Photo-z's for AGNs

1 – Some updates

2 – AGN photo-z

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Michael Strauss

Masayuki Tanaka

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Yasuhiro Hashimoto

See the wiki page for more about our activities.

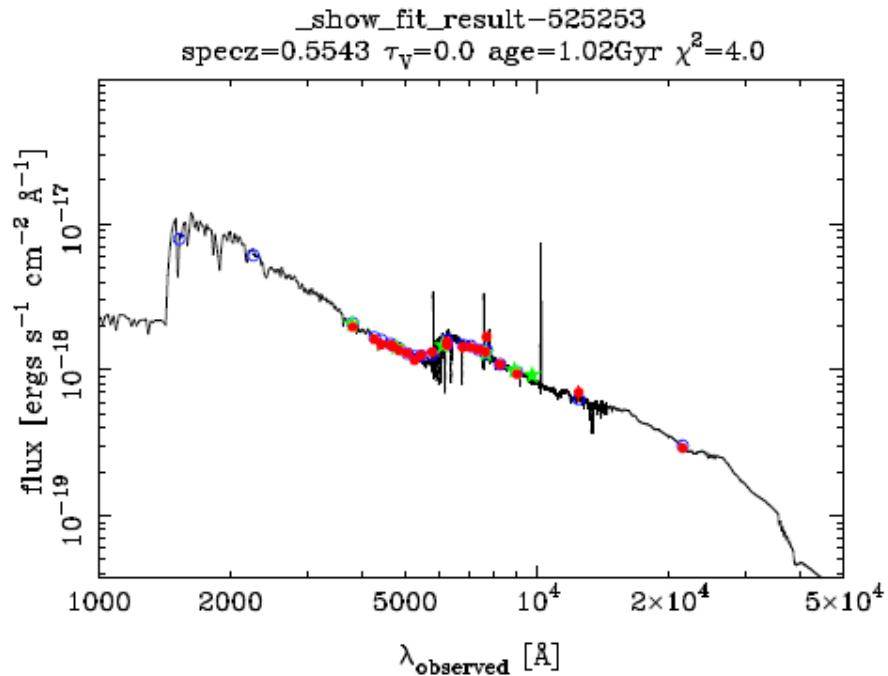*1 – some updates*

Why do we need (photometric) redshifts?

physical quantities

- Luminosity (absolute magnitudes)

- Physical sizes

- Rest-frame mags/colors

- Stellar masses

- Star formation rates

- Dust extinction

- etc.

observables

- apparent fluxes

- apparent sizes

distance
(redshift)

HSC photo-z simulation

_show_fit_result-525253
specz=0.5543 τ_V=0.0 age=1.02Gyr χ^2=4.0

● Observed photometry

○ Model photometry

★ HSC photometry

1 – collect public medium/broad- band photometry in COSMOS

2 – collect public/private spec-z's

3 – supplement the spec-z's with 30-band photo-z's

4 – fit SEDs of objects with i<25

5 – convolve the best-fit SED with the HSC filters to derive synthetic mags

6 – perturb the photometry and assign mag_err to each object according to the mag limits.

There are a few issues about the COSMOS catalog. We need real HSC data to to fully understand our photo-z's.

Photo-z codes

- LePhare : template-fitting code by Arnouts + Ilbert
    BC03 templates + VVDS prior by Nishizawa-san
    Adapted CWW templates + VVDS prior by Jean

- EAZY : PCA code by Brammer + van Dokkum.
    PC from PEGASE models + millennium sim. Prior by Bau-Ching

- ZEBRA : template-fitting code by ETH (Zurich) people
    CWW templates + simple z<4 prior by Rachel

- ANNz : neural network
    trained with public 10k redshifts and 30-band photo-z by Nishizawa-san

- BCH : empirical polynomial fit
    Developed for RCS2 by Bau-Ching. Need a (unbiased) training set

Private photo-z code by Tanaka

- **Based on Charlot & Bruzual 2007 population synthesis models.**
  - Solar metallicity models only
  - Calzetti attenuation law
  - Chabrier IMF
  - Emission lines included (Inoue et al. 2011)
  - *Thermal emission from dust is not included yet*
  - Assumed exponentially decaying SFRs (tau=0 to infinity)
  - Attenuation due to neutral H (Madau+ '96)
  - Template error function included

- **Baysian priors on physical properties**
  - N(z) prior
  - Extinction vs SFR prior
  - SFR vs stellar mass prior
  - *Size prior is ready to be included*
  - *Morphology prior is ready to be included*

This is for HSC-Wide. Some of the physical priors may be disabled for HSC-Deep.

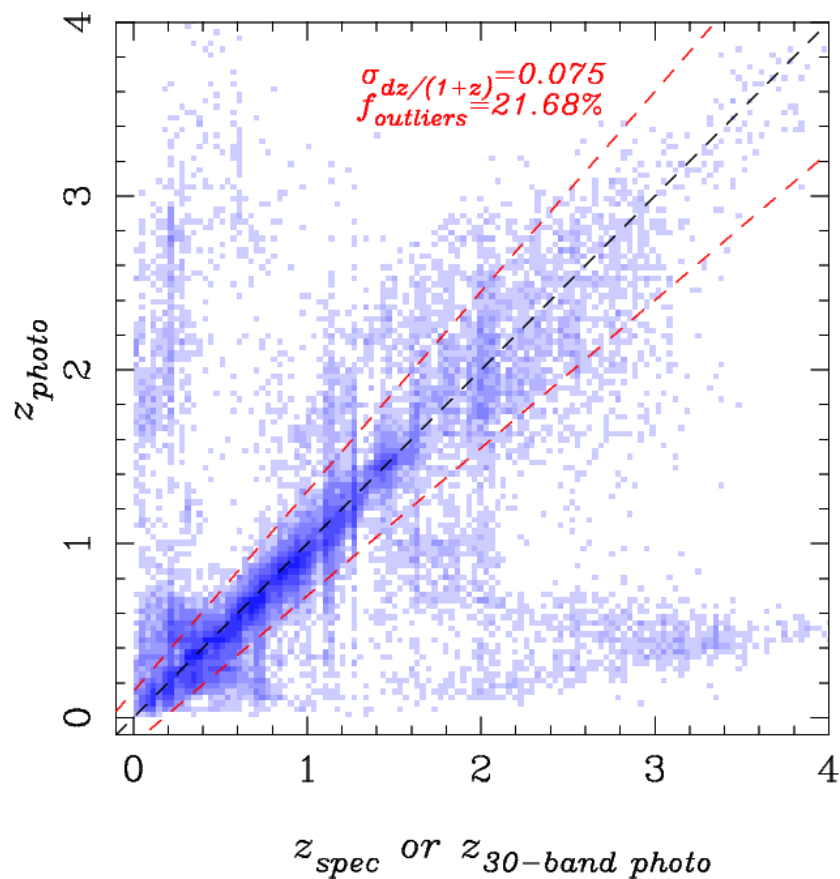This code does not have a nickname yet. Any brilliant ideas?

Photo-z codes

Code	People
ANNz	A. J. Nishizawa
EAZY	B.-C. Hsieh
BCH	B.-C. Hsieh
LePhare	J. Coupon, A. J. Nishizawa
Tanaka	M. Tanaka
ZEBRA	R. Mandelbaum

We do not know yet who will actually compute photo-z's for HSC and which code performs 'best' on the real HSC data. Different science cases would need different photo-z's.
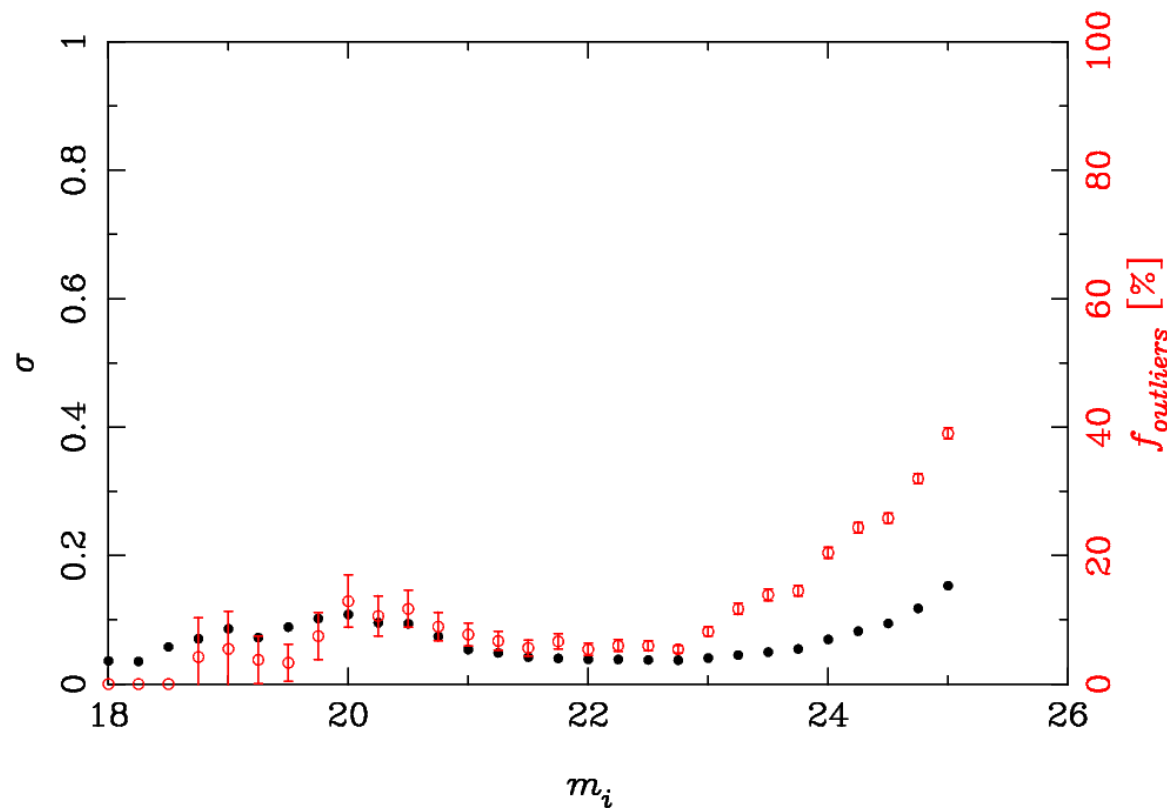
It's important for the photo-z working group to know what metric/statistics is important for your AGN science.
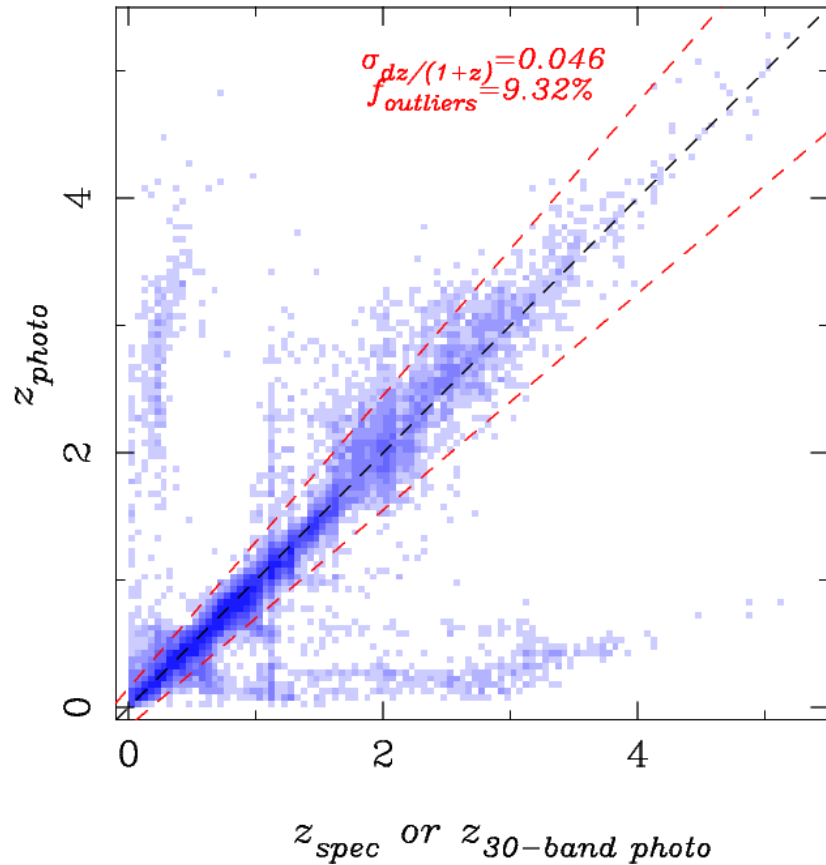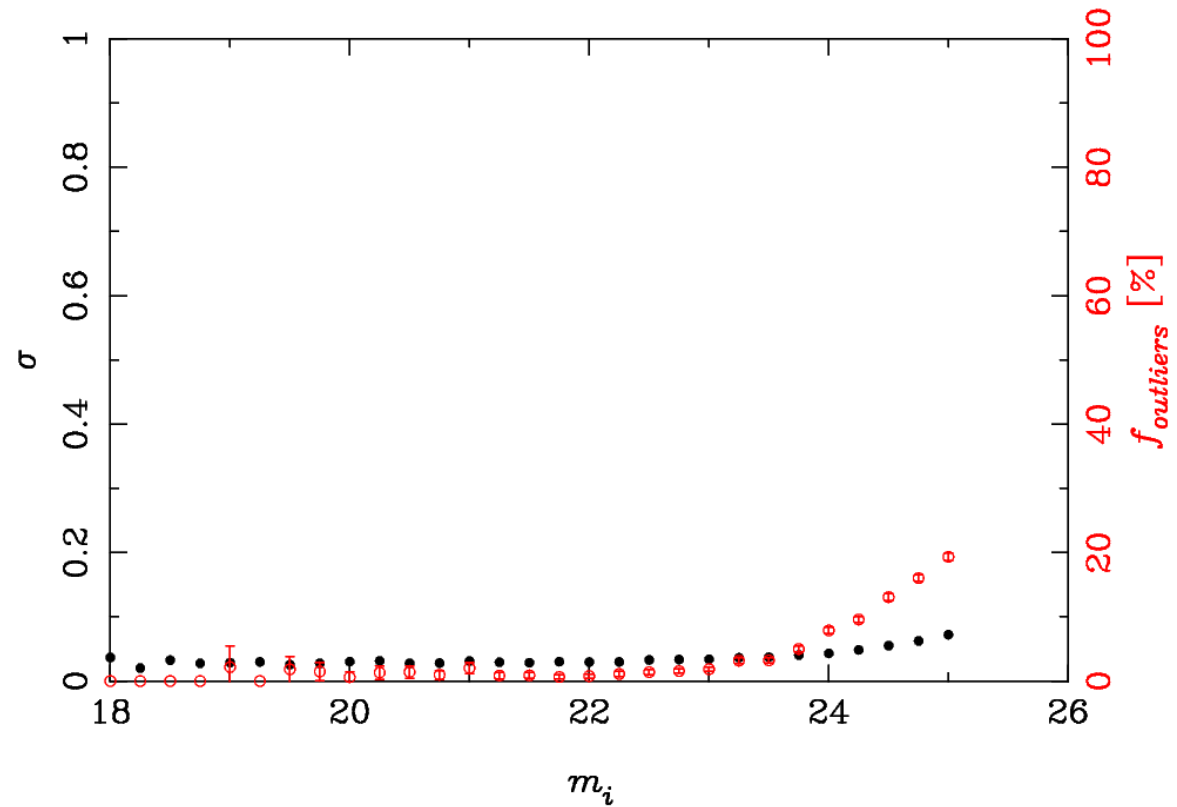
HSC-Wide only

TANAKA: grizy

$\sigma_{dz/(1+z)}=0.075$
$f_{outliers}=21.68\%$

z_{photo}

z_{spec} or $z_{30-band\ photo}$

TANAKA: grizy

σ

$f_{outliers}$ [%]

m_i

Wide	Band	g	r	i	z	y
	Depth	26.7	26.2	26.0	25.2	24.4

HSC-Deep : ELAIS-N1

TANAKA: ugrizyJK

$\sigma_{dz/(1+z)}=0.046$
$f_{outliers}=9.32\%$

TANAKA: ugrizyJK

ELIAS-N1	Band	u	g	r	i	z	y	J	K
	Depth	25.5	27.5	27.2	27.0	25.9	24.7	23.3	23.0

2 – Photo-z's for AGNs

HSC photo-z simulation
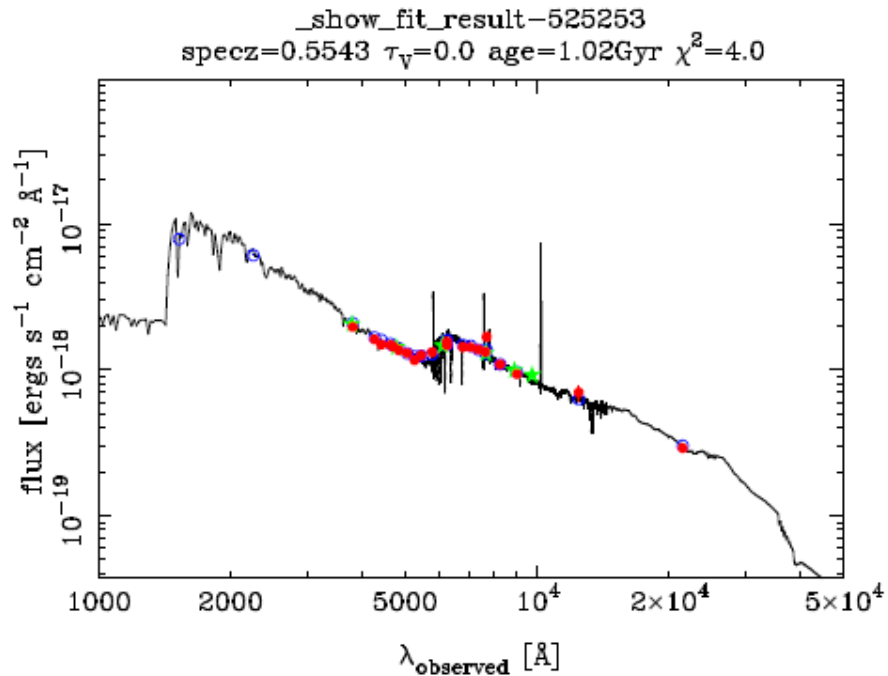
_show_fit_result-525253
specz=0.5543 τ_V=0.0 age=1.02Gyr χ^2=4.0

● Observed photometry

○ Model photometry

★ HSC photometry

1 – collect public medium/broad- band photometry in COSMOS of known AGNs (Brusa et al. 2010 ApJ).

2 – collect their public/private spec-z's

3 – supplement the spec-z's with 30-band photo-z's

4 – fit SEDs of the objects with i<25

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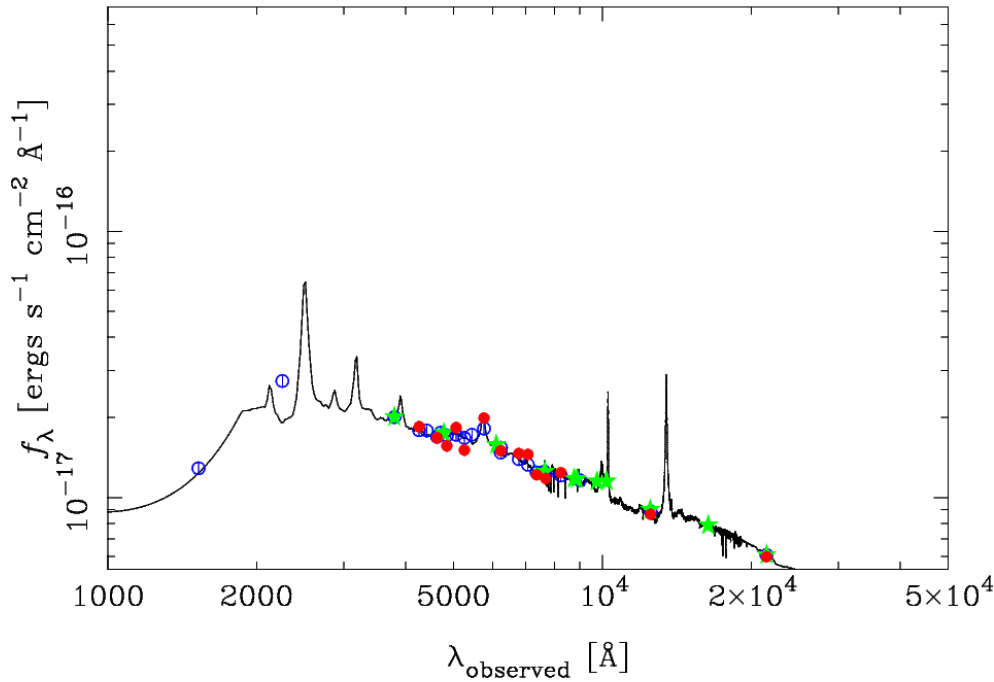
AGNs templates
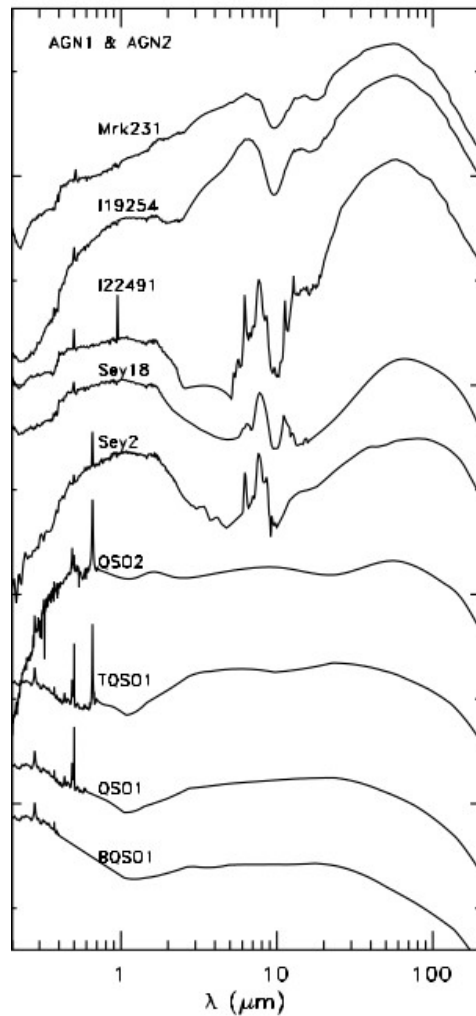
Galaxy-AGN composite templates are made by combining galaxy templates with
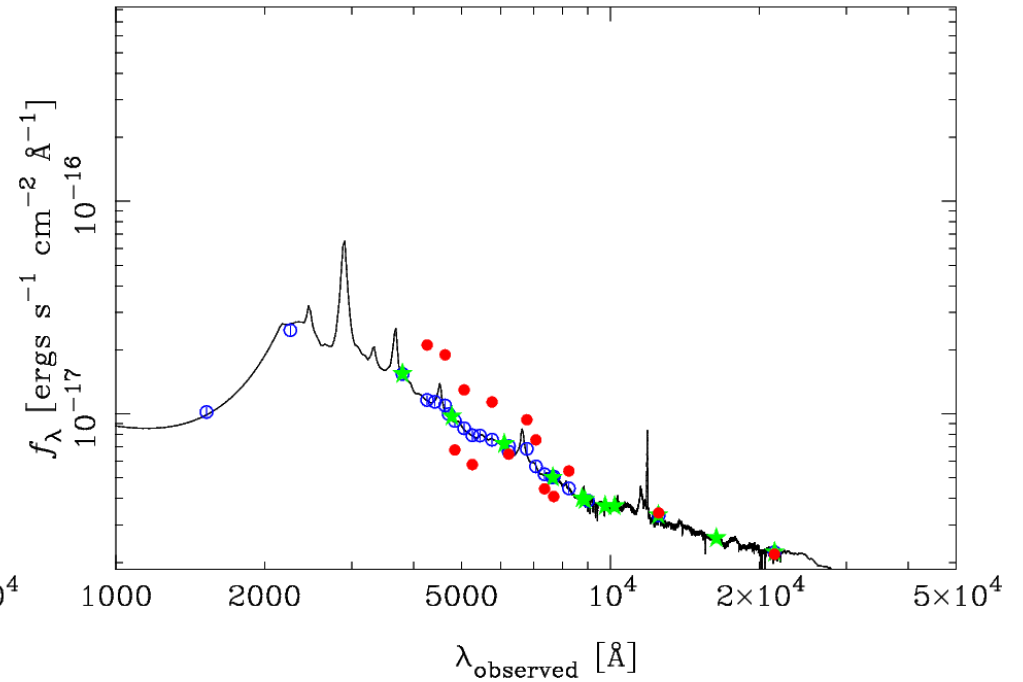
tau=1Gyr, age<3Gyr, tau_V=0,1,2,4,7

with the AGN templates. The relative fractions of the galaxy and AGN components are 0:1, 1:0.5, 1:1, 1:2, and 1:4.

Polletta et al. 2007, ApJ, 663, 81

AGNs change their brightness over time...

results/results_offsets2_agn_bbmasked.dat−1419368
specz=1.0500 $\tau_V=-1.0$ age=−1.00Gyr $\chi_\nu^2=1.5$

results/results_offsets2_agn_bbmasked.dat−1181006
specz=1.3710 $\tau_V=-1.0$ age=−1.00Gyr $\chi_\nu^2=37.0$
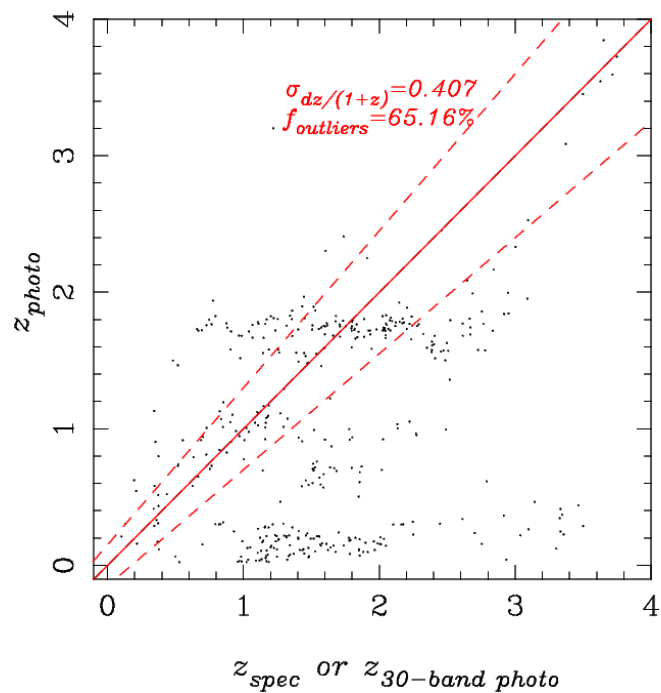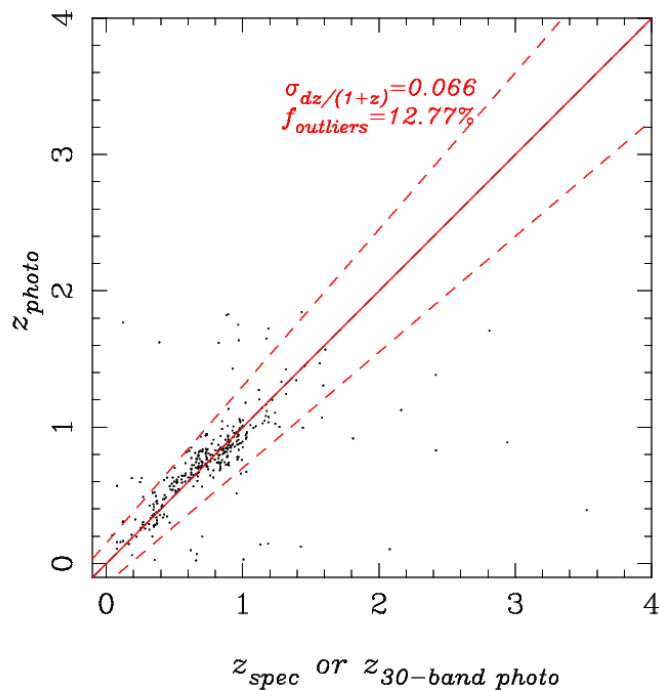
● Observed photometry   ○ Model photometry   ★ HSC photometry

Photo-z's: galaxy templates only
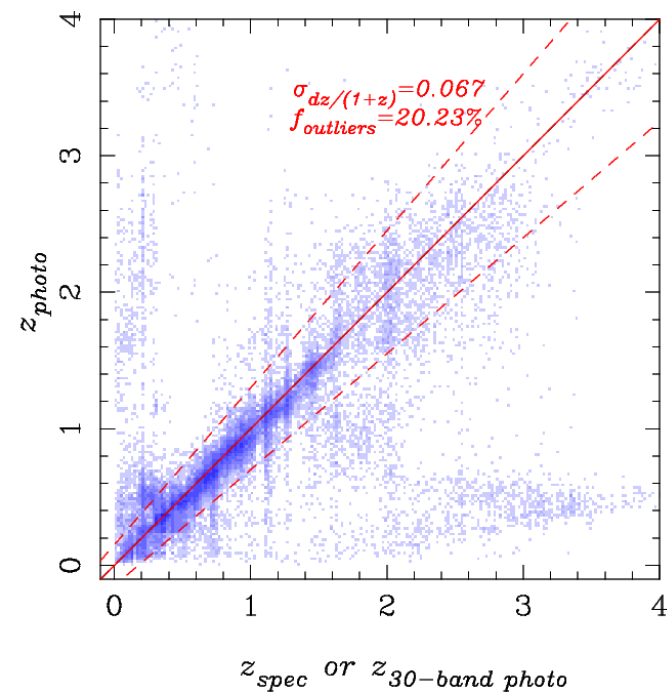
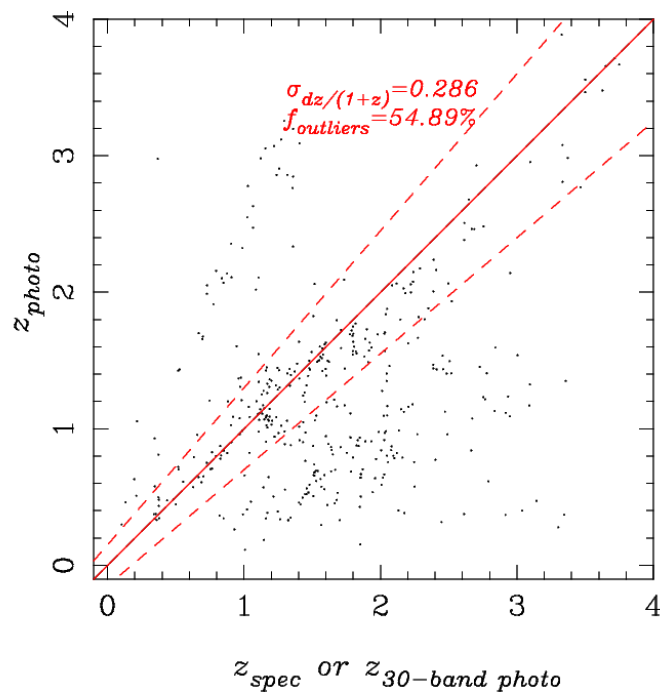Type-I AGN   Type-II AGN   Normal galaxies

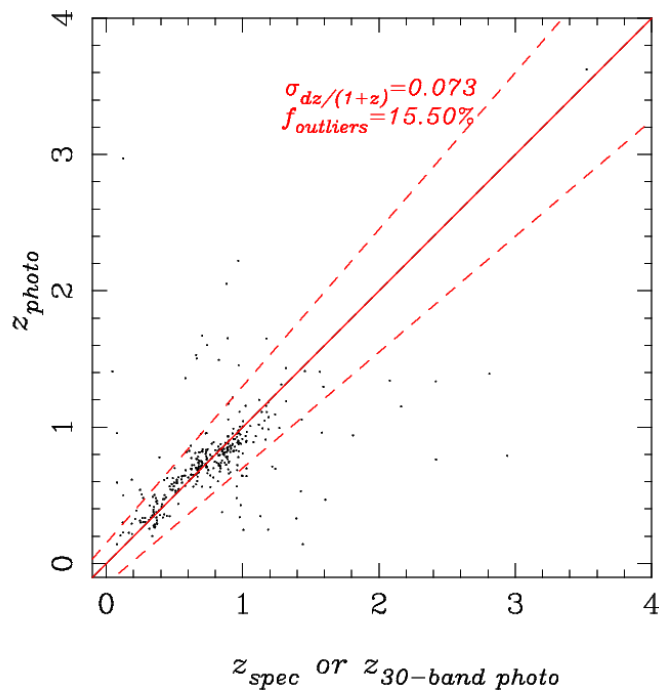

AGN types are from Brusa et al. 2010, ApJ, 716, 348

Photo-z's: galaxy templates + AGN templates

Type-I AGN

Type-II AGN

Normal galaxies

$\sigma_{dz/(1+z)}=0.286$
$f_{outliers}=54.89\%$

$\sigma_{dz/(1+z)}=0.073$
$f_{outliers}=15.50\%$

$\sigma_{dz/(1+z)}=0.102$
$f_{outliers}=32.70\%$

z_{photo}

z_{spec} or $z_{30-band\ photo}$
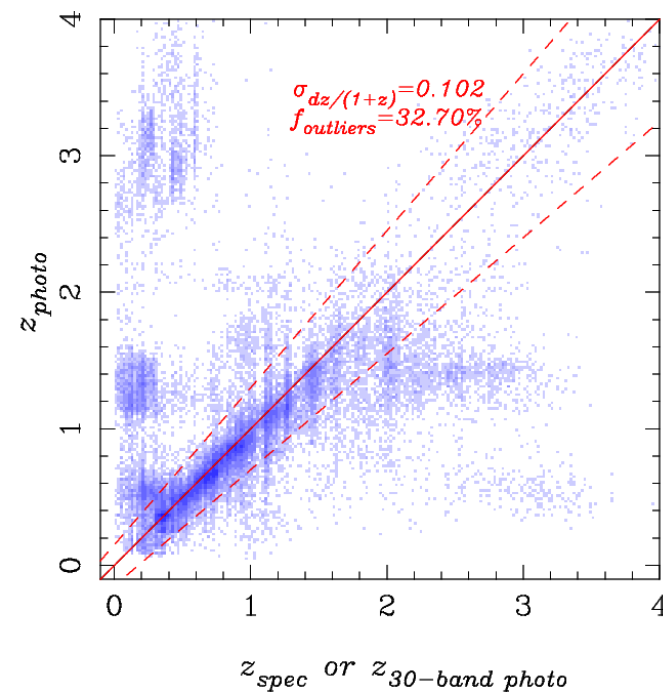
AGN types are from Brusa et al. 2010, ApJ, 716, 348

Lx>10^44 erg/s is hard

Assumed:
grizy at HSC-Wide depth

● z<1.5

● z>1.5

Typical accuracy for normal galaxies

Mostly type II   Mostly type I
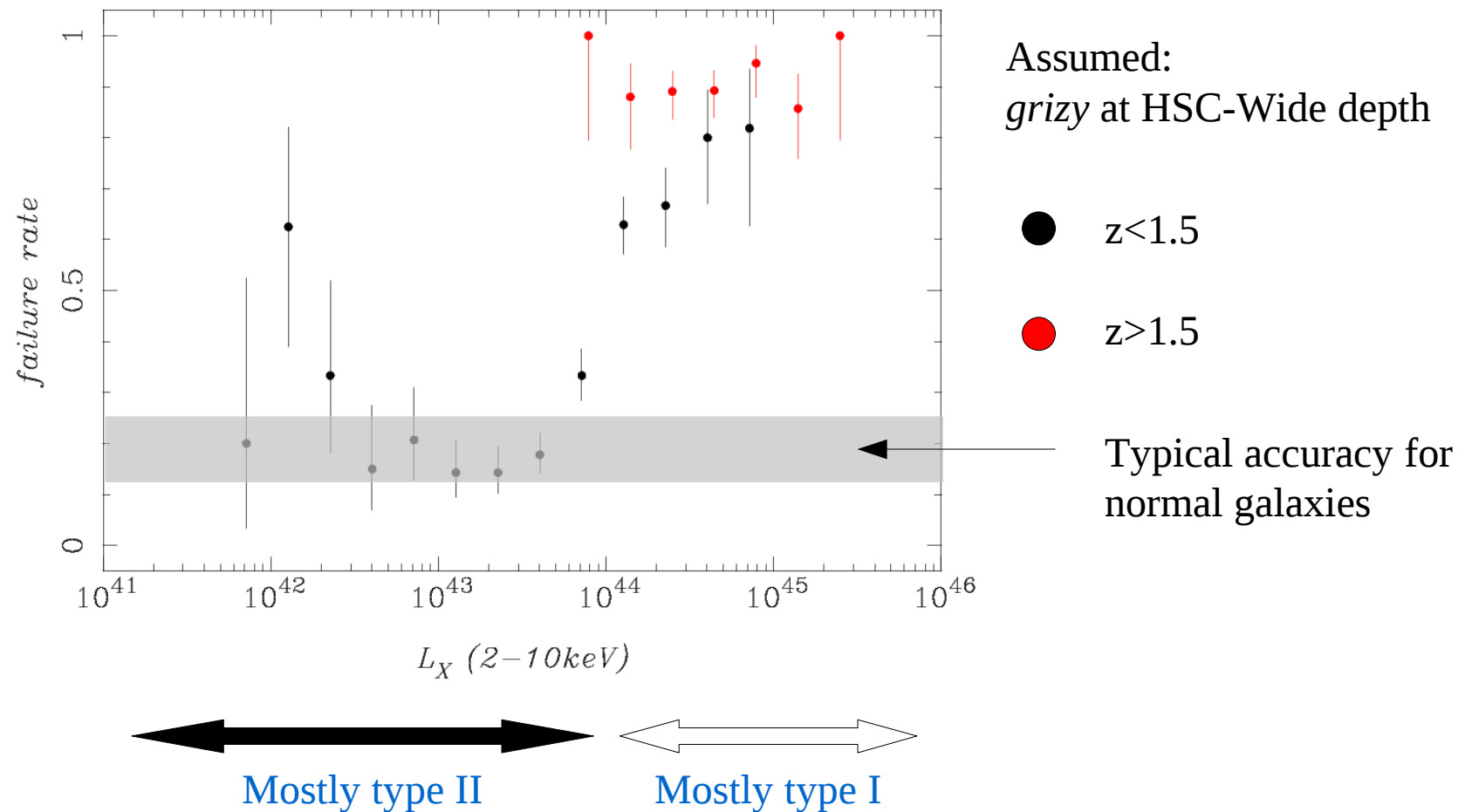
AGN photo-z's

- Type I AGNs need AGN templates.

- Type II can be fit by normal galaxy templates.

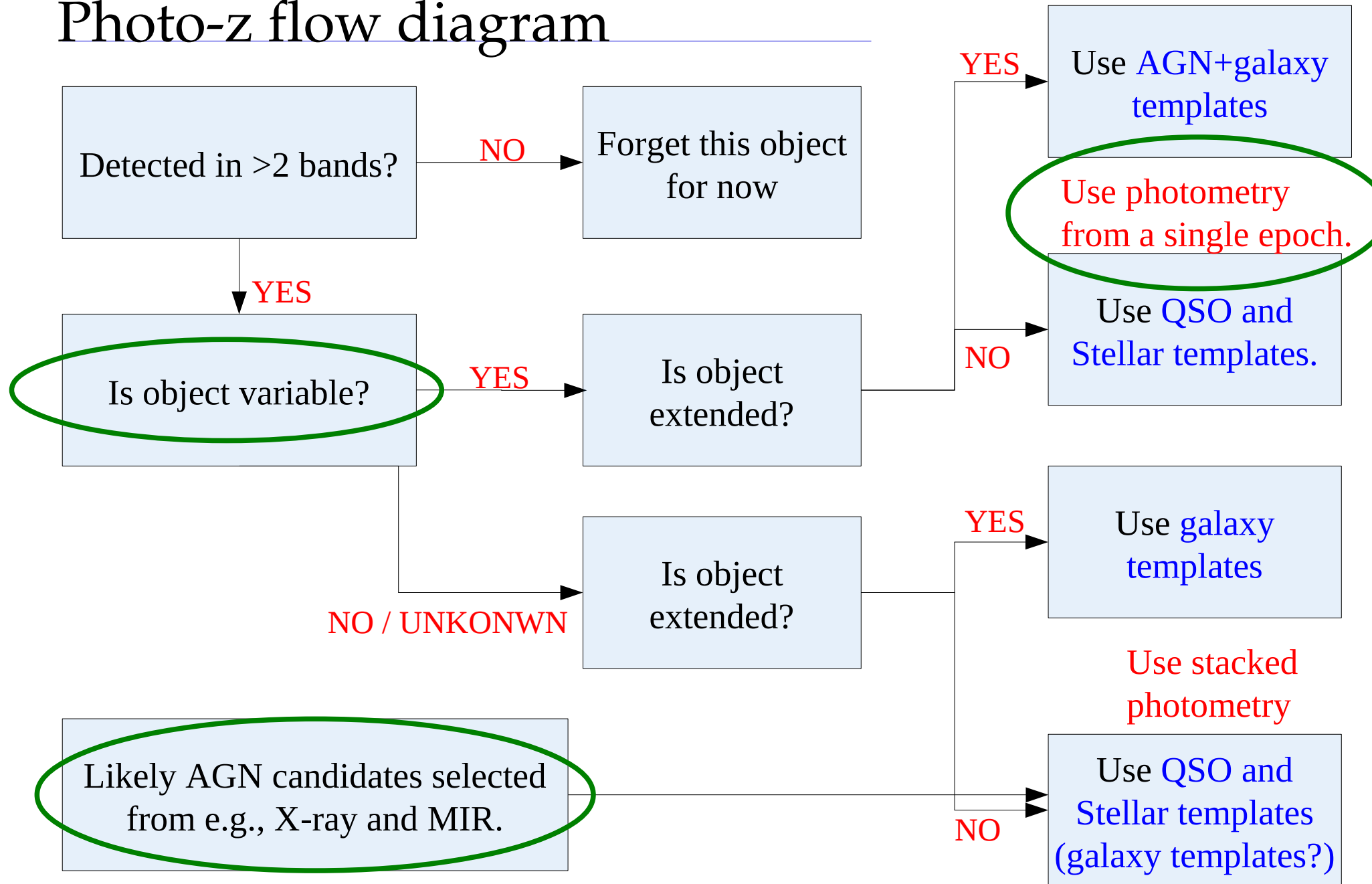- Even with the AGN templates, photo-z's for type I are difficult.

- If we include the AGN templates, photo-z's for type II and normal galaxies tend to degrade.

We need to explore the AGN templates further, but perhaps we do not want to blindly use AGN templates...

Photo-z flow diagram

Detected in >2 bands?	→**NO**→	Forget this object for now

↓ **YES**

YES → Use AGN+galaxy templates

Is object variable? →**YES**→ Is object extended? →**NO**→ Use QSO and Stellar templates.

Use photometry from a single epoch.

NO / UNKONWN

Is object extended? →**YES**→ Use galaxy templates

Likely AGN candidates selected from e.g., X-ray and MIR. →**NO**→ Use QSO and Stellar templates (galaxy templates?)

Use stacked photometry

Questions for the AGN group

- Are photo-z's important for your AGN science?

- What aspect of photo-z is important for you? Are bias, scatter, and outlier rate enough for you? Do you want to look at any other statistics?

- Any suggestions for AGN templates?

- Any good idea to include AGN templates without degrading photo-z's for normal galaxies?

- Good to have a variability flag and other AGN flag (e.g., X-ray or MIR). Photometry of which epoch can be used for photo-z?

You don't have to answer these questions at this workshop, but let's start thinking about them.