AGN Physics with HETDEX (mostly low-z)

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Outline

- Fundamental supermassive blackhole questions HETDEX can address
- Finding low-luminosity AGNs – what to expect from HETDEX

[Other issues:

- Instrumentation desires
- Parallel observations
- Data reduction pipeline issues]

Fundamental Supermassive Black Hole Questions

- We want to understand how we got here
- We need to know how galaxies formed
- Every massive galaxy has a supermassive black hole (SMBH) in it.
- The masses of these black holes are *tightly* correlated with the properties of the bulges of the host galaxies.
- To understand the formation and evolution of galaxies we must understand the evolution of SMBHs over cosmic time.
- AGNs represent the growth phase of SMBHs
- AGNs are the easiest way to measure black hole masses and to probe the growth of SMBHs over time.
- Because of the importance of identifying “seed” black holes – a valuable contribution of HETDEX to understanding SMBH/galaxy evolution is determining the luminosity function of AGNs at the very low end.

How common are active low-luminosity galaxies?

Quite common!

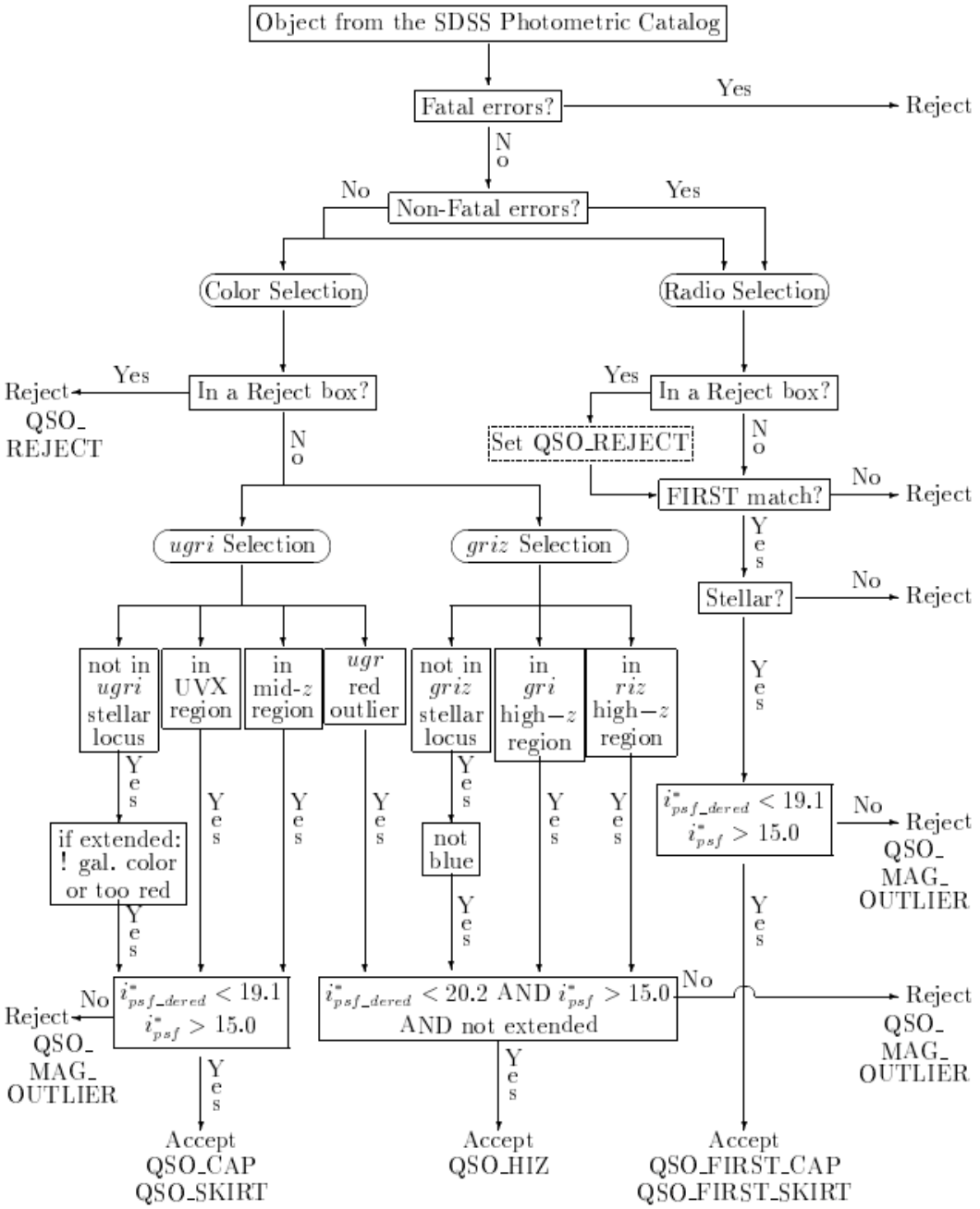
- Seyfert (1943) original list: 1 in 6 ⇒ NGC 4051 – 1.9×10^6 M_{sun}
- Herschel (late 18th century) ~ 3000 galaxies ⇒ NGC 4395 – 360,000 M_{sun}
- plus a handful of Seyfert 2s (Veron & Veron 1984)
- Kunth *et al*. (1987) 1 in 23 emission-line galaxies ⇒ POX 52 ~160,000 M_{sun}

Comparison of HETDEX with SDSS

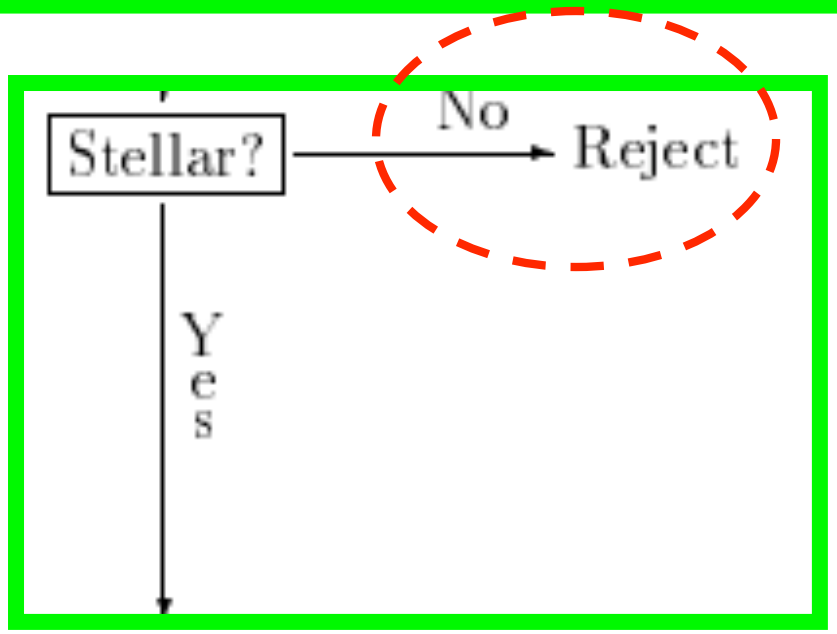
- HETDEX ~ 420/7.5 ~ 56 sq. deg (?) *vs*. SDSS ~ 8400 sq. deg.
- SDSS *targeted* ~ 930,000 galaxies and 120,000 quasars
- "The [HETDEX] survey will detect 0.8 million Lyman-alpha emitting (LAE) galaxies with 1.9<z<3.5 and more than a million [OII] emitting galaxies with z<0.5." (Hill *et al*. 2008)
- Key point: although HETDEX covers a smaller area it (a) is not limited to a small number of fibers and (b) is blind – so ***avoids bias***

BIAS IN THE SDSS: How were the QSOs selected?

(Richards *et al.* 2002)



Close up of selection criteria:

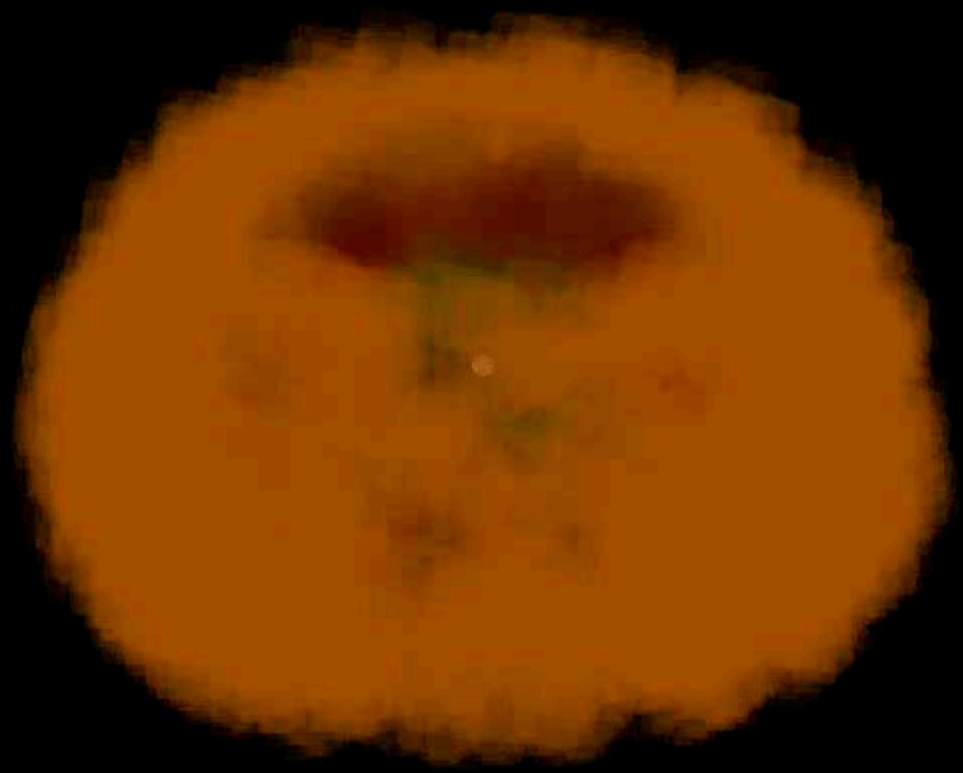


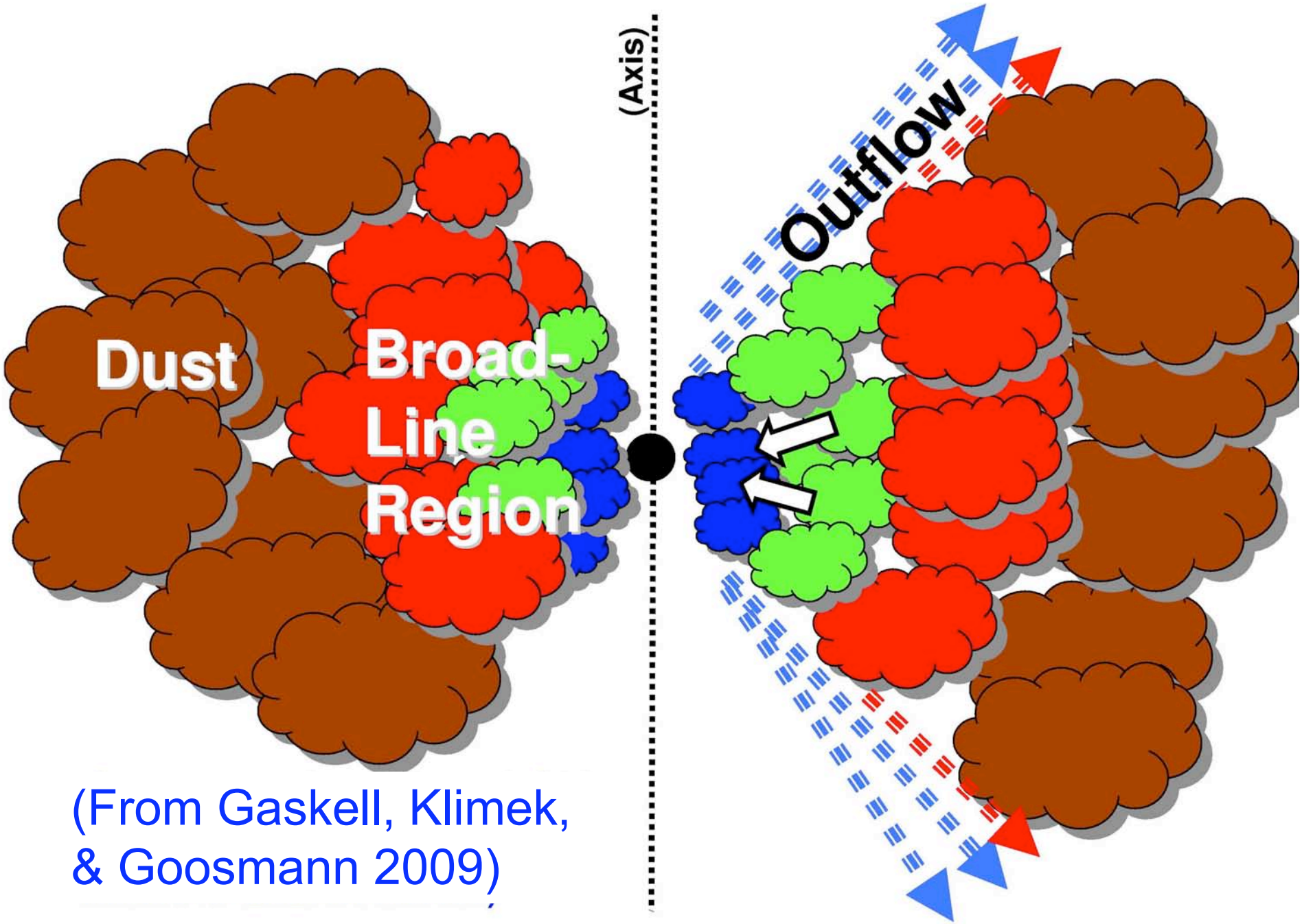
Remark 1: a deeper SDSS-like survey would be even more biased!

Remark 2: SDSS *galaxy* search criteria would not target POX 52 because it was unresolved

Remark 3: Greene & Ho (2004, 2007) lists taken from objects that were selected by SDSS *as AGNs* and *not as galaxies* (NGC 4395 would not be targeted *as an AGN*)

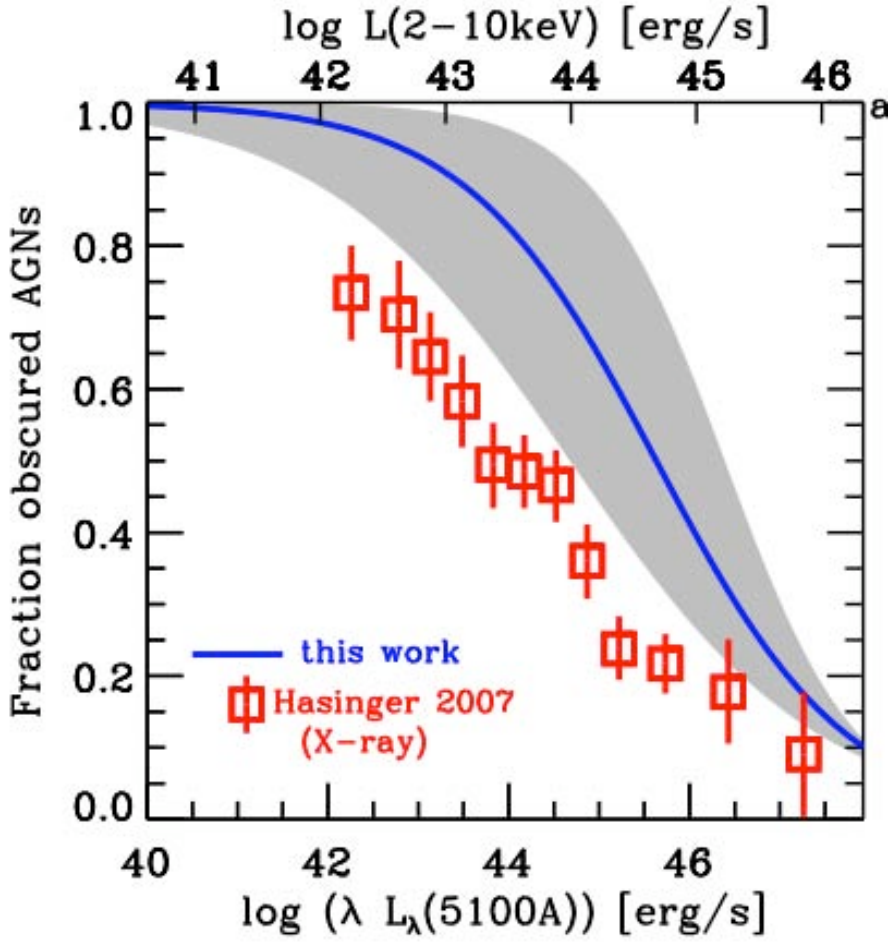
What an AGN is like



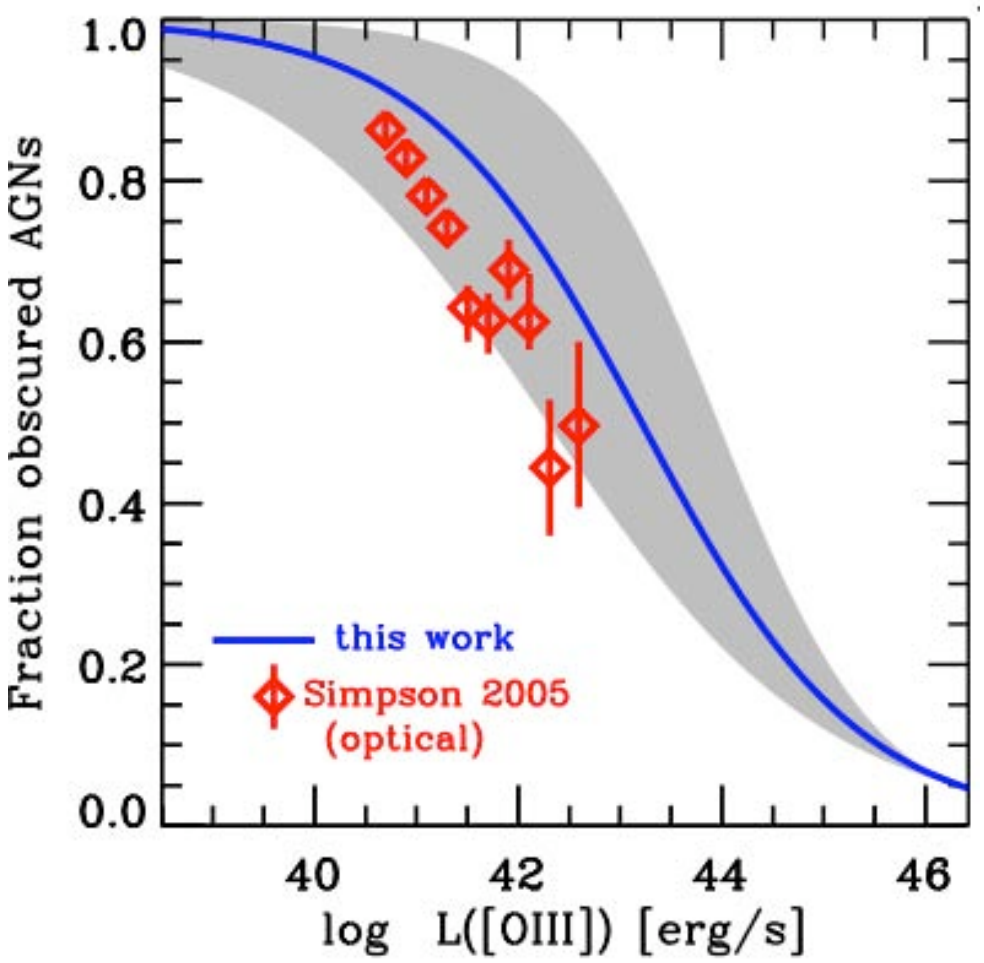


(From Gaskell, Klimek, & Goosmann 2009)

Problem: most AGNs hidden, esp. at low luminosity



Maiolino *et al*. (2007)

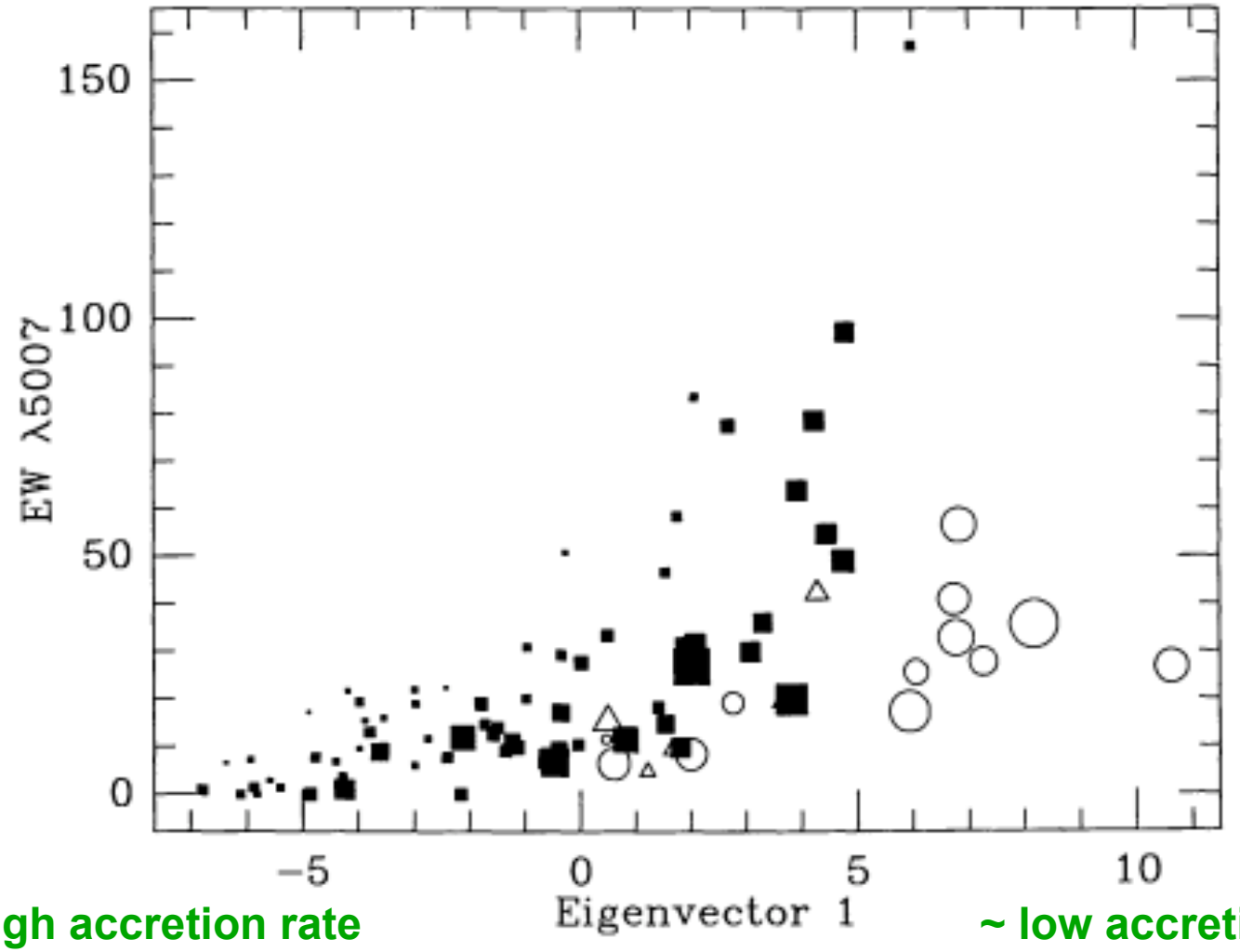


Maiolino *et al*. (2007)

Most edge-on AGNs are also Compton thick – *i.e*., can't readily see them in X-rays either.

Conclusion: to detect most low-mass AGNs the survey must not be biased by color

[O III] selection is also biased:

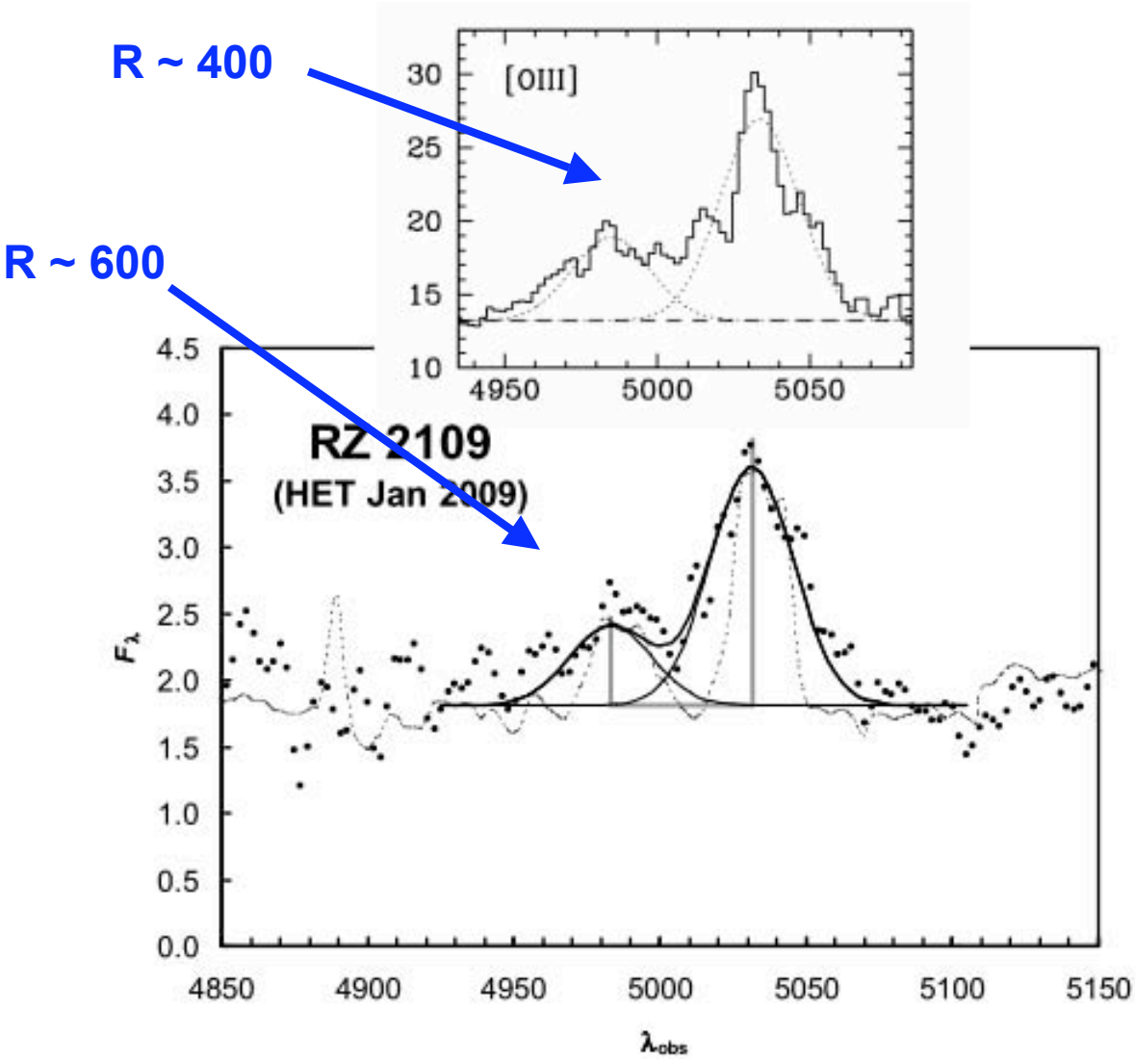


~ high accretion rate

~ low accretion rate

Boroson & Green (1992)

A good illustration of what HETDEX can find...



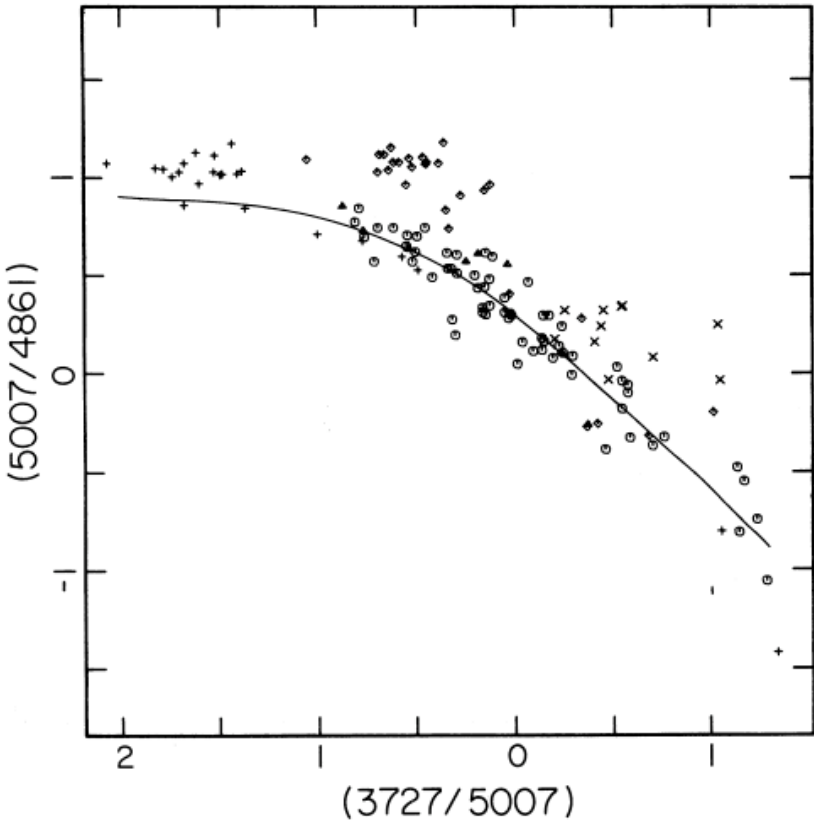
[O III] from a 21st mag. globular cluster! – an active intermediate mass BH??

Would not be in SDSS because (a) too faint, and (b) unresolved

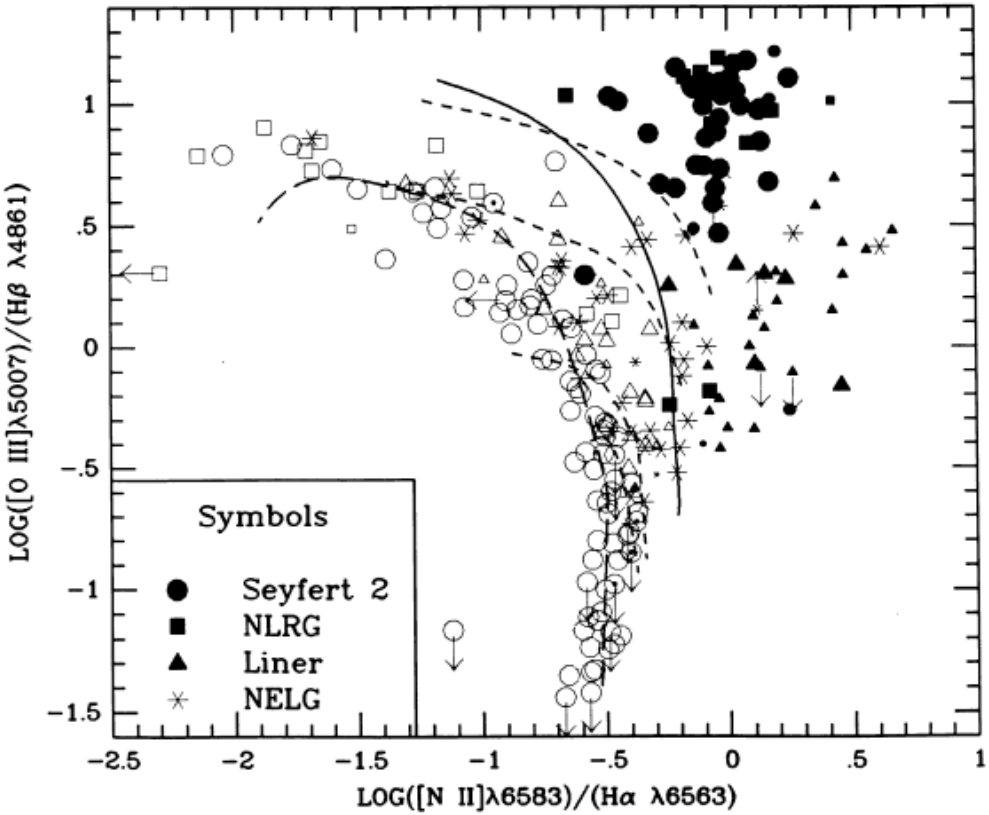
Also, should find more POX 52 type objects (active versions of M 32?)

DESIRED SURVEY CHARACTERISTICS:

BPT diagrams or “how do you know you’ve got an AGN when you can’t see it directly?



Baldwin, Phillips, & Terlevich (1981)



Veilleux & Osterbrock (1987)

⇒ **RED COVERAGE DESIRABLE .**

Non-DEX-survey observations (*e.g.*, parallel)

- Could be very important for statistics of objects
- Potentially higher S/N ratio (but what about dithering?)
- Don't need same homogeneity as for the DEX experiment. ("V/V_{max}")
- Value of *repeated* observations – all type-1 AGNs are *variable*. Maybe a lot of low luminosity AGNs have been missed because they were turned off during SDSS.

(DATA REDUCTION PIPELINE ISSUES)

Needs:

- Weak features $\Rightarrow$ Good stellar template subtraction needed (with approximately right σ and [Fe/H])
- Automated emission line parameters
- Automated BPT classification to flag potentially interesting objects for follow up.