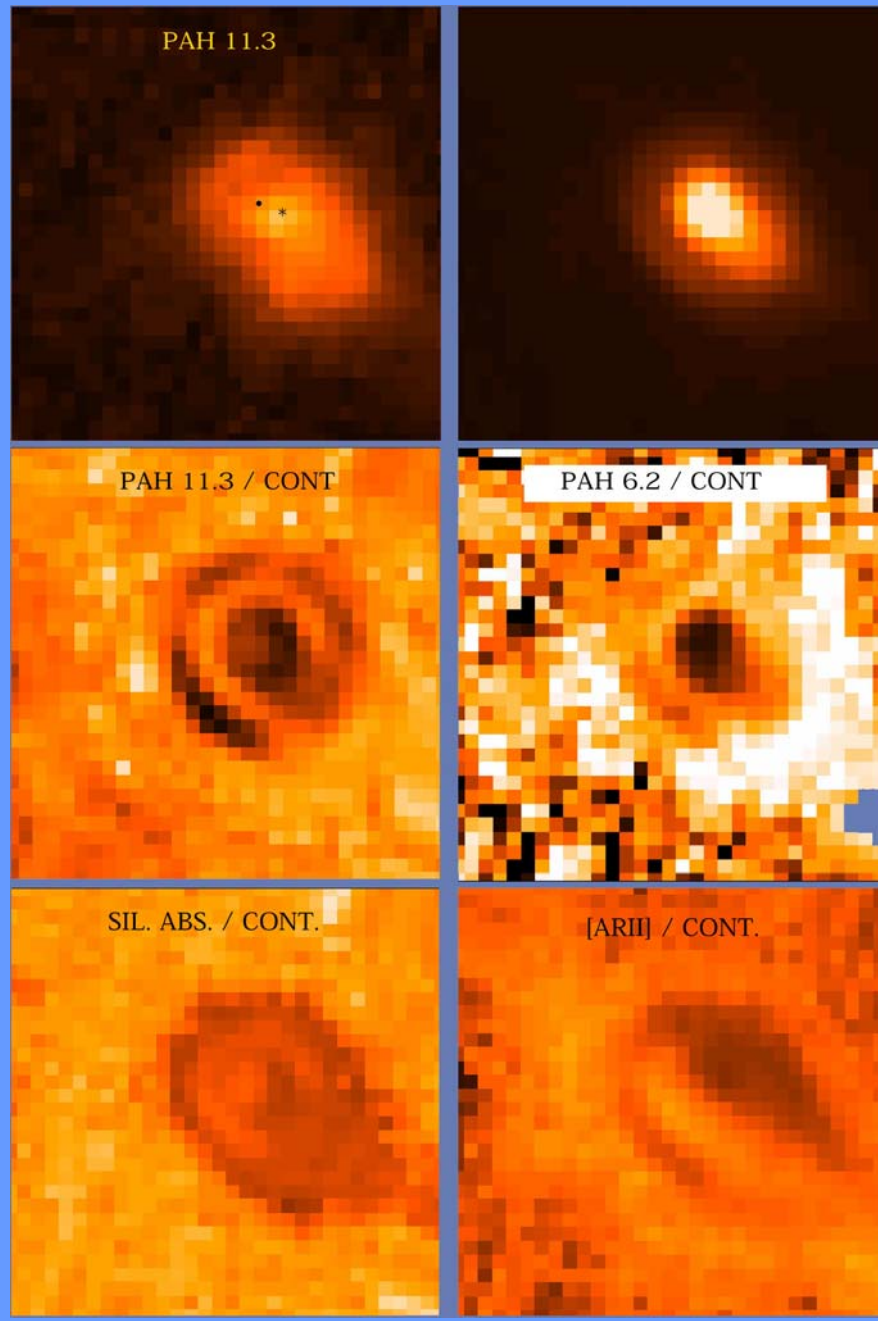
15*15.4 pc and N = 5 SSCs

Nº SSC/area = 180 SSC/kpc²

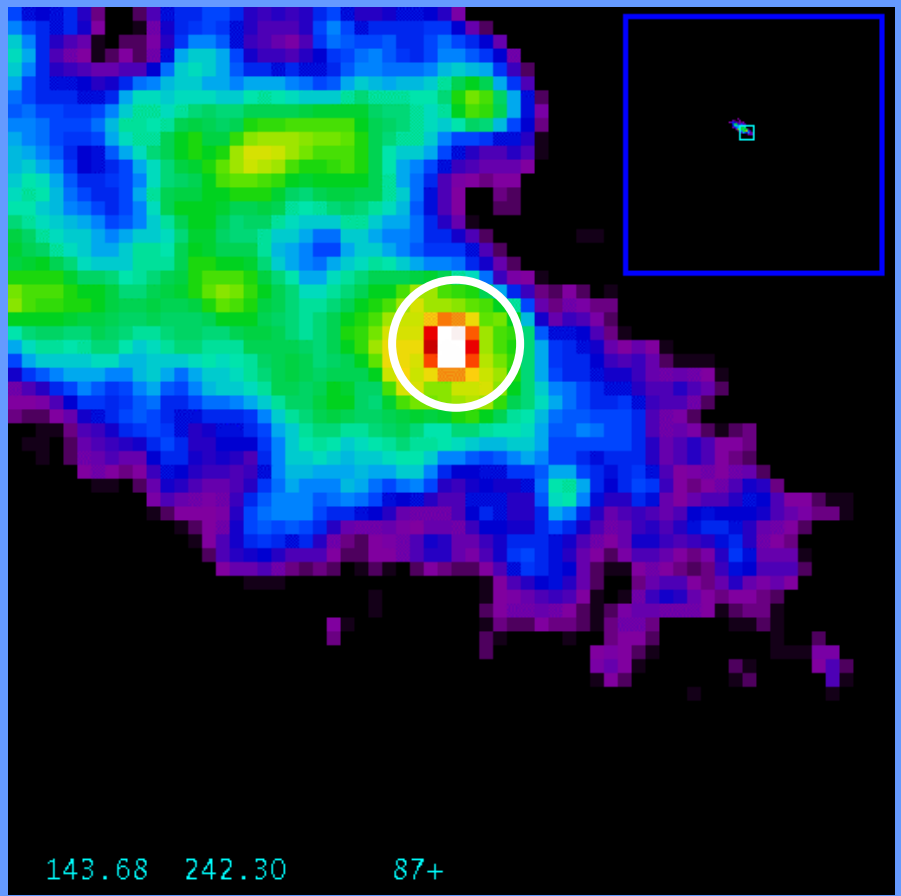
The nearest-neighbour proyected separation is typically ≤18 pc in M82, but in NGC 253 the separation is between 14pc and 90pc

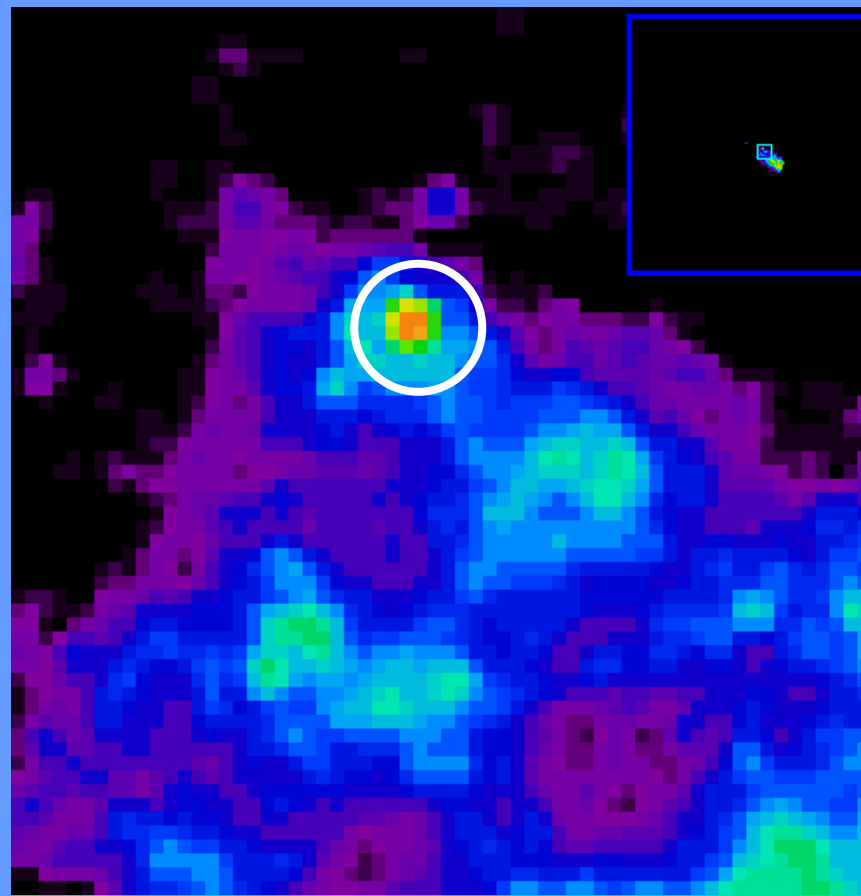
Reaffirm for having a SGW in M82 which we do not found in NGC253

- The confinement is important to produce SGWs
- We have detected (Peréz-García et al 2001) a PAHs ring in the center of NGC253 with radius of 6”(ISOCAM data) => it´s the ionization front interfacing between the ionized material in the starburst and the neutral material (interstellar medium)



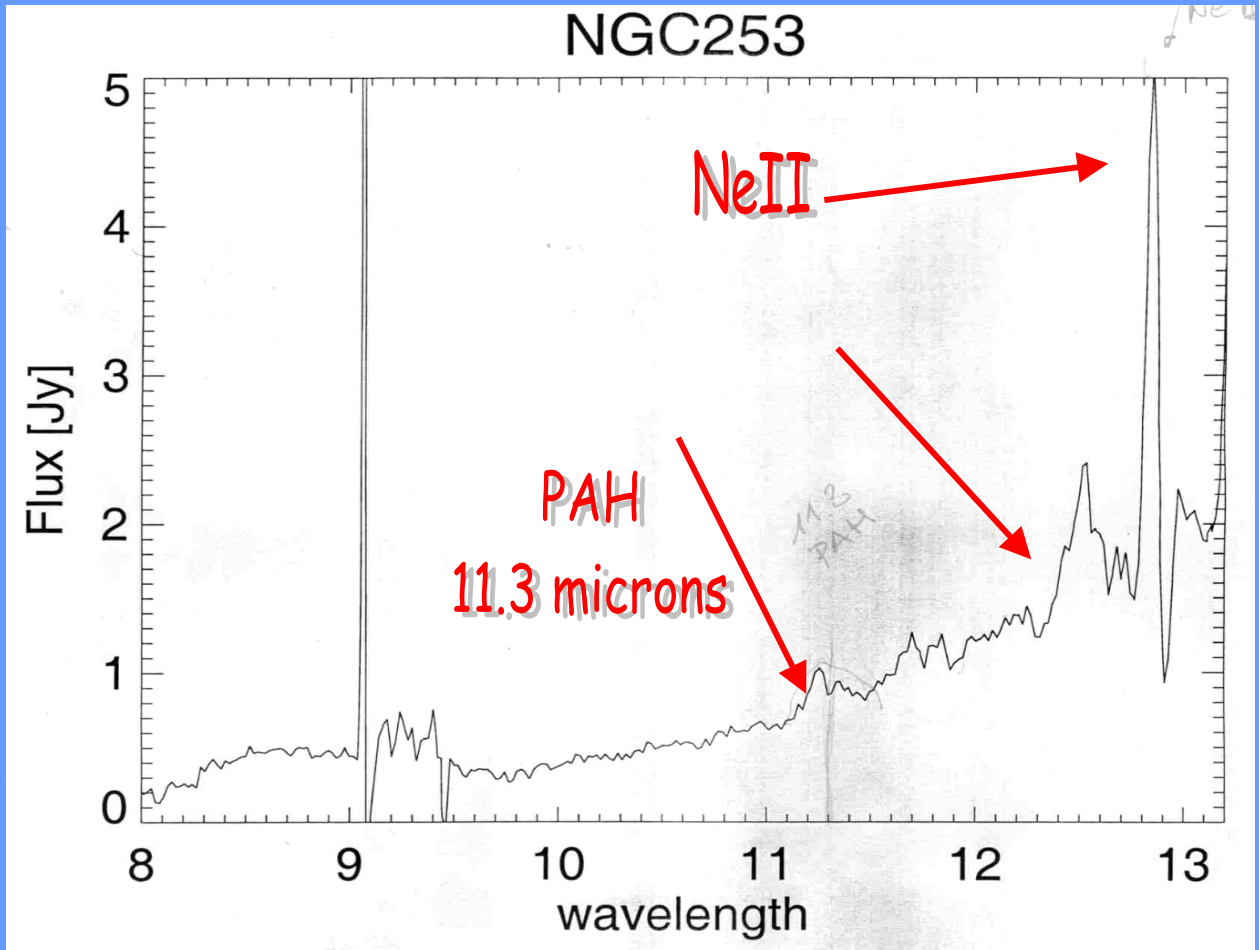
NICMOS (CO) data show little rings around two SSCs candidates





R ~ 3.8 pc

Now we* are going to analyse a MID-IR spectrum (8-13 μm) crossing through one of this little ring

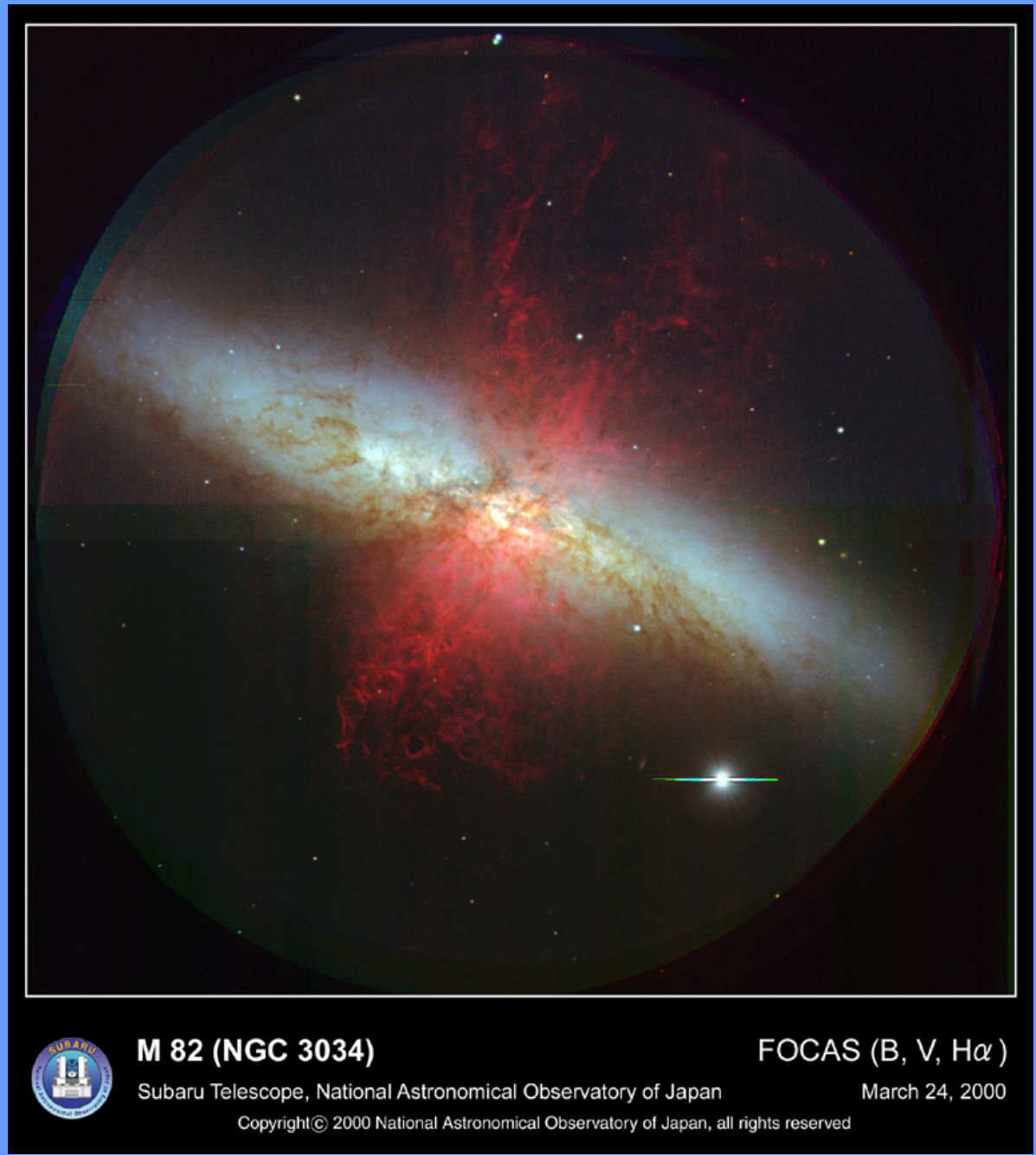


* **J.M.Rodríguez-Espinosa**, C.Muñoz-Tuñón, A.M.Pérez-García, J.A.Acosta-Pulido, V.Mel

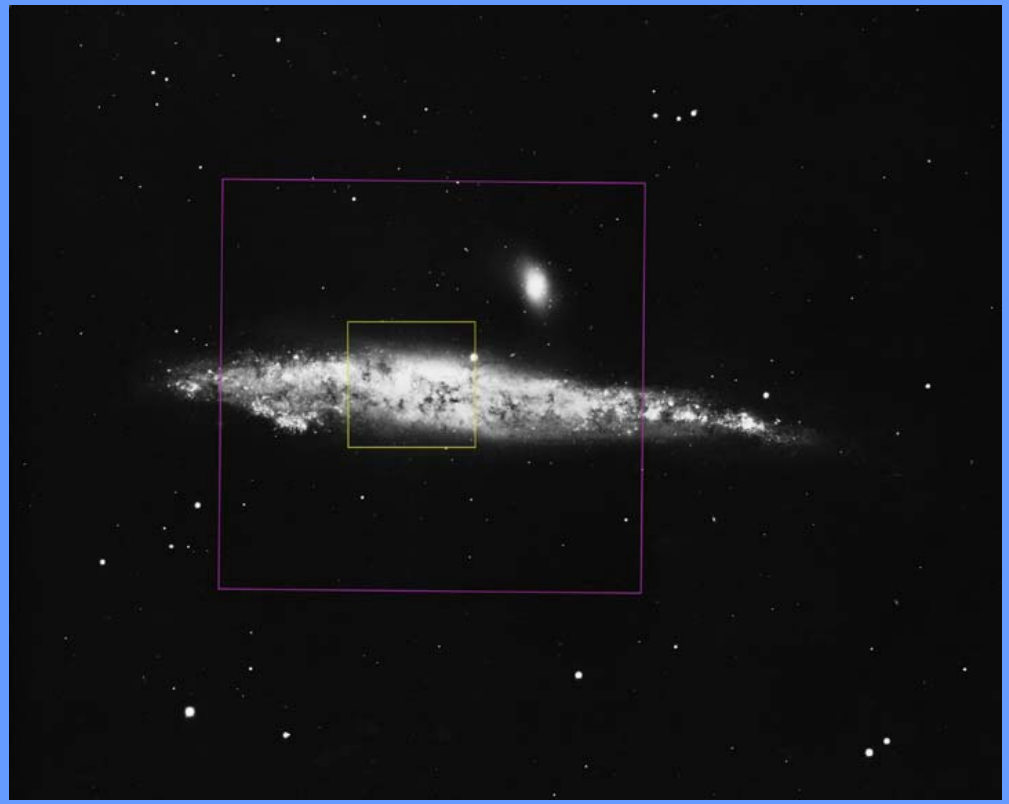
We detect a large amount of cold dust in the disk

We do not have the same Super Star Clusters distribution (and number) in NGC 253 and in M82 => this difference can be define the key to produce the Super Galactic Wind structure

M82


M 82 (NGC 3034)
FOCAS (B, V, Hα)
Subaru Telescope, National Astronomical Observatory of Japan
March 24, 2000
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NGC 4631

Optical image(B-filter)

ESO database



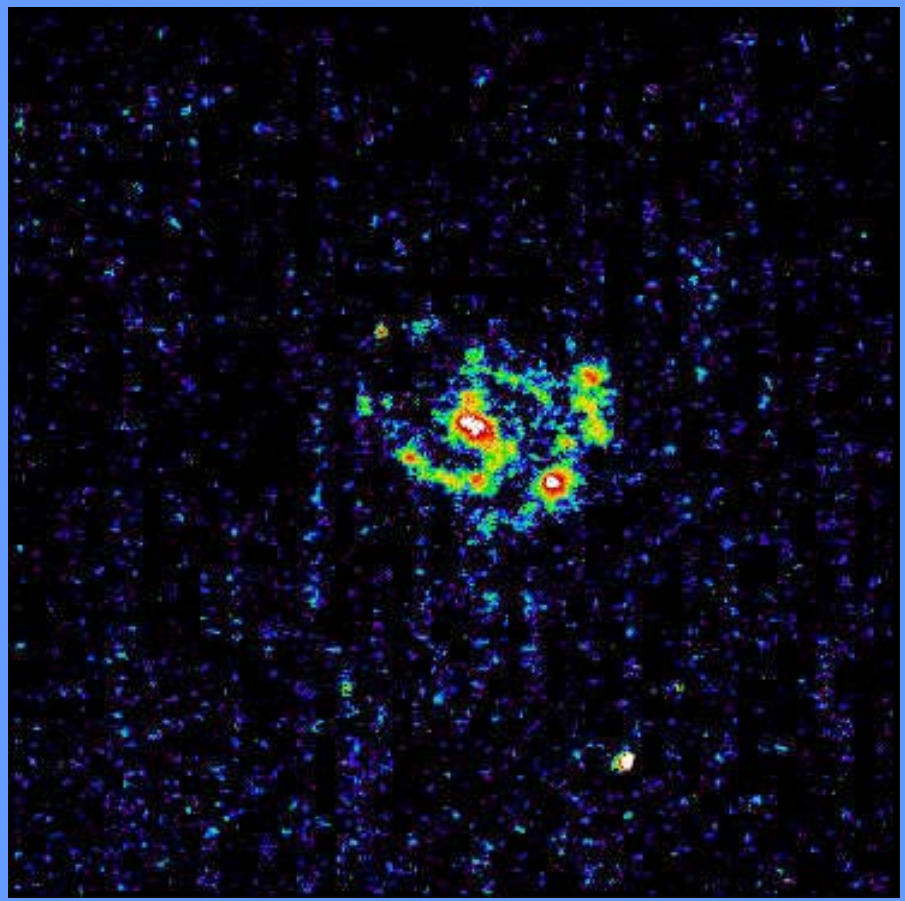
NGC 253

Optical image (B-filter)

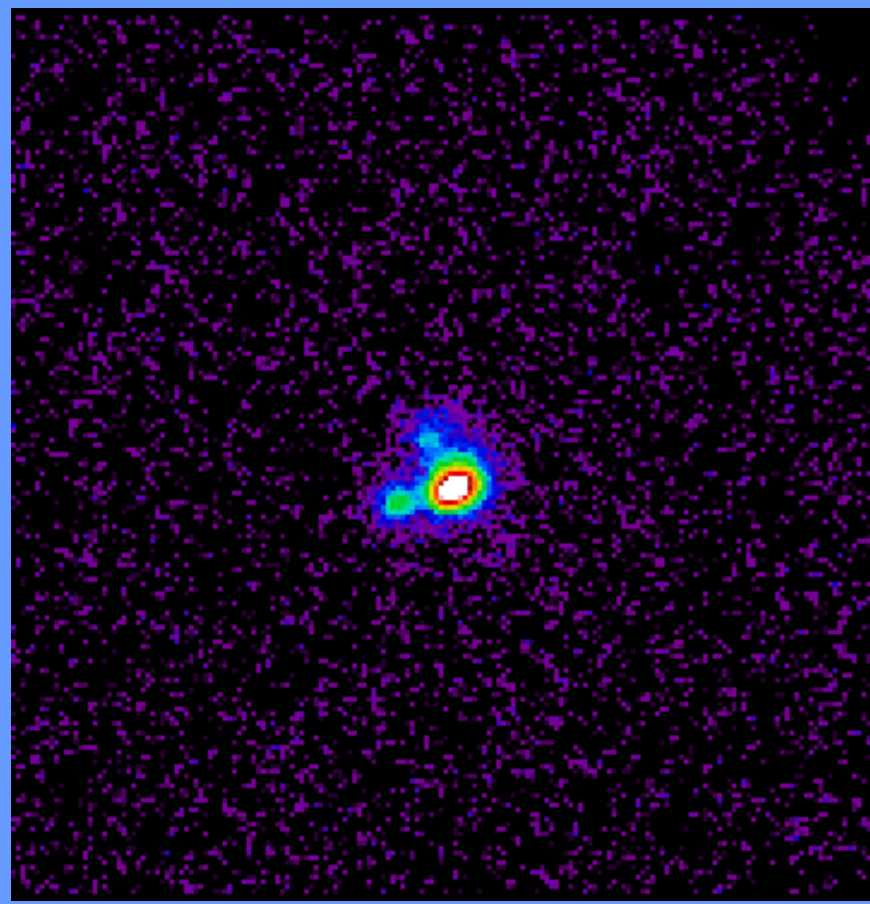
ESO database

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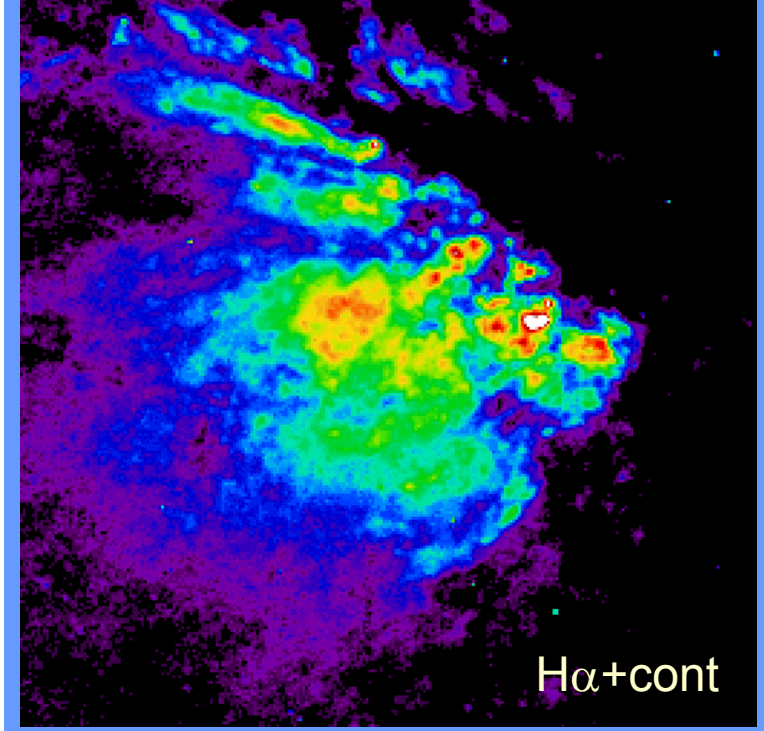
mrk307

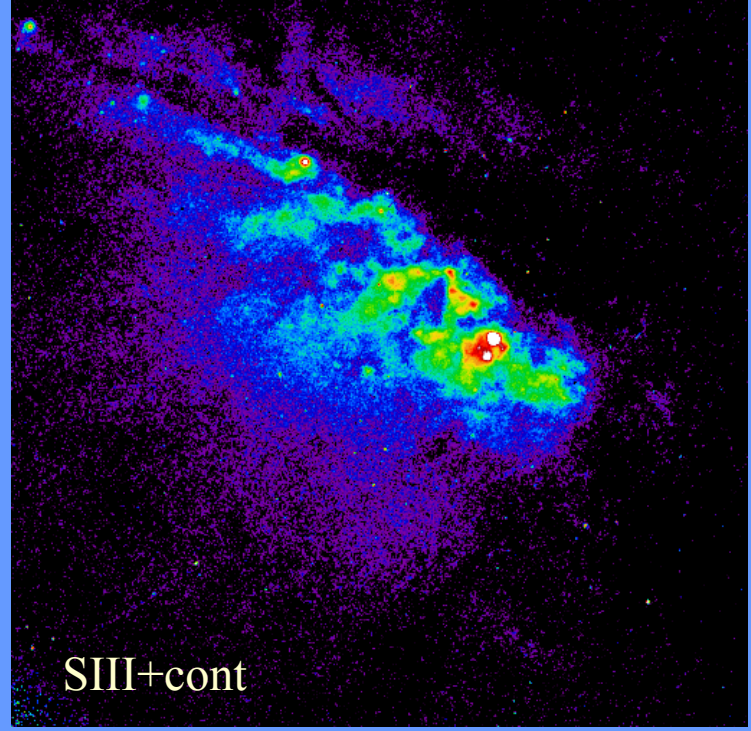


Mrk921



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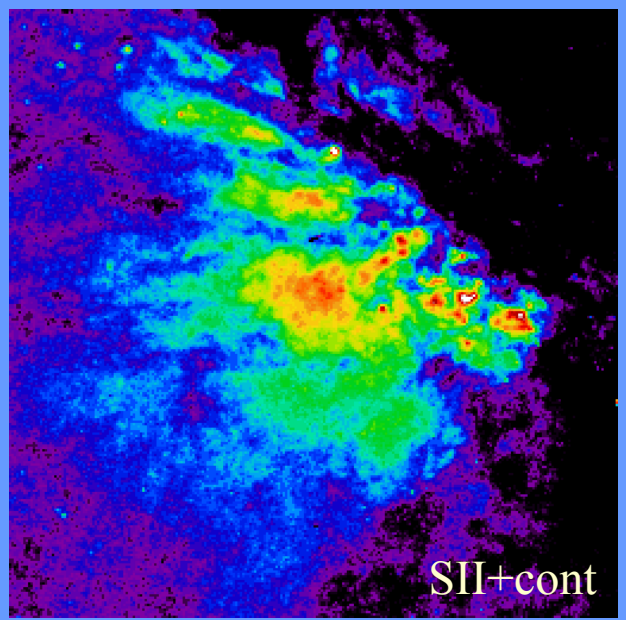


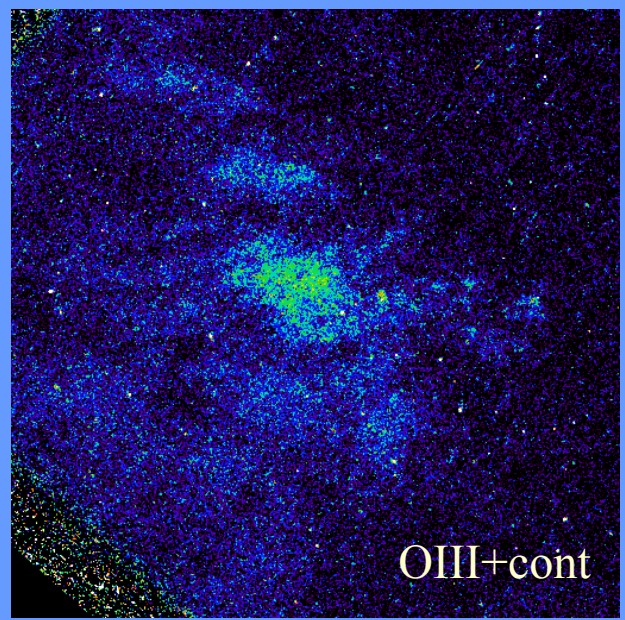


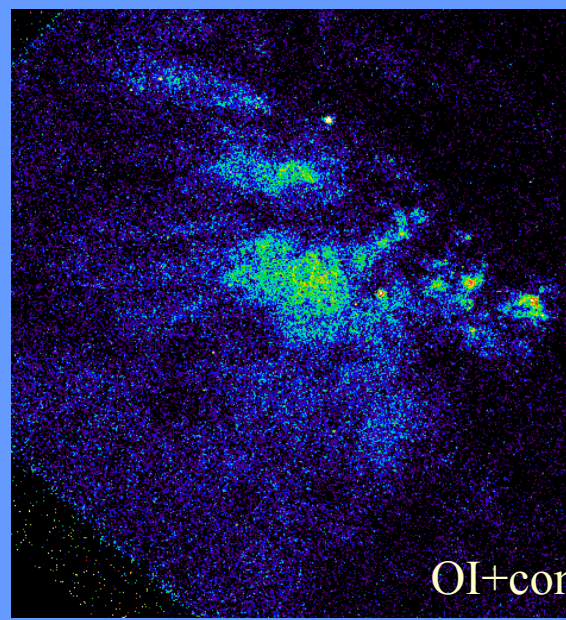
NGC 253

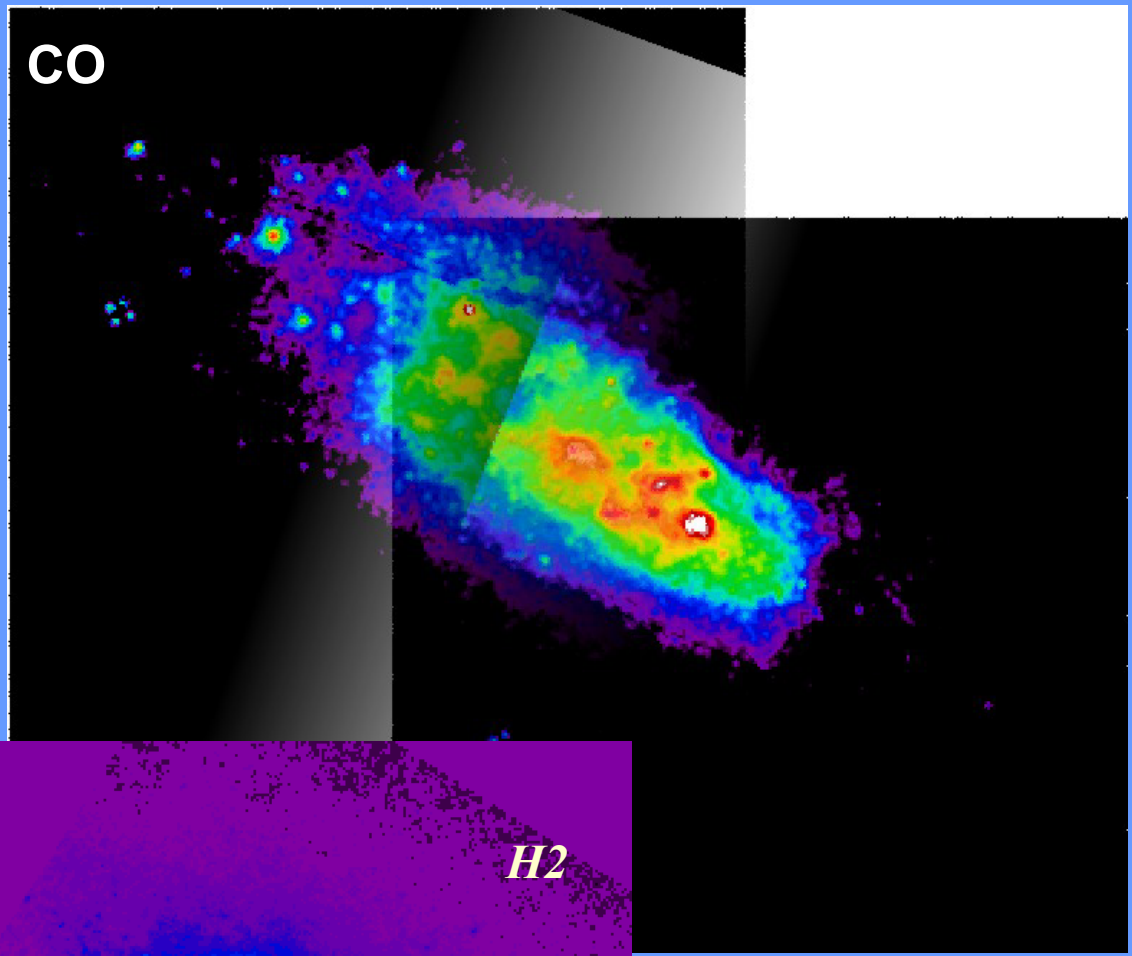
WFPC2

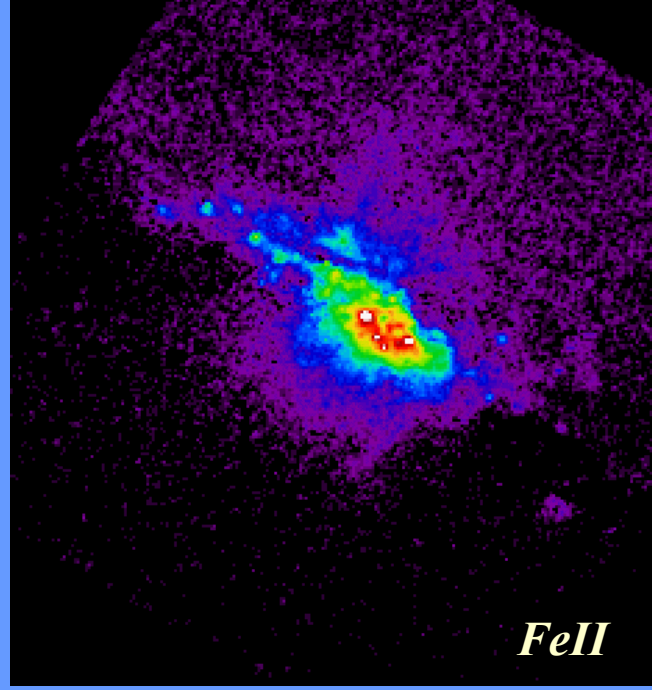
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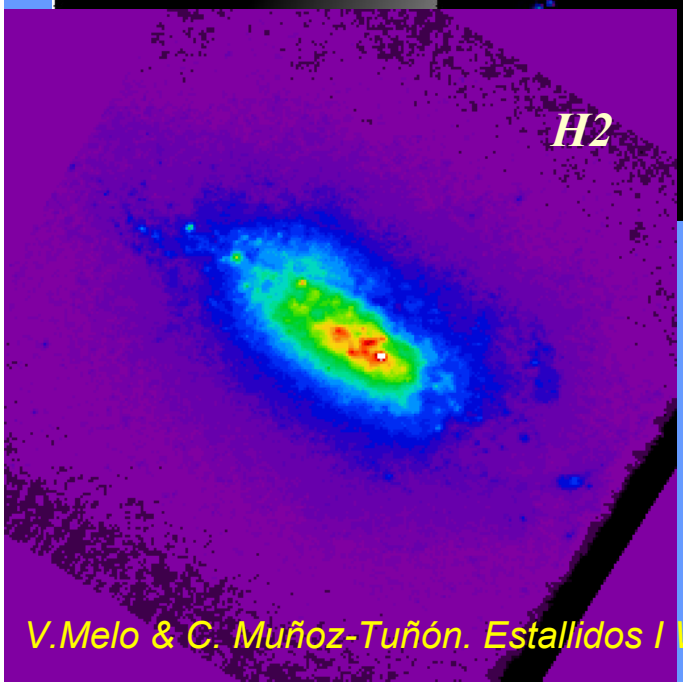


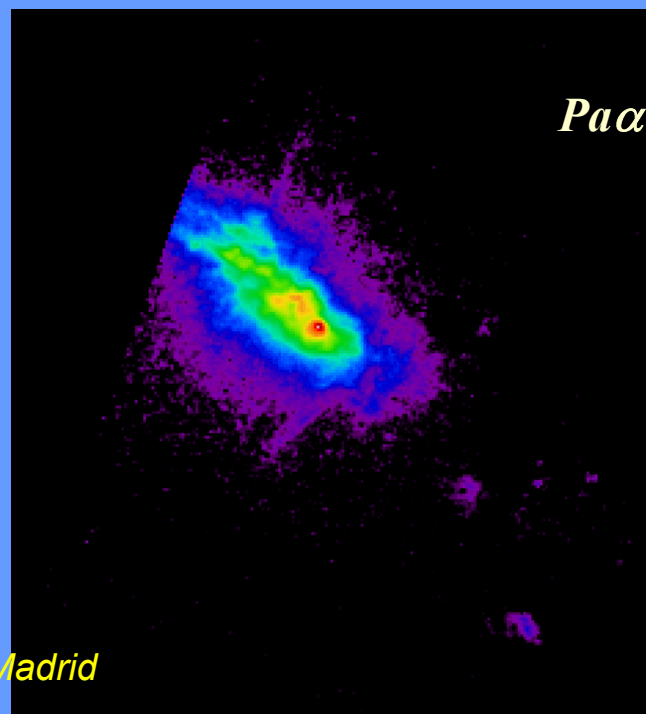




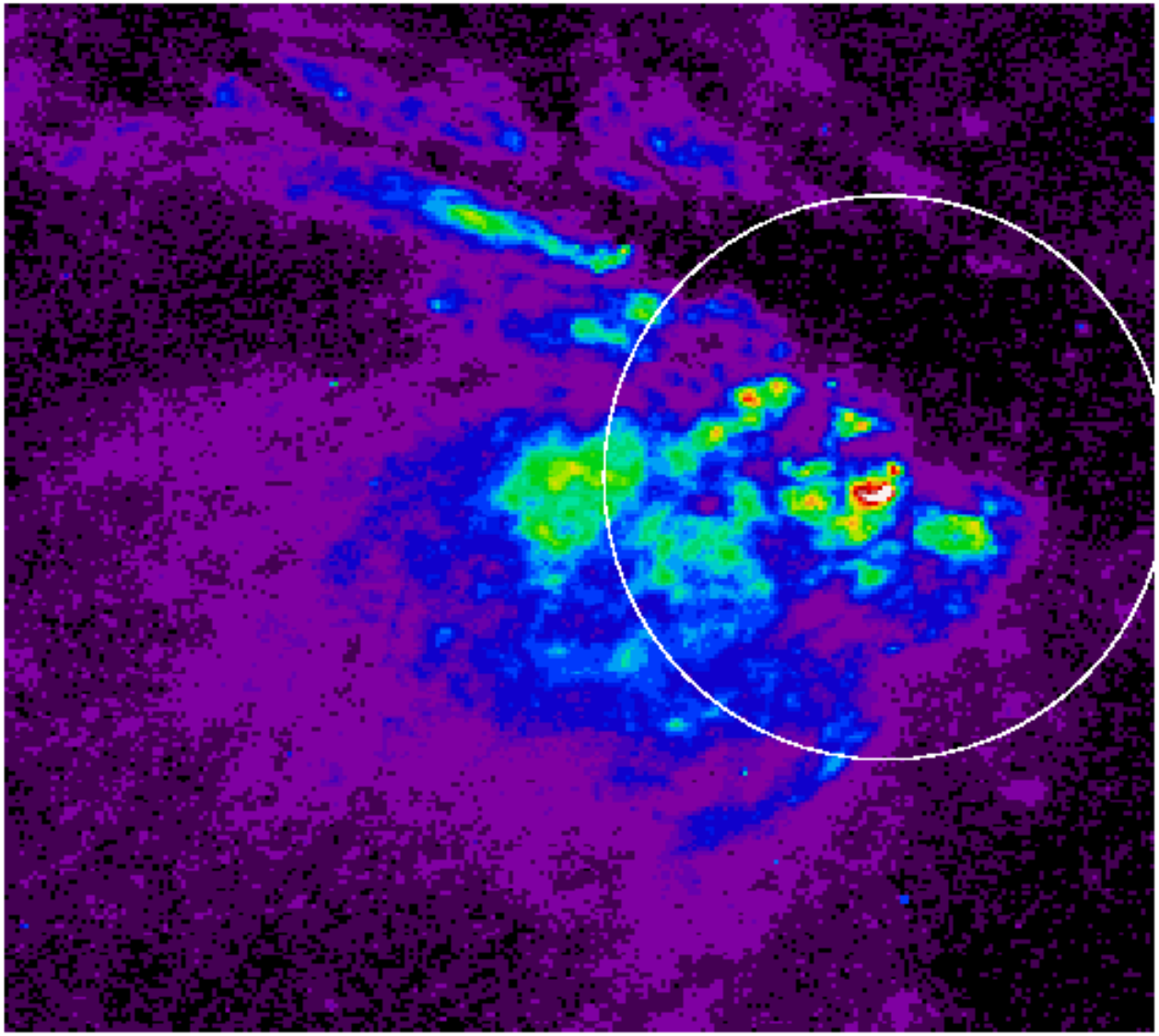








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