

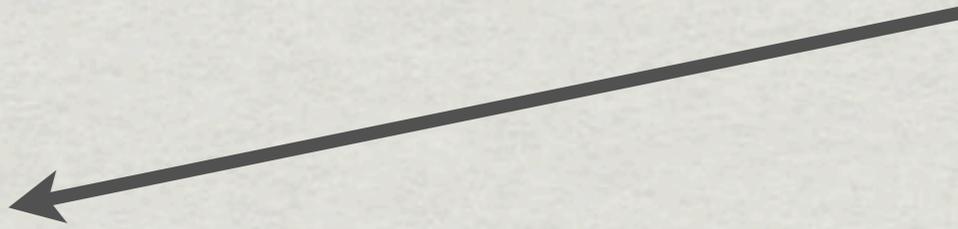
# The GLEAMing of supermassive black holes in the early Universe

**Collaborators:** N. Seymour (ICRAR/Curtin), T. Falkendal (IAP/ESO),  
C. De Breuck (ESO), J. Vernet (ESO), B. Emons (NRAO),  
M. Lehnert (IAP), R. Turner (UTas), S. Shabala (UTAS),  
D. Stern (JPL), B. Rocca (IAP)

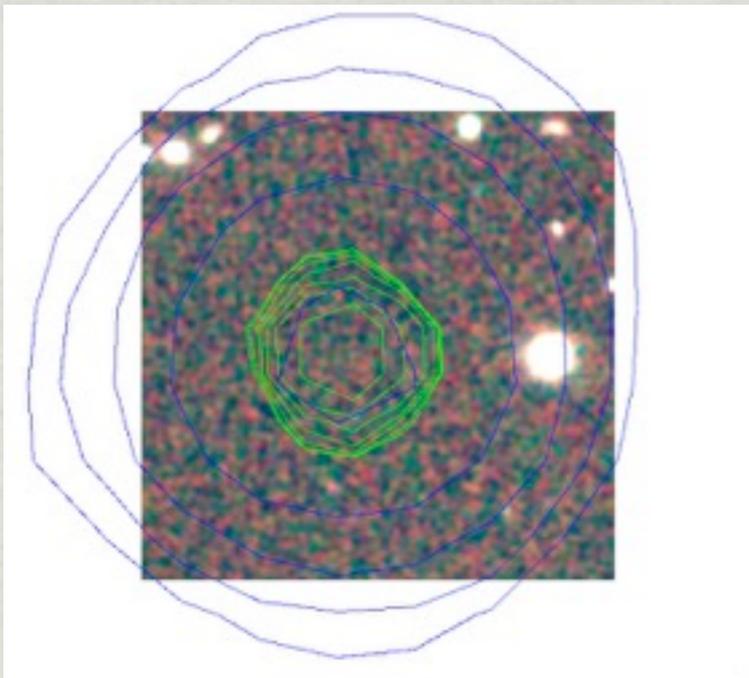
G. Drouart (ICRAR-Curtin), SALF IV, 13 Dec 2017

# What's for?

**better SEDs of HzRGs in the  $1 < z < 5$  range**



**TEMPLATES TO PUSH  
REDSHIFT LIMIT,  $Z > 6$**

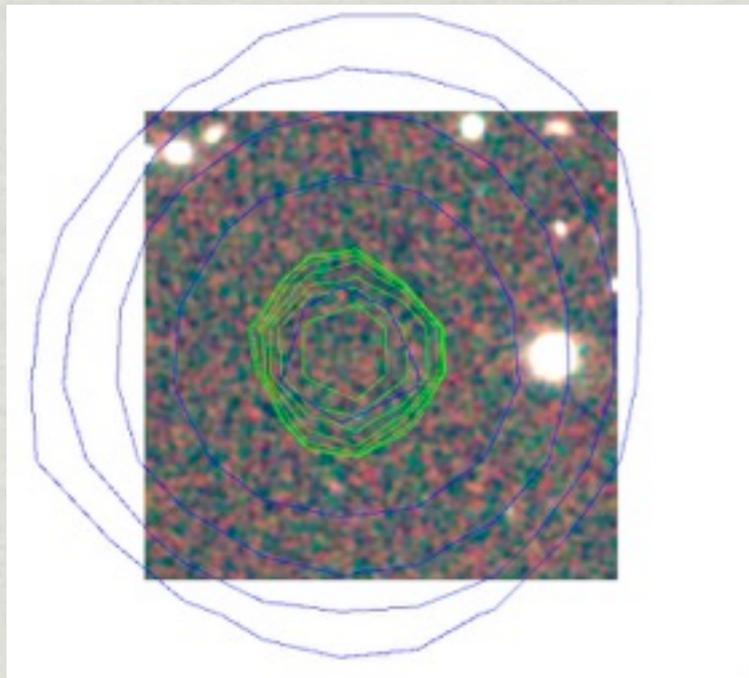


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**UNDERSTAND EARLIER STAGE  
OF EVOLUTION OF BOTH AGN  
AND HOST GALAXY**



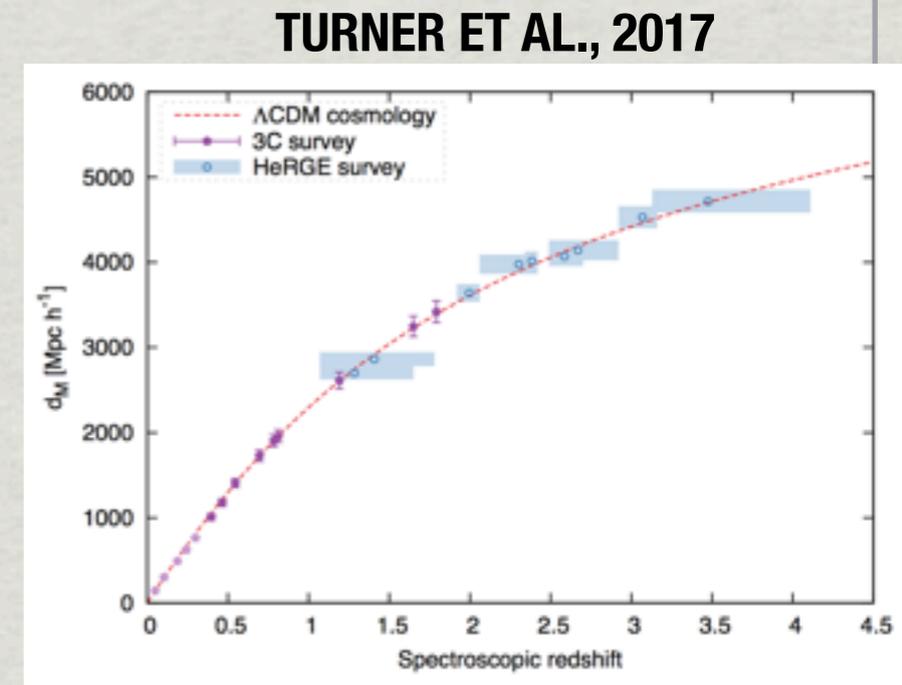
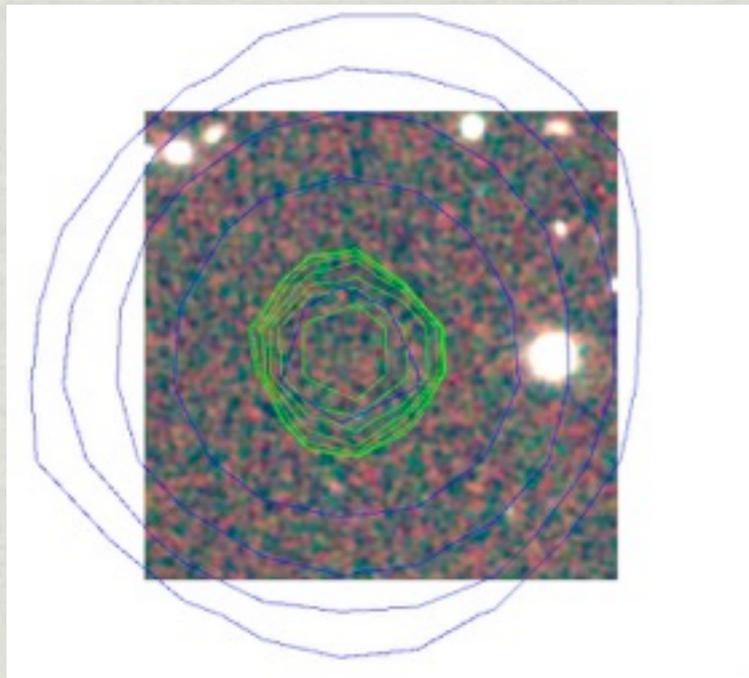
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**FEED THIS KNOWLEDGE FOR  
REDSHIFT ESTIMATES IN RADIO**



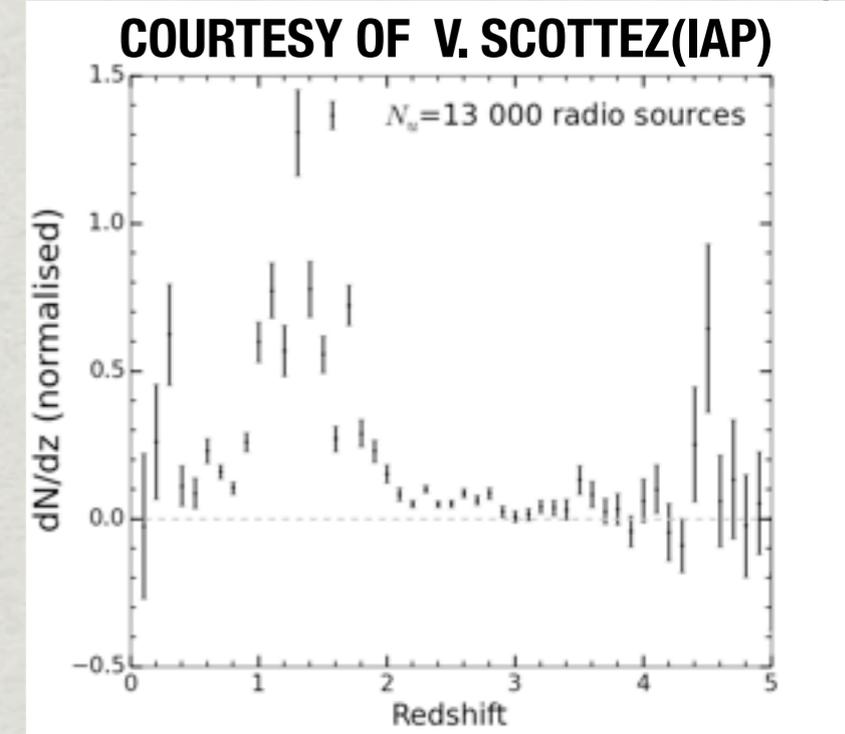
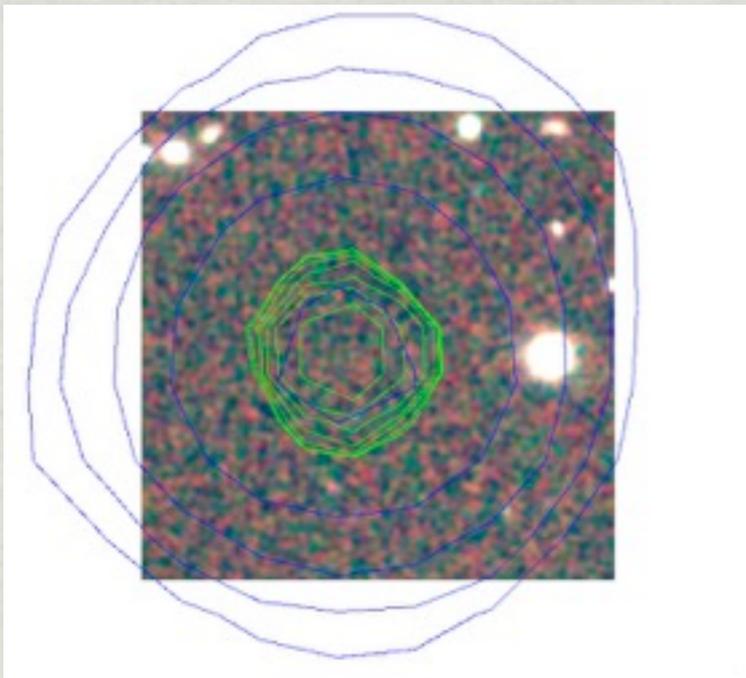
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**Once upon a time,  
in a far far away galaxy,  
a radio loud supermassive  
black hole...**

# The main protagonists

- \* Luminosity selected sample at 3GHz restframe:  $L > 10^{26}$  W/Hz (yes, they are pretty bright :)), from a parent sample of >200 all-sky objects
- \* 70 powerful radio galaxies in the  $1 < z < 5$  range (projet HeRGÉ)
- \* Observations from VLT, Keck, HST, Spitzer, Herschel, APEX, JCMT, ALMA, VLA, ATCA, MWA, etc. both in continuum and line emissions.
- \* SED coverage from UV to radio with >30 broad bands

*Some publications:* Seymour et al., 2007, **Miley & De Breuck 2008**, Nesvadba et al. 2008, De Breuck et al. 2010, Galametz et al. 2012, Mayo et al. 2012, Seymour et al. 2012, Ivison et al. 2012, Wylezalek et al. 2013, Rocca et al. 2013, Drouart et al. 2014, Emonts et al. 2015-2016, Gullberg et al. 2016, Drouart et al. 2016, Nesvadba et al. 2017a & b, Vernet et al. 2017, Drouart & Falkendal, sub., T. Falkendal in prep., Drouart et al. in prep, Kolwa et al. in prep

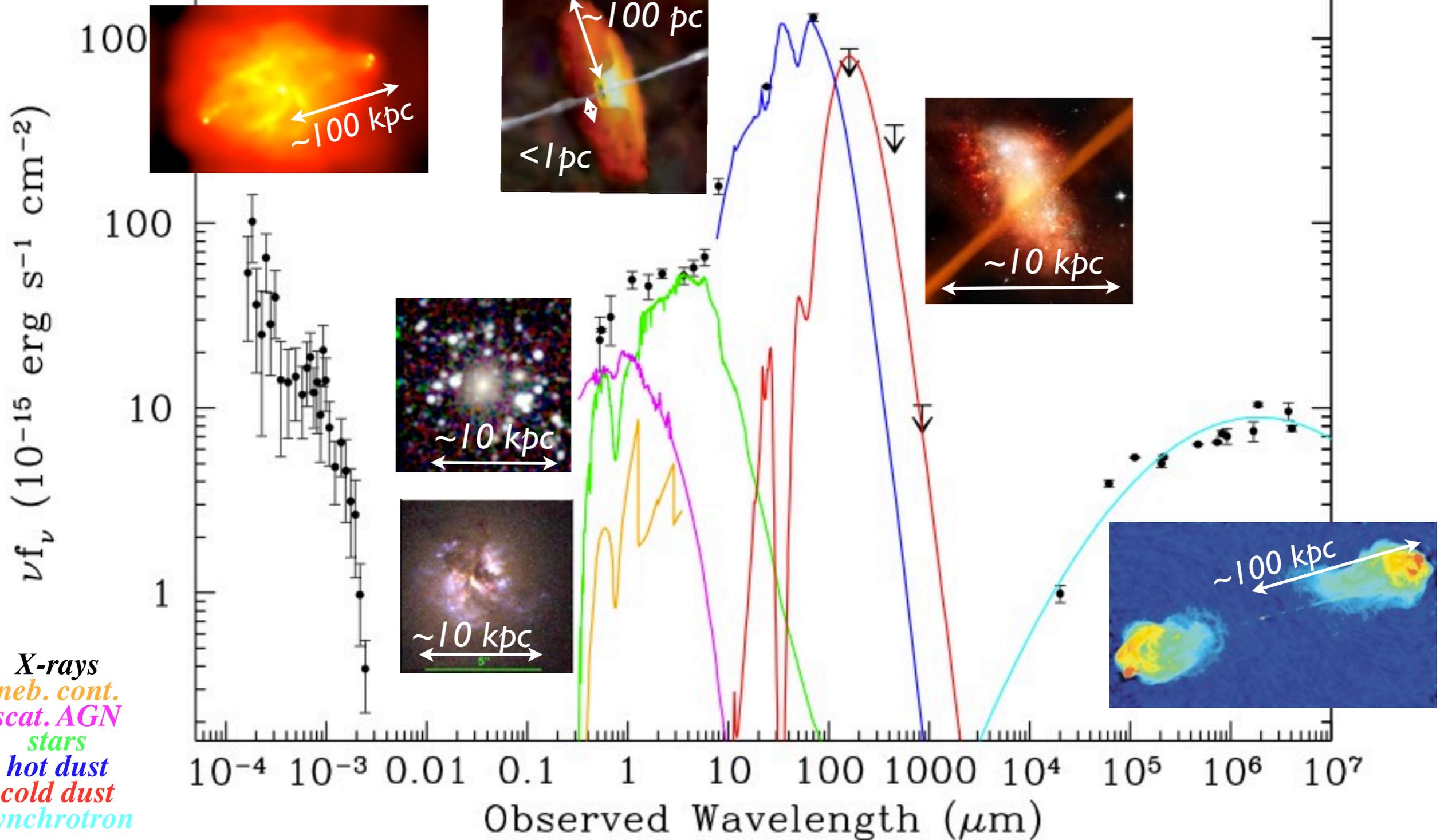
# 4C 23.56

Restframe Wavelength ( $\mu\text{m}$ )

$z=2.46$

10<sup>-4</sup> 10<sup>-3</sup> 0.01 0.1 1 10 100 1000 10<sup>4</sup> 10<sup>5</sup> 10<sup>6</sup>

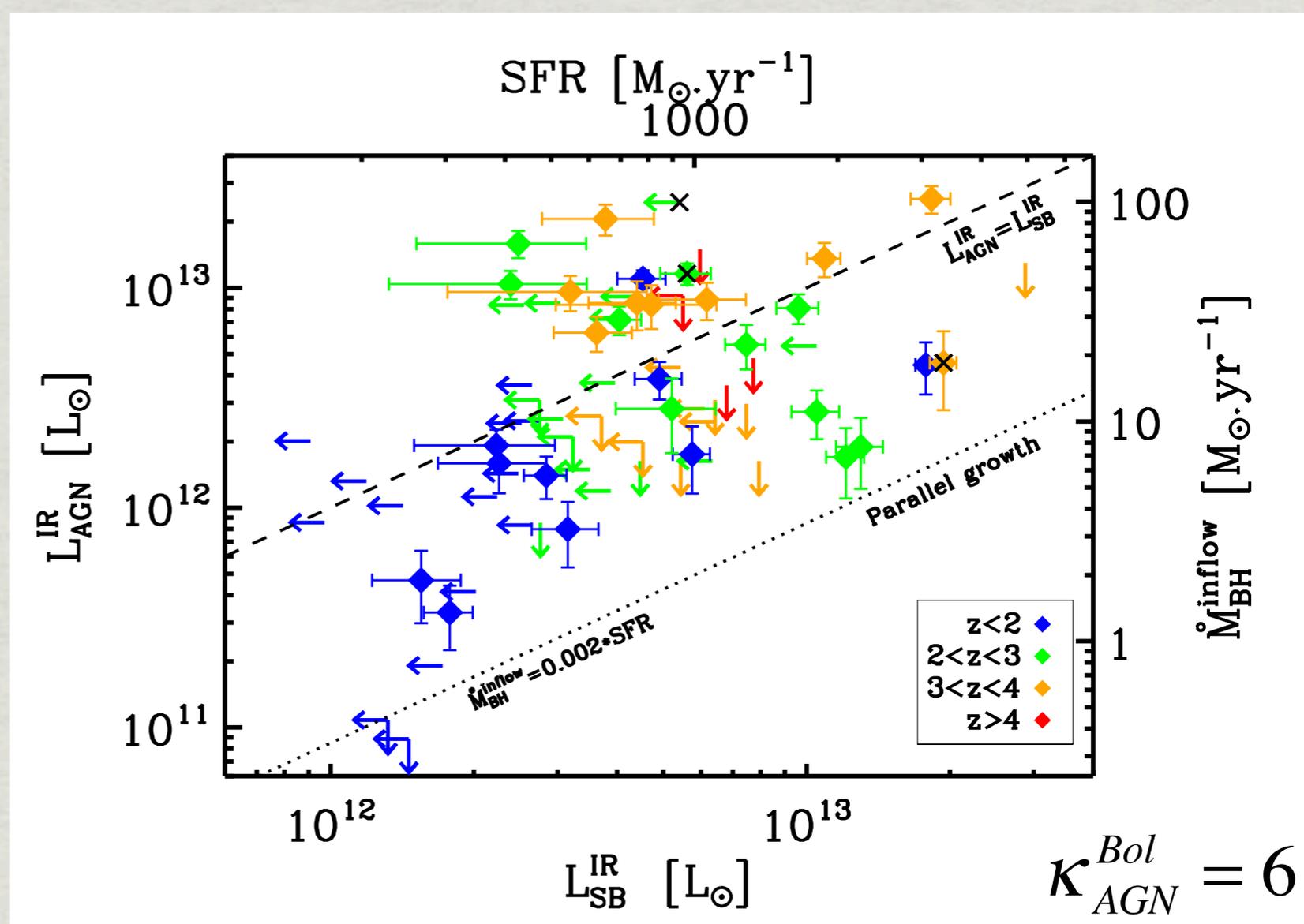
*Miley G. & De Breuck C., 2008*



MILEY AND DE BREUCK, 2008

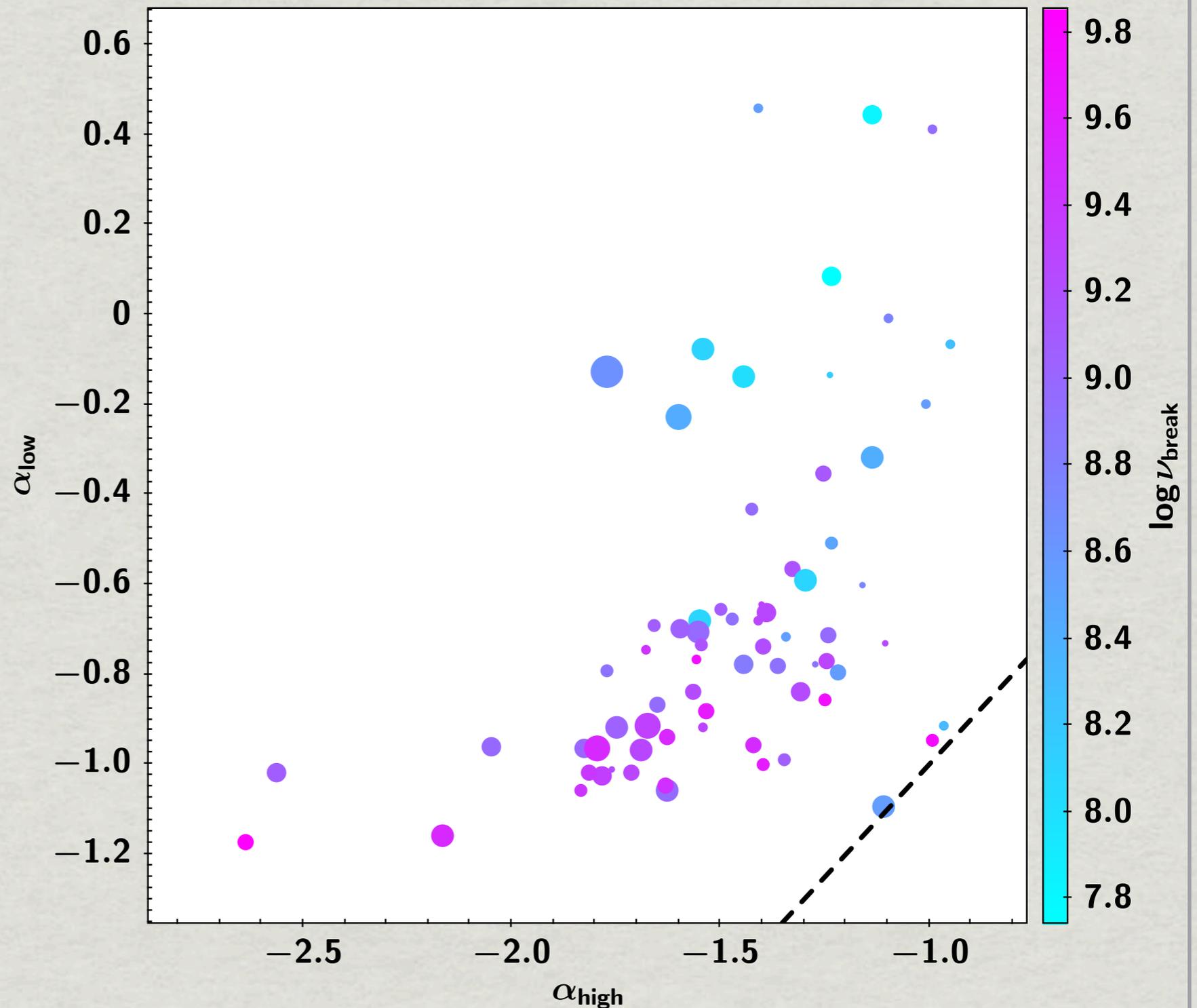
# Some action on the bright side... (IR)

- HzRGs are massive galaxies sitting in denser environments (Seymour et al. 2007, De Breuck et al. 2010, Wylezalek et al. 2013,...)
- The radio emission betrays the presence of a SMBH having an impact on its environment (e.g. Nesvadba et al. 2009, Emonts et al. 2016)
- They are the progenitors of the massive ellipticals in the local Universe (Rocca et al. 2004, Labbe et al. 2005, Drouart et al. 2016)
- they are type 2 AGN (Obscured): Excellent laboratories to study host, to understand feedback impact and SMBH-host relation (e.g. Nesvadba et al. 2016, Drouart et al. 2016, Falkendal et al., in prep)



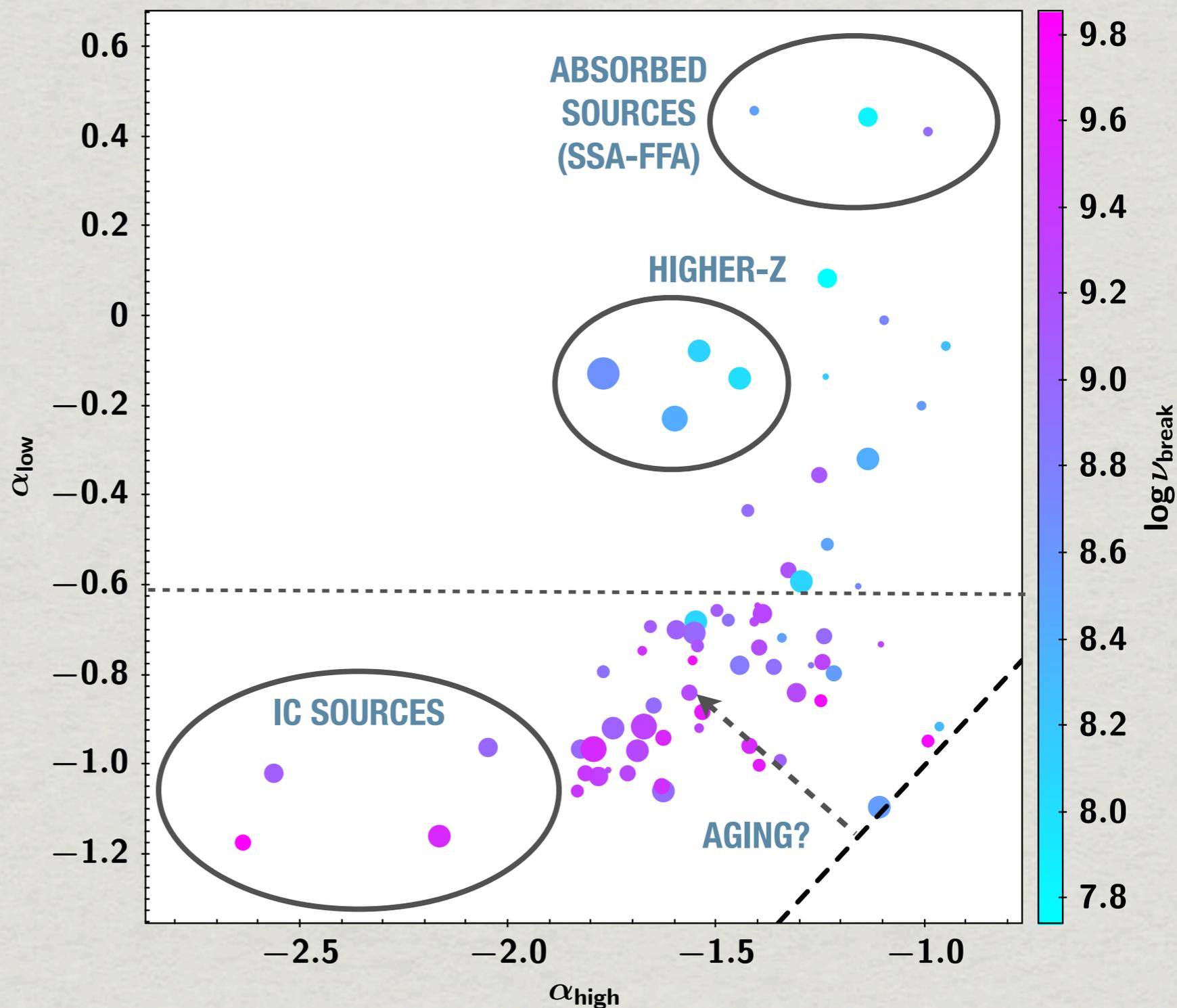
# Meanwhile, on the dark side... (radio)

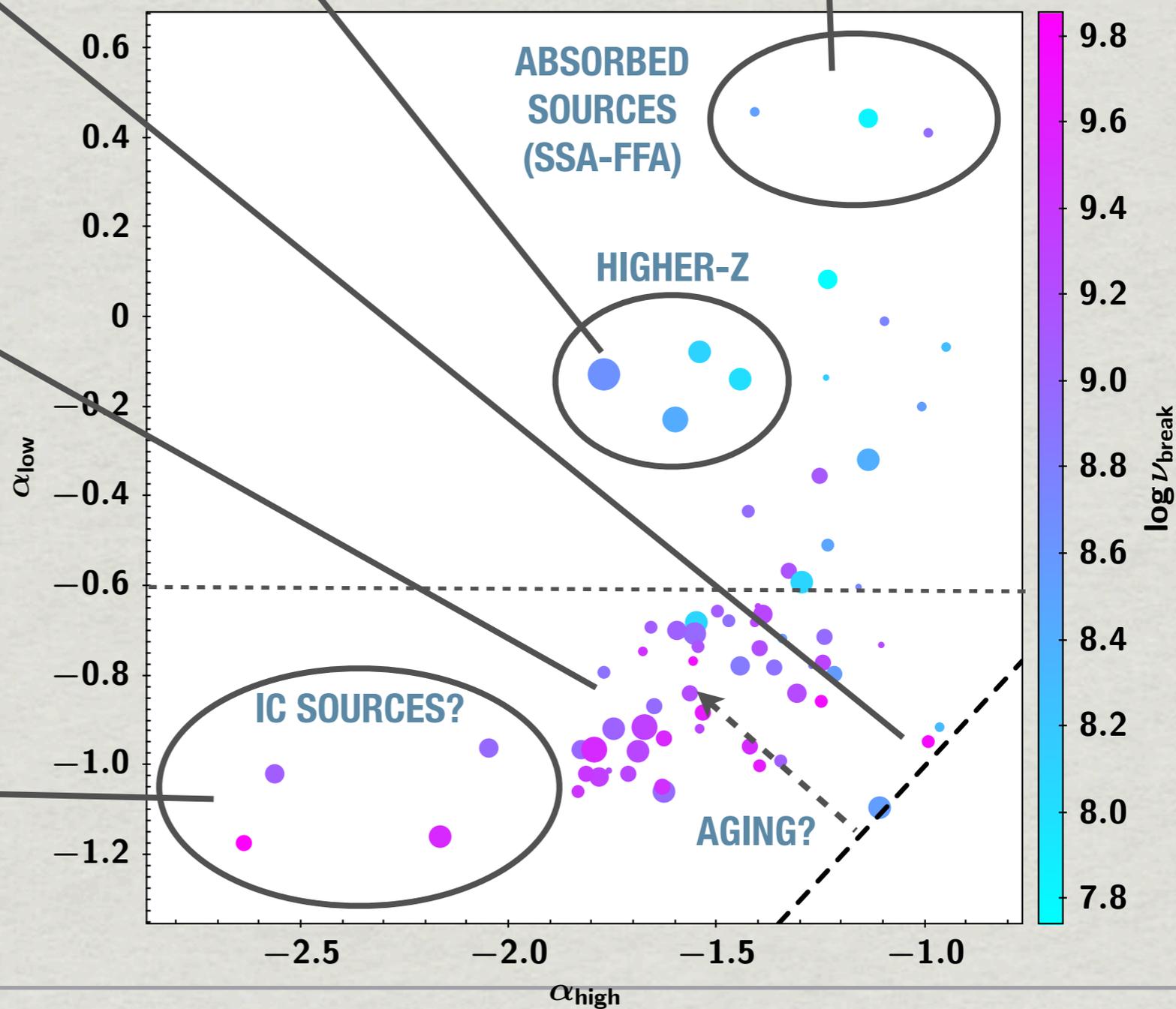
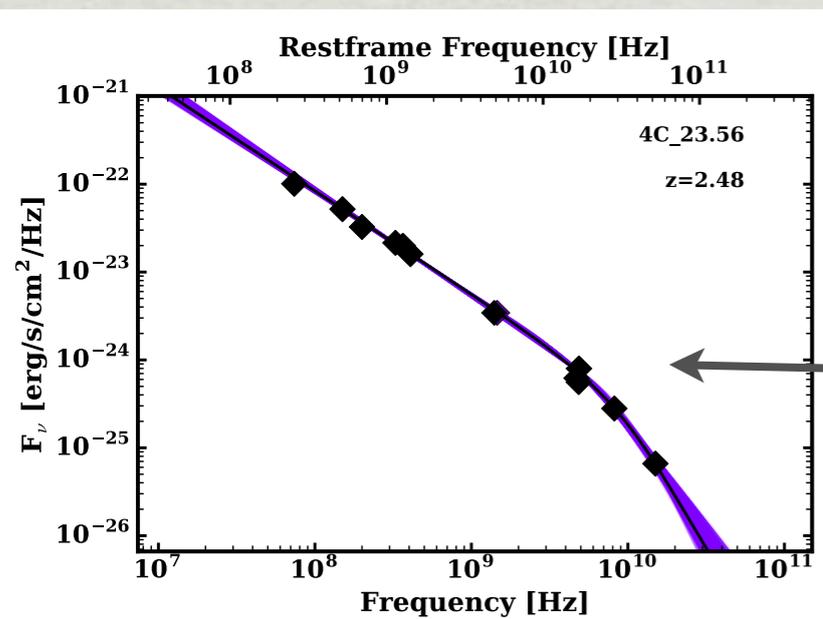
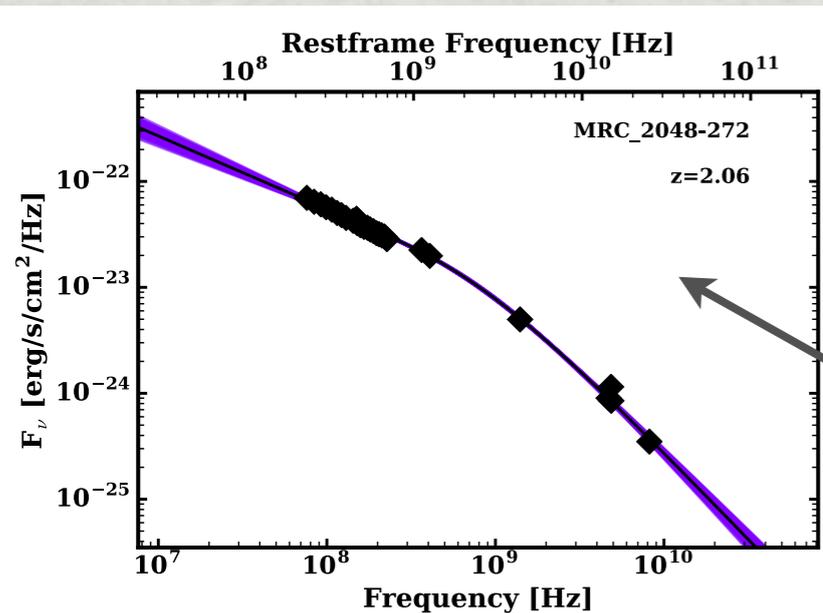
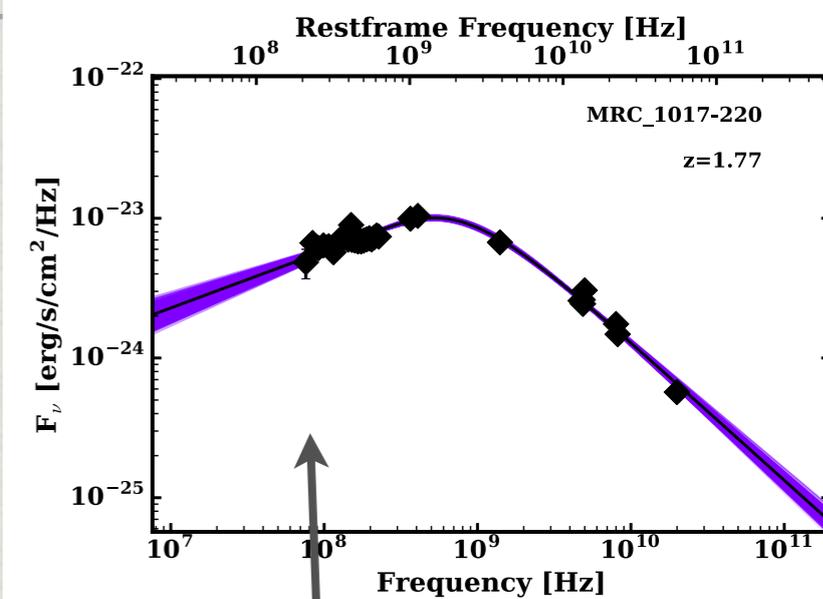
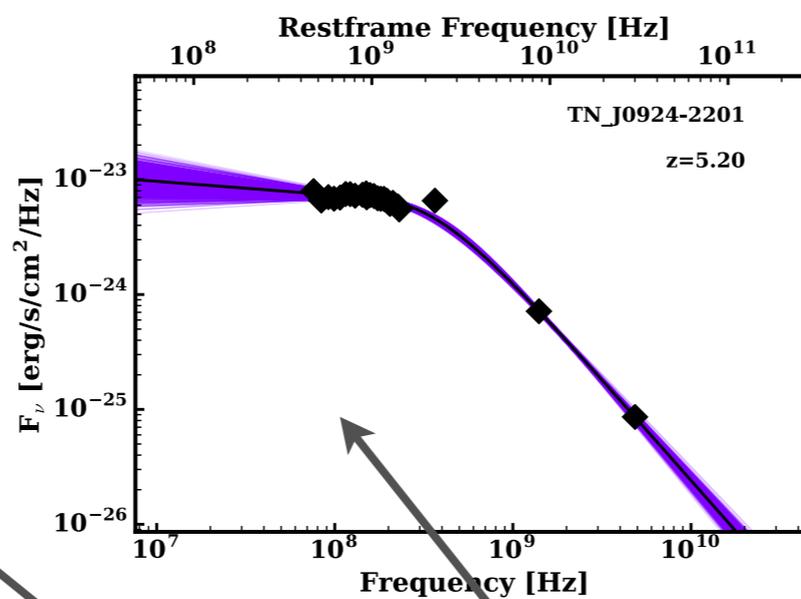
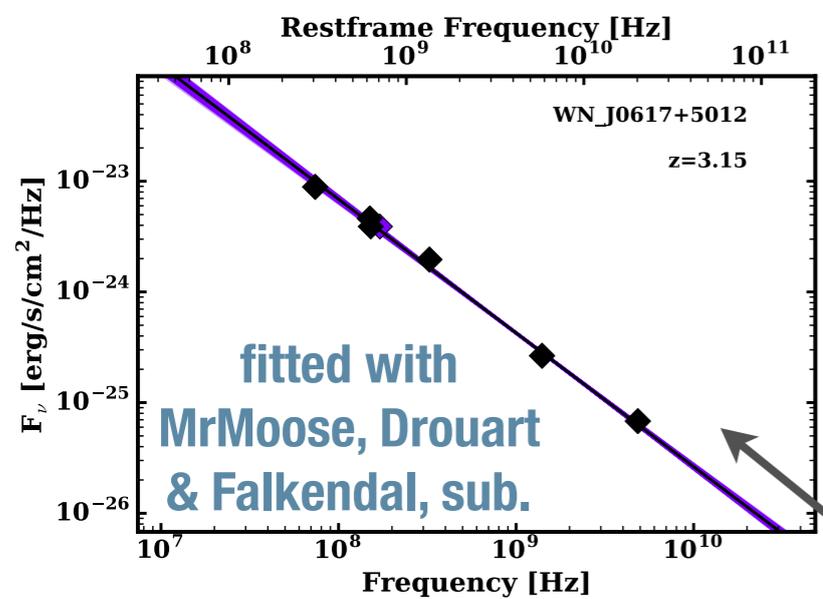
- Fitting a double power law with a break frequency (MrMoose, Drouart & Falkendal sub.)
- At least 20 datapoints on most of the sample, covering the 50MHz-20GHz range
- Size refers to redshift
- Two different type of sources as the break do not correspond to the same physical process
- Contains environmental and intrinsic property information



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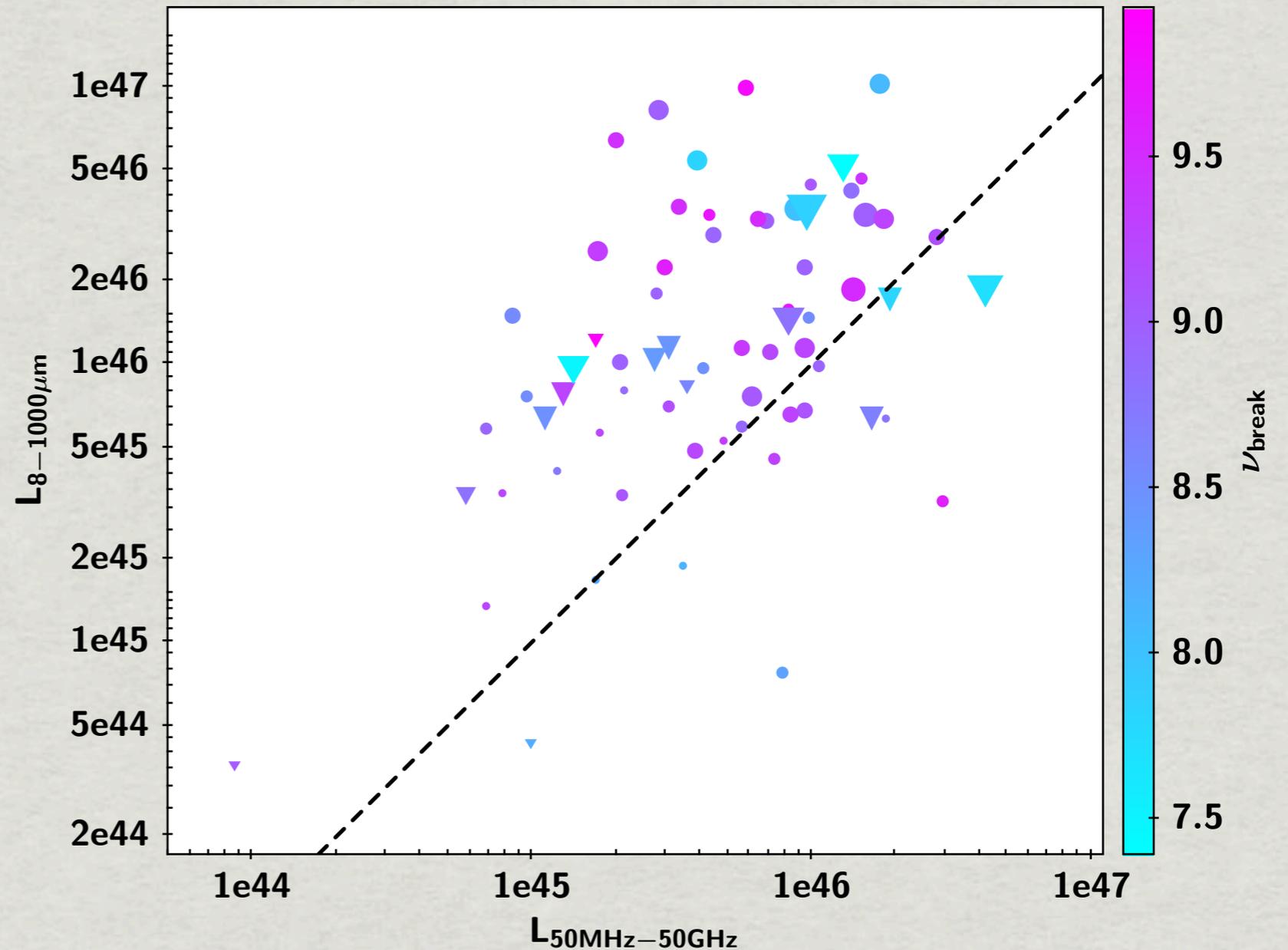
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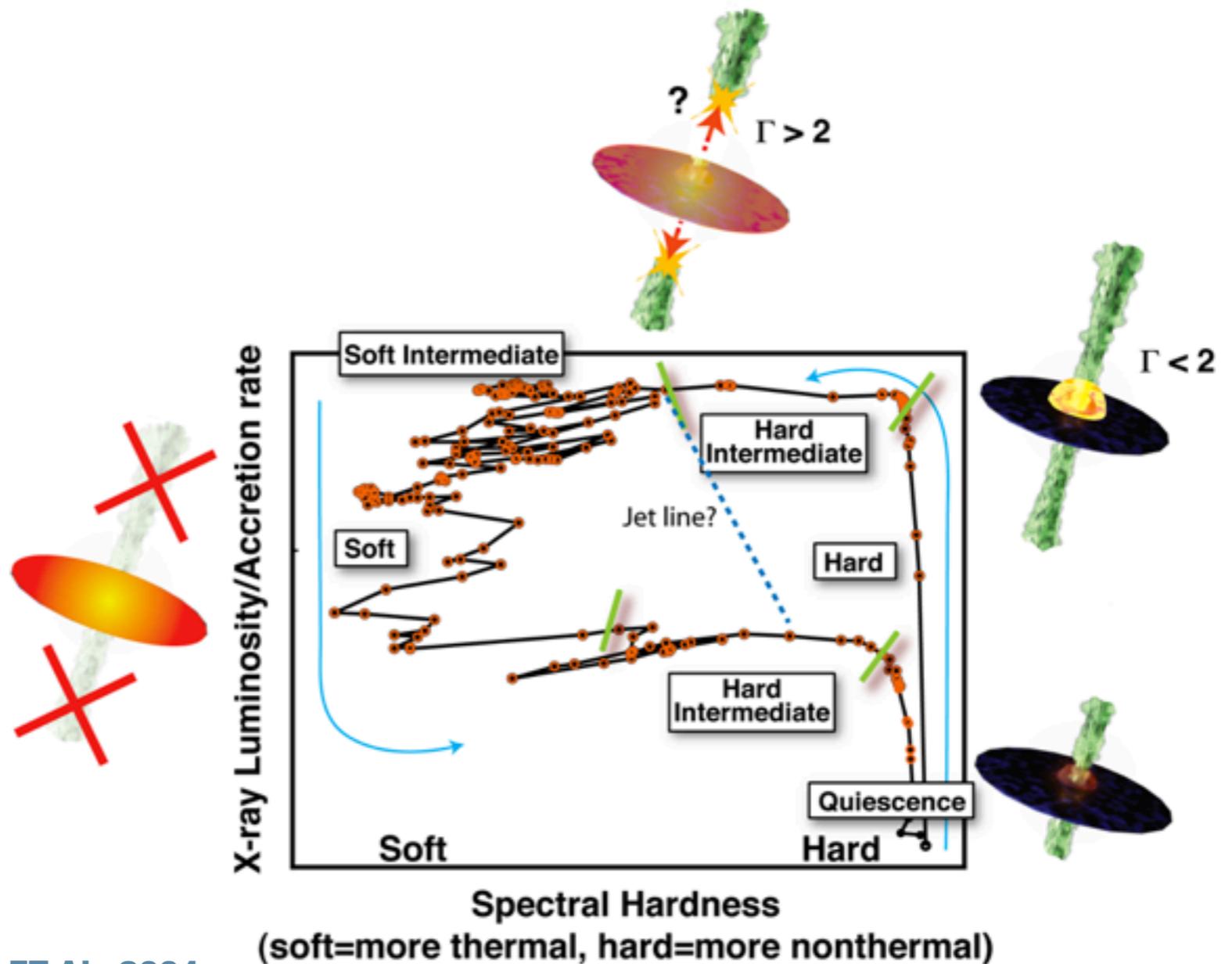
# Who wins? The bright side of course!

- Size refers to redshift, axes are both integrated luminosities
- Also modelled with RAiSE (Turner et al. 2015) from 4 and 8 GHz VLA observations
- Jets are 1-10Myr old!
- Estimated integrated power  $Q$  higher than the IR ( $Q \sim 10^{47-48}$  [erg/s]), similar to Nesvadba et al. 2016
- Looking now for environmental effects
- Can estimate the past accretion rate!



# But this is never this simple...

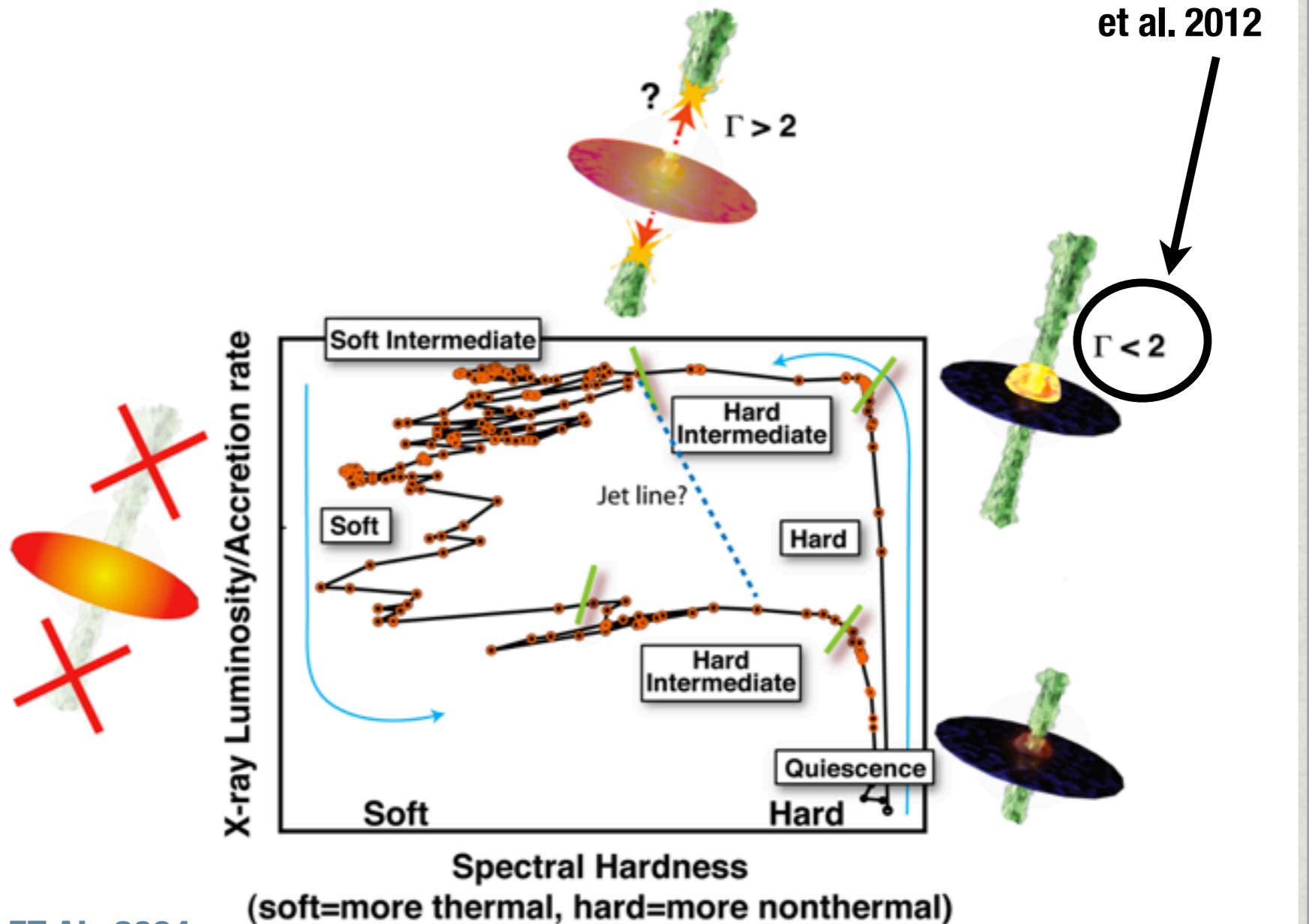
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- no X-ray available yet...
- ...still, all information available in radio,
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- and previous results from this well-studied sample



FENDER ET AL. 2004

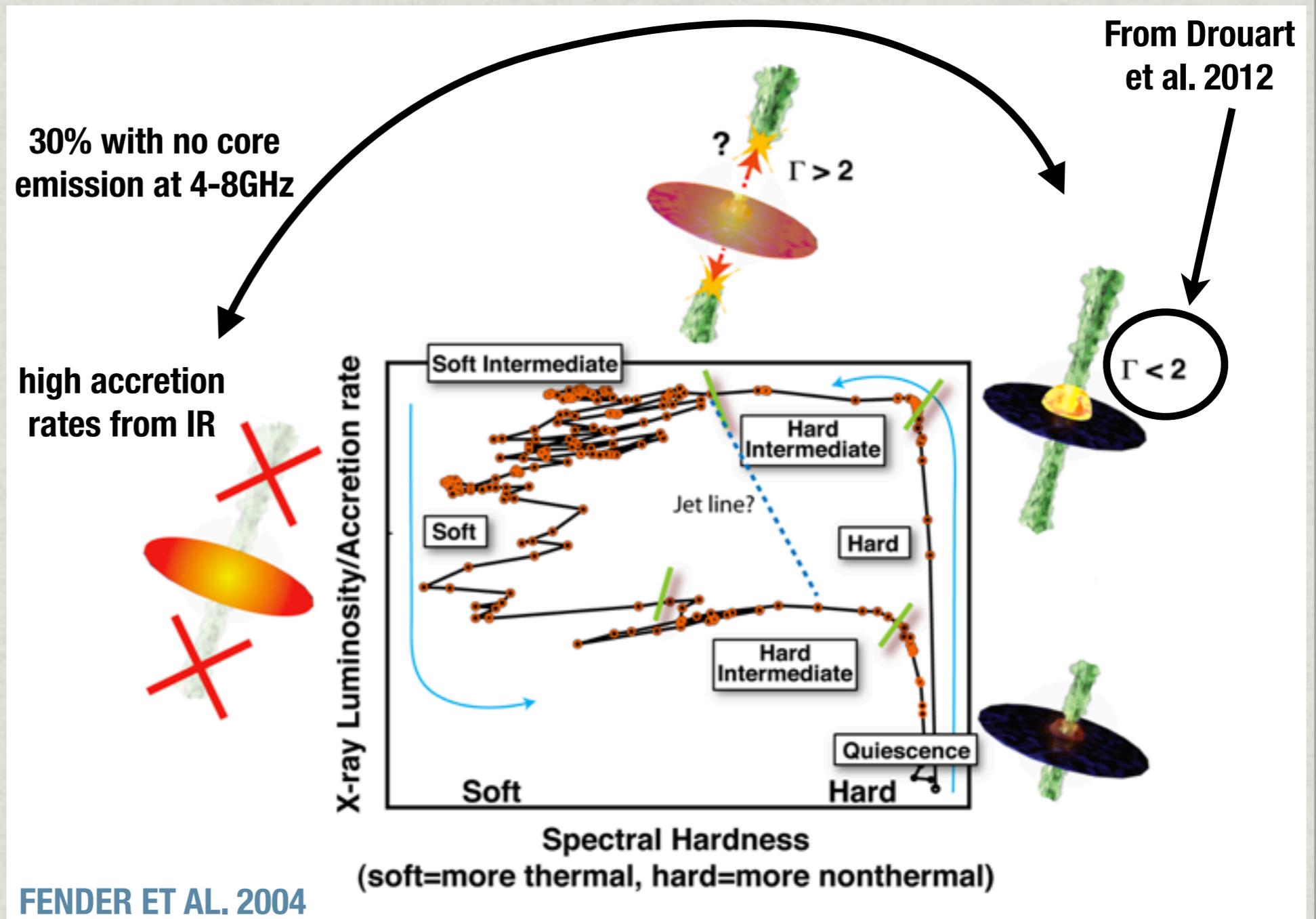
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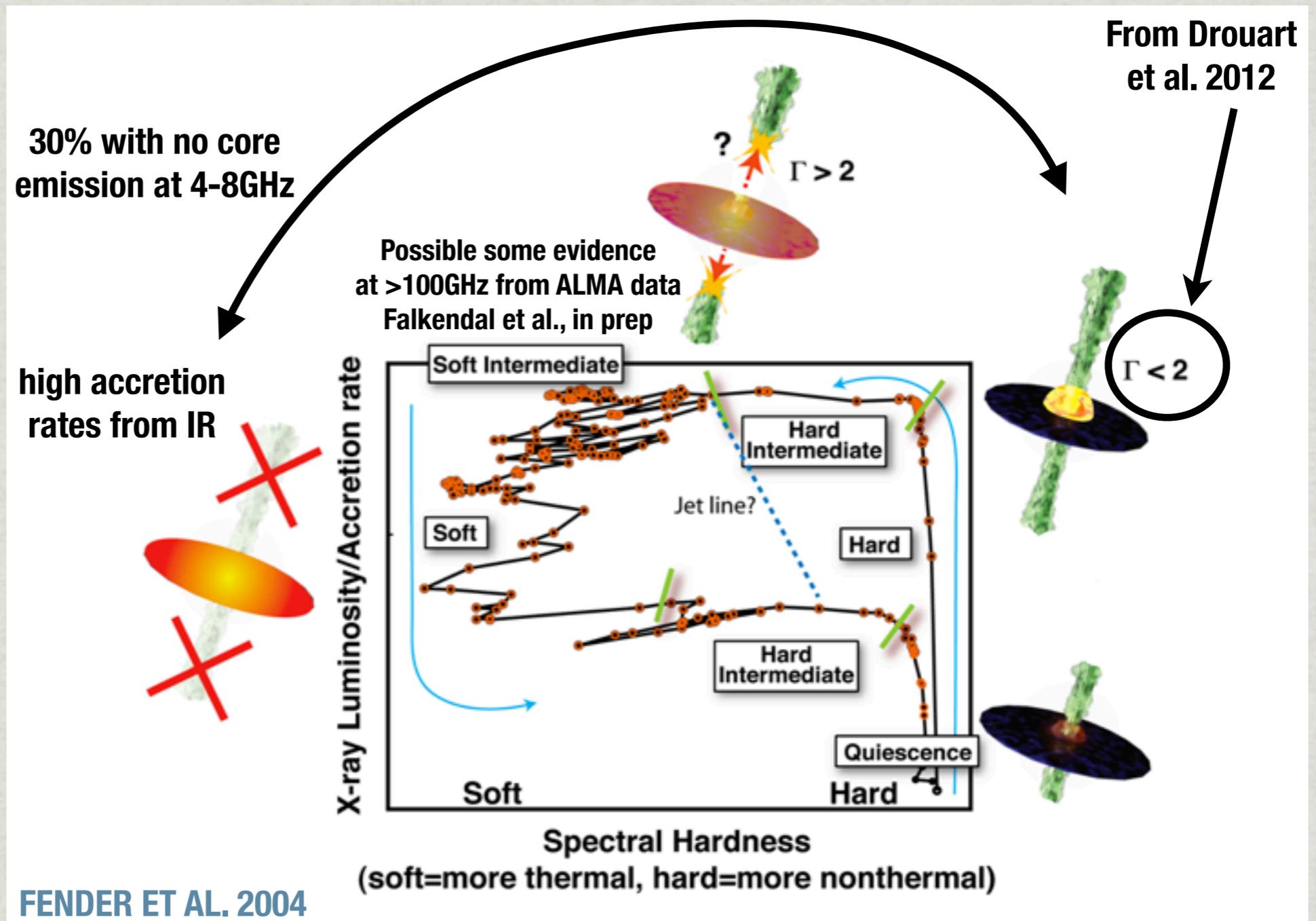
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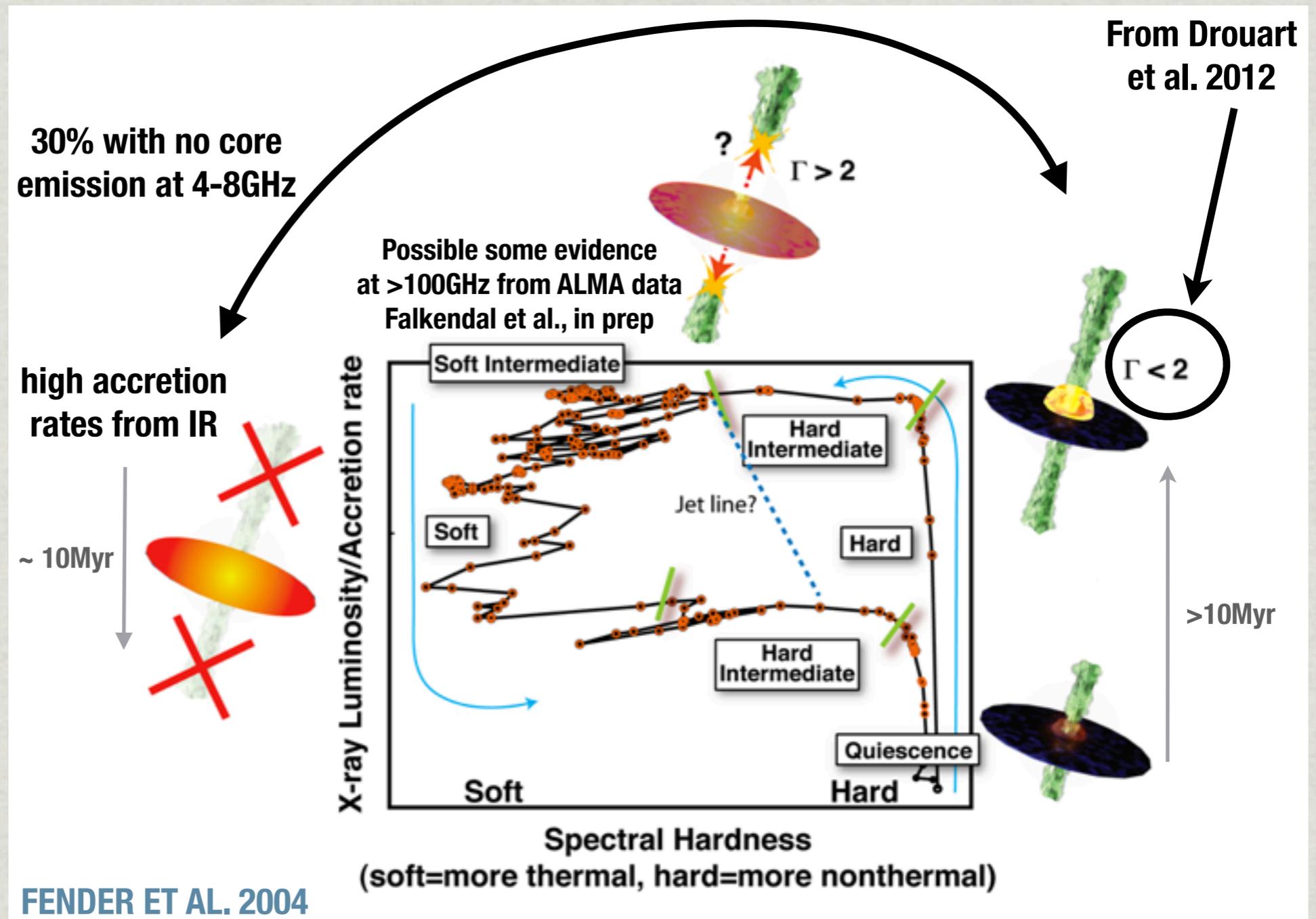
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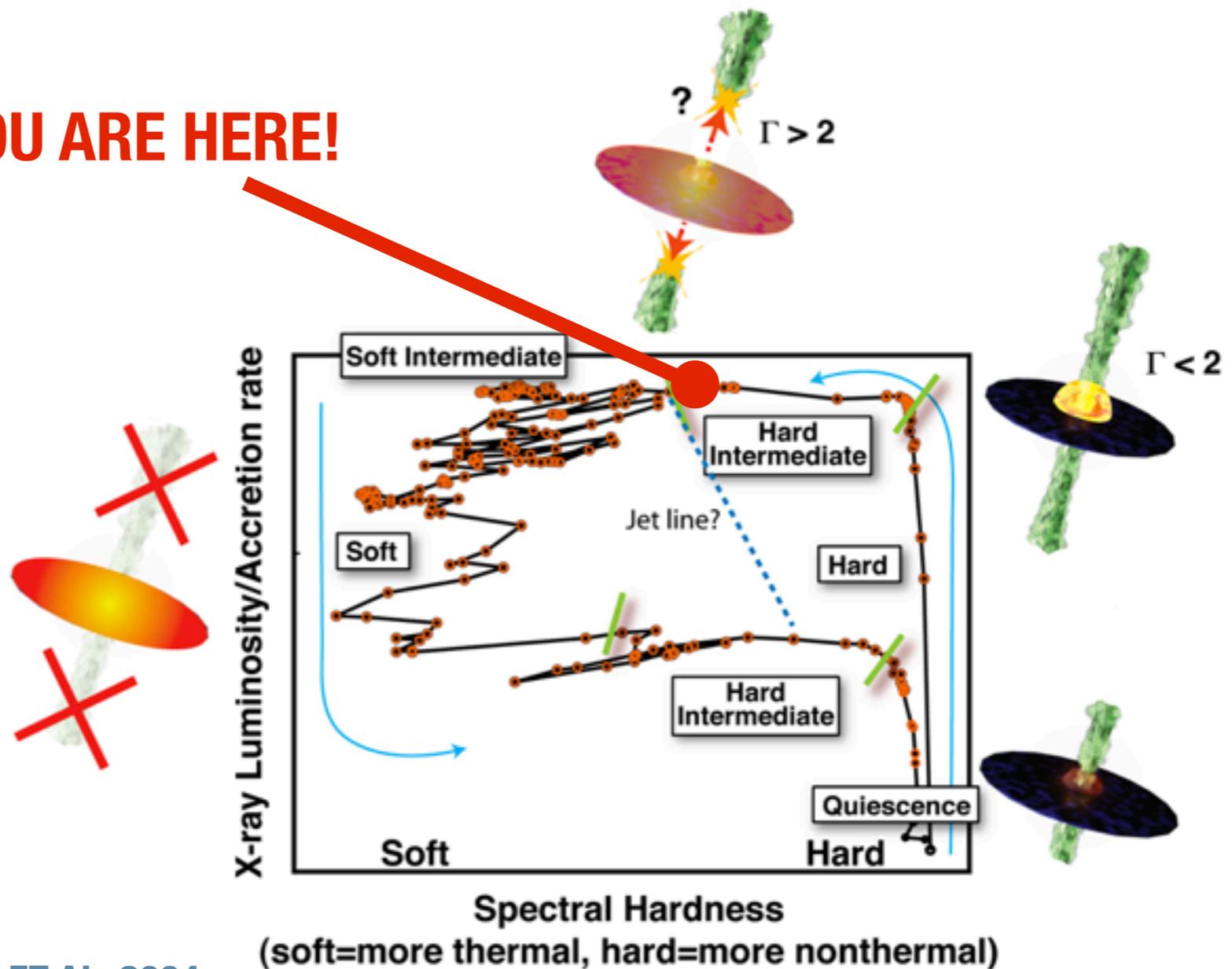
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**YOU ARE HERE!**



FENDER ET AL. 2004

INTERESTING IMPLICATION IN TERM OF FEEDBACK - POSITIVE/NEGATIVE? AND FOR AGN RADIO POPULATION

# Conclusions

- Powerful jet-phase seems to prelude quasar (radiative) phase (at least for this type of objects)
- Radio SED is a direct proxy of recent AGN activity and allow to reconstruct recent history
- Couple of things not clear yet, but on-going work:
  - Gas distribution (ATCA/ALMA for molecular, Gullberg et al. 2016, Emonts et al. 2016)
  - BH masses (Nesvadba 2008, X-rays data required)
  - ICM/ISM gas phase (Vernet et al. 2017, Falkendal et al, in prep, Kolwa et al., in prep)
- Using this knowledge to break the current redshift limit for RL AGN