Update on
Comparing X-ray AGN w/ Emission-line AGN

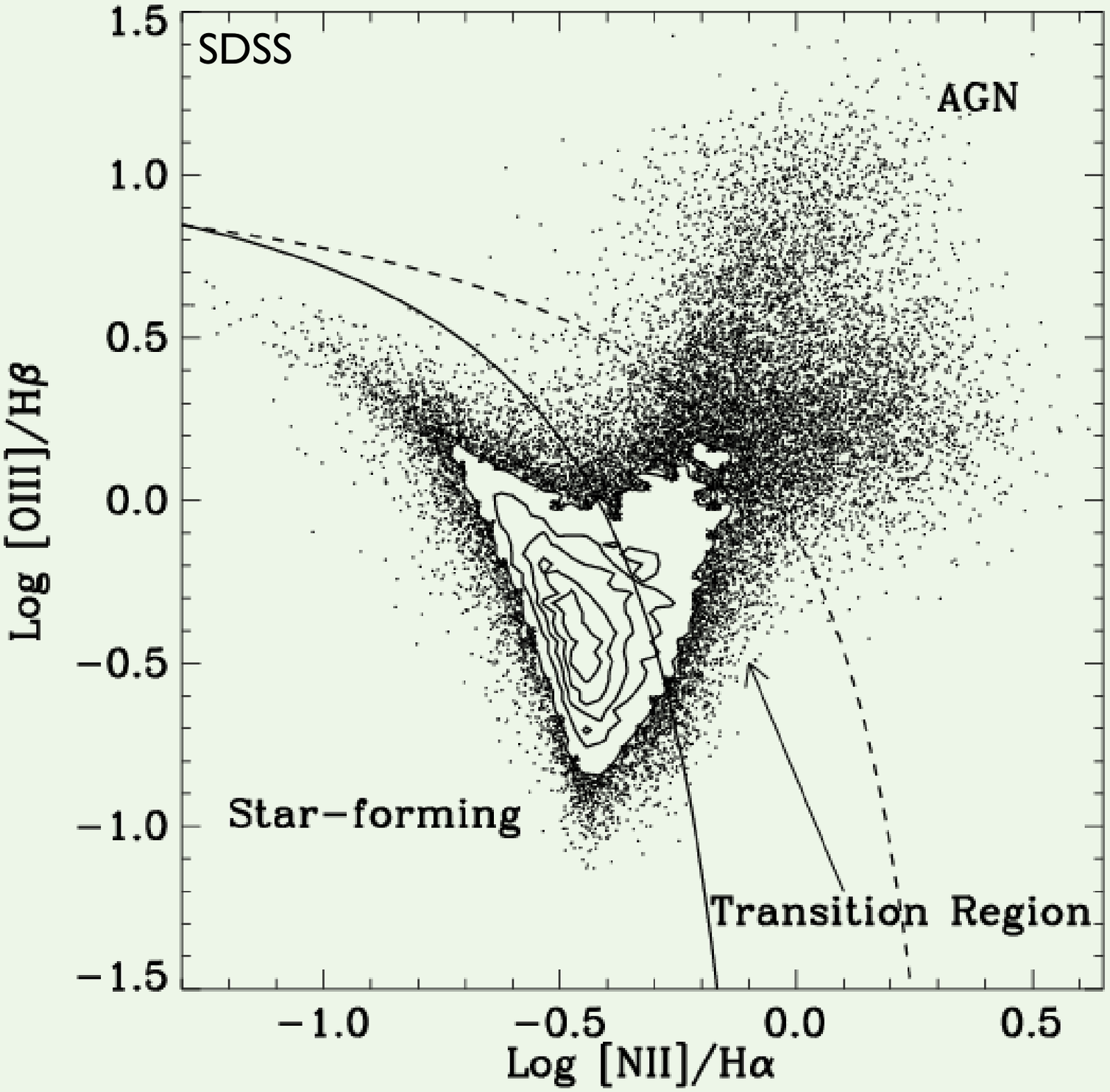
Renbin Yan
University of Toronto

Co-authors: J. Newman, Luis Ho, M. Cooper, S. Faber,
P. Nandra, E. Laird, A. Georgakakis, D. Koo, V. Sarajedini,
M. Davis, B. Weiner, A. Coil, C. Willmer, P. Barmby,
S. Park, S. Willner, A. Koekemoer, L. Simard
and other interested AEGIS members

Science Questions

- More complete AGN census.
- The demographics of AGN at high-z, and the demographics of the host galaxies.
- How AGN co-evolve with galaxies, in relation to the stellar pop evolution and the structural evolution?

Optical Selection of AGN



Difficulty at z>0.4:

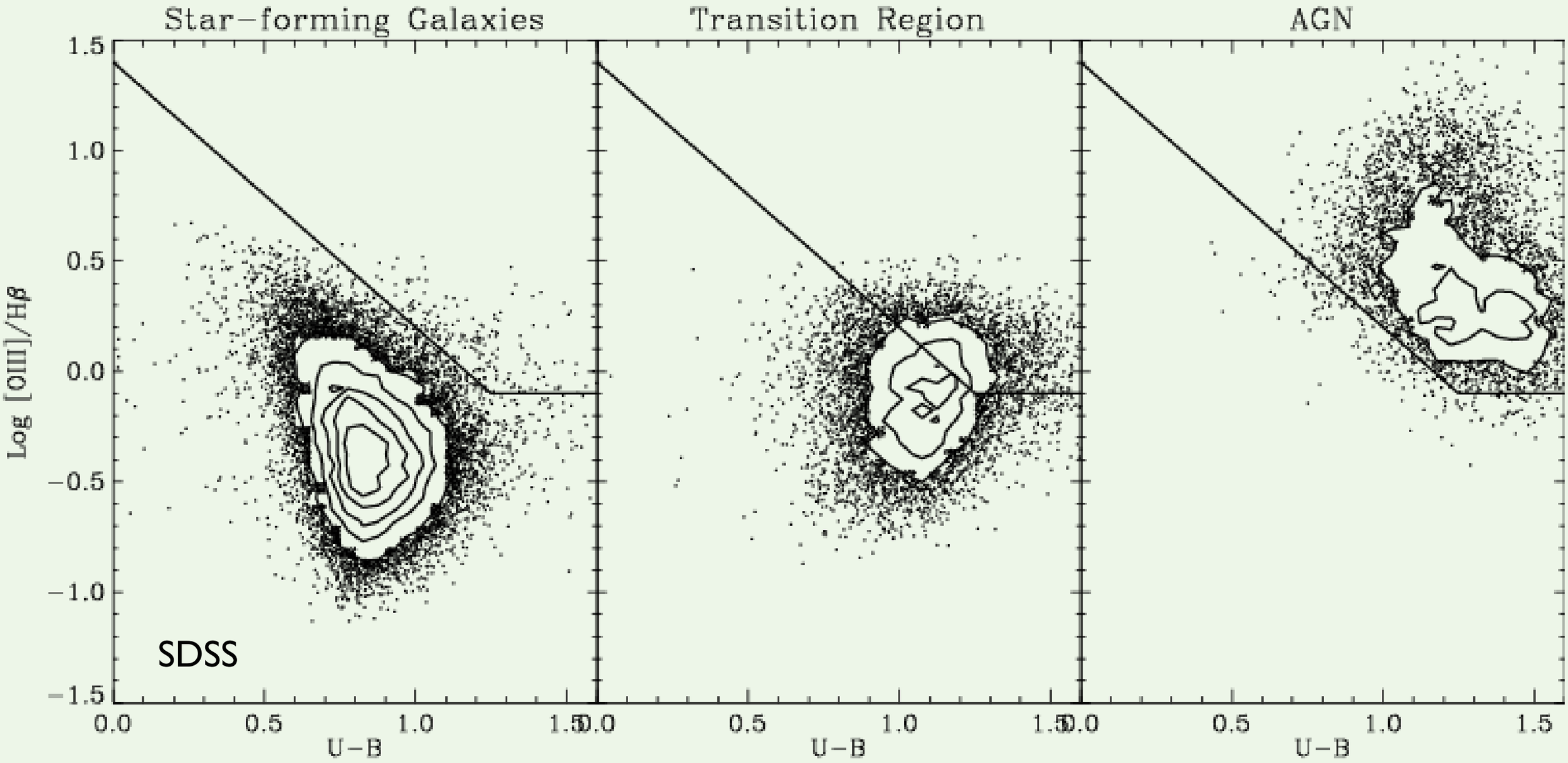
[NII] and Halpha are redshifted out of the optical window. And the NIR spectroscopy is very expensive.

Solution:

Use galaxy color!

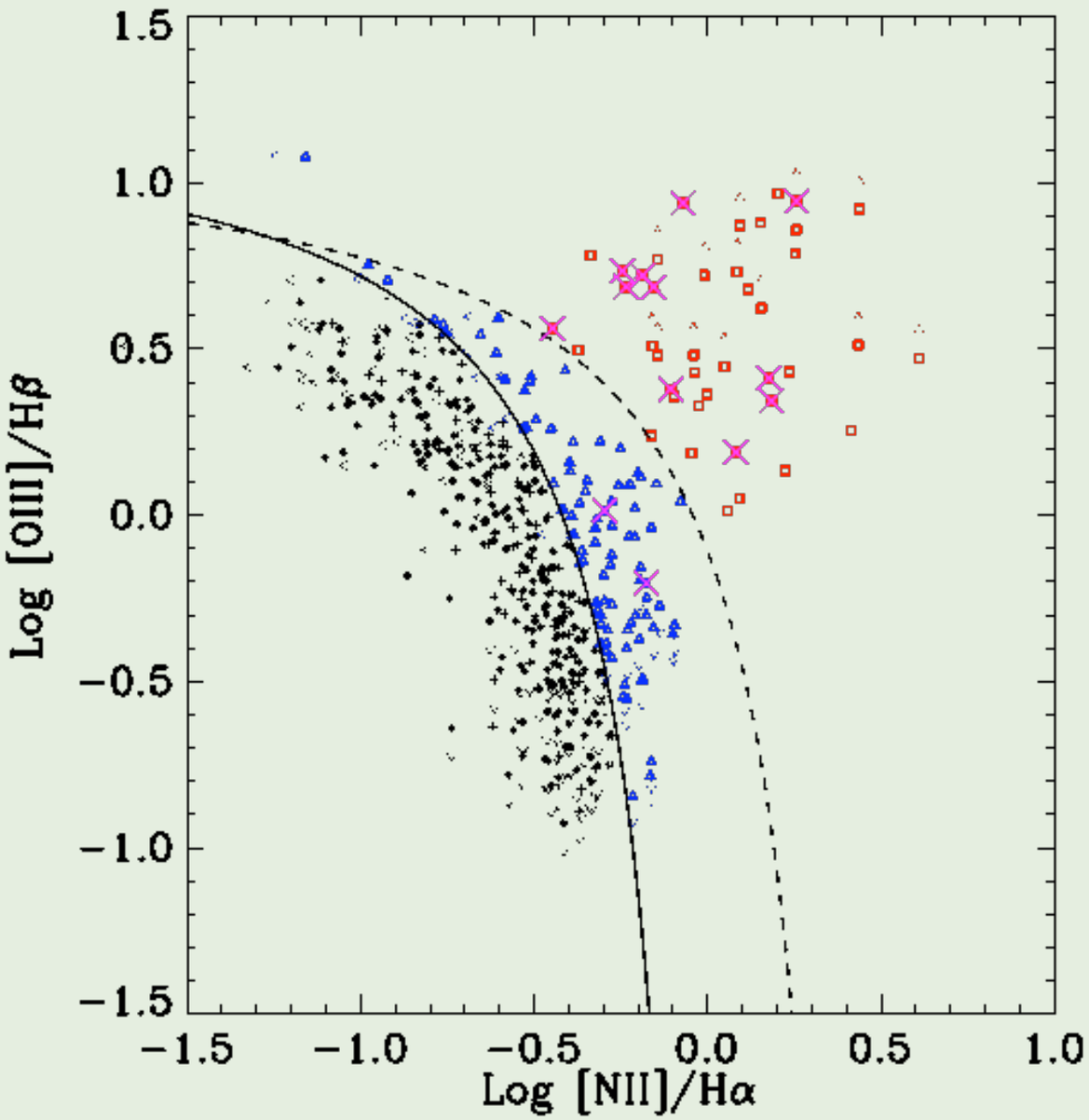
Optical Selection of AGN

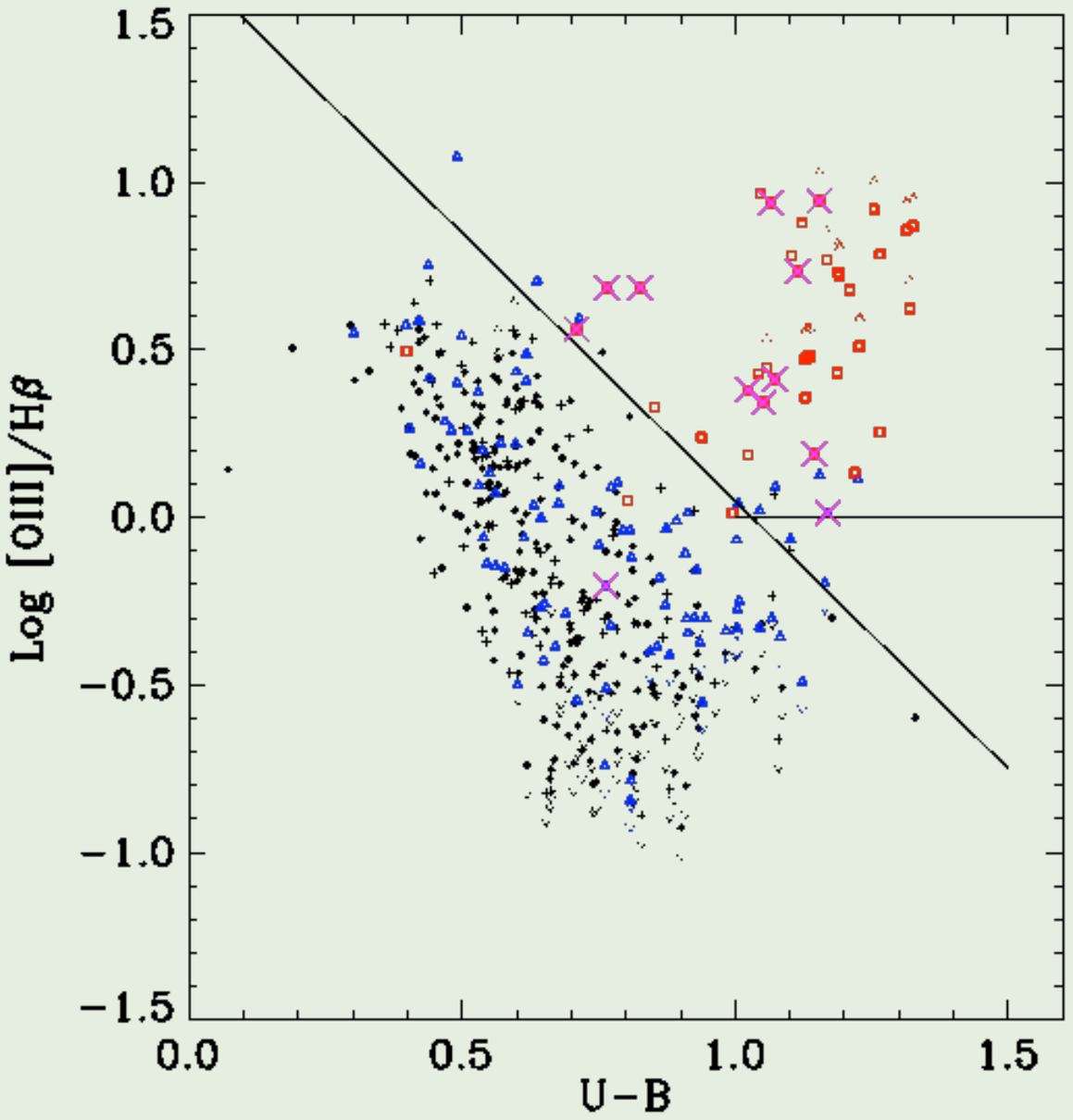
---- when we do not have all the necessary lines



Most AGN reside in red or greenish host galaxies. The method only works for Type-2 AGNs.

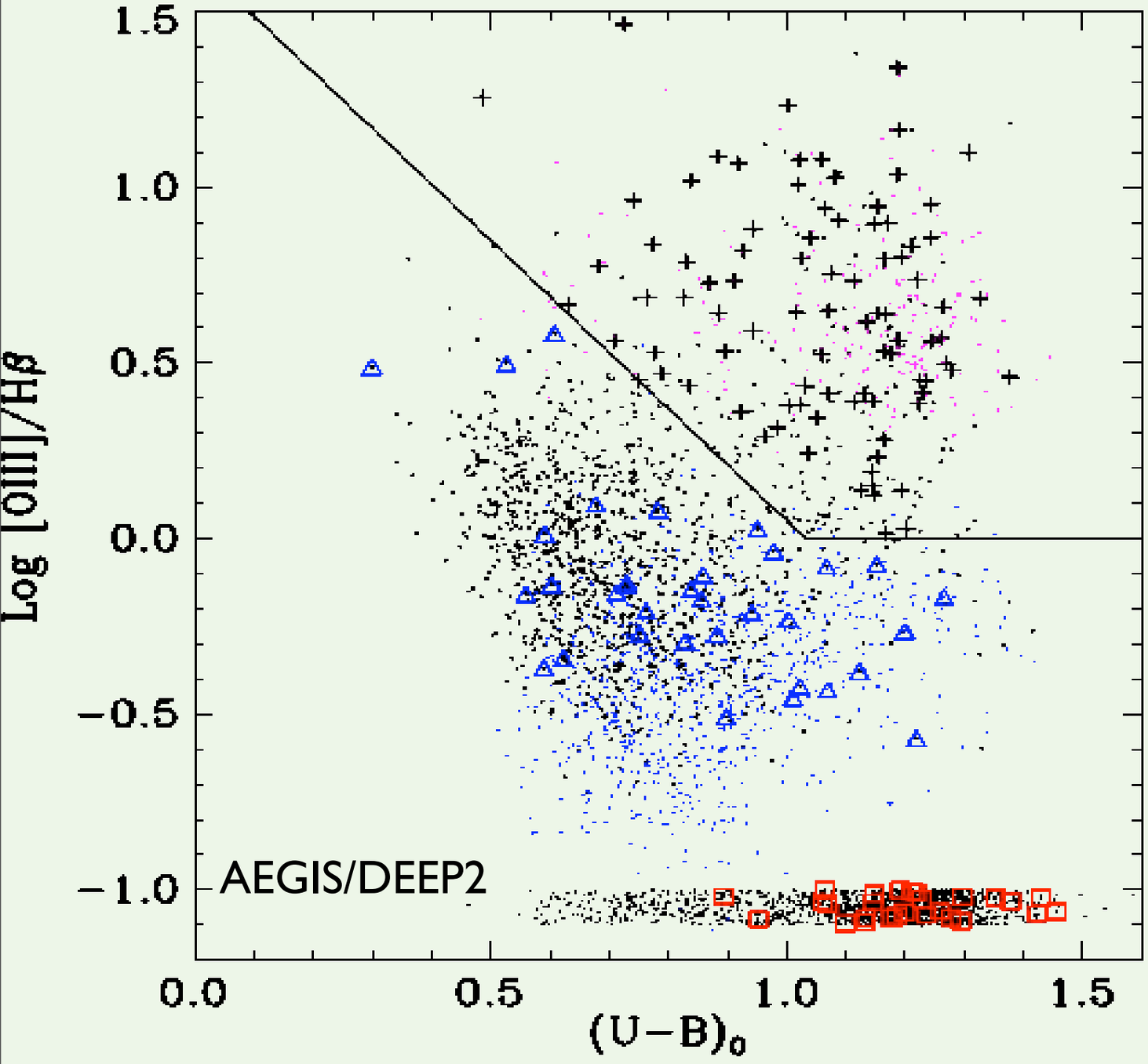
Test of the Selection in EGS





$0.2 < z < 0.4$

X-ray sources on BPT diagram



$0.3 < z < 0.8$

Among 1325 X-ray sources,

-- 895 are matched to DEEP2 CFHT photometry catalog with likelihood ratio (LR) > 0.5

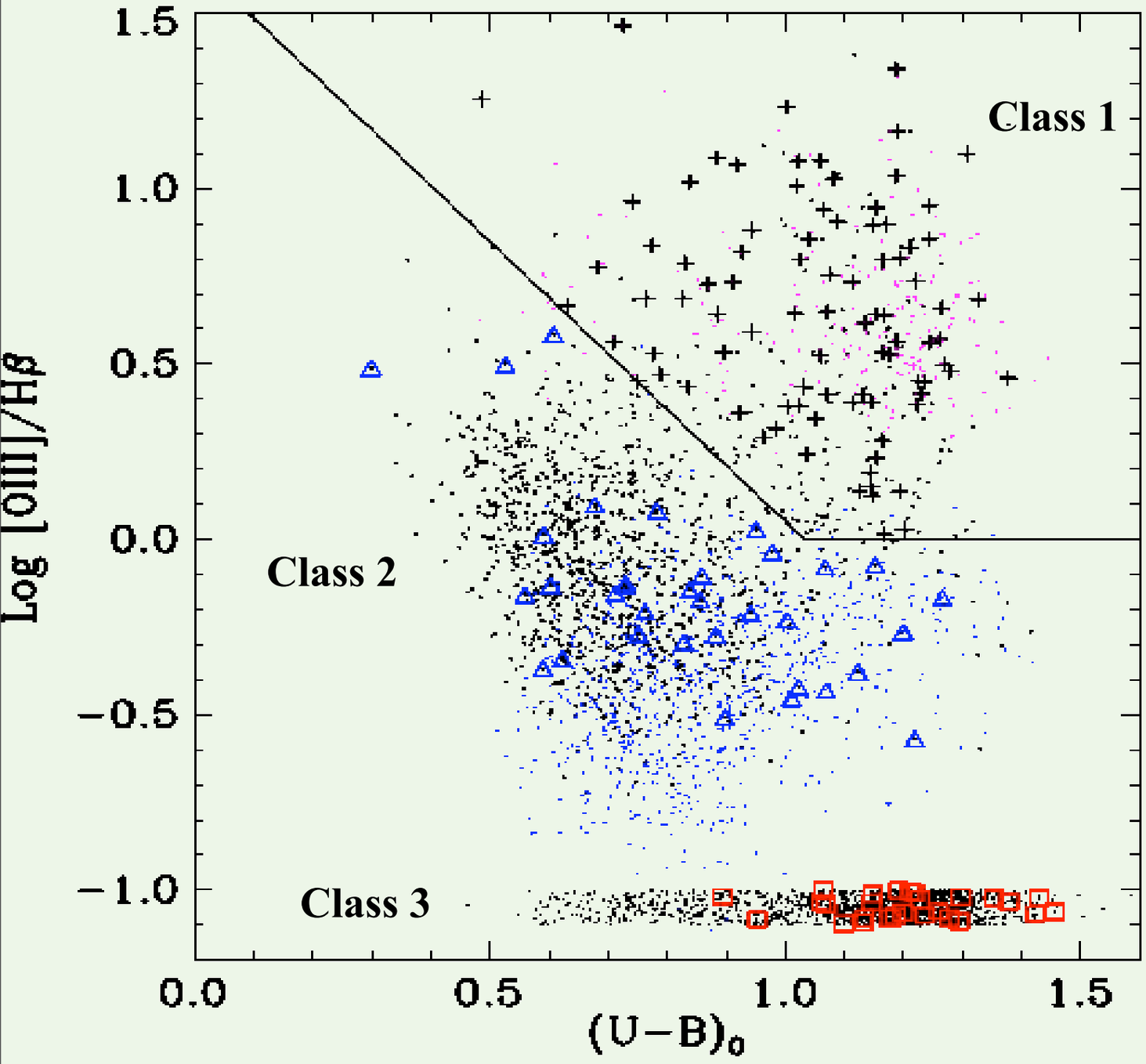
--- 468 have secure redshifts from DEEP2 and Hectospec Follow-up

--- 187 with both [OIII] and Hbeta covered.

We have a larger sample!

- 468 X-ray sources have secure redshifts.
- With re-extraction around ~12,000 X-ray undetected galaxies with secure redshifts, 135 additional sources qualify as significant detections ($P_{spurious}$< 4.e-6).
- It turns out most of them (except for 20) are not new, but are low Likelihood Ratio matches in the X-ray catalog.
- The detection threshold is currently set to P<4x10^{-6}. With X-ray measurements at pre-determined positions, we can raise the threshold without including many spurious detections.
- With P<0.001, we have 846 X-ray sources with secure redshifts, nearly doubling the sample.

X-ray sources on BPT diagram



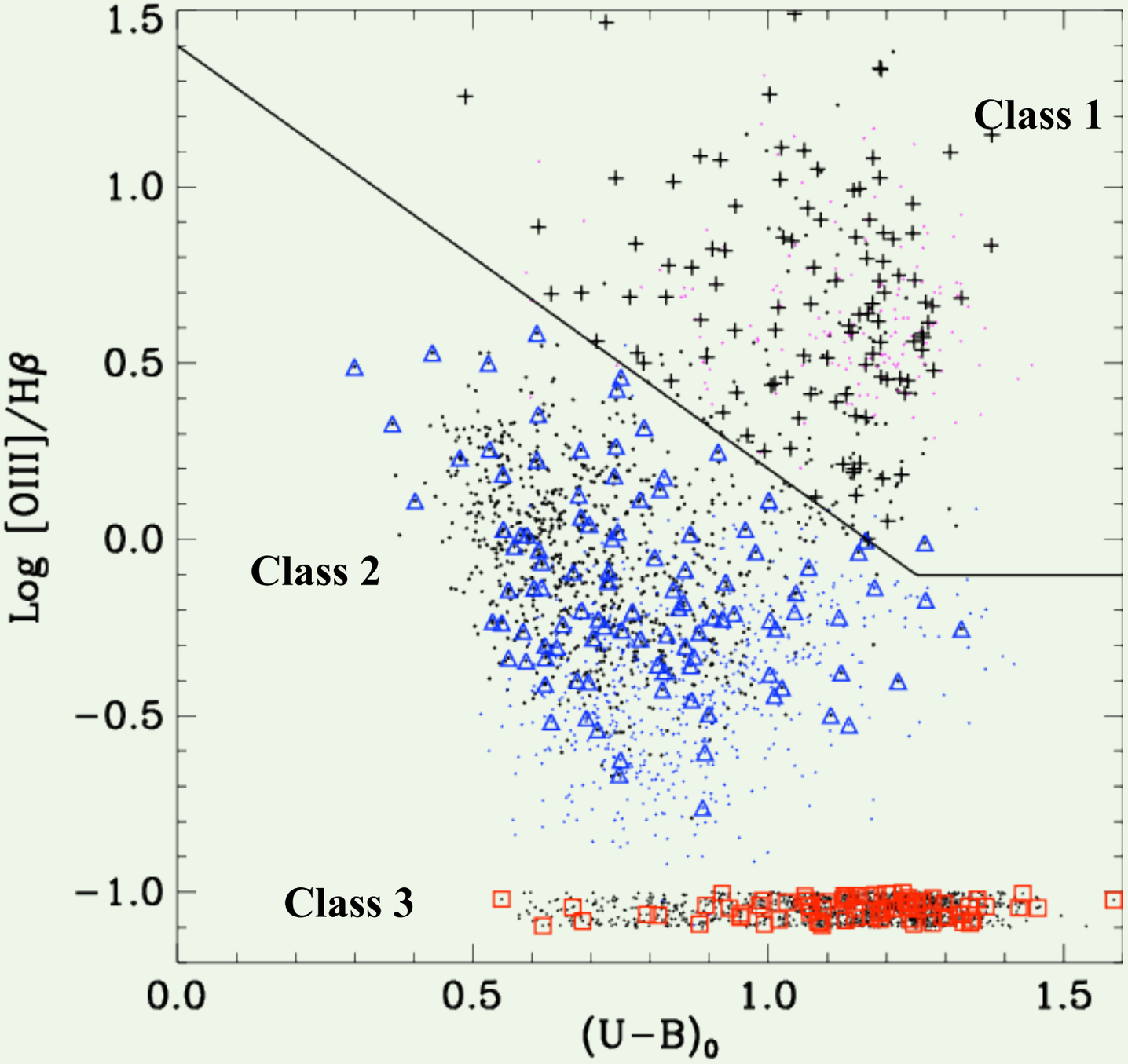
$0.3 < z < 0.8$

Class 1: X-ray sources that are also emission-line AGN.

Class 2: X-ray sources on the star-forming branch.

Class 3: X-ray sources with no detectable emission lines. These would be classified as "optically-dull" or "X-ray bright, optically normal galaxies (XBONGs)."

X-ray sources on BPT diagram



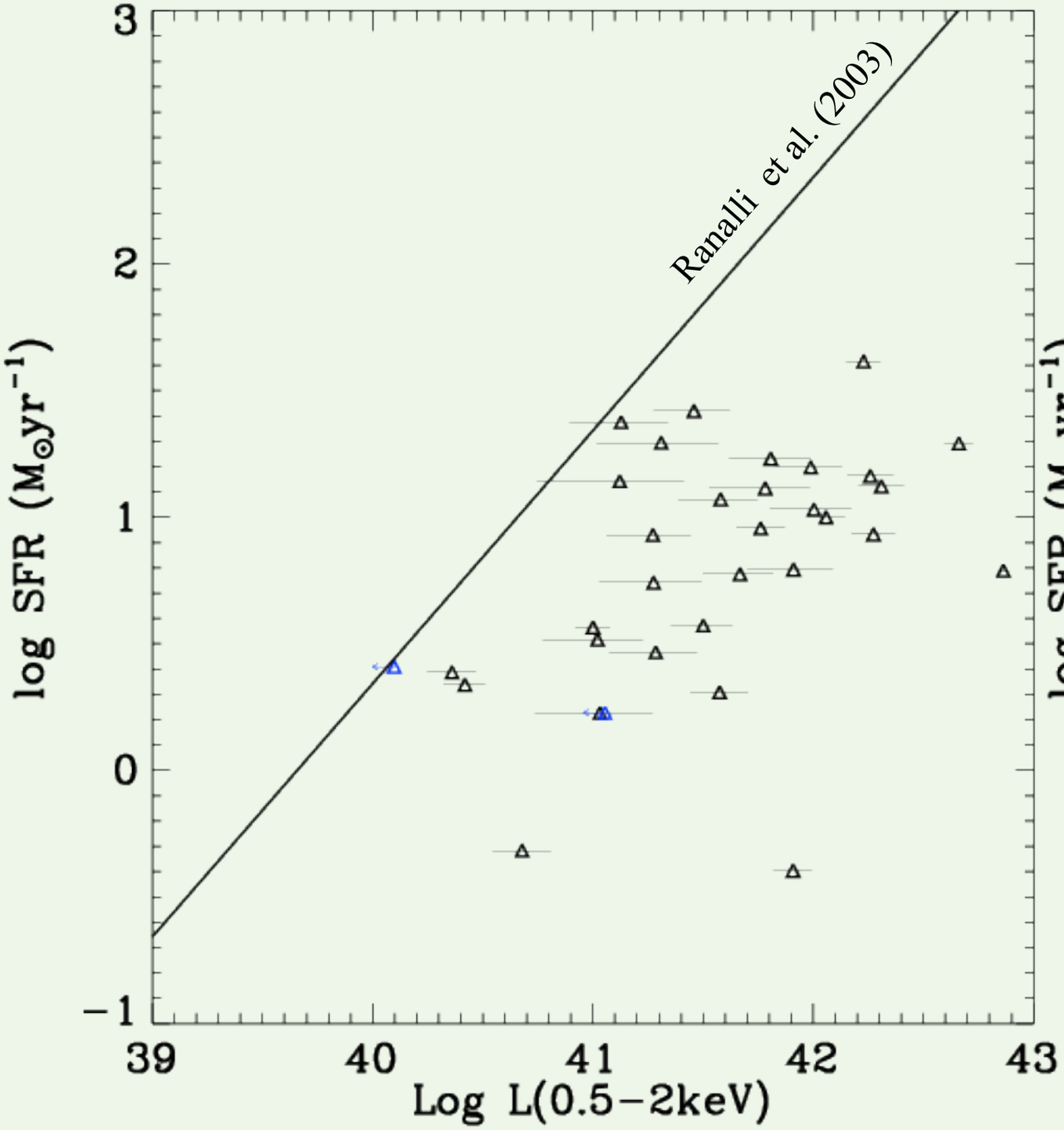
$0.3 < z < 0.8$

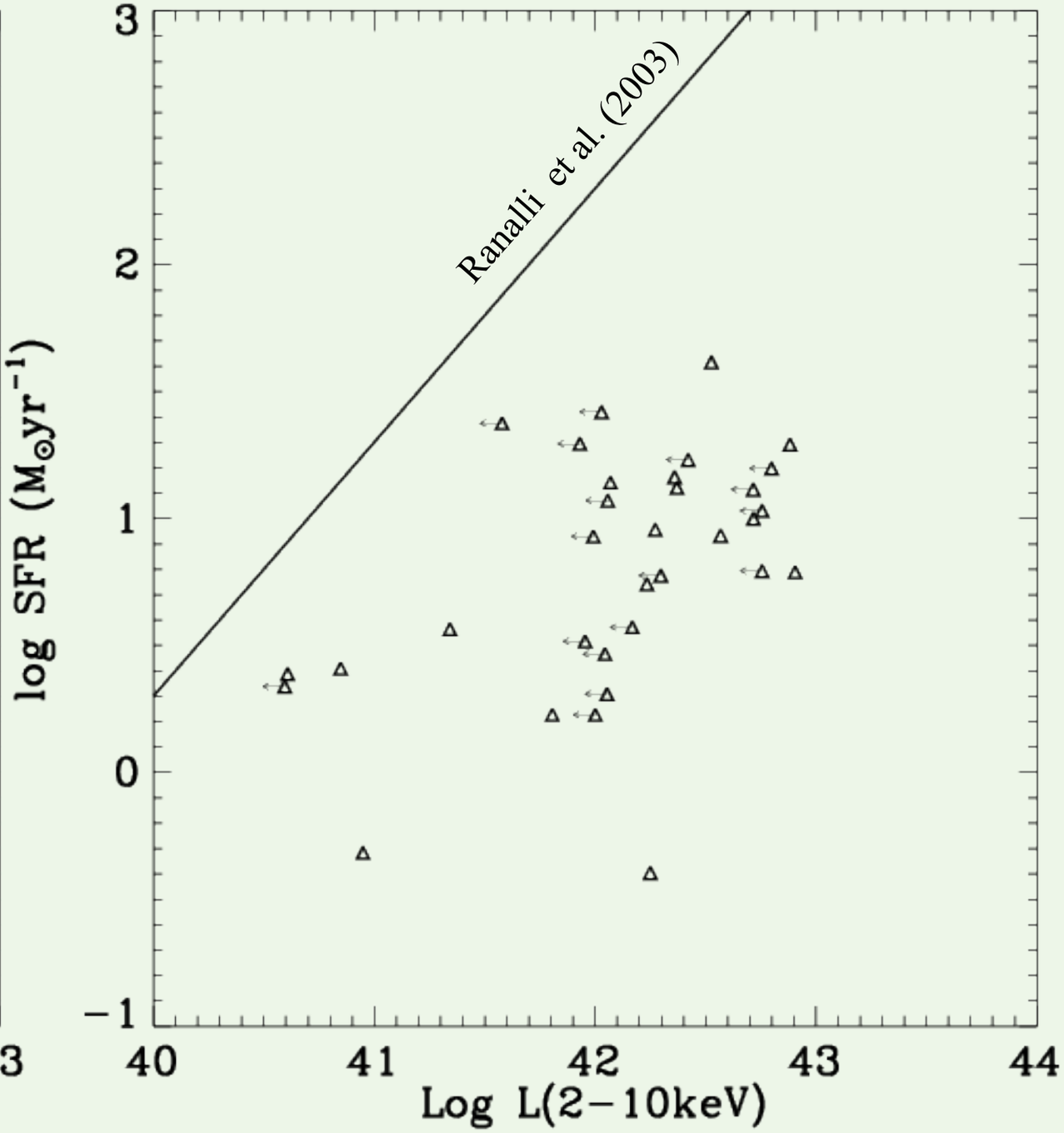
Class 1: X-ray sources that are also emission-line AGN.

Class 2: X-ray sources on the star-forming branch.

Class 3: X-ray sources with no detectable emission lines. These would be classified as "optically-dull" or "X-ray bright, optically normal galaxies (XBONGs)."

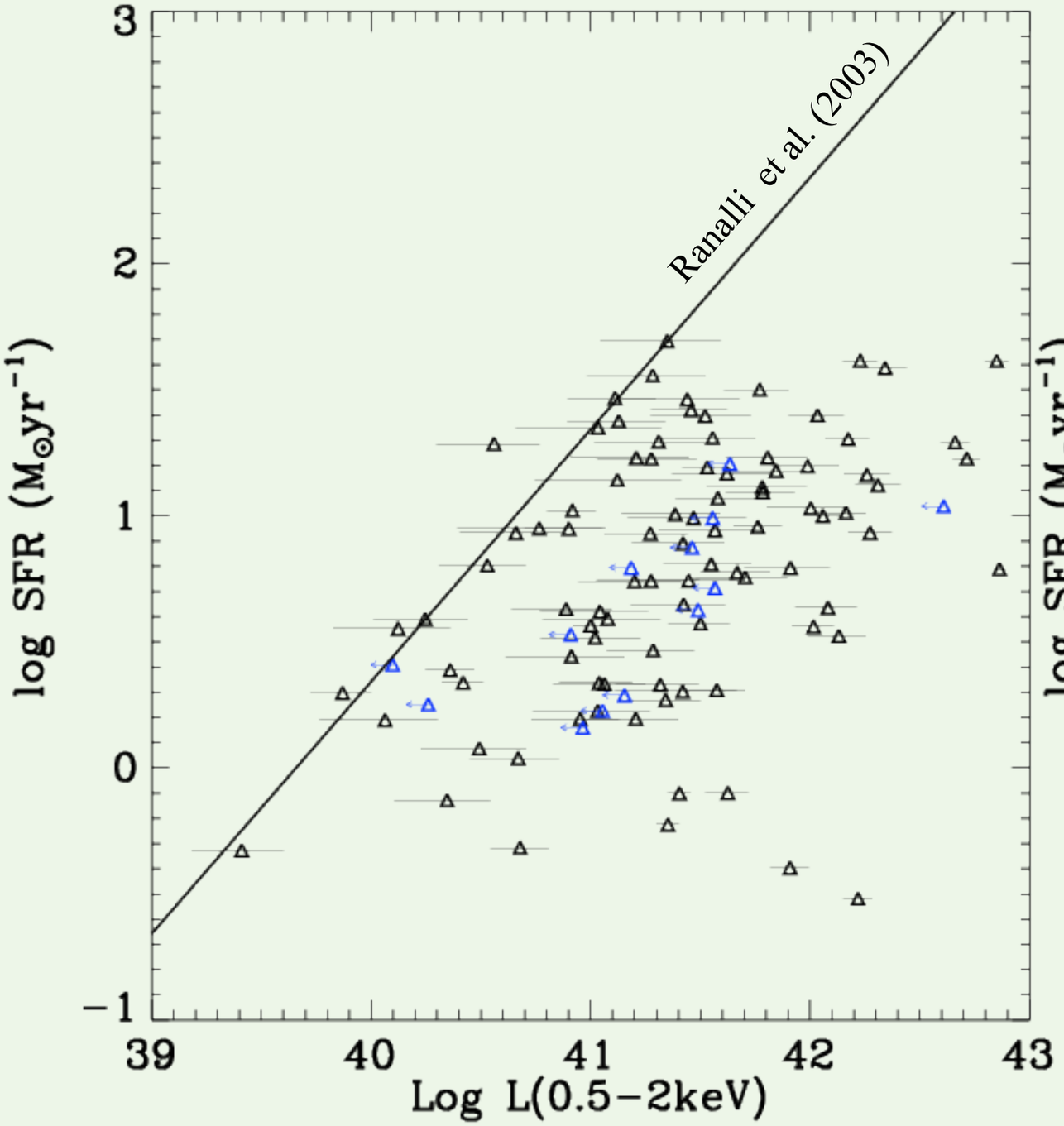
X-ray sources on the SF sequence

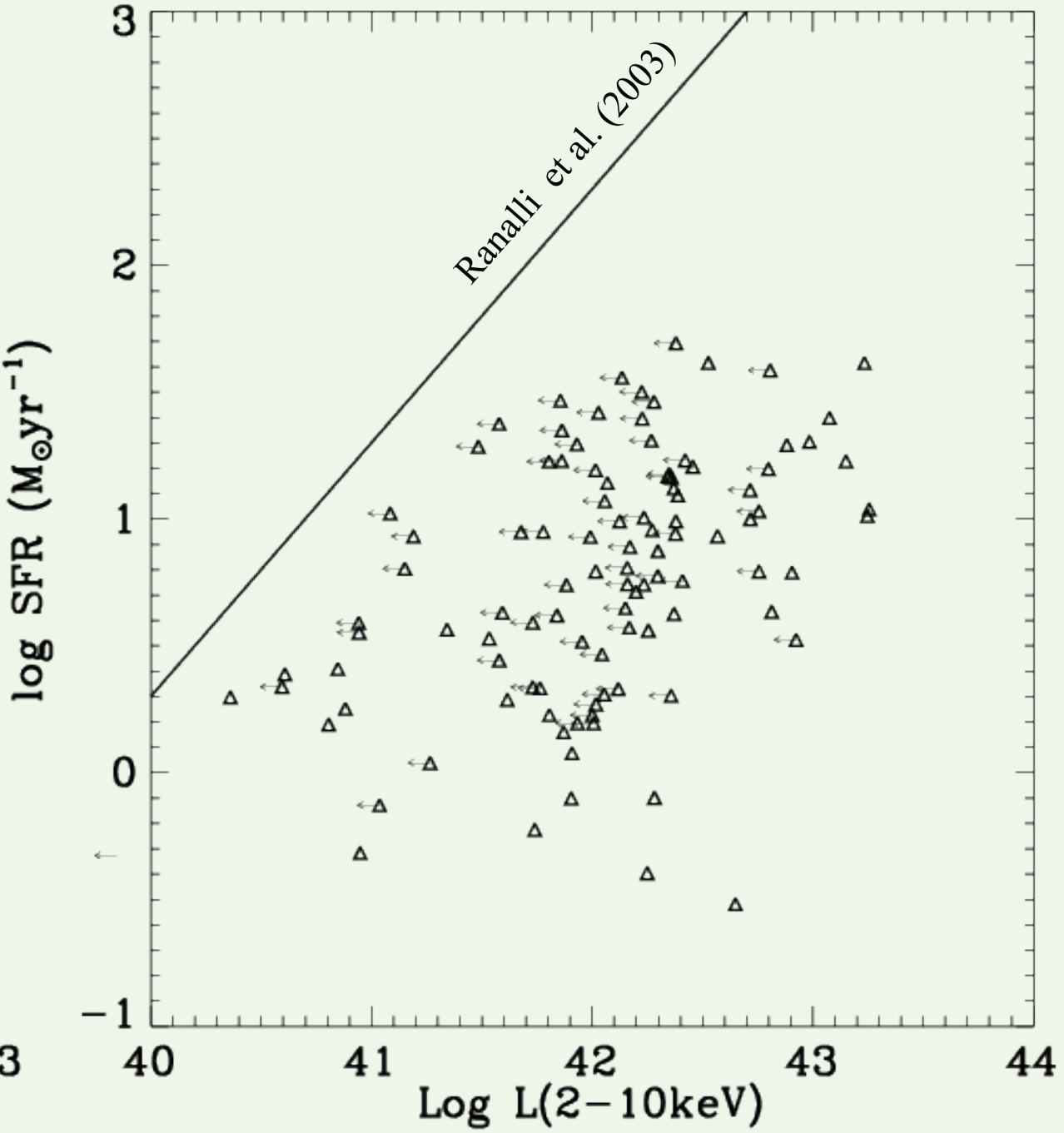




There is an excess in X-ray than expected from star formation.

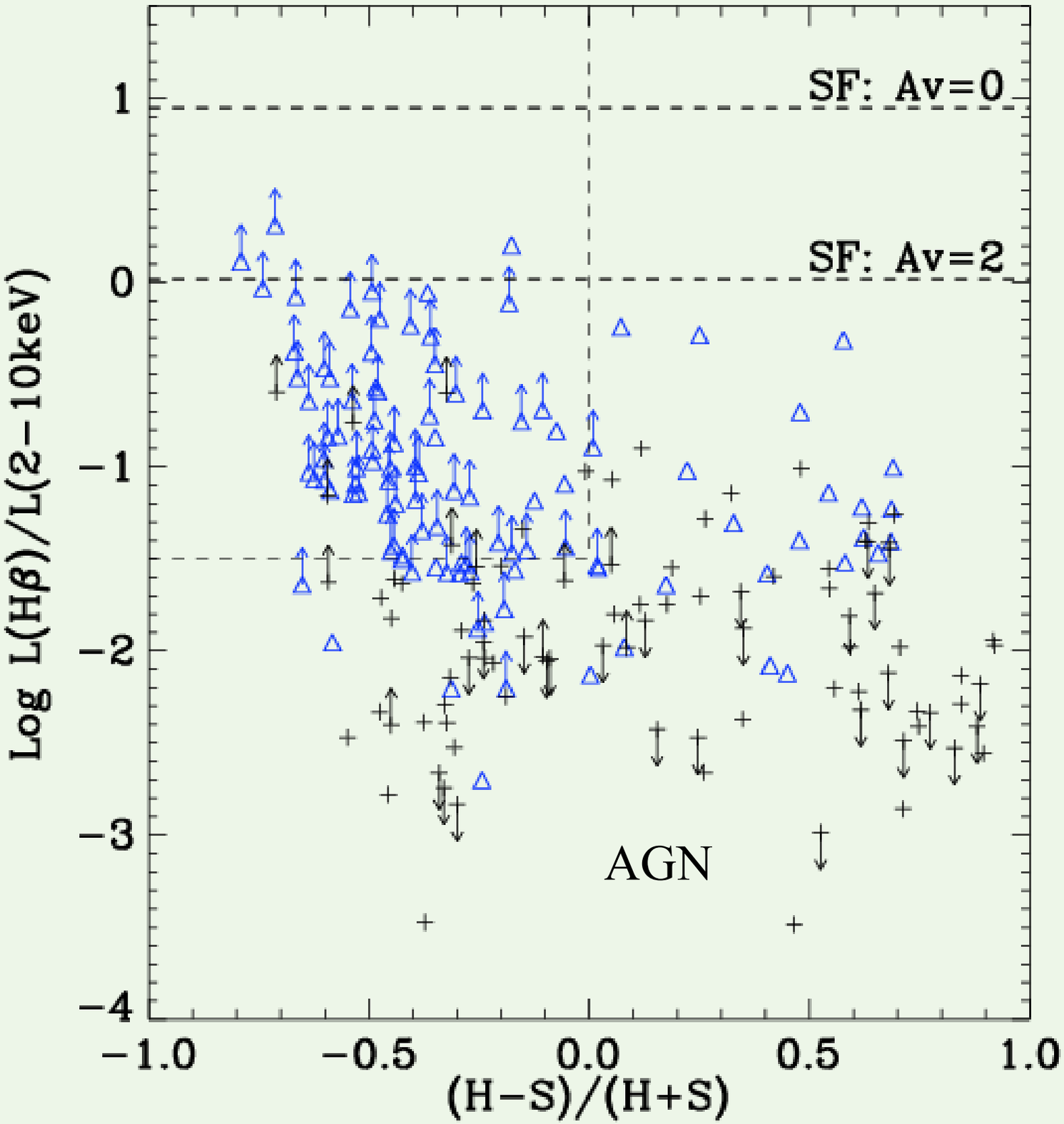
X-ray sources on the SF sequence





There is an excess in X-ray than expected from star formation.

X-ray sources on the SF sequence



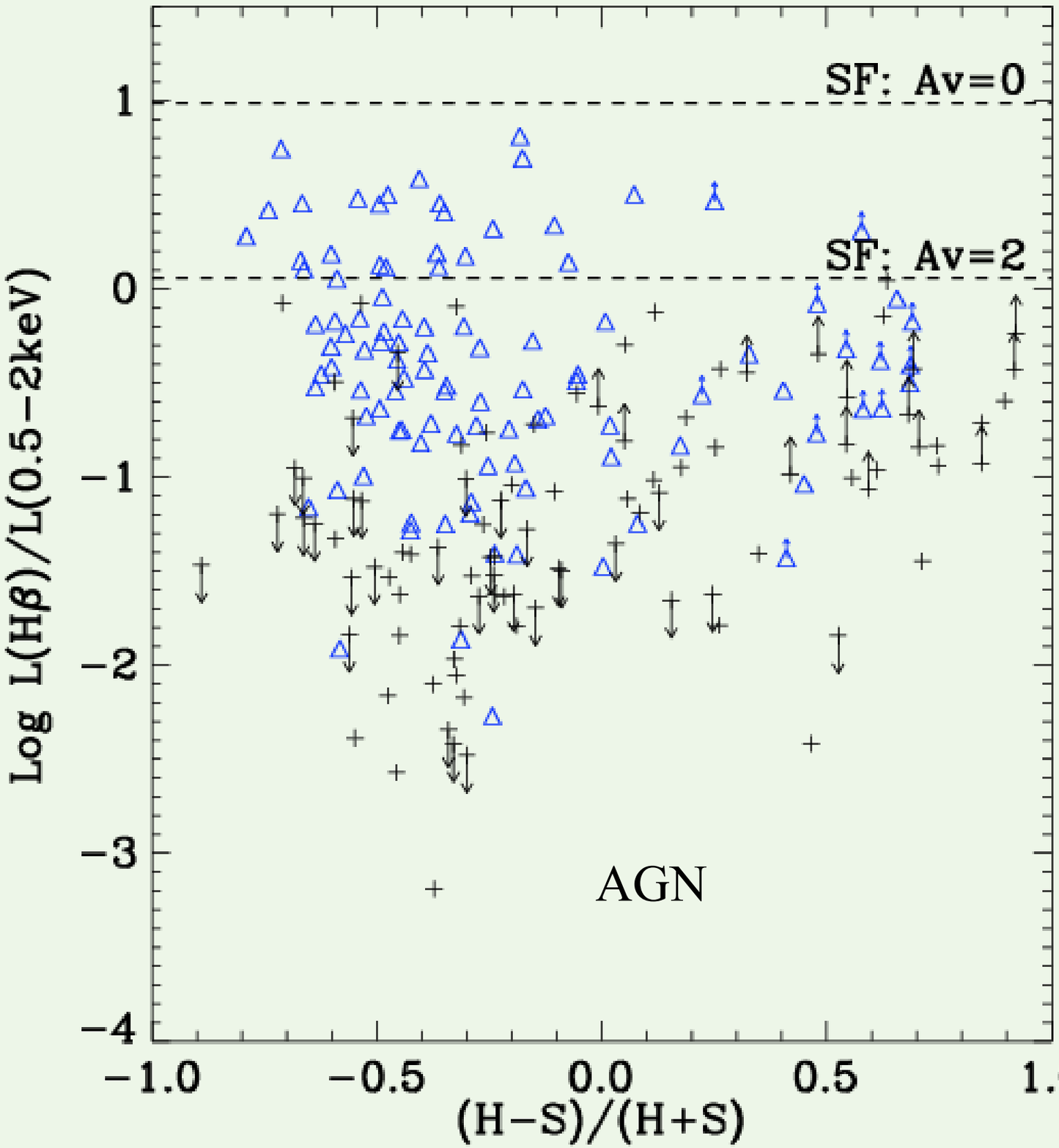
△ X-ray sources on SF sequence

\+ X-ray emission-line AGN

Their L(Hb)/Lx ratios are lower than SF galaxies but higher than typical AGNs. The higher ratios are not due to X-ray being absorbed, as shown by their low hardness ratios.

Therefore, they are star-forming-AGN composites with X-ray from AGN and Hb from SF.

X-ray sources on the SF sequence

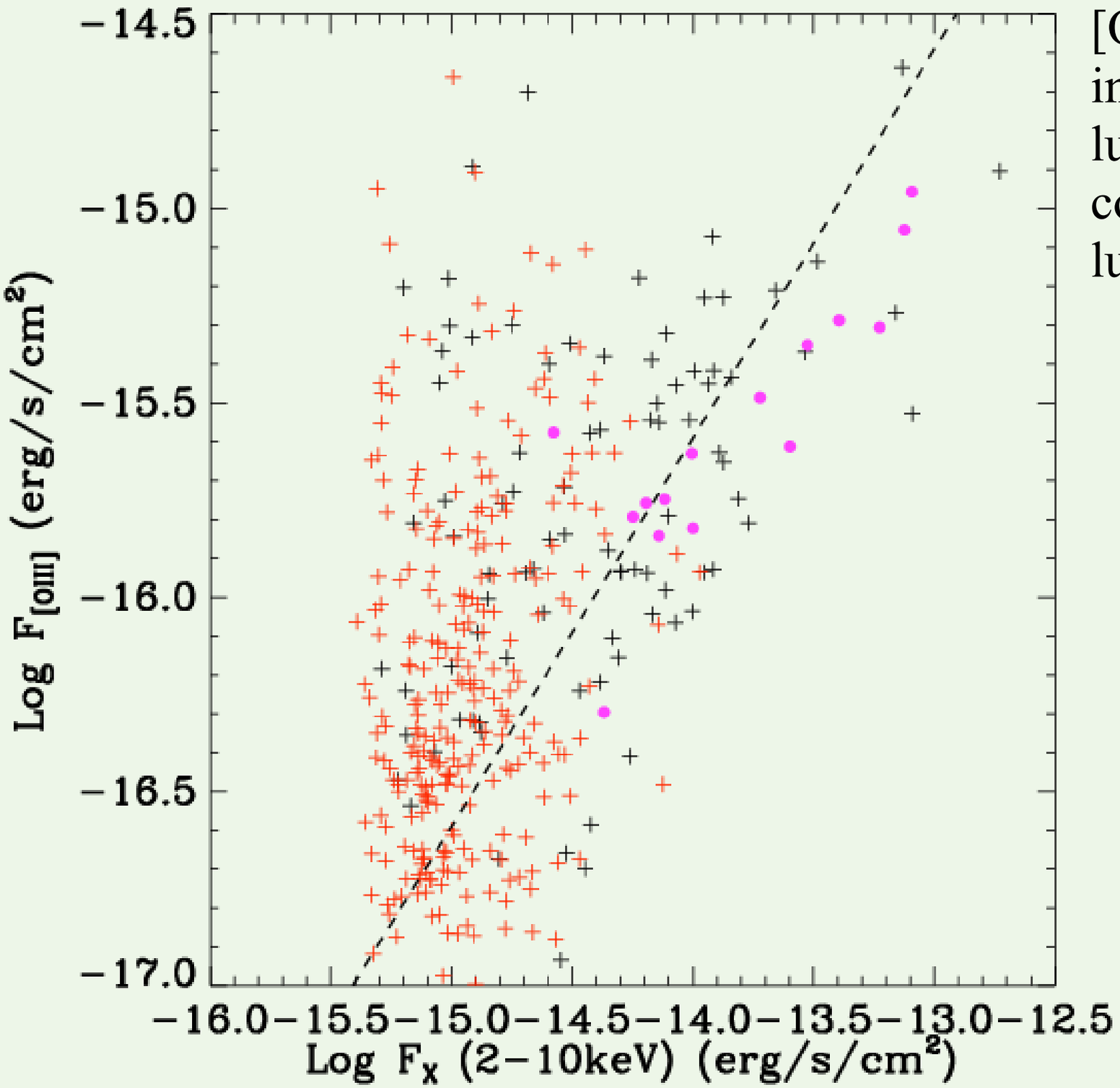


△ X-ray sources on SF sequence

\+ X-ray emission-line AGN

Their L(Hb)/Lx ratios are lower than SF galaxies but higher than typical AGNs. The higher ratios are not due to X-ray being absorbed, as shown by their low hardness ratios. Therefore, they are star-forming-AGN composites with X-ray from AGN and Hb from SF.

[OIII] vs. X-ray for Optical AGN



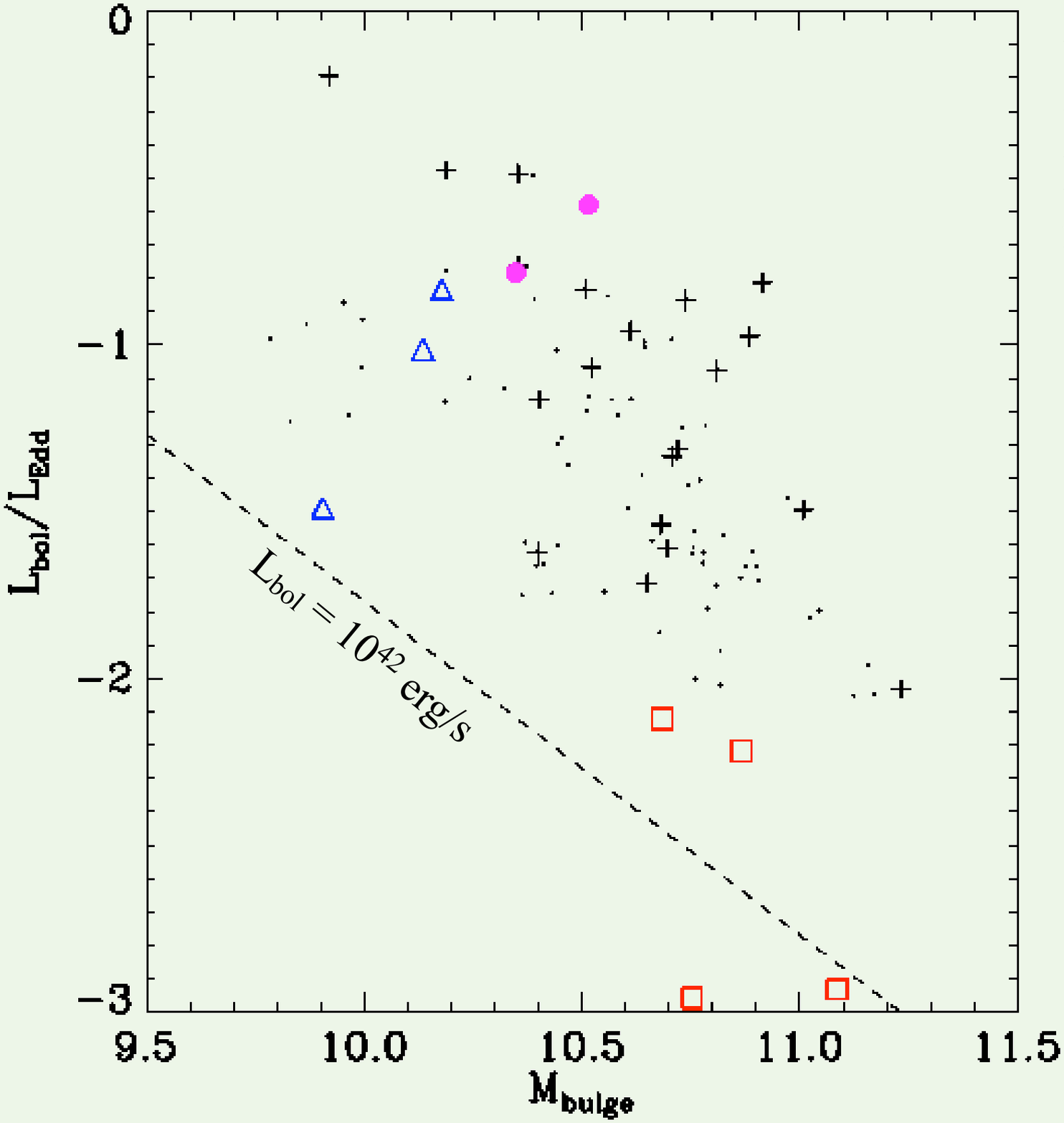
[OIII] can be used as an isotropic indicator of the bolometric luminosity of the AGN. It is well correlated with the X-ray luminosity for Type-1 AGNs.

Hard band detections

Hard band non-detections

Type-1 AGN

Eddington Ratio distribution



With bulge-disk decomposition of the ACS images, we estimated the BH mass using the Magorrian relation.

Optical line selection and X-ray selection are very complementary.

+ X-ray emission-line AGN

△ X-ray sources on SF sequence

□ X-ray sources without lines

● Type-1 AGN

Conclusions

- U-B color provides a good alternative to [NII]/Ha ratio for the identification of Type-2 AGN.
- Compare to emission-line AGN, X-ray misses the highly obscured AGNs, but can picks up faint AGN in SF galaxies and massive galaxies.
- Combining [OIII], Hbeta, galaxy color, X-ray flux, hardness ratio, we can constrain the origins for the optical emission and the X-ray emission, and disentangle the SF and AGN.

X-ray sources with no optical lines (XBONGs)

- Possibilities:
  - X-ray originate from LMXBs and diffuse hot gas.

    Ruled out, because they are too bright in X-ray.

  - Dilution by the host galaxy light.
  - Heavy Extinction for [OIII].
  - High-z counterparts of local LINERs, with low Eddington ratio (<1.e-2), thus having low Opt/X-ray ratio.