

# IR to Uv to X-rays in Early-type galaxies

A work in progress

G. Trinchieri

INAF-OABrera

With Roberto Rampazzo Paola Mazzei Antonietta Marino (INAF-OAPd)

Anna Wolter (INAF-OABrera)

# MIR Spectra in the nuclear region [ $\sim 1/8 r_e$ ] relative to the “passive” template ( $\sim$ CLASS 0)

$\sim 90$  ETGs

Class 0 Passive

Class 1 Very low  
past SF

Class 2 post  
SF phase

Class 3 SF phase

Class 4 Nuclear active  
phase (AGN)

transition

- relative presence and strength of PAHs
- atomic and/or molecular line emission
- dust underlying continuum

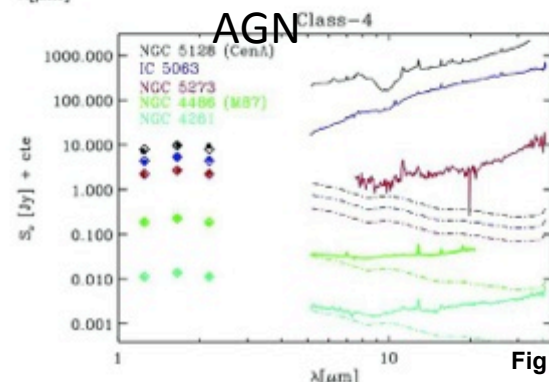
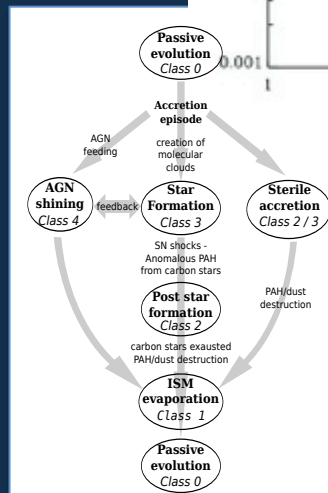
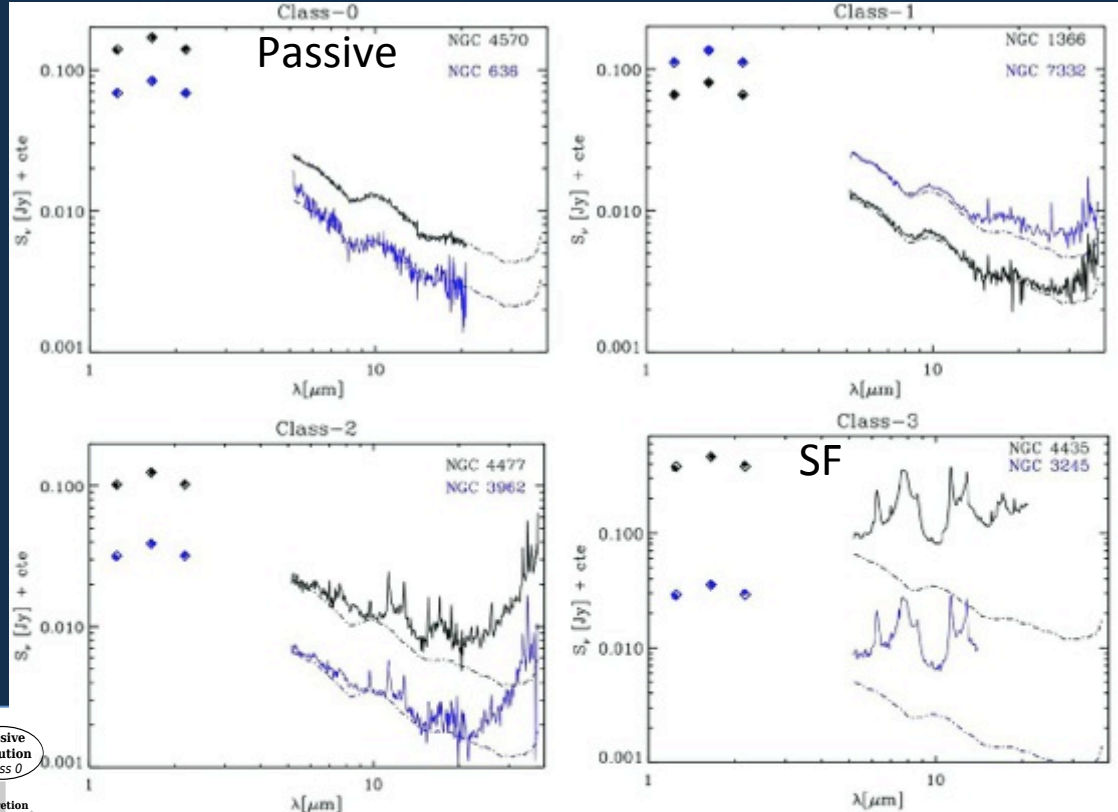
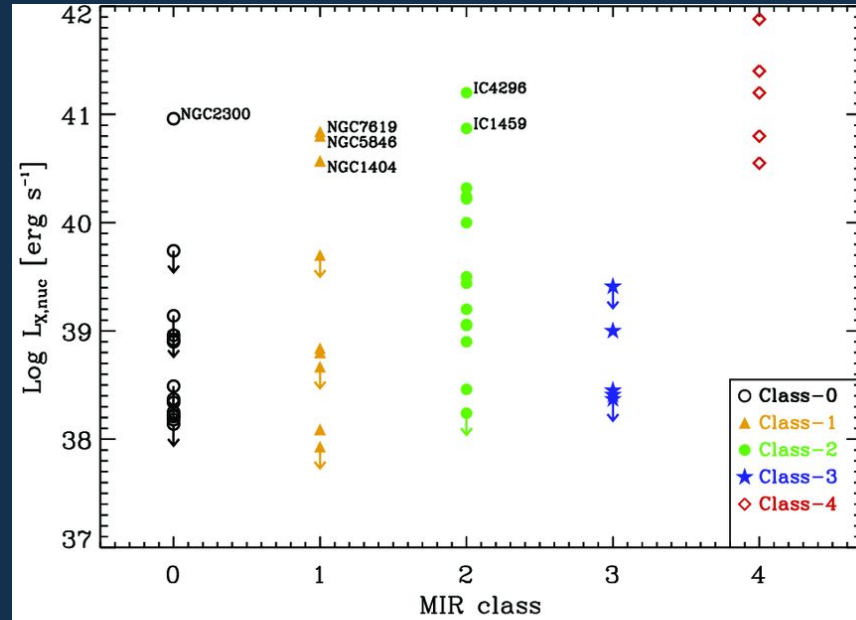


Fig 2 Rampazzo et al. 2013

Fig 11 Panuzzo et al 2011

# Nuclear $L_x$ versus MIR class -- PAH features 11.3/7.7 $\mu\text{m}$

- Class 0 Passive
- Class 1 Very low past SF
- Class 2 post SF phase
- Class 3 SF phase
- Class 4 Nuclear active phase (AGN)



SF have lower  $L_x$  than transition phases/AGN

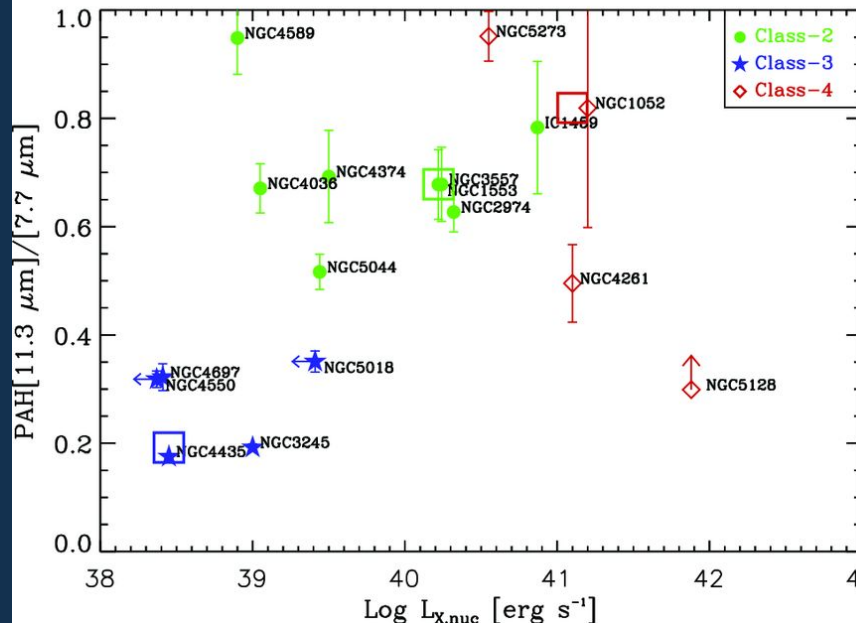


Fig 6 Rampazzo et al. 2013

PAH ratio  $\Leftrightarrow$  current SF

Available MIR spectra - Spitzer - “nuclear” region

Class 0-1-2-3-4 [passive → moderately SF - AGN]

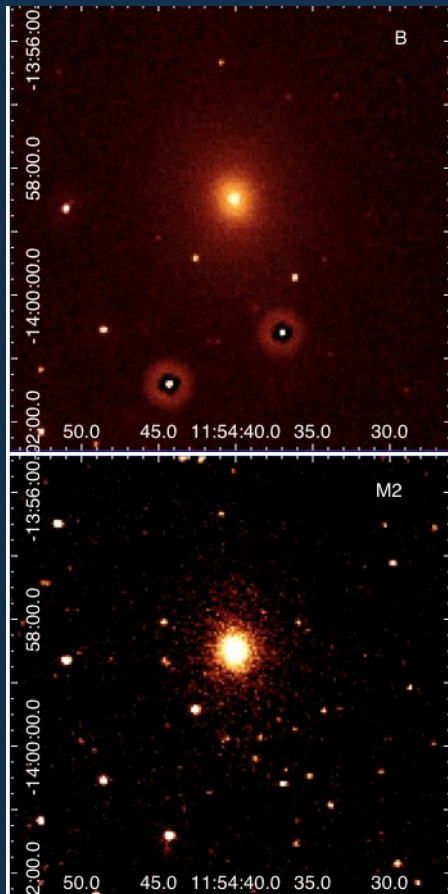
Galex NUV-FUV images

New data:

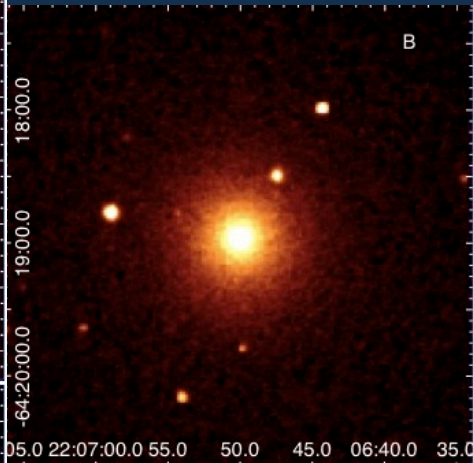
11 galaxies with SWIFT : XRT + UVOT

1 galaxy with XMM-Newton

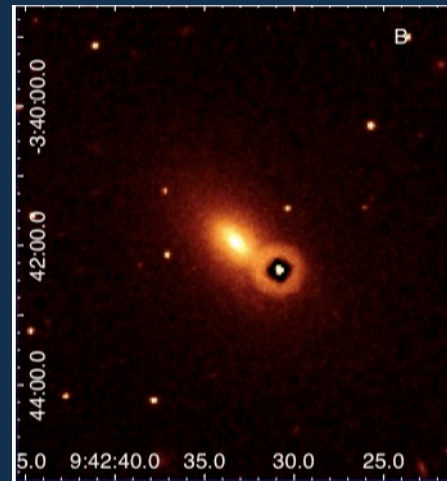
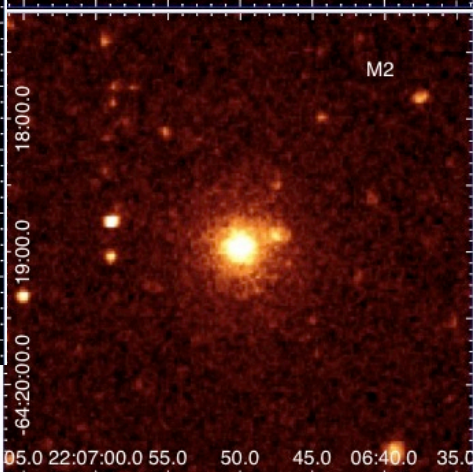
# UVOT B and M2 images



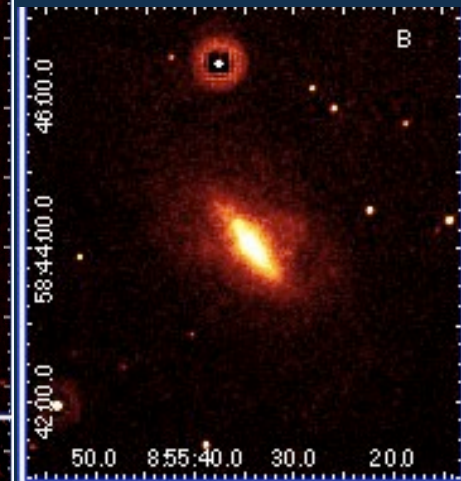
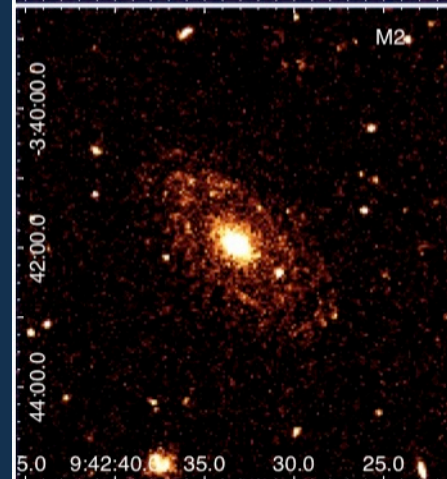
NGC 3962  
Featureless



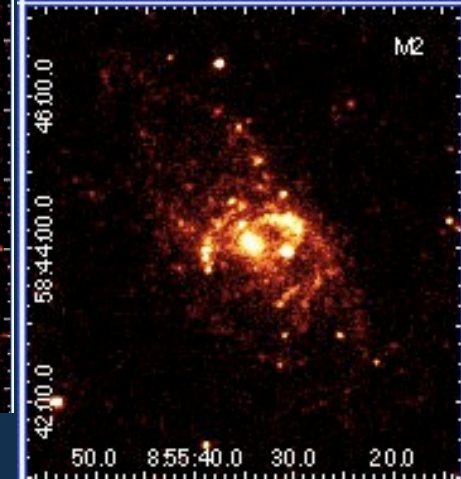
NGC 7192  
Possible "nuclear" Knot



NGC 2974  
External arms/rings



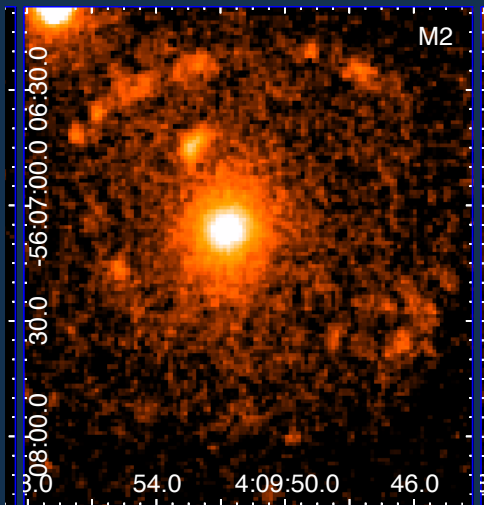
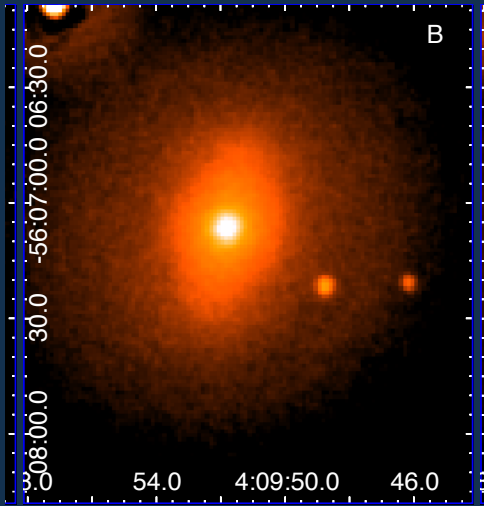
NGC 2685  
Several Overlapping  
structures





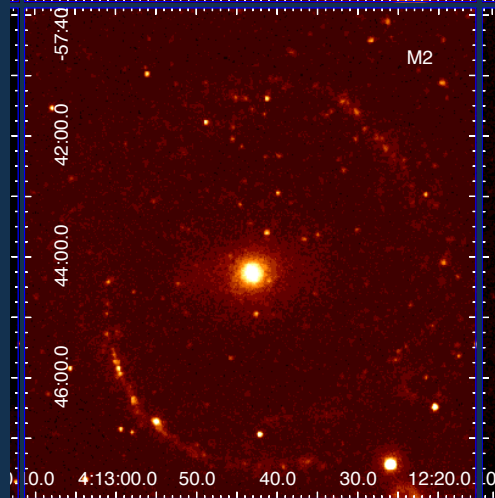
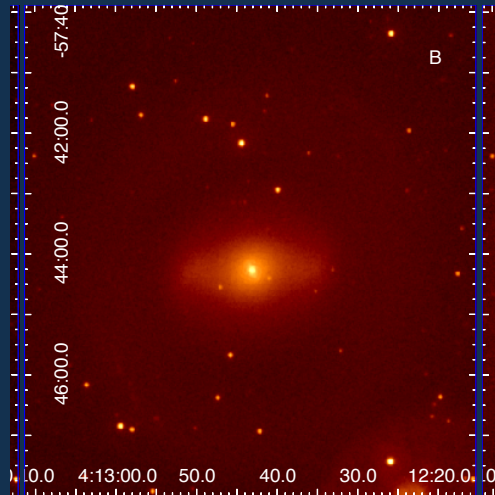
# UVOT B and M2 images of “rings”

NGC 1533



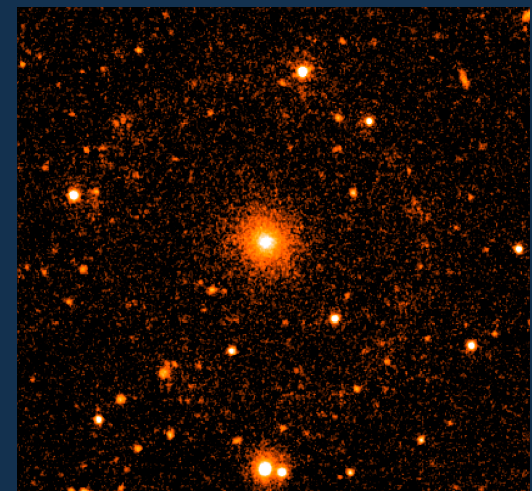
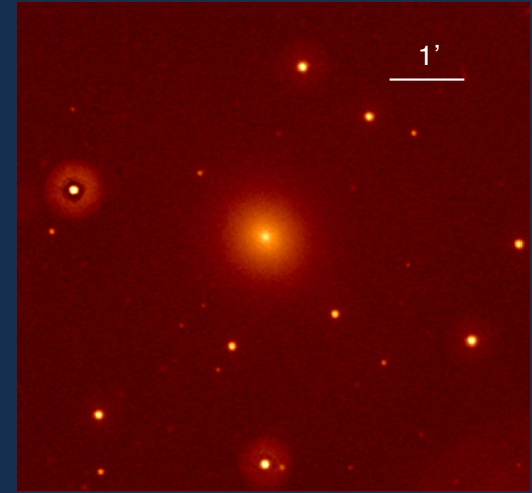
Ring  $\sim 1'$

NGC 1543



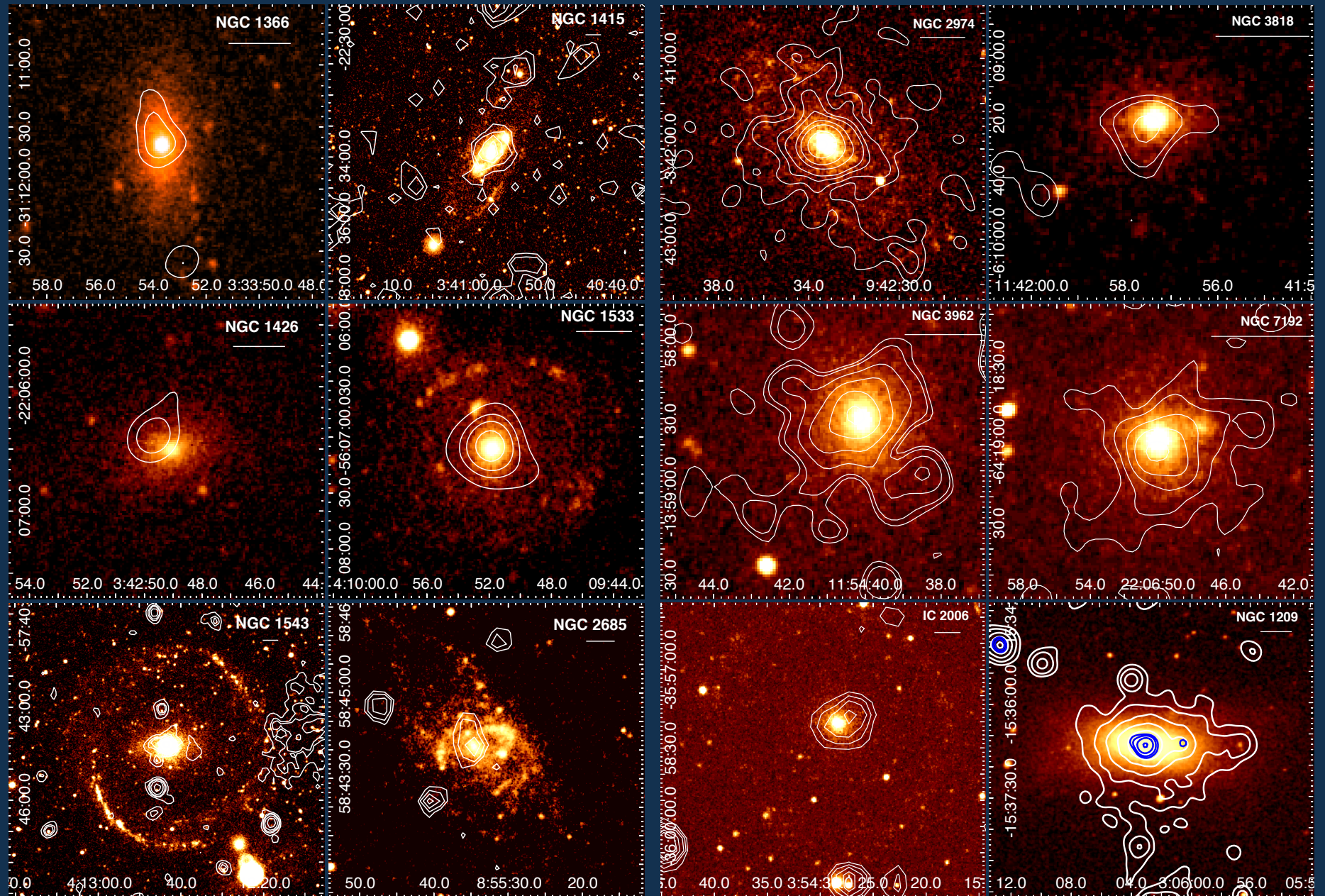
$\sim 3'$

IC 2006



$\sim 2'$

# UVOT M2 images and X-ray contours

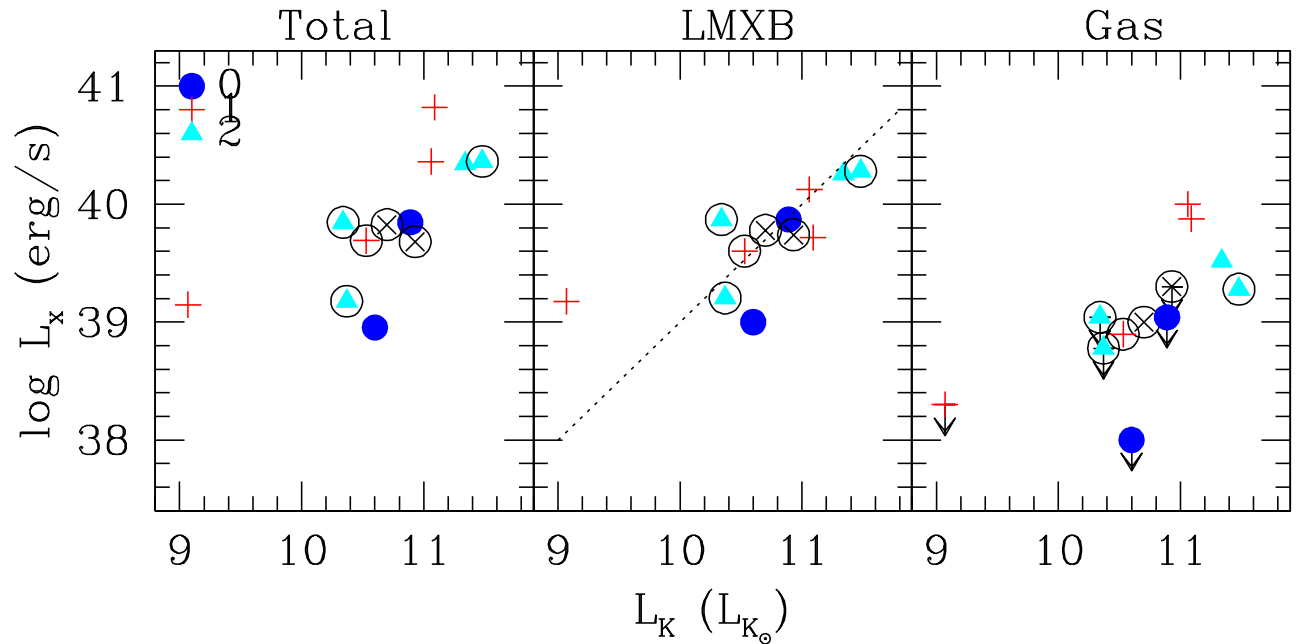
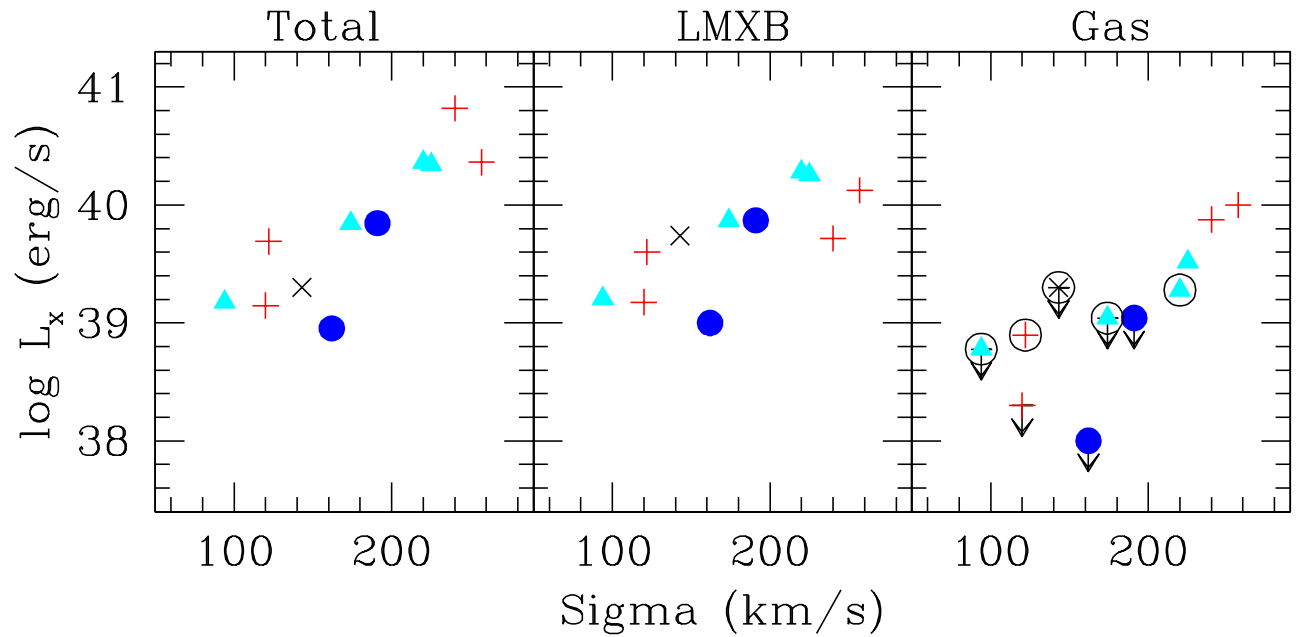


$$L_x \sim 10^{39} - 10^{41} \text{ erg/s}$$

$L_{\text{XRB}} \sim$  Boroson et al rel.

Gas : 50% yes

$$L_x \sim 10^{39} - 10^{40} \text{ erg/s}$$



MIR=0 Passive

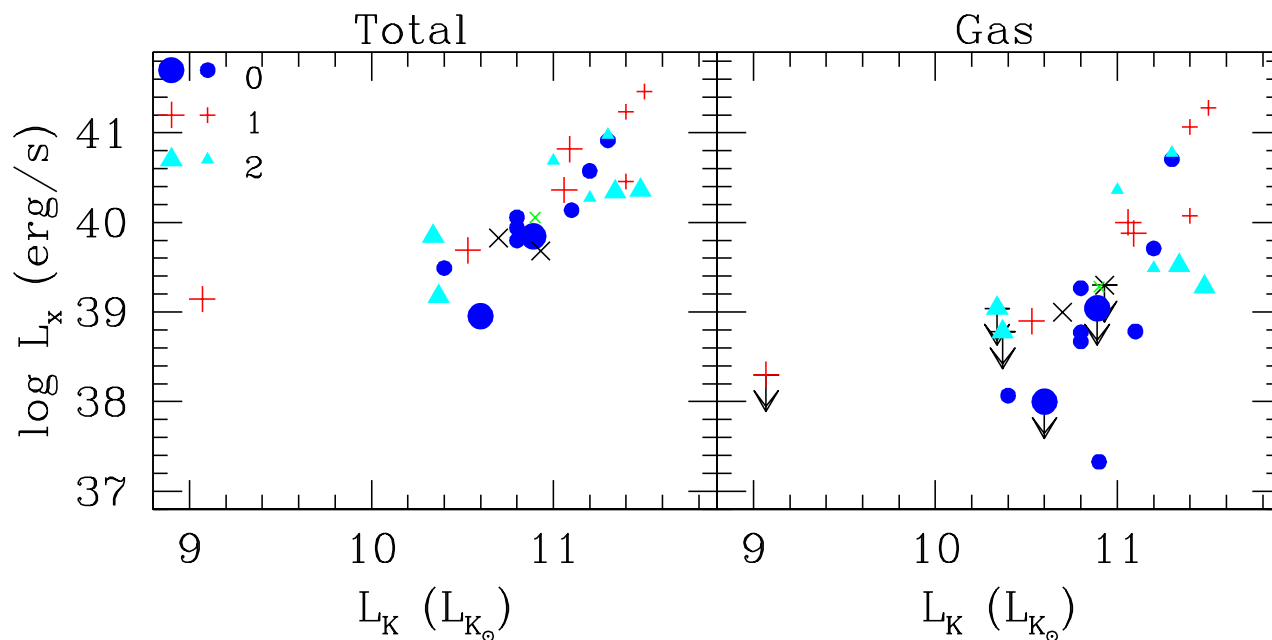
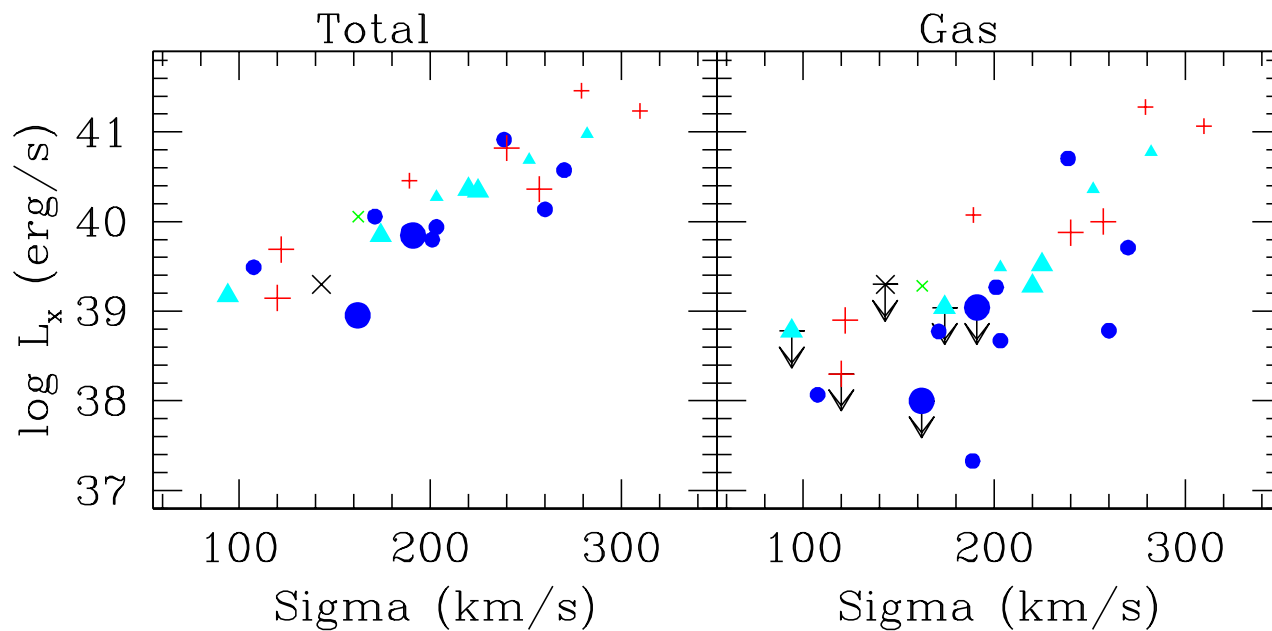
MIR=1 Very low past SF

MIR=2 post SF phase

O Extended SF



Adding galaxies  
from Boroson et al 2011  
with MIR spectra



MIR=0 Passive  
MIR=1 Very low past SF  
MIR=2 post SF phase  
MIR=3 SF phase

# “Age”

Ages from modeling  
line-strength indices  
in optical spectra

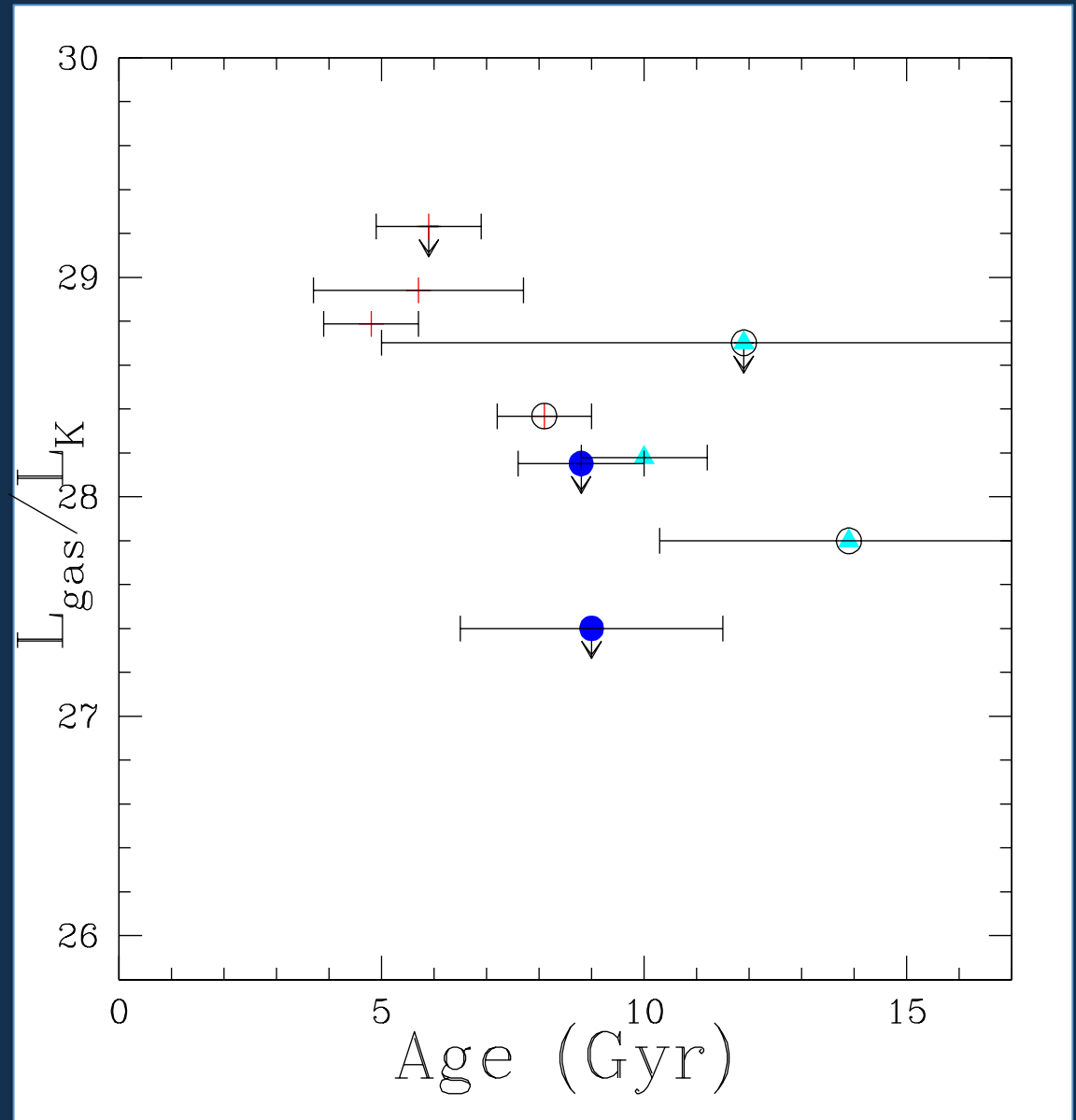
Annibali et al 2007

MIR=0 Passive

MIR=1 Very low past SF

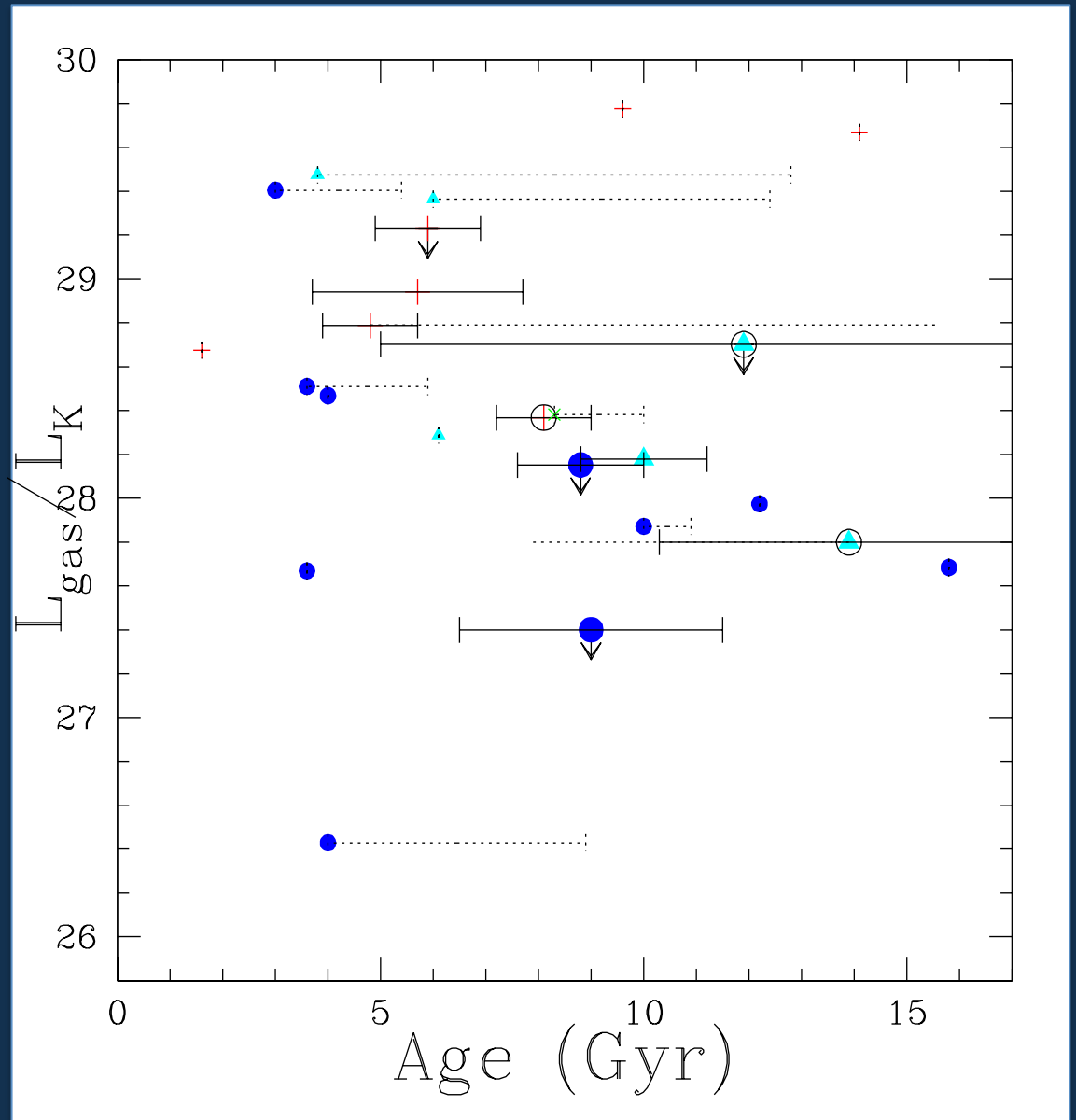
MIR=2 post SF phase

MIR=3 SF phase

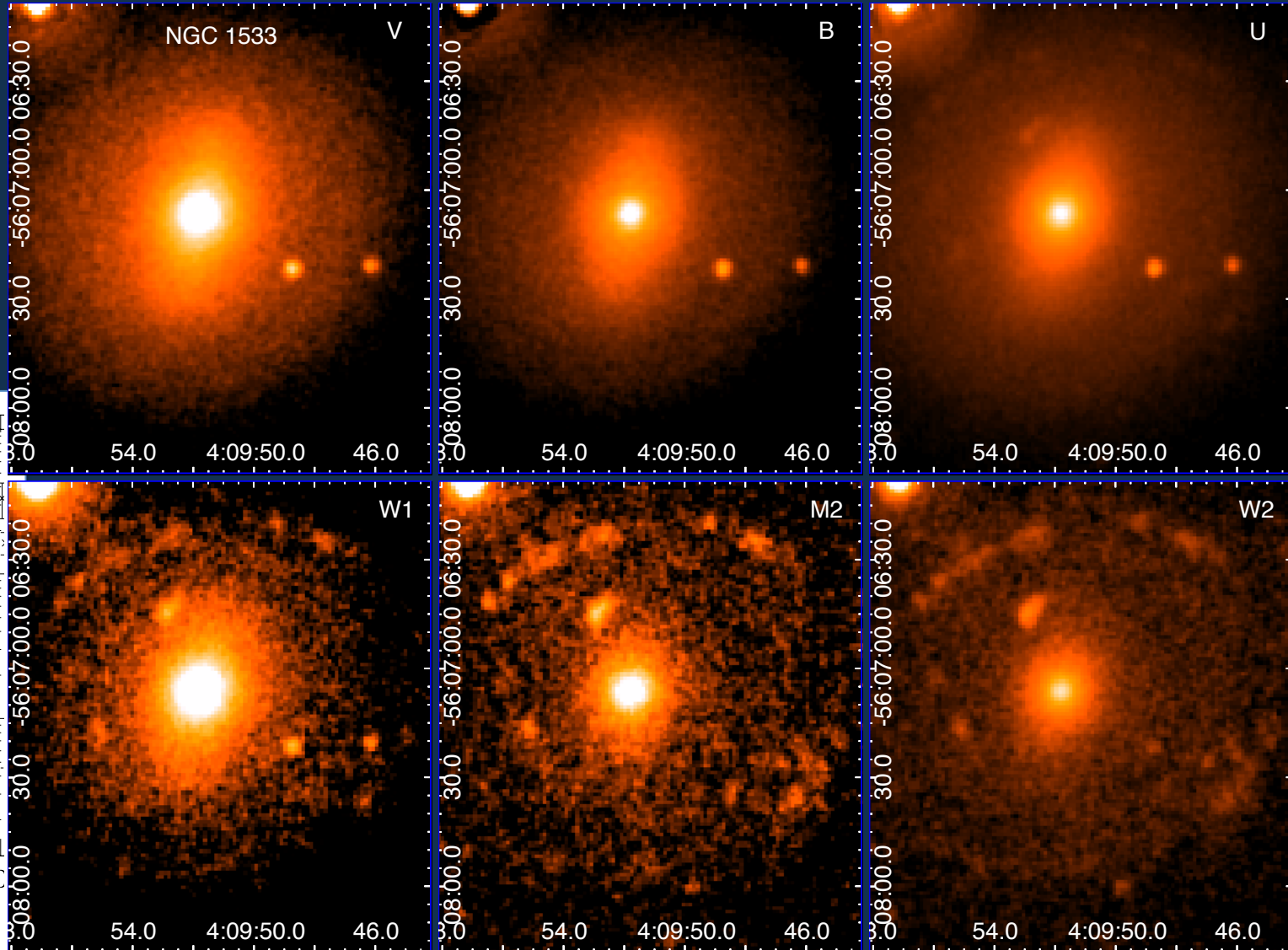
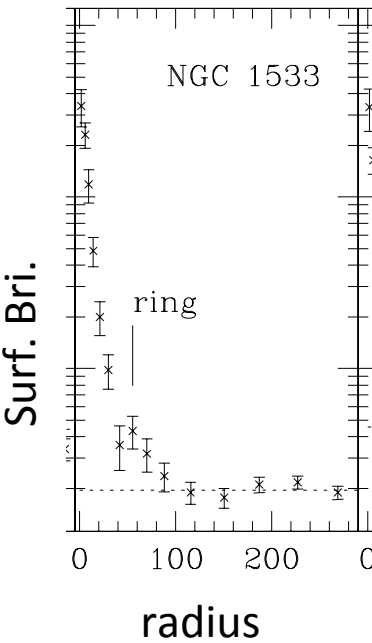
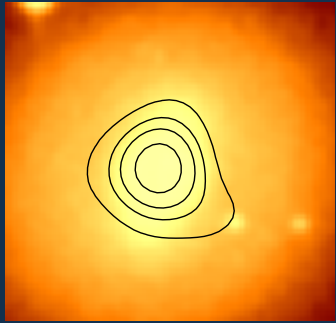


# “Age”

- MIR=0 Passive
- MIR=1 Very low past SF
- MIR=2 post SF phase
- MIR=3 SF phase



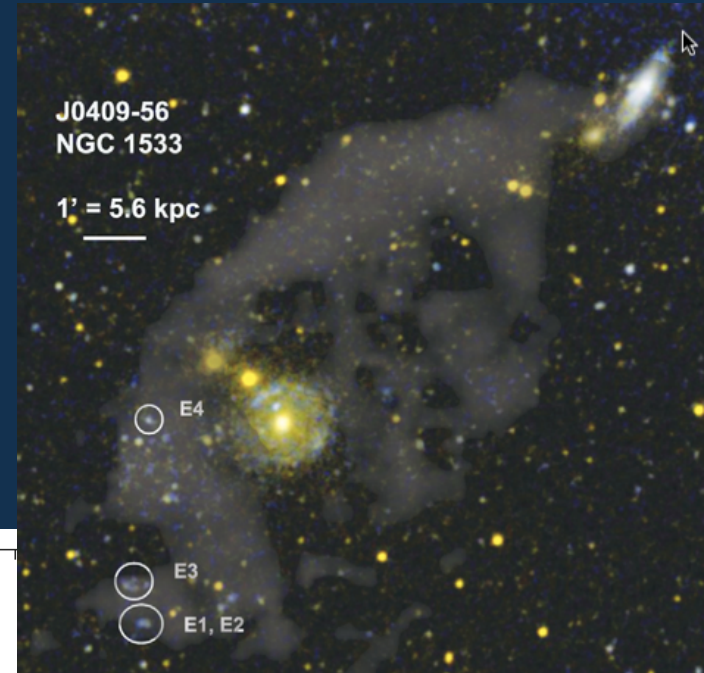
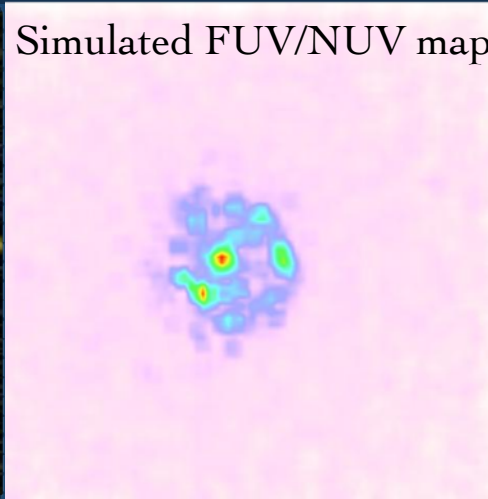
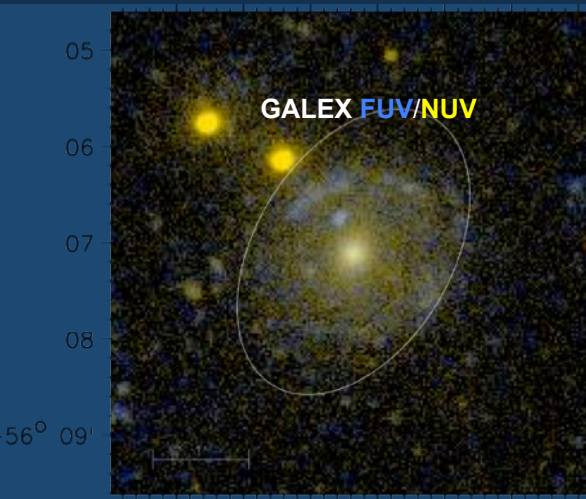
# NGC 1533





# Chemo-photometric $S_{\text{smooth}}P_{\text{particle}}H_{\text{hydrodynamical}}$ simulations

## Matching morphology and SED



Galaxy age 13.7 Gyr

Mean Stellar age

~ 6 Gyr @  $R_{25}$

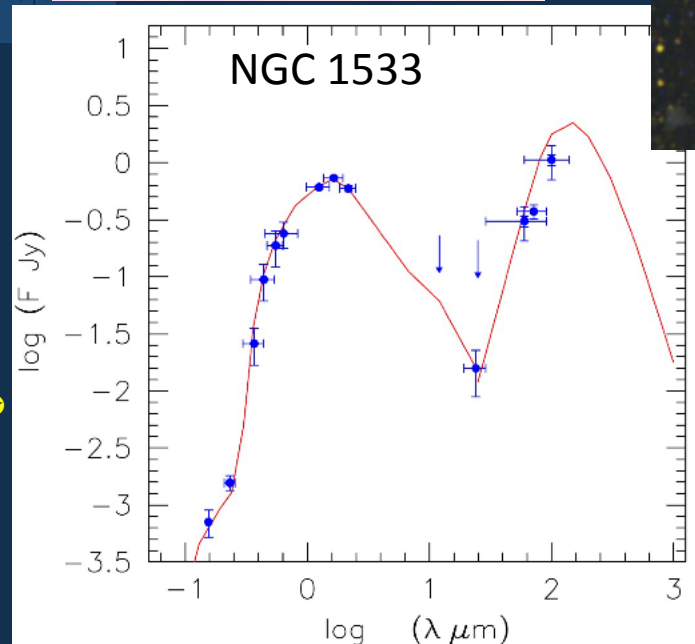
~ 3.7 Gyr @ 1  $R_e$   
but 1% of Mass

0.5 Gyr ring + central

Total Mass  $4.9 \times 10^{10} M_{\odot}$

Gas Mass  $1 \times 10^{10} M_{\odot}$

SFR ~  $0.14 M_{\odot}/\text{yr}$



The merger begins 3.5 Gyr after the onset of the SFR.

Rings/arms like features arise in the latter stages of the merger episode, when the galaxy is almost 8 Gyr old as a consequence of the head-on collision.