Enhanced star formation in Narrow Line Seyfert 1 AGN

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NLS1s and their place in the Universe 4 April 2010

Outline

Motivation and Background:

NLS1 main properties

What we know about possible star formation in NLS1

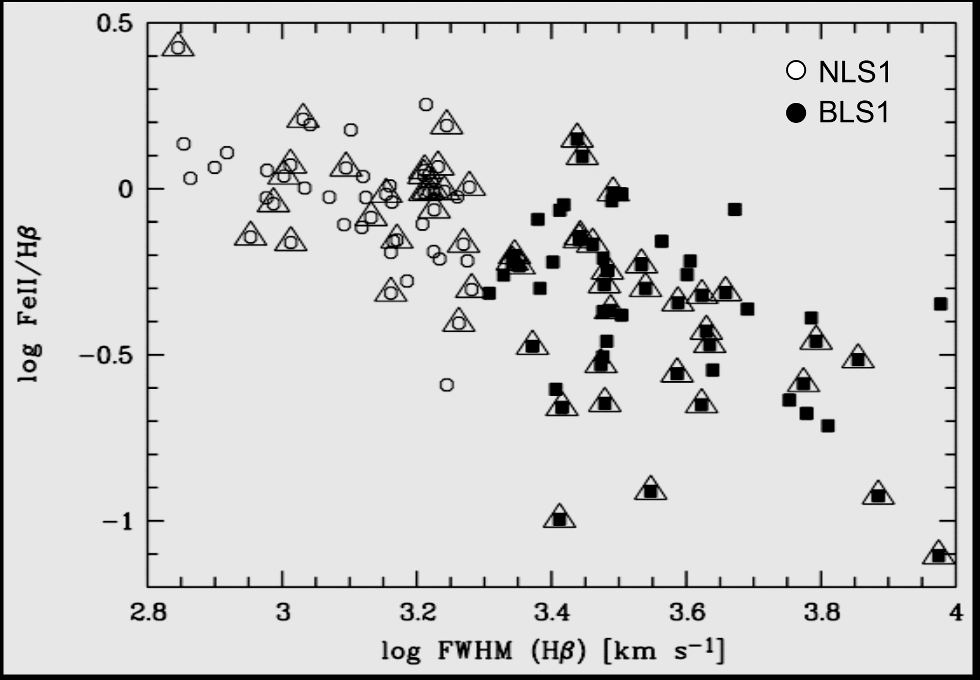
SF vs accretion strength in Seyfert 1 AGN

- strategy: comparison between complete NLS1s and BLS1s samples
- diagnostic: 6.2 μm PAH feature (traces Starburst), 6 μm thermal dust (traces hot dust heated by the AGN)
- star formation and AGN accretion parameters

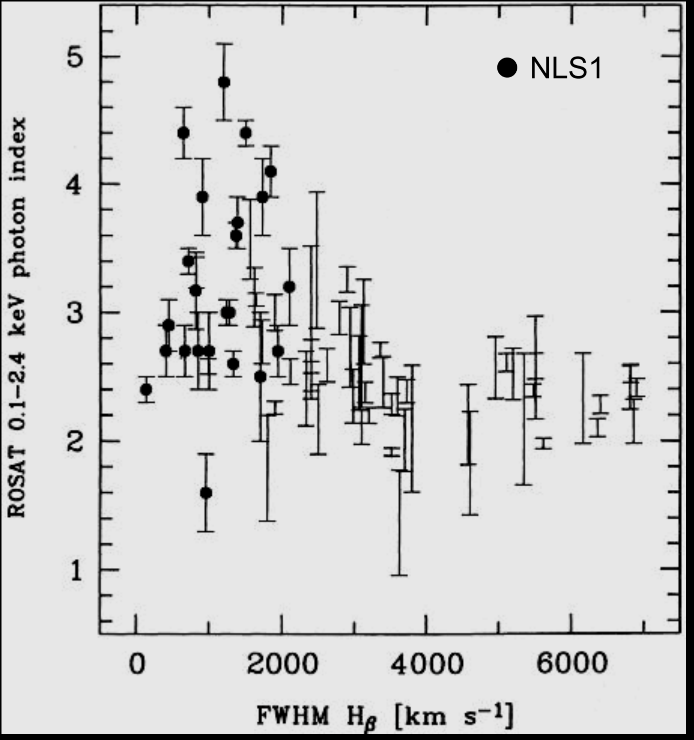
Narrow Line Seyfert 1 galaxies

Optically defined: H_β FWHM ~ 500-2000 km/s
[OIII]/H_β < 3
(Osterbrock & Pogge 1985, Vèron-Cetty & Vèron 2001)

Properties: FeII/H_β > 2
steep X-ray spectra, soft X-ray excess
rapid and strong X-ray variability
low M_{BH}, high L/L_{Edd}

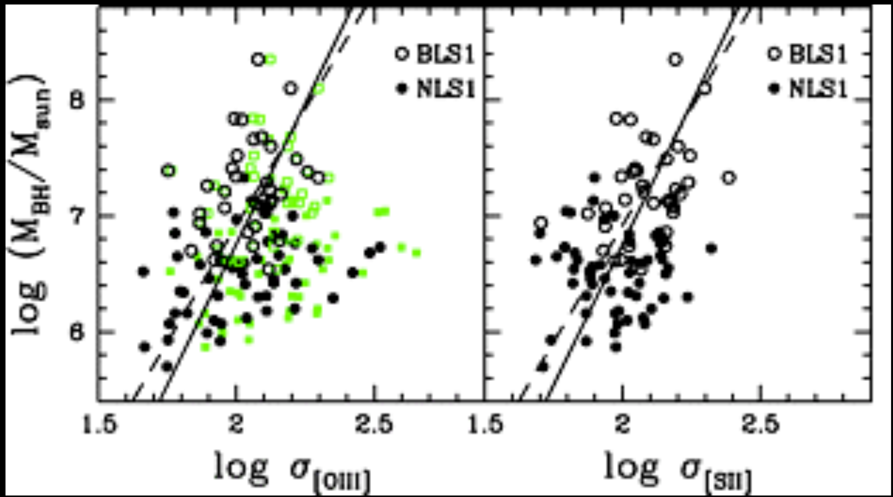


Grupe 2004



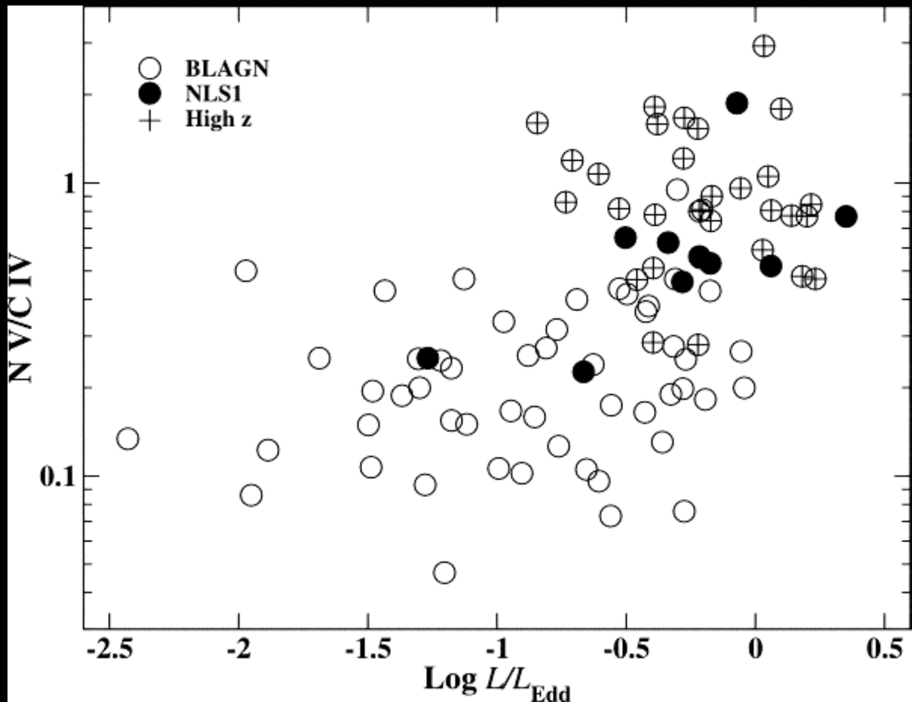
Boller et al. 1996

NLS1 galaxies: the nuclear region



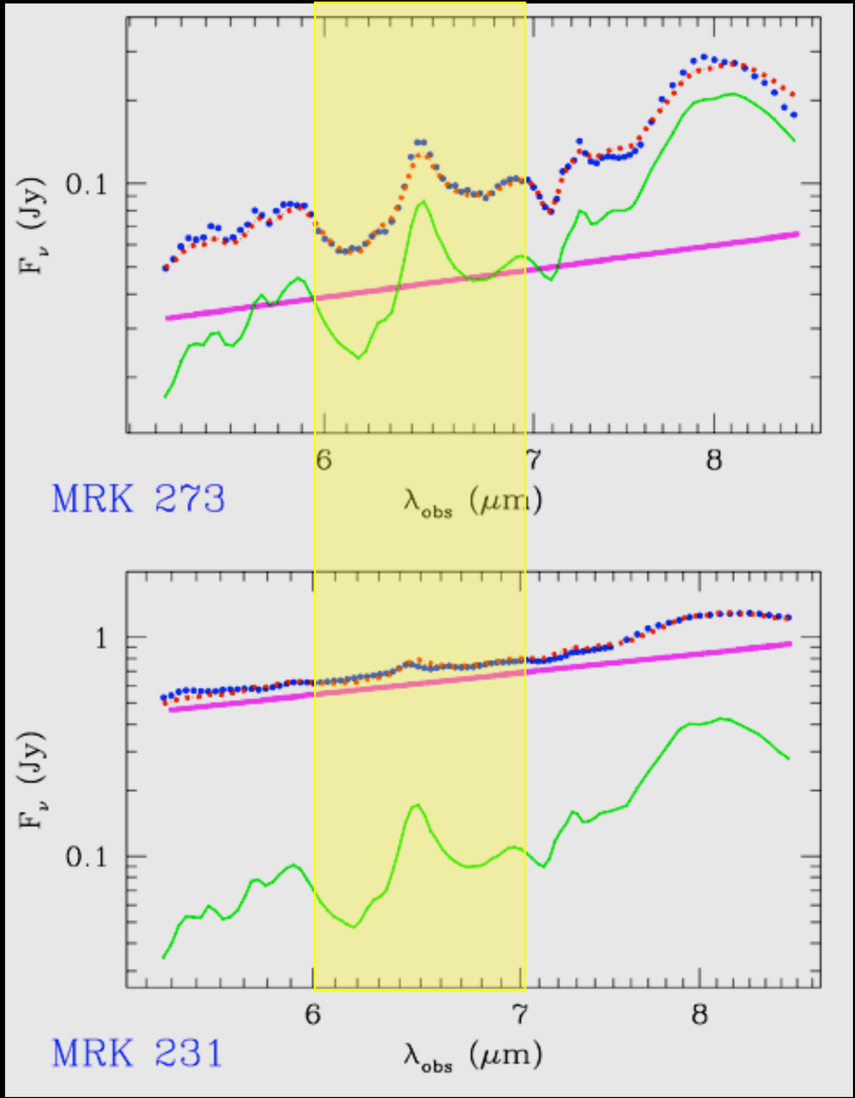
ULIRG nature of some NLS1: ULIRG/AGNs radiate at 50% Edd rate.
(Tacconi et al. 2002)

NLS1s lie on the M_{BH}-σ relation
(Komossa & Xu 2007)



NLS1s have high L/L_{Edd} and high metallicity
(Shemmer et al. 2004)

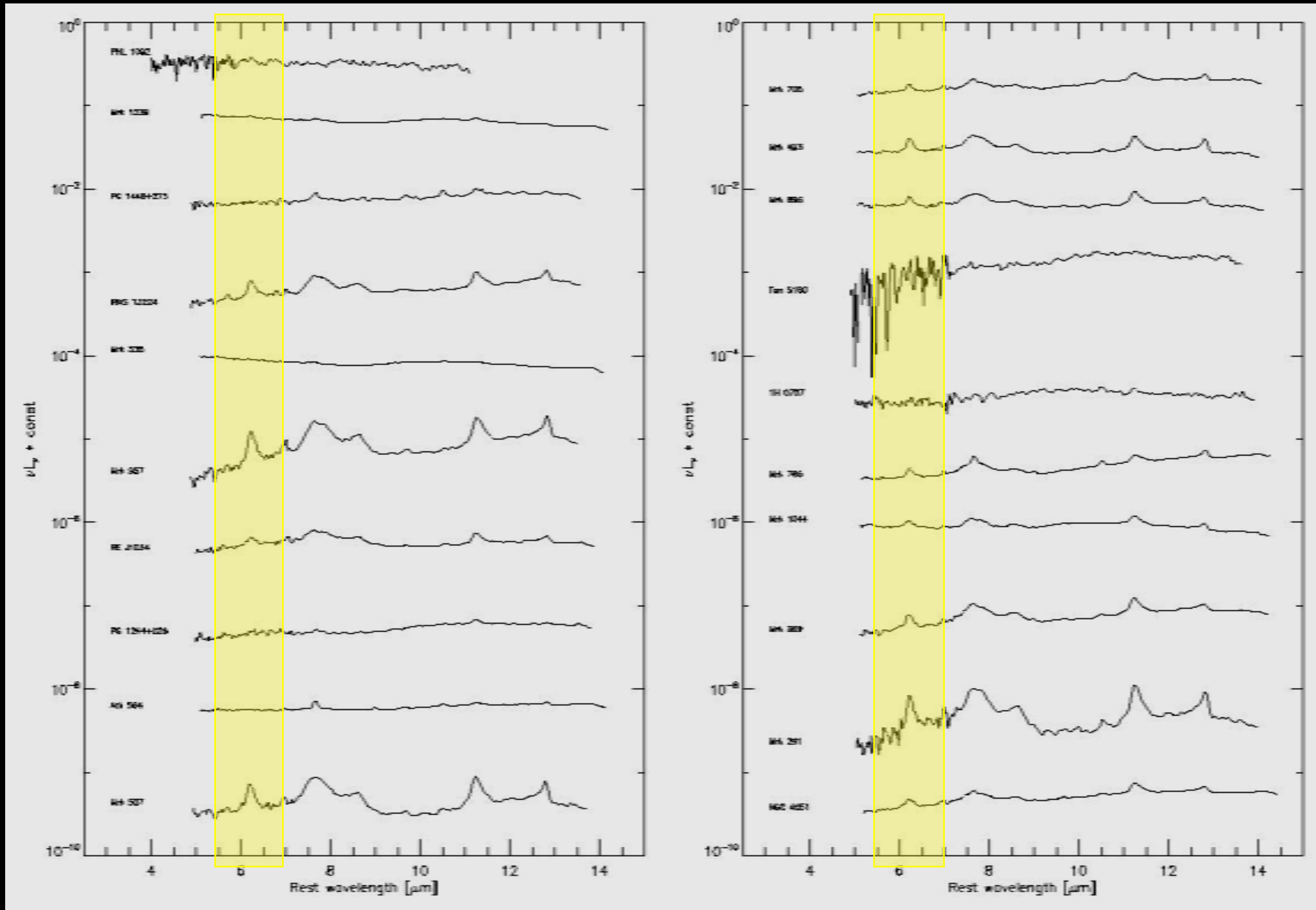
NLS1 galaxies: the deconvolution method



Decomposition of low res. spectra through a
Power law (AGN) + Starburst template (M82)

NLS1 galaxies: Spitzer/IRS spectra

20 well known NLS1: z<0.1,
spanning NLS1 class properties over several order of magnitude



L_{PAH}~10^{39}-10^{42}erg/s

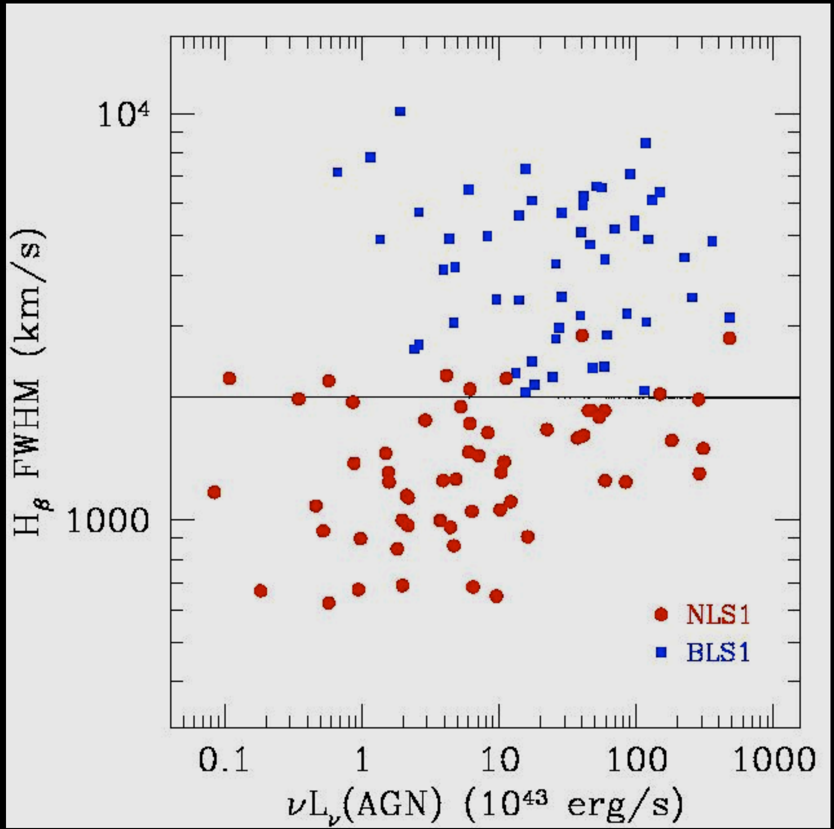
Unbiased NLS1 + BLS1 samples

Catalogue of Quasars and Active Nuclei (12th edition Vèron-Cetty & Vèron 2006)
z < 0.2: cover 2 orders in D_L , 6 orders in L(AGN) maintaining good quality
Exclude Sy 1.5, 1.8, 1.9 to avoid optical biases toward type 2 objects
Exclude Radio Loud objects with synchrotron dominated mid-IR spectra

Check

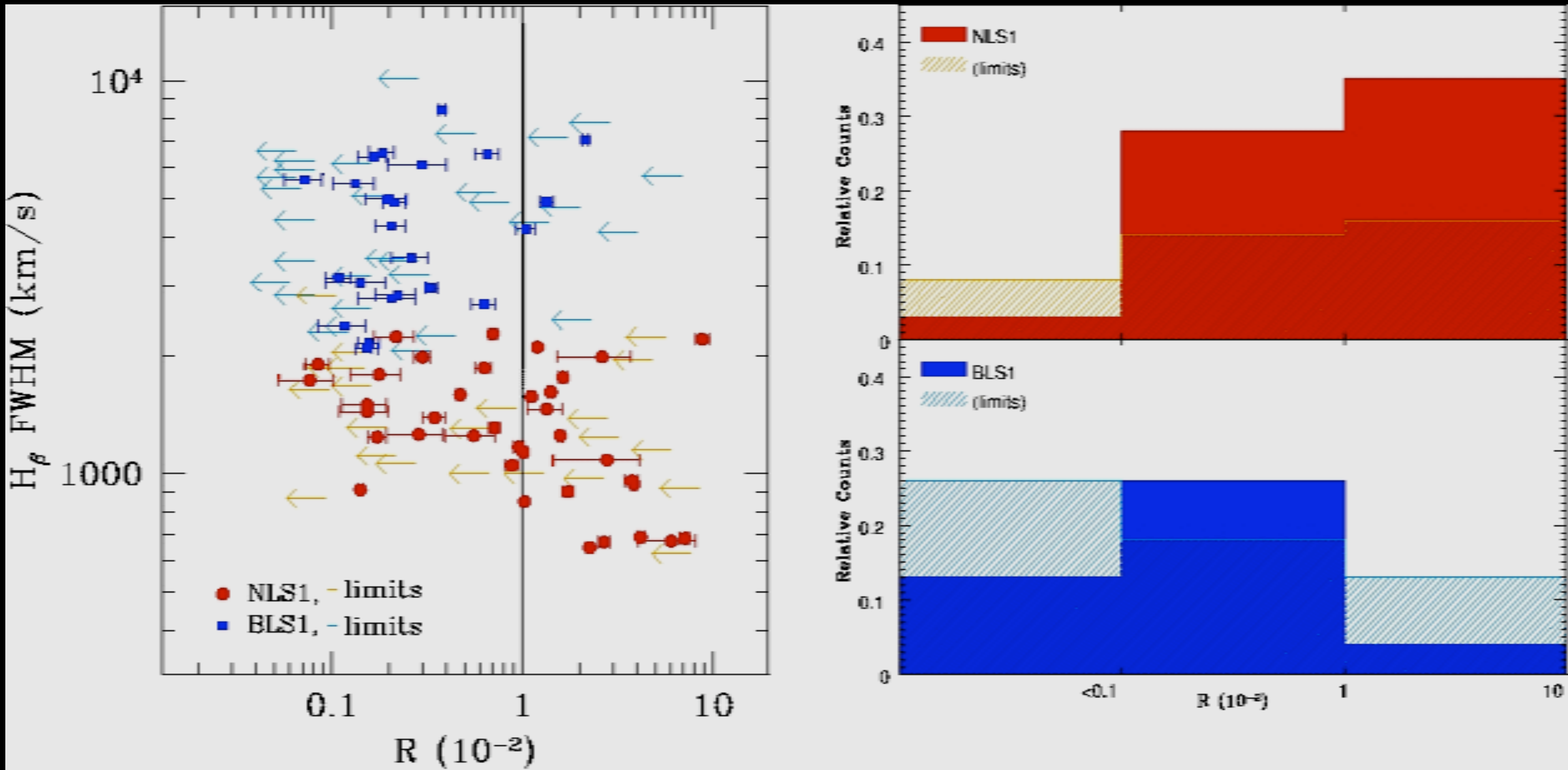
-some NLS1 have FWHM>2000 km/s
but: have all the other NLS1 properties
and are included in well known NLS1 samples
-all BLS1 with FWH <2000 km/s are excluded

59 NLS1s + 54 BLS1s



Results: H_β vs PAH

H_β FWHM and $R=L(PAH)/\nu L_6(AGN)$ are intrinsic and independent quantities.
Larger R values indicate a larger relative SF contribution to the MIR spectrum.

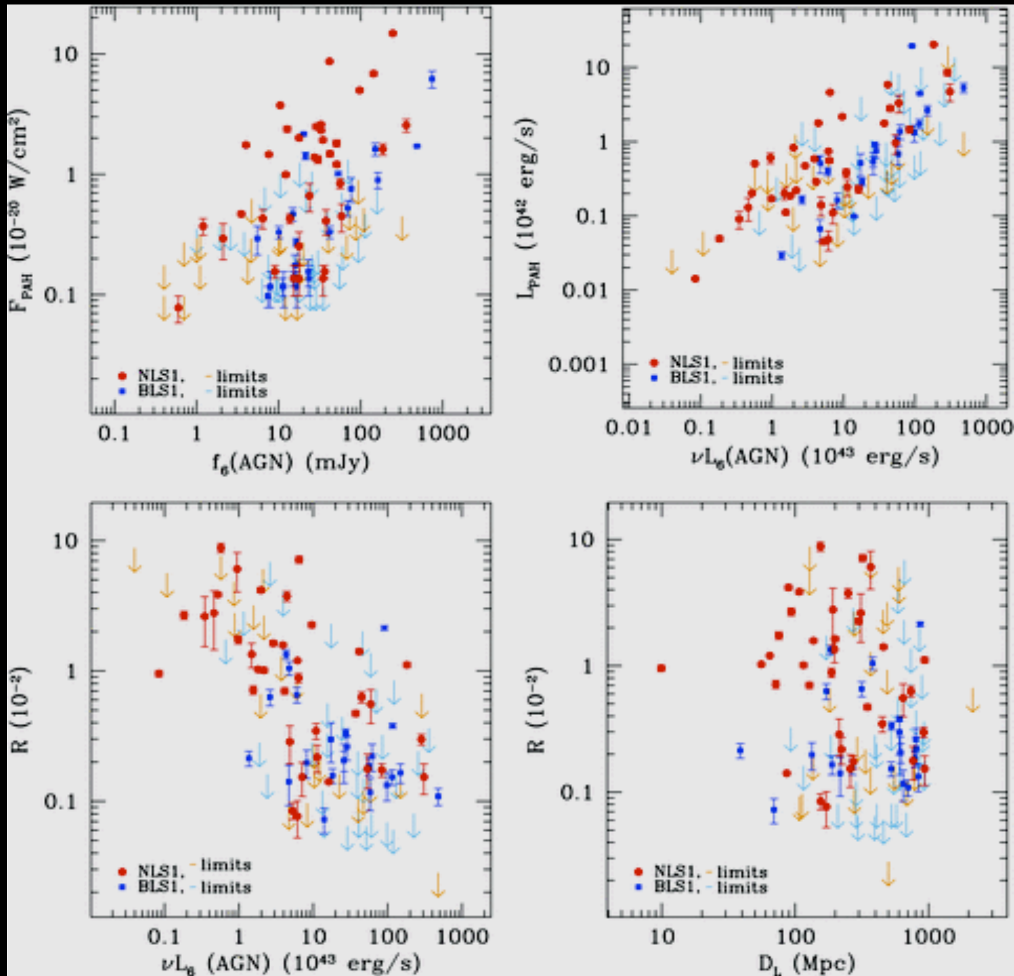


- Two distinct populations of type 1 AGNs.
- PAH detection rate larger in NLS1 than in BLS1.
- The majority of detections for NLS1s correspond to the strongest SF (R>1).
- R values for BLS1 are mostly upper limits

Flux, Luminosity and distance correlation

F(PAH)>10^{-20}Wcm^{-2}
holds mostly NLS1s

L(PAH) ~ L(AGN)$^{0.7}$

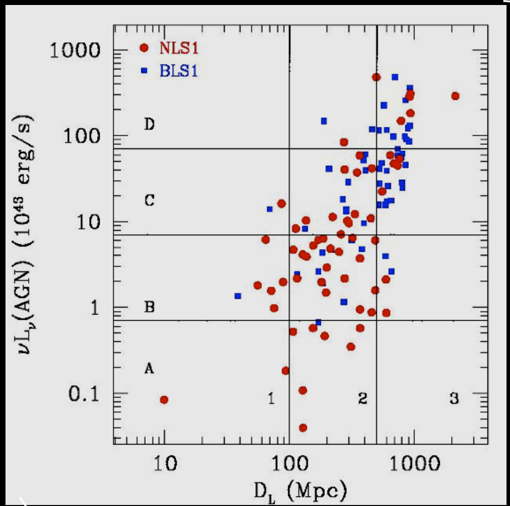


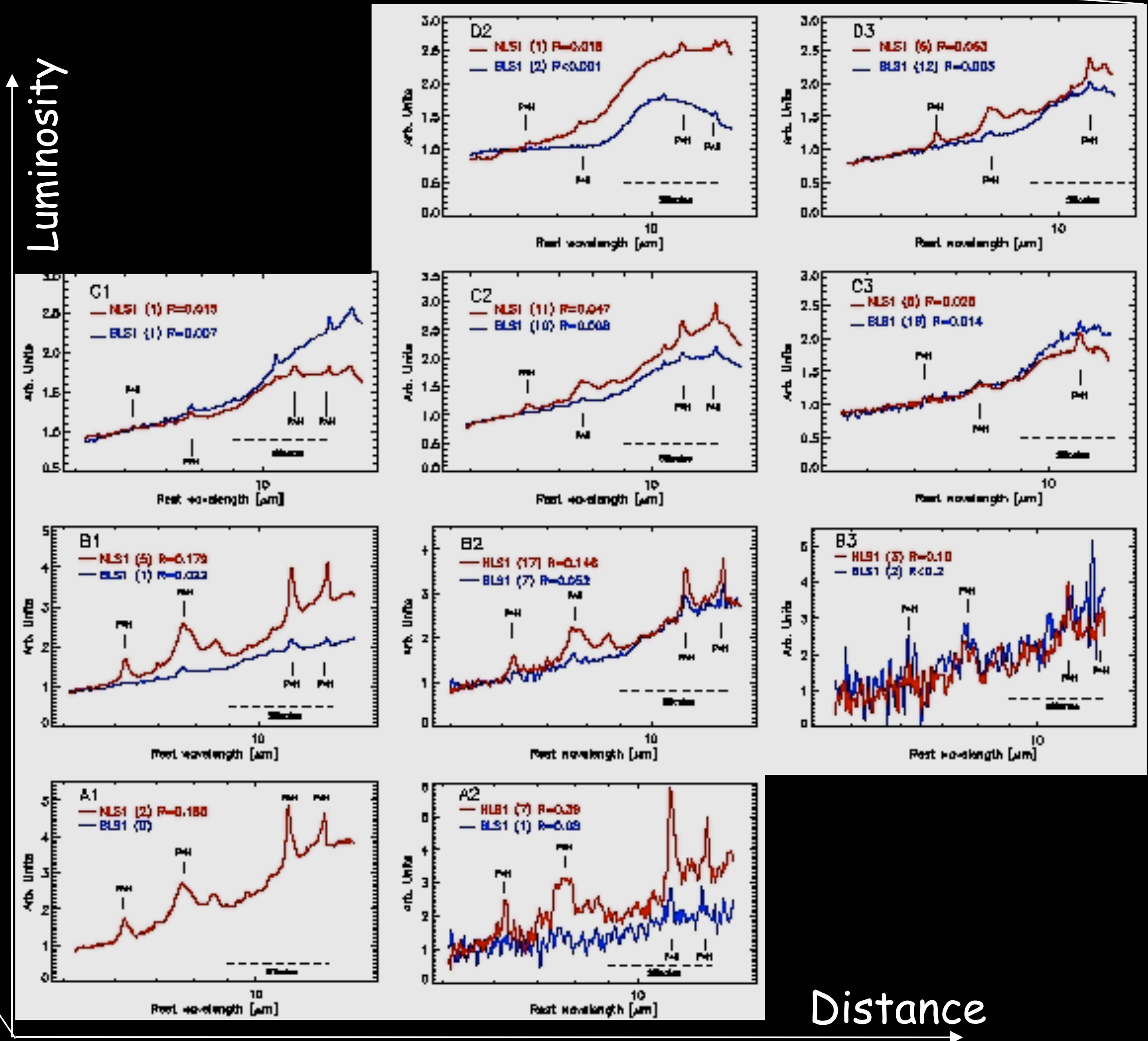
@ a given L(AGN)
NLS1s show larger
R values

no trends,
i.e. no significant host
contribution to R

increasing host contribution

Biases control: stacked spectra





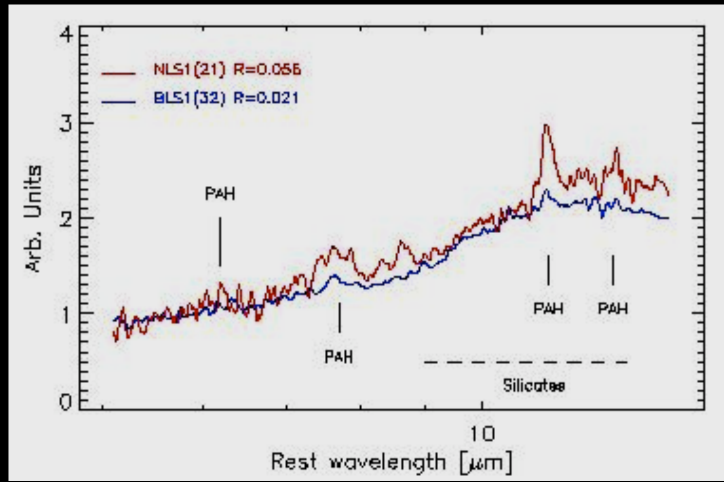
$F_{SB}=R_{NLS1}/R_{BLS1}$

$F_{SB}>2$
except in A1, B3

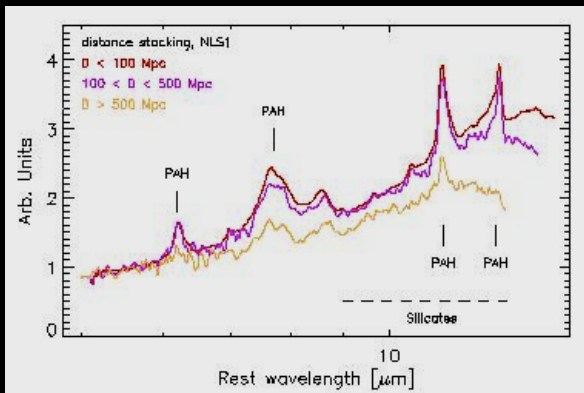
Further check and confirmation

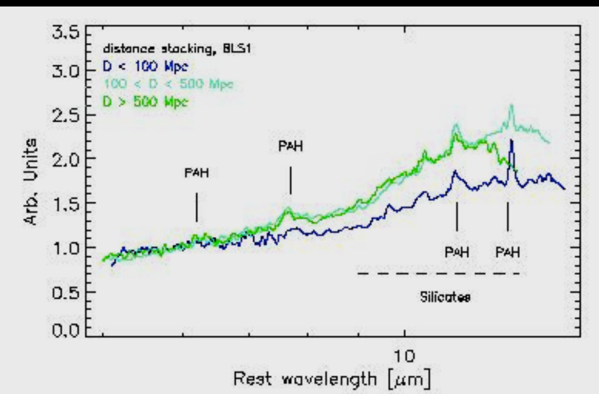
Stacked spectra for sources with NO
6.2 PAH detection in the individual spectrum:

F_{SB}=2.6±0.5

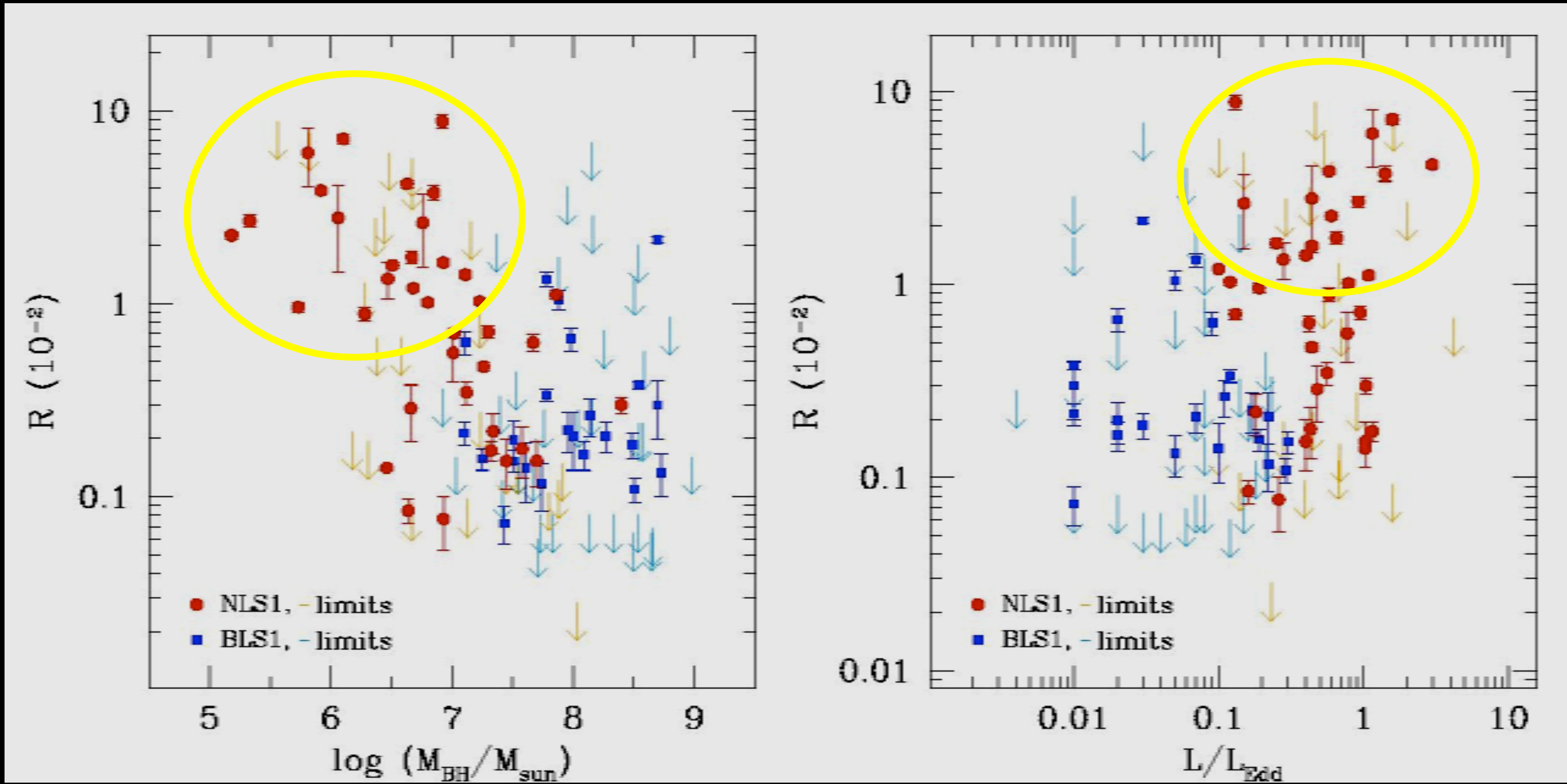


Stacking zones are collapsed along the luminosity axis





AGN fuelling and SF connection



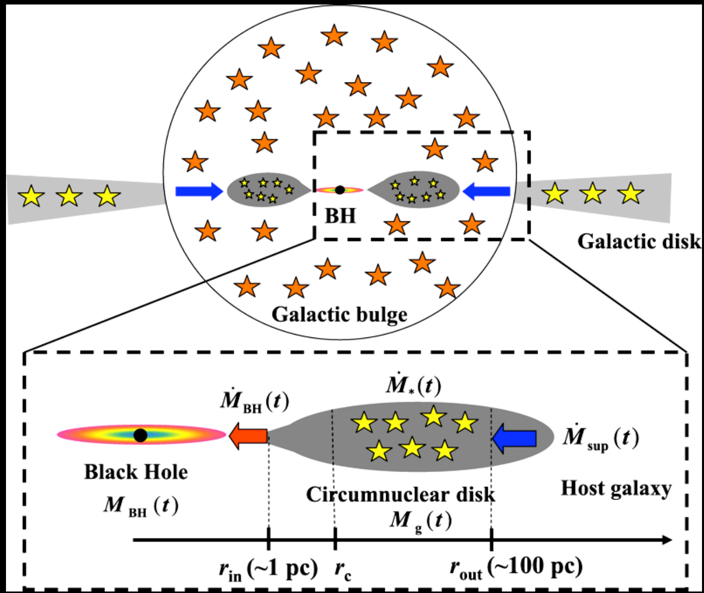
$M_{BH}/M_{sun} = 1.05 \times 10^8 (L_{5100}/10^{46} ergs^{-1})^{0.65} \times (FWHM(H\beta)/1000 kms^{-1})$

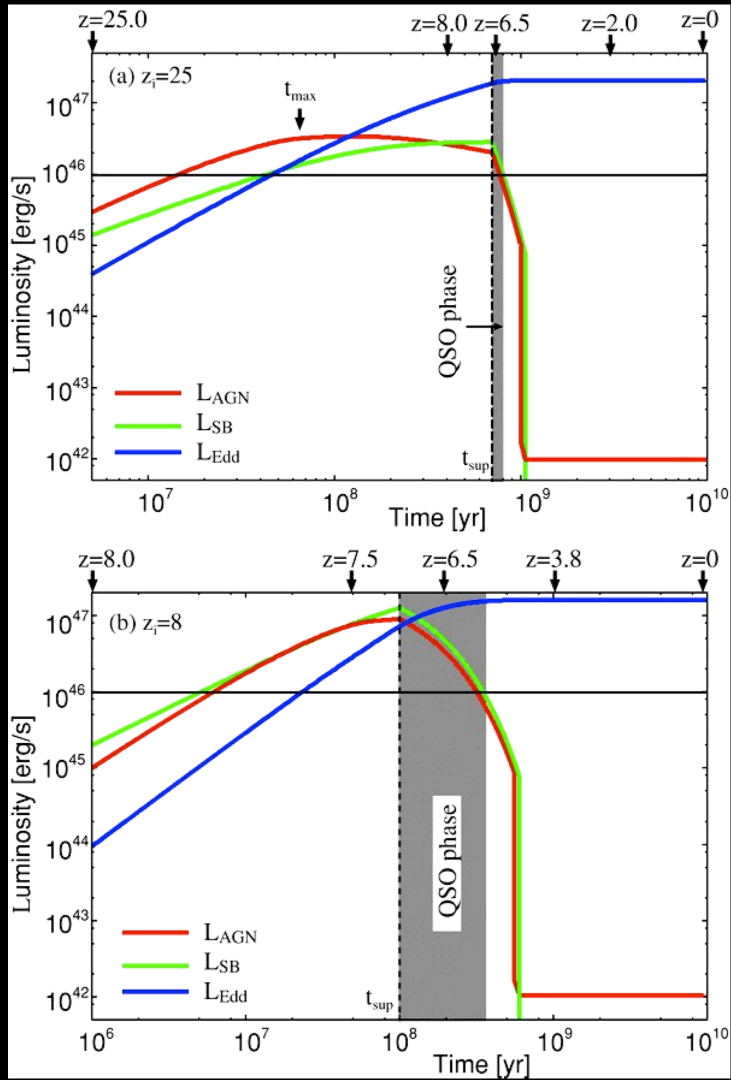
$L/L_{Edd} = f \times L_{5100} / (1.5 \times 10^{38} M_{BH}/M_{sun})$ (Kaspi et al. 2005)

-SF increases with decreasing BH masses and increasing Eddington ratios

-Regions of extreme values are populated only by NLS1

What drives SF-AGN connection ?

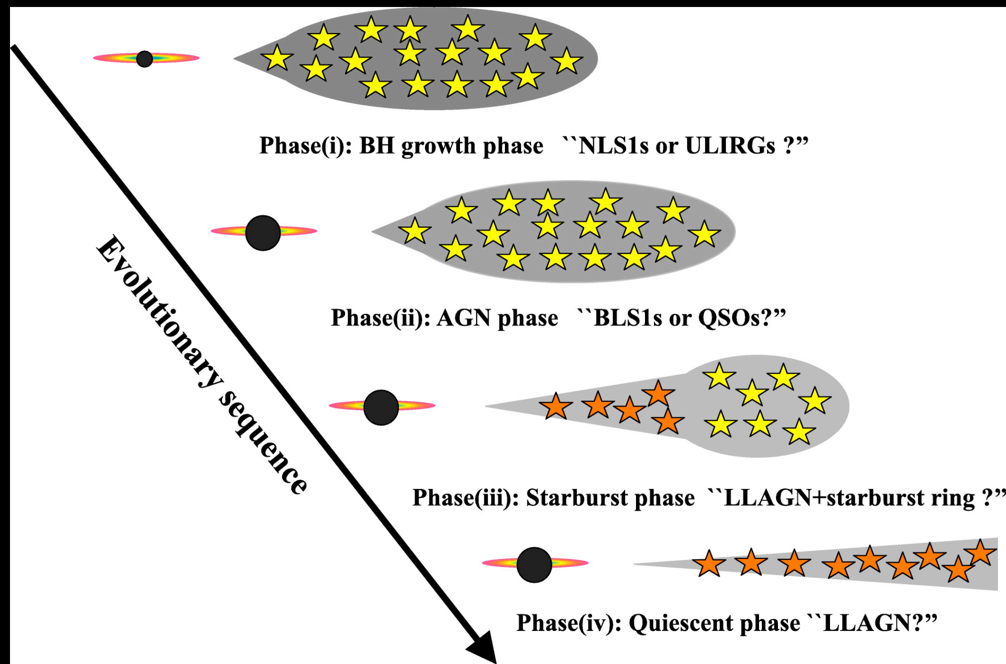




Turbulent pressure supported circumnuclear disk

- The nuclear SB luminosity for the proto-QSO phase is larger than in the QSO phase.
- High SF efficiency necessary for a rapid BH growth in high z systems
- If NLS1s are the early phase of BLS1s, our observations are consistent with predictions

Kawakatu & Wada, 2008, 2009


Phase(i): BH growth phase ``NLS1s or ULIRGs ?”
Phase(ii): AGN phase ``BLS1s or QSOs?”
Evolutionary sequence
Phase(iii): Starburst phase ``LLAGN+starburst ring ?”
Phase(iv): Quiescent phase ``LLAGN?”

Conclusions and future observations

- PAH features are detected with a 3sigma significance in 70% of NLS1s and 45% of BLS1s.

- NLS1s and BLS1s are separated populations.
  NLS1s host a more intense SF activity than BLS1s

THANKS!

- Luminosity and distance effects are carefully taken into account.

- NLS1s hosting more violently accreting BHs harbour more intense SF

Sani et al. 2010, MNRAS, 403, 1246

- Gemini/GMOS IFU observation of the nearest NLS1s holding the most intense SF