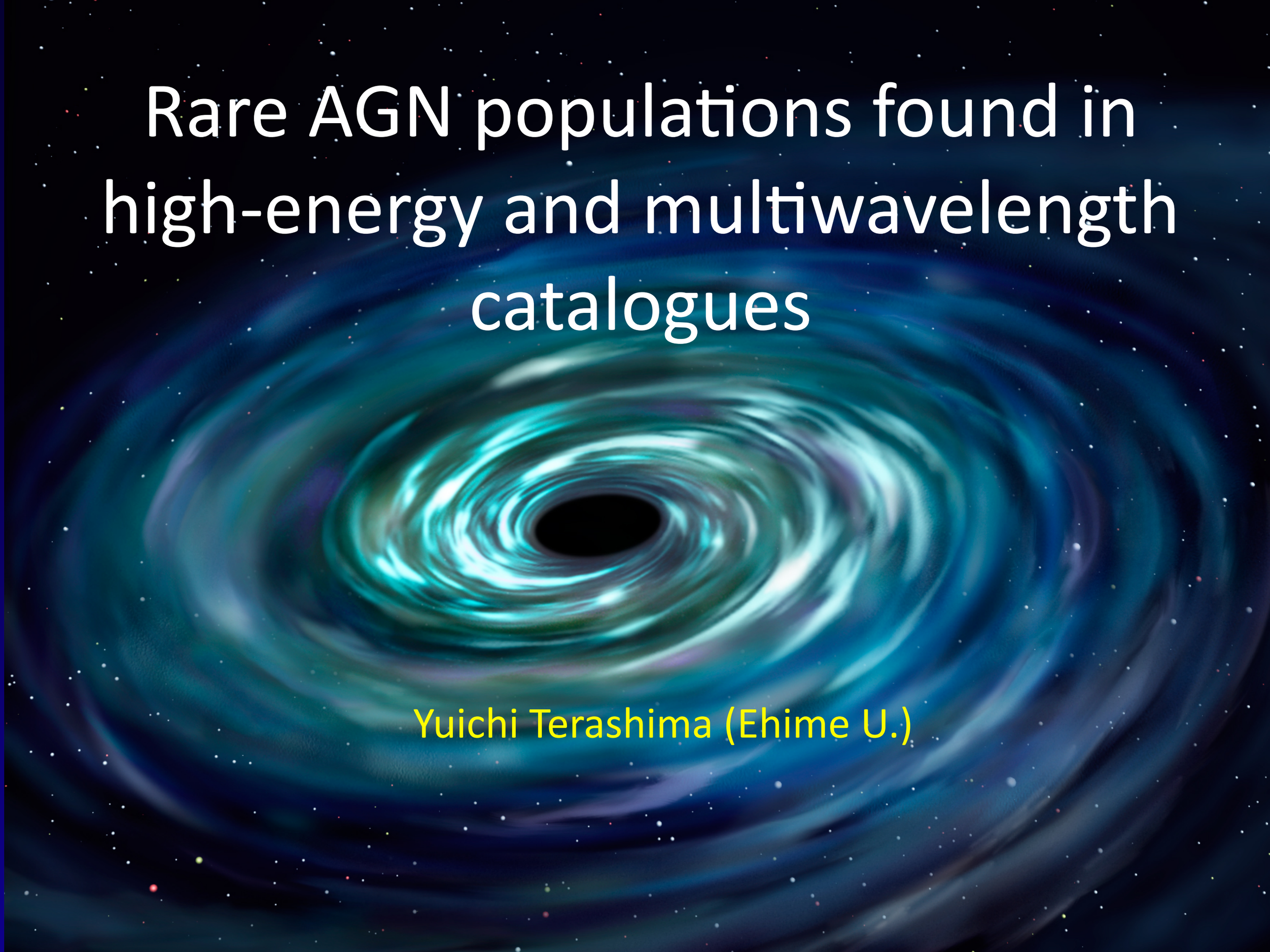
Rare AGN populations found in high-energy and multiwavelength catalogues

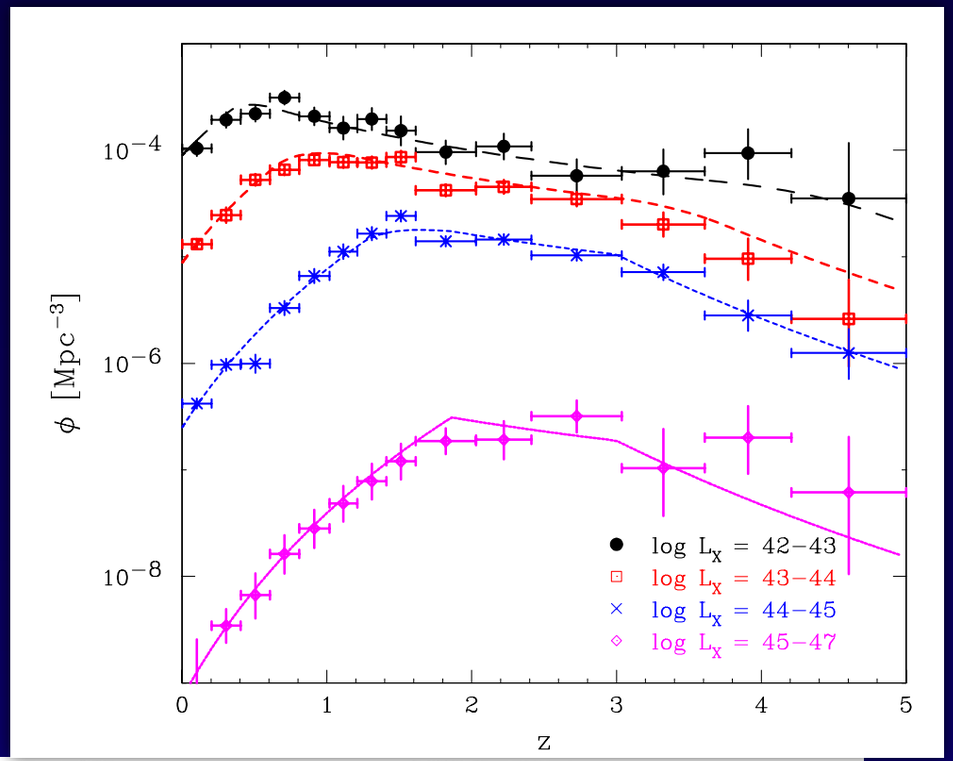


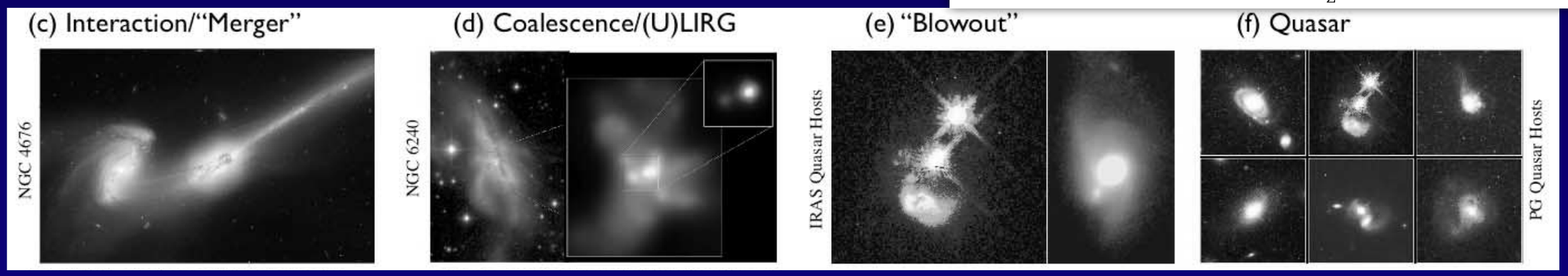
Yuichi Terashima (Ehime U.)

1. Introduction:
AGN evolution and "rare" populations

- Mass accretion - BH growth
- Fueling / obscuration

Ueda+14





Fueling - obscuration - blowout - luminous AGN Hopkins+08

Sample all the stages of AGN evolution
Large area coverage/combination of various selection technique

Outline

Use XMM-Newton serendipitous source catalogue to find:

Buried AGN
- X-ray color selection
- X-ray + IR selection
- X-ray + optical selection

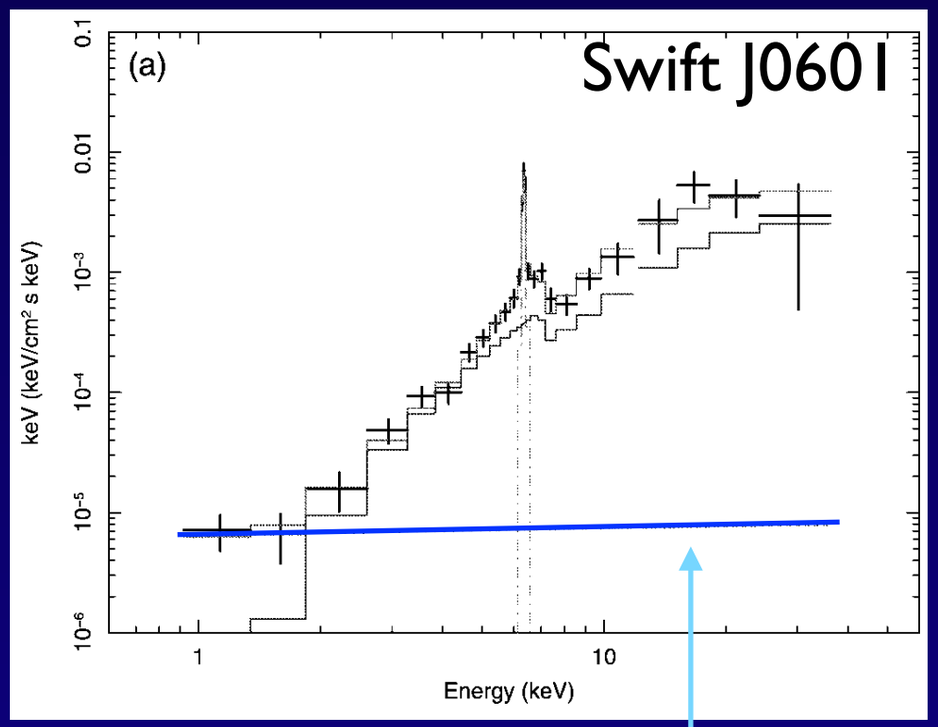
Low-mass AGN
- Highly variable AGN
- AGN in “new state”

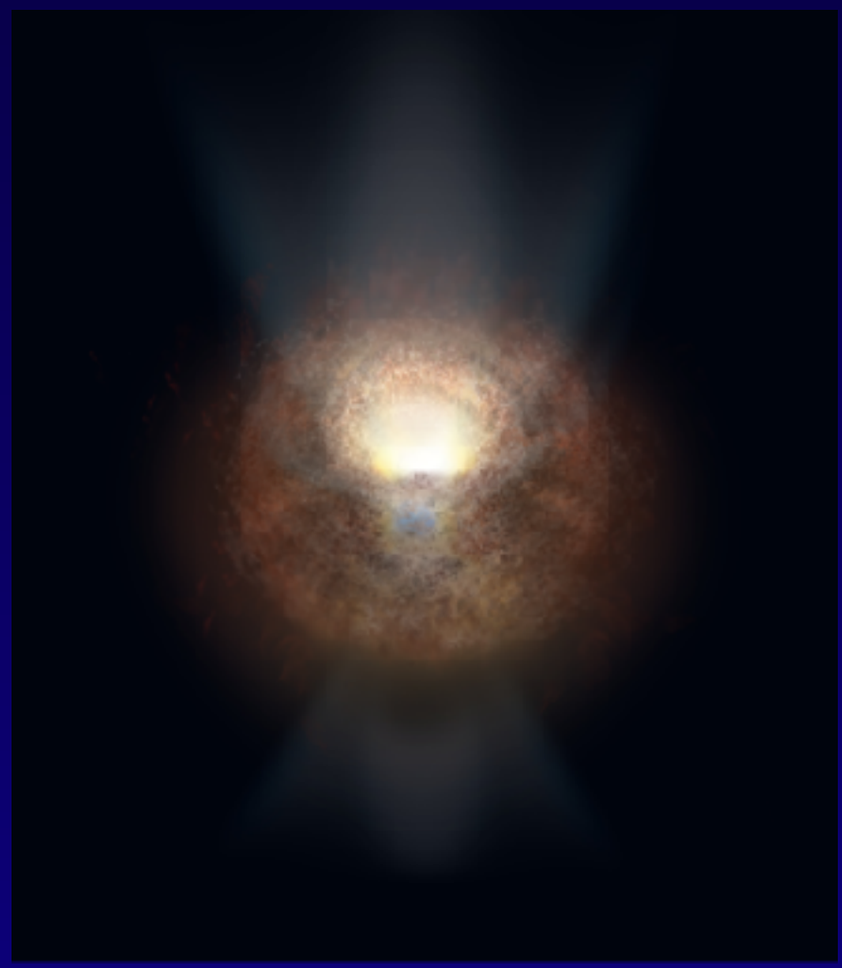
Buried AGN

X-ray color selection
X-ray + IR selection
X-ray + optical selection

2. Buried AGN
(1) X-ray color selection of buried AGN

Motivation:
Suzaku follow up of
Swift/BAT selected AGN



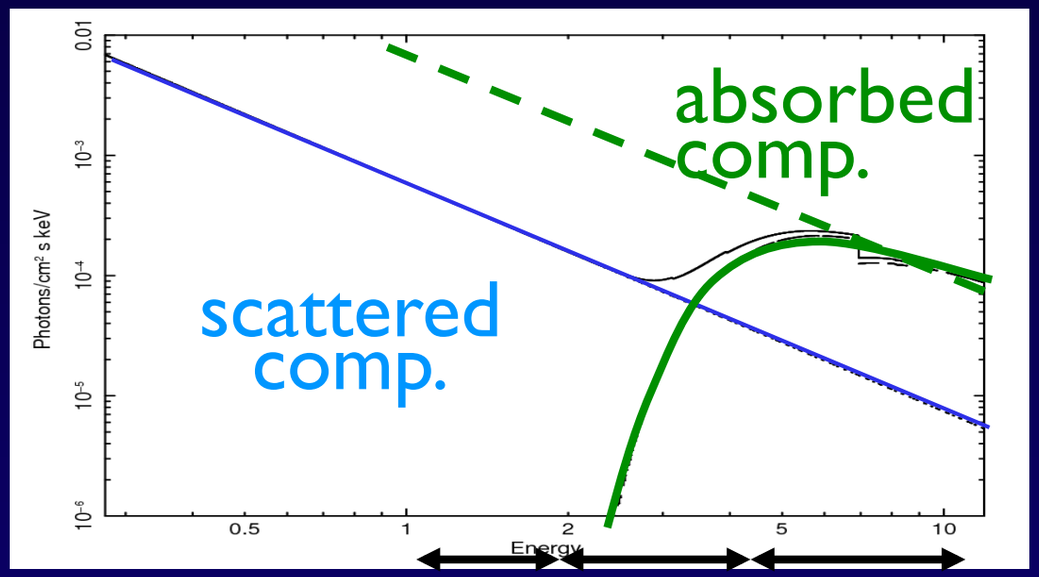


Very weak scattered component (f_{scat}= 0.2%)

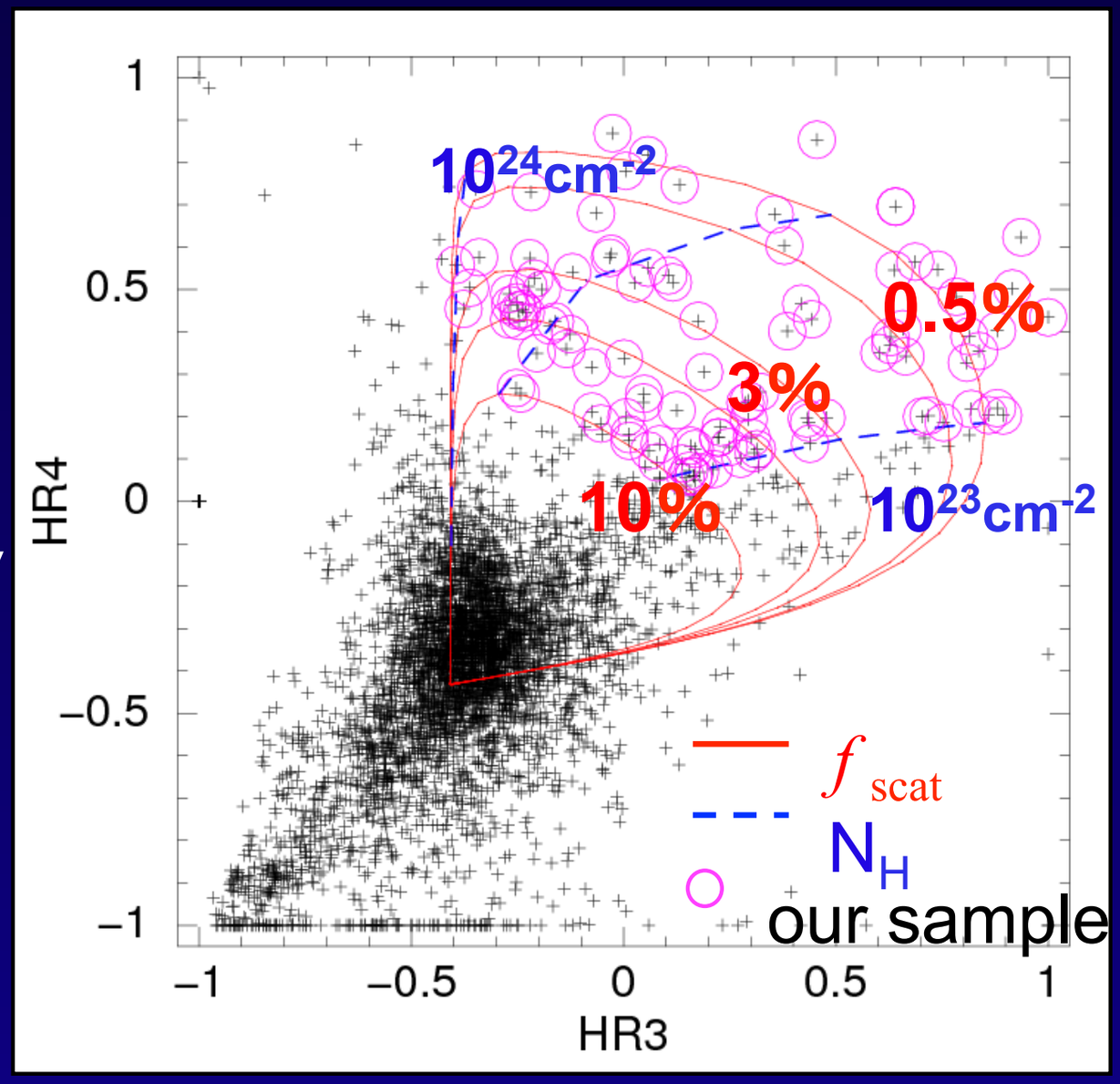
Ueda+07

suggesting AGN buried in geometrically thick absorber

2. Buried AGN
(1) X-ray color selection of buried AGN



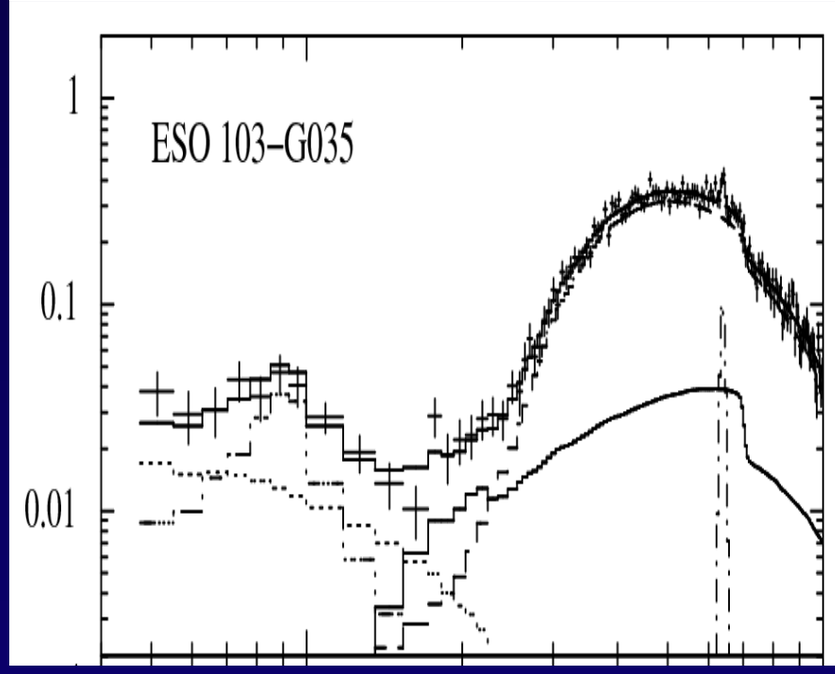
1 2 4.5 12 keV



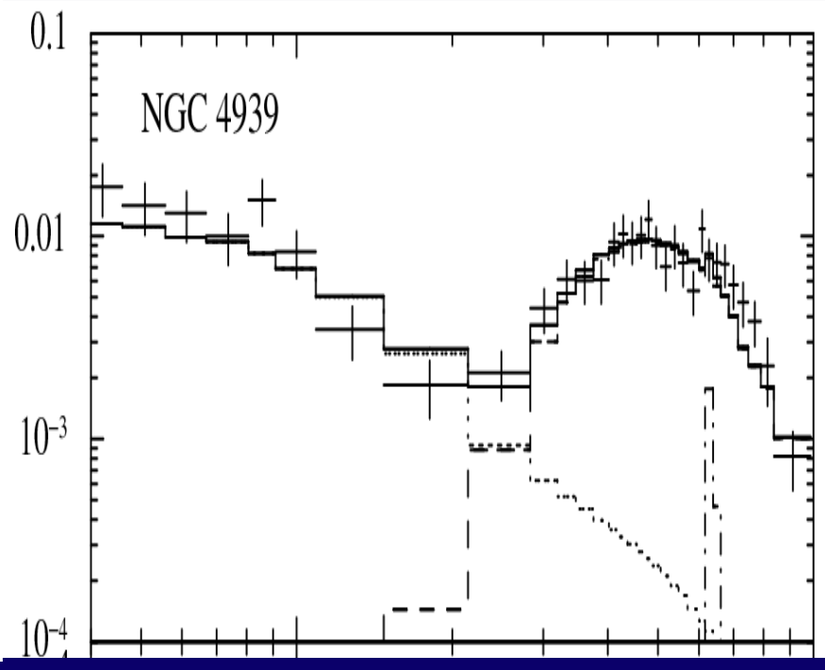
Noguchi, YT+08,09

Examples

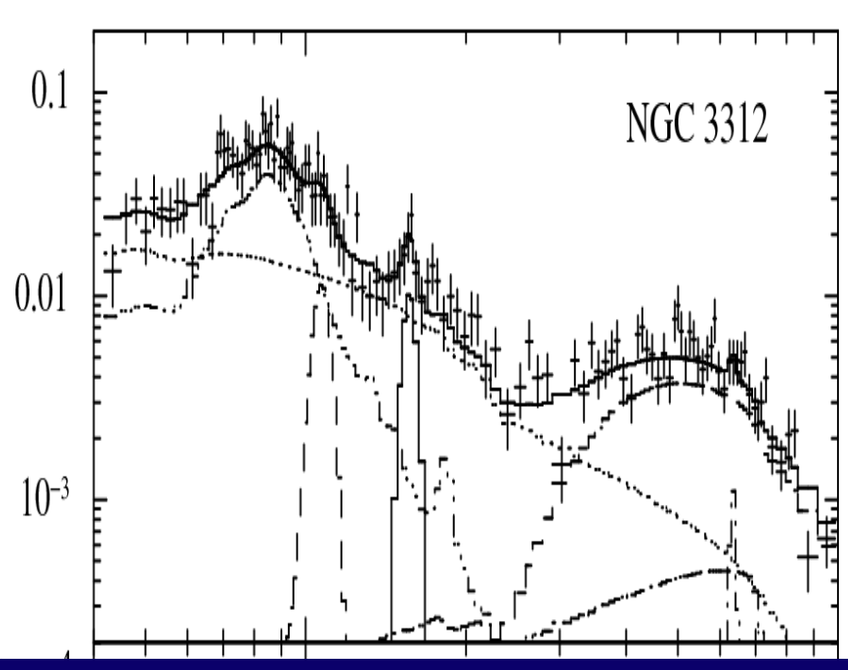
f_{scat}= 0.1%



f_{scat}= 1%



f_{scat}= 10%



8/32 objects: f_{scat}< 0.5%, i.e., buried AGN

Noguchi, YT+09,10

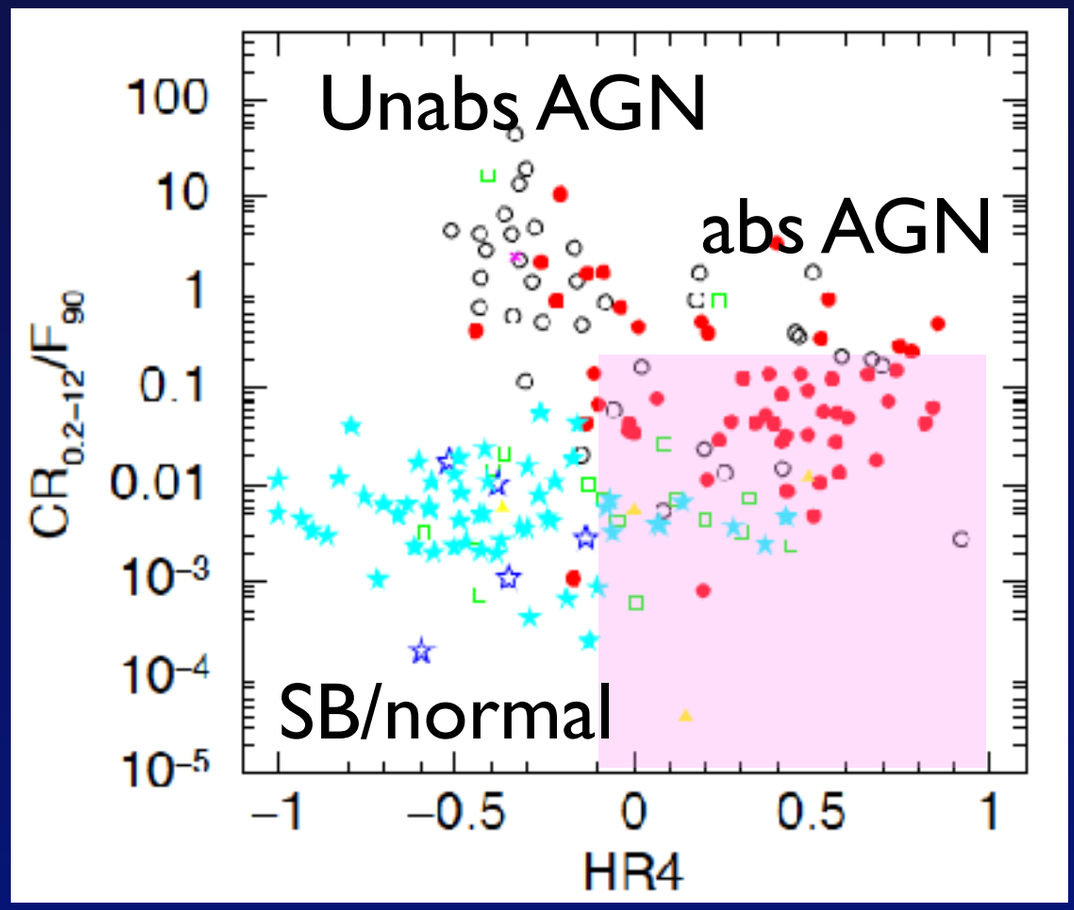
(2) X-ray and IR selection of Buried AGN

- Buried AGN are expected to be bright in IR (emission from dust heated by AGN)

- X-ray (<10 keV) biased against heavily absorbed (N_H>10 ^{24} cm^{-2}) AGN

→ select X-ray faint IR bright objects

IR data: Akari all sky survey



Terashima+15
see also Severgnini+12

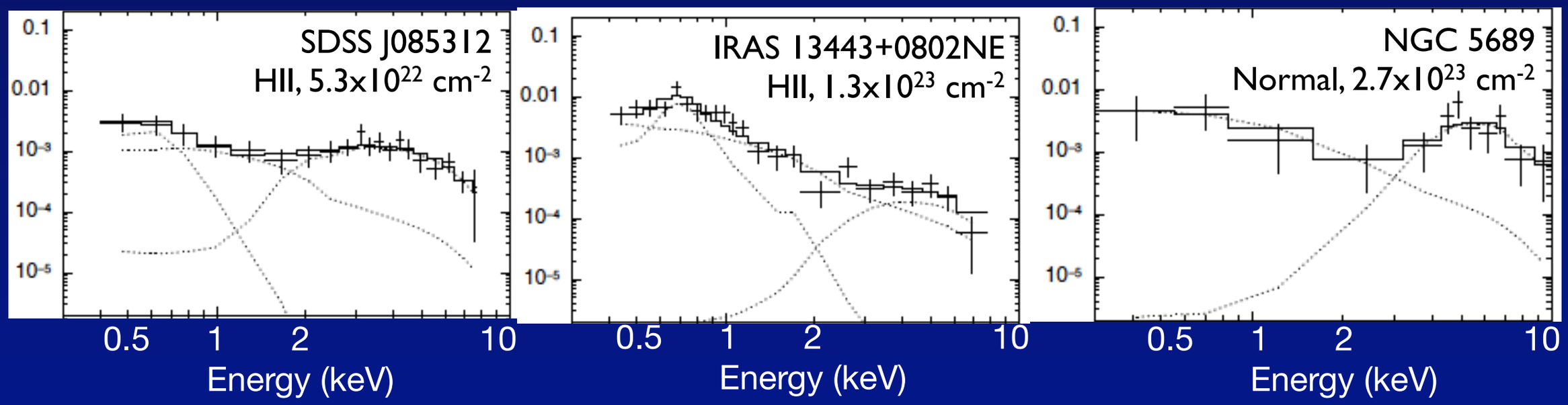
XMM spectra of 48 candidates were analyzed

Optically Elusive AGNs

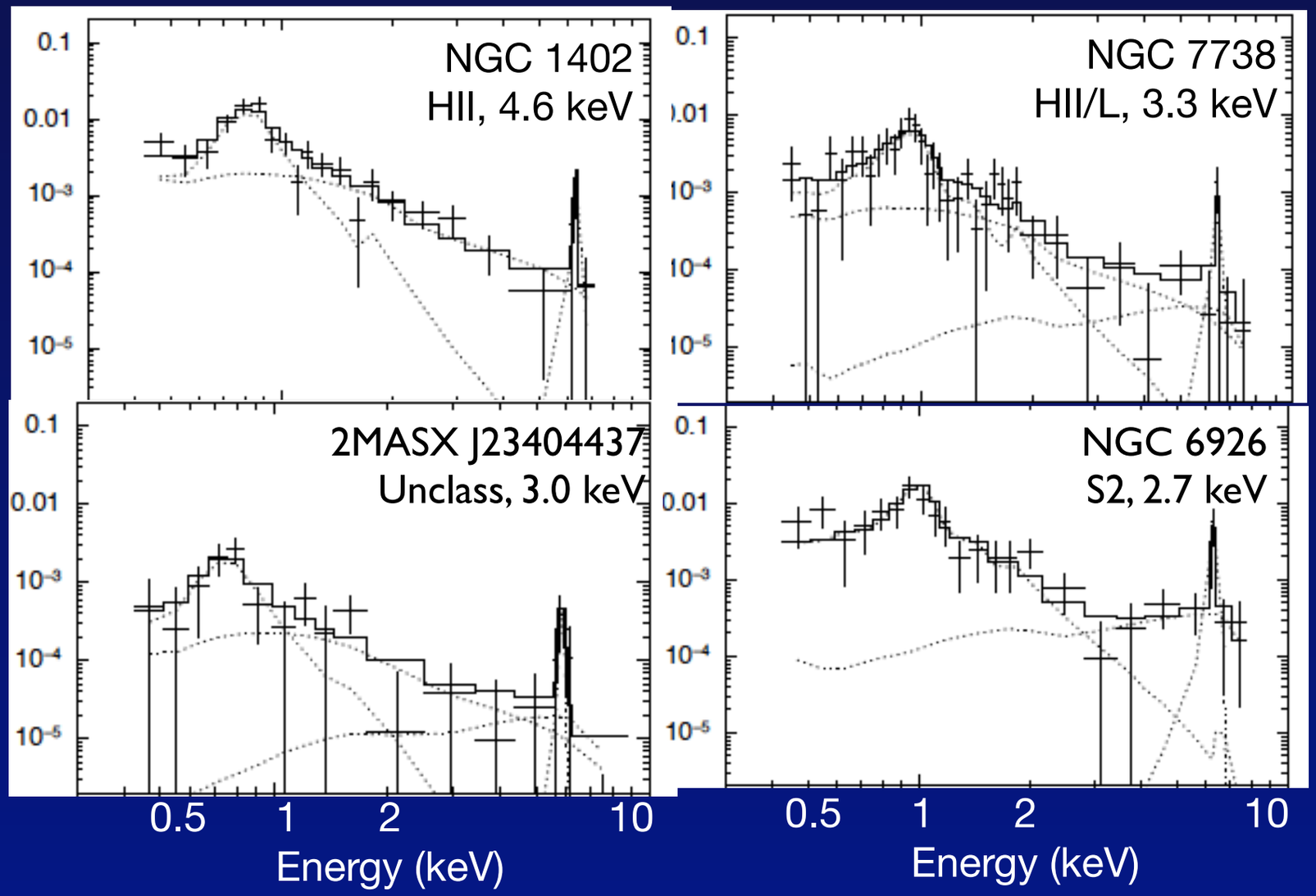
- 6 objects are classified as HII nucleus,
  or normal galaxies based on optical spectra.

- Optical emission lines from AGNs are diluted and not visible.

  "Optically elusive AGNs"
  (IR selected obj. with X-ray data Maiolino+03)



Buried AGNs
w/ huge Fe EW

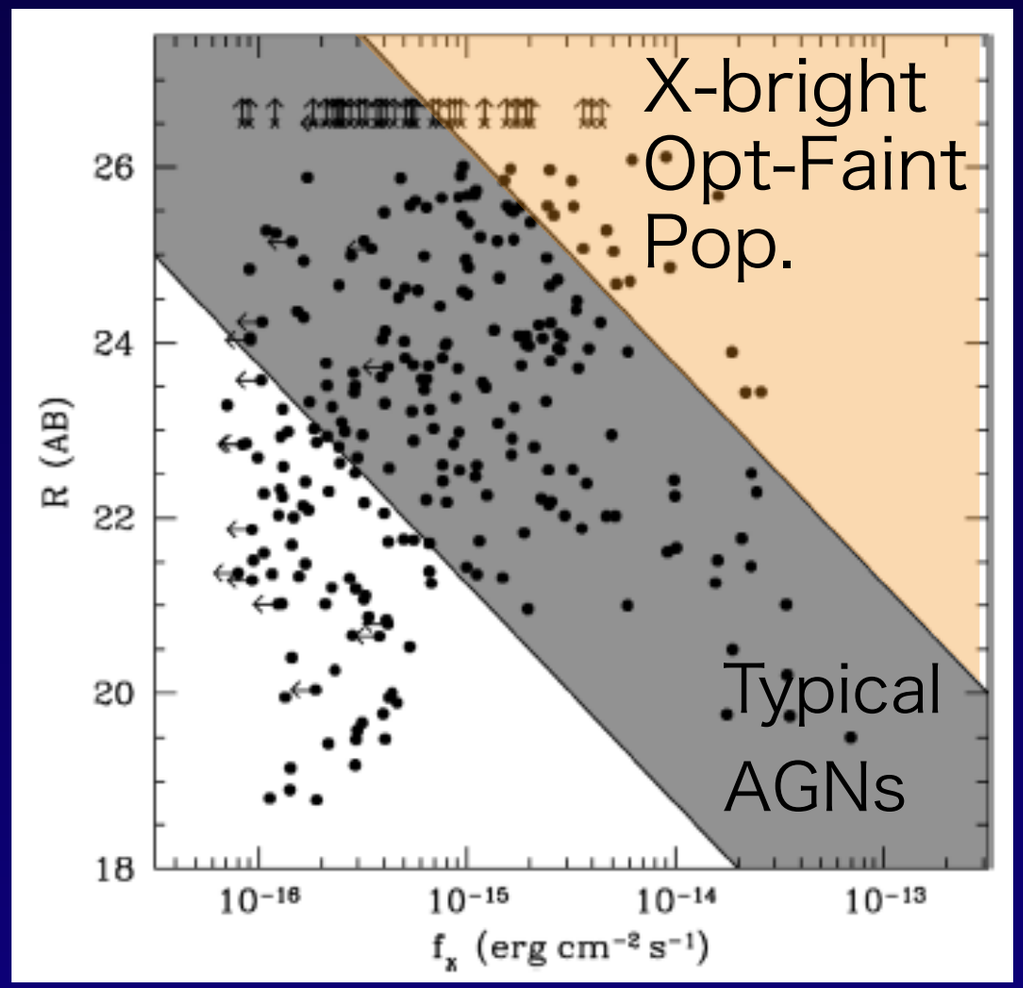


6: Compton-thick AGNs

4: Fe-K EW> 2keV

Large solid angle is covered by opt. thick matter

(3) X-ray Bright Optically Faint AGNs



0.5-8 keV

Obscured AGN
and/or
z>1 opt. dropout

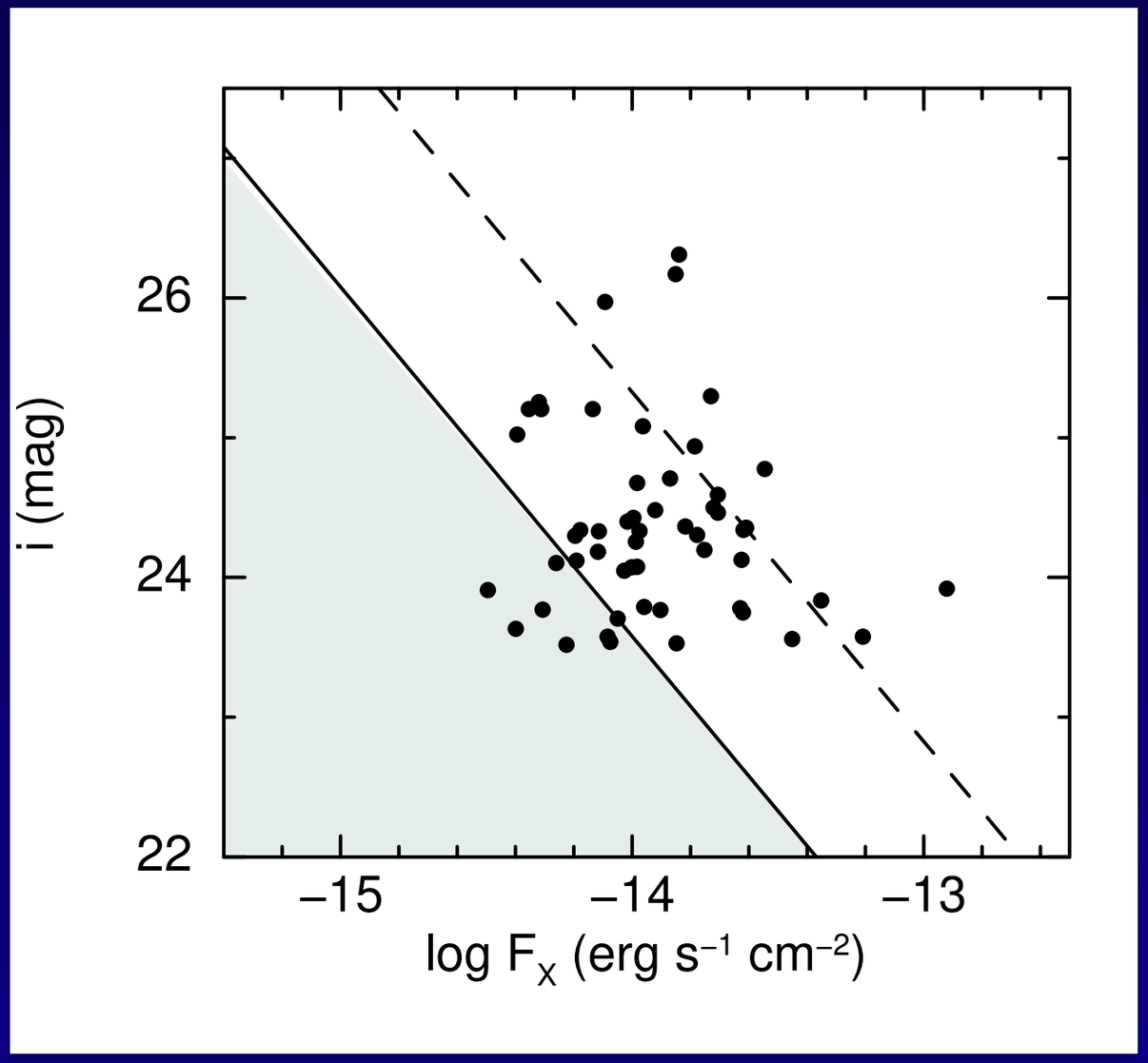
role of accretion/obscuration
at peak of AGN activity
at z~1-2

Rovilos+10

(3) X-ray Bright Optically Faint AGNs

- Subaru HSC-wide survey, XXL field: 9 deg^2 covered by SWIRE

  53 objects: i>23.5, >70 counts in 0.2-12 keV



46/53: Fx/Fi > 10

X-ray bright

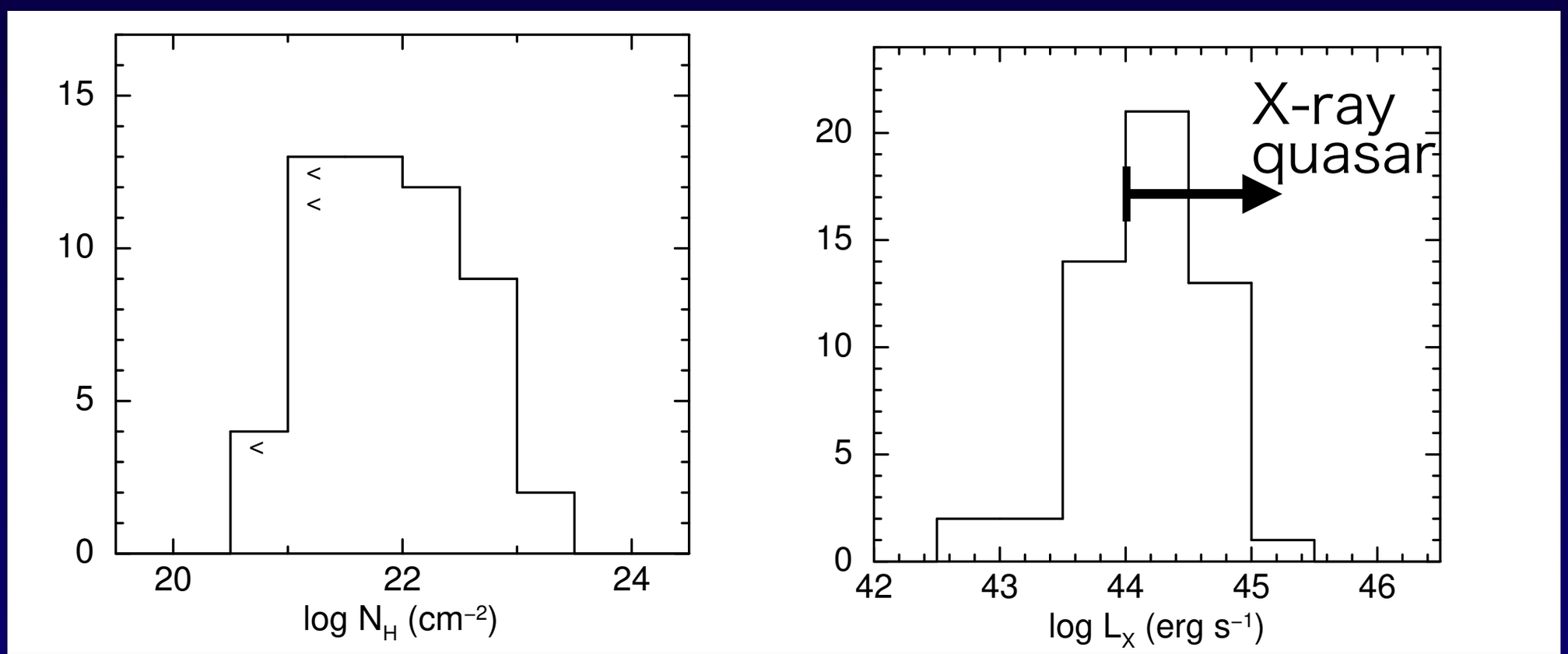
optically faint

Terashima+18

N_H and X-ray luminosity

N_H
(photon index=1.9 fixed)

$L_{2\text{-}10}$ corrected
for absorption



X-ray absorption is modest

None: $>10^{23.5}$ cm^{-2}

20: X-ray absorbed quasars ($N_H>10^{22}$ cm^{-2})

Type 2 quasars are efficiently found

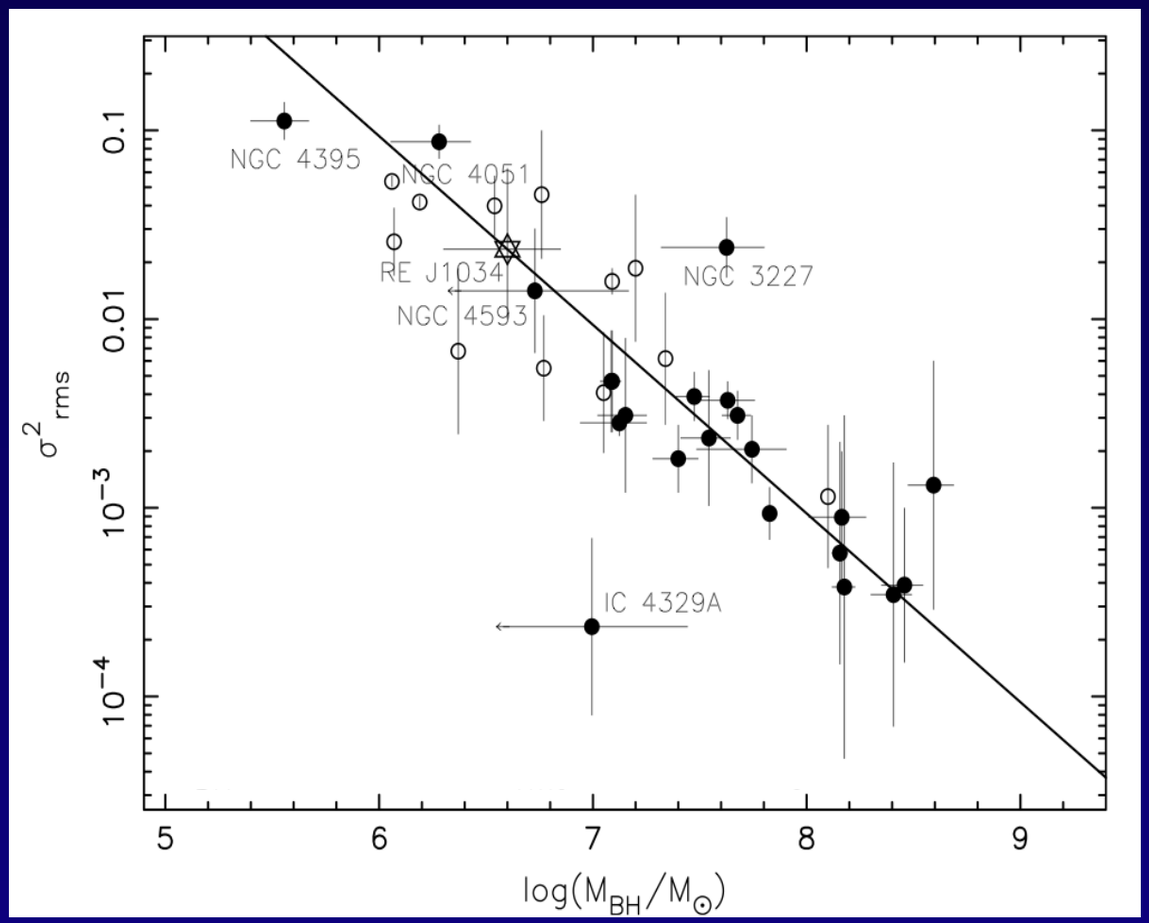
Terashima+18

Low-Mass AGN

Highly variable AGN
AGN in “new state”

Low-Mass AGNs in mass growing phase

X-ray variability time scale: Related to M_{BH}



Normalized excess variance (NXS)

$$\sigma^2_{\rm NXS} \equiv \frac{1}{\bar{x}^2}\left[\frac{1}{N-1}\sum_{i=1}^{N}\left(x_i-\bar{x}^2\right)^2-\frac{1}{N}\sum_{i=1}^{N}\sigma_i^2\right]$$

NXS - M_{BH} correlation
(e.g., Zhou+10, Ponti+12, Pan+15)

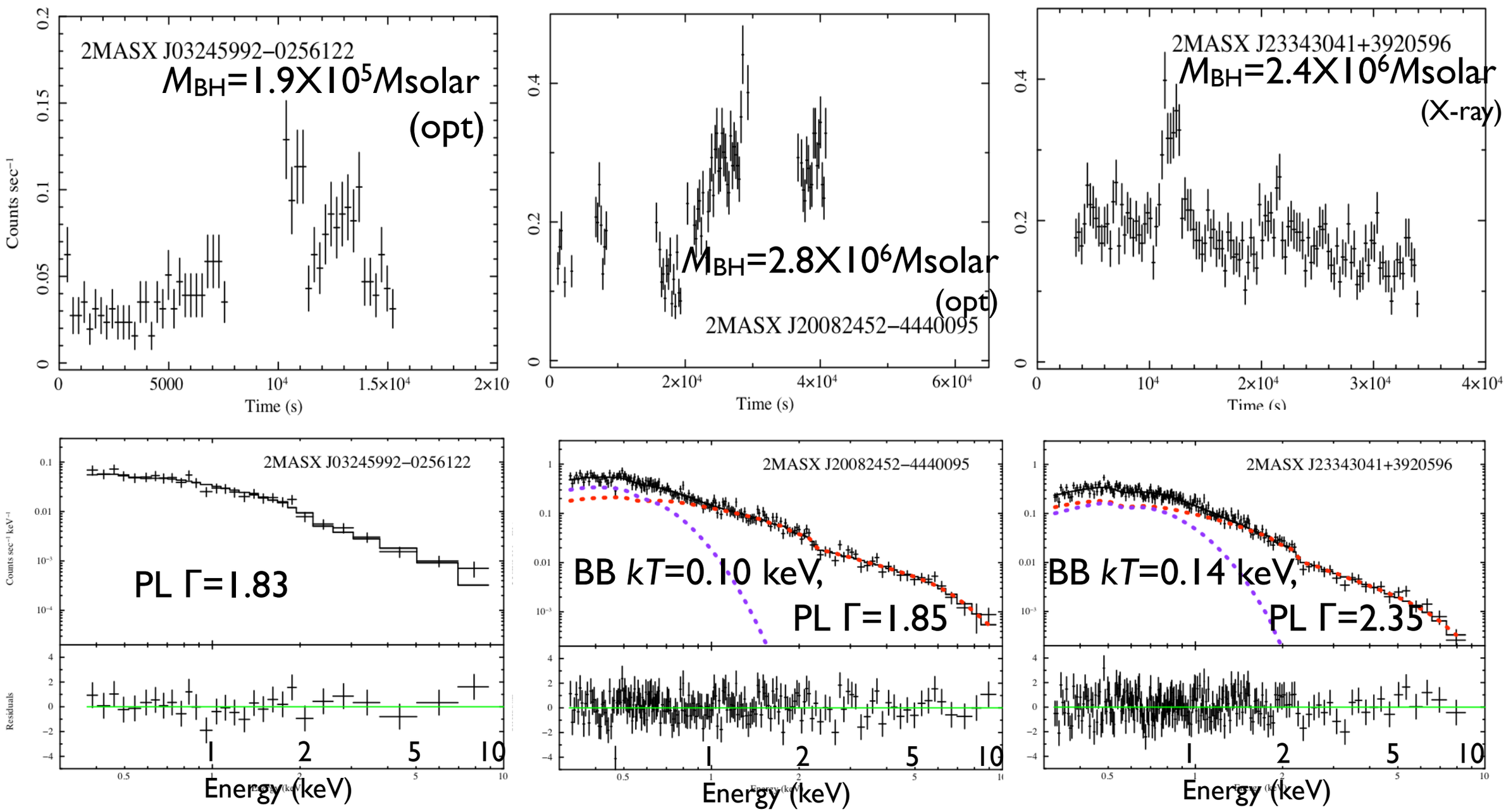
$$M_{\rm BH}=10^{5.76\pm0.13}\left(\sigma^2_{\rm NXS,0.5-10}\right)^{-0.64\pm0.04}M_\odot$$

Highly variable
→ candidate low-mass AGN

New Low-mass AGNs: Light Curves and Spectra

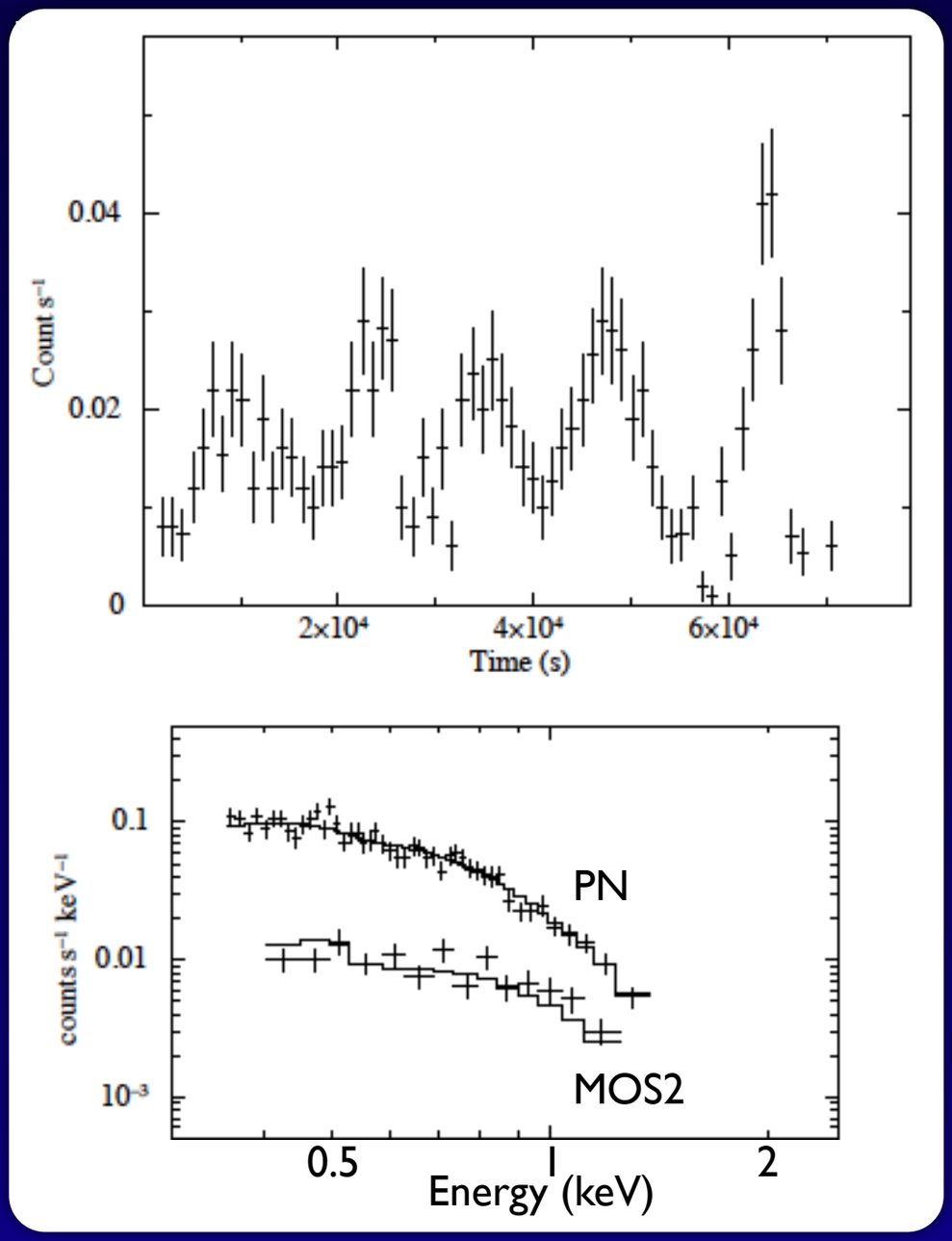
Kamizasa, YT+12

M_{BH} from opt. spec. Ho & Kim 16



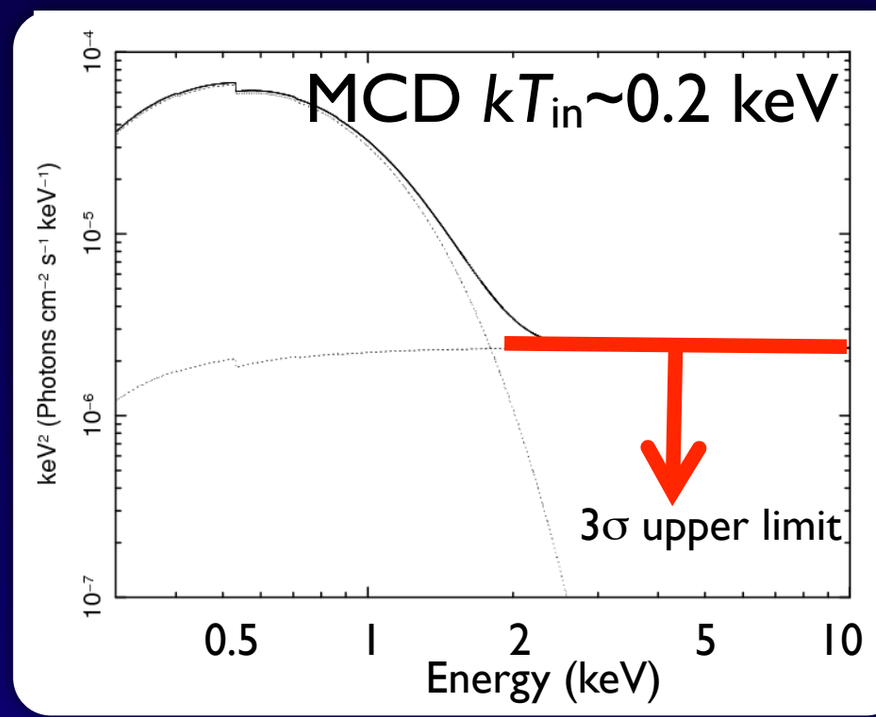
AGN w/ Soft Thermal Spectrum
2XMM J1231+1106

YT+12



- Rapid variability
- QPO (3.8 h)
  (Lin+13)

- No signals above 1.7 keV
- Steepest 1 keV - 5 keV slope among AGNs



- M_{BH} ~ 1x10^{5}Msolar
  (Ho, Kim, &YT12)

- Only soft thermal seen

High/Soft state? – variability NOT compatble
Very high state?
New state in AGN?
Tidal disruption event? (Lin+17)

Summary

- Rare AGNs successfully found by combining various selection criteria and multi-λ data thanks to the wide survey area

Buried AGN/Low-mass AGN/ AGN in new state?