HSCを用いた(多波長+)形態・時間変動解析による銀河研究

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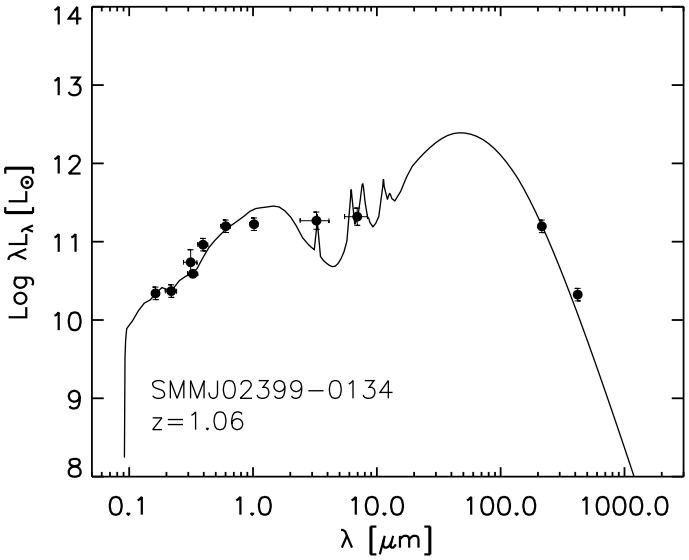
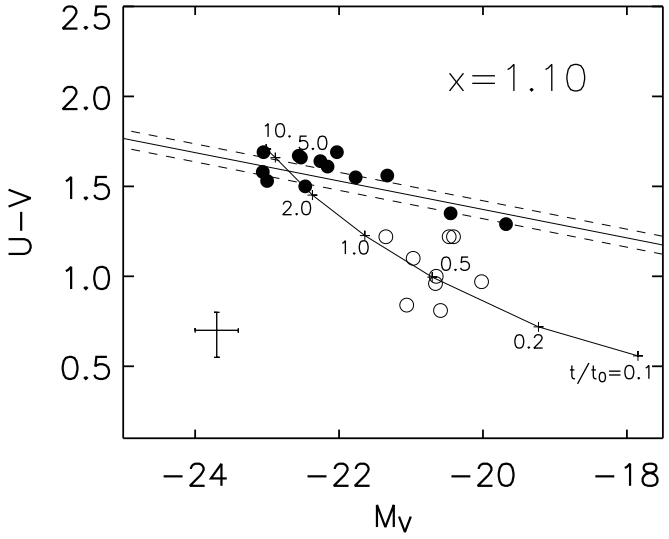
HSC/AKARI Synergy for Gal.Ev.

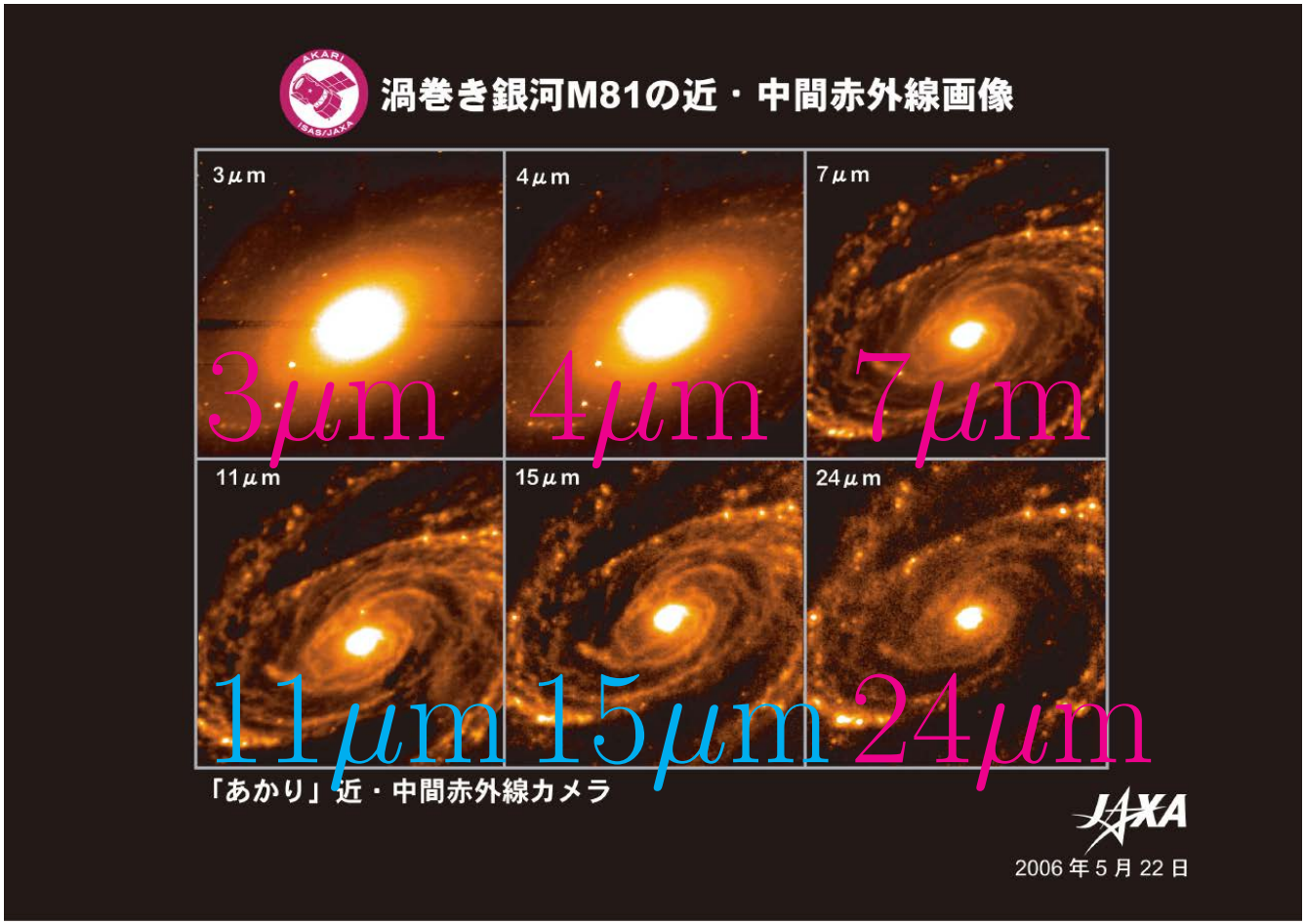
Luminous IR Galaxies @$z \sim 1$ (黄昏れた五月蝿い奴)

- Active Systems with Star + ISM(Dust) + AGN
- SF & AGN Activities were Peaked @$z \sim 1-2$
  - **What quenched SF around $z < 1$?**
  - **Dusty SED Analysis**; Takagi+2004





Using AKARI/IRC $2 - 24\mu$m

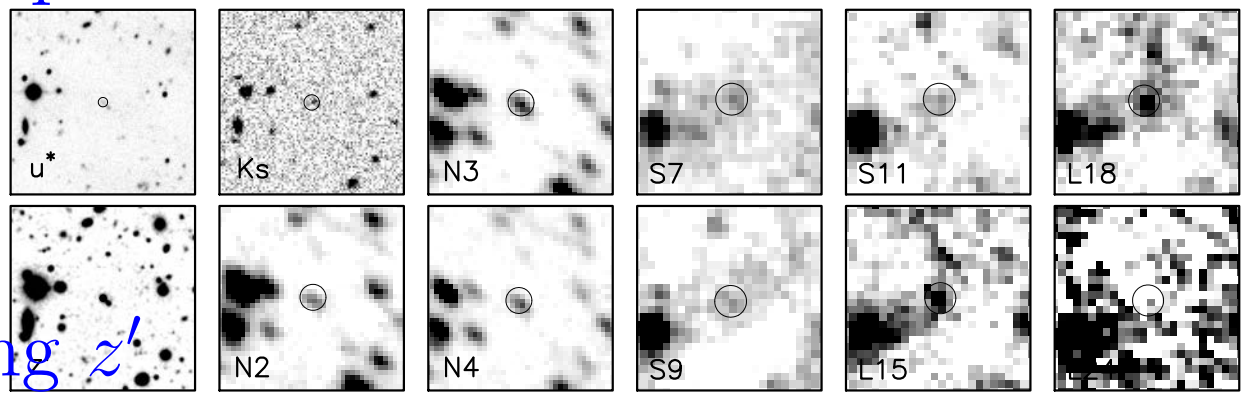


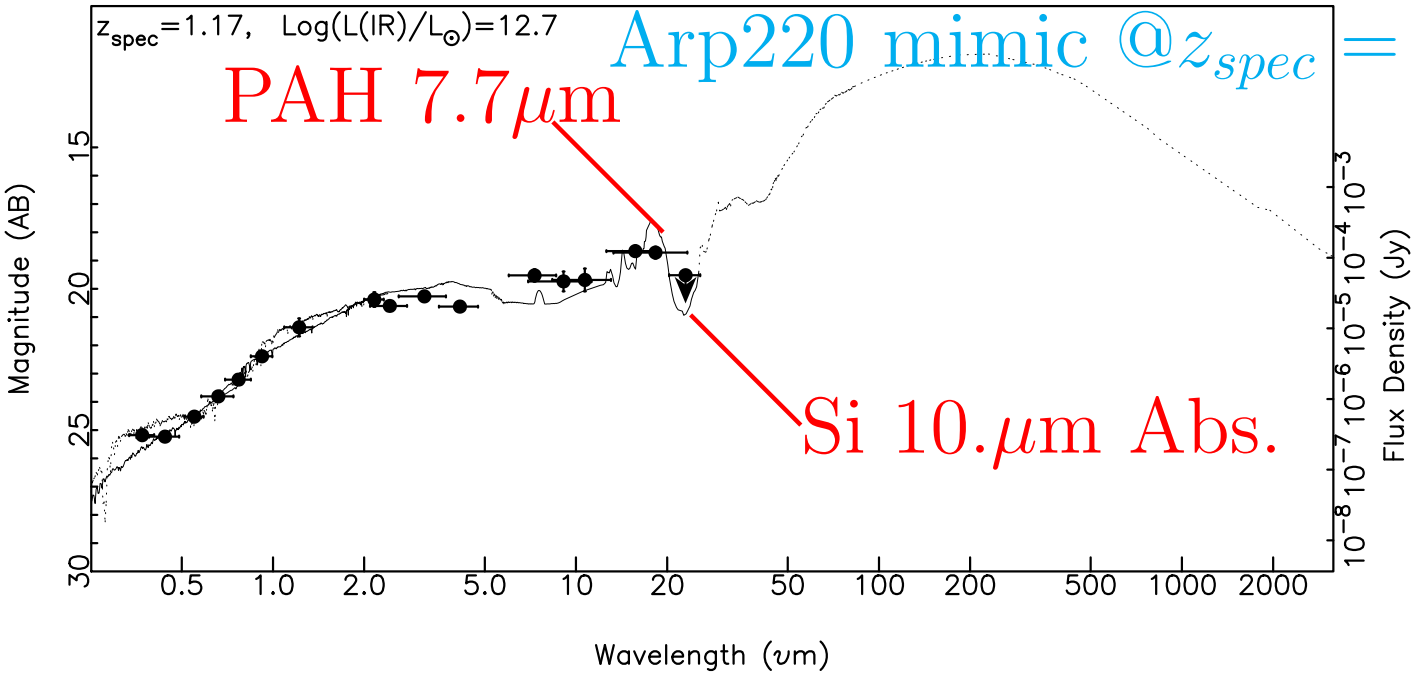
$9, 11, 15, 18\mu$m **cover IRAC/MIPS Gap**

Detect PAH & Si in SF LIRG @$z \simeq 1$

Opt. $\longrightarrow$ NIR $\longrightarrow$ MIR

detecting z'





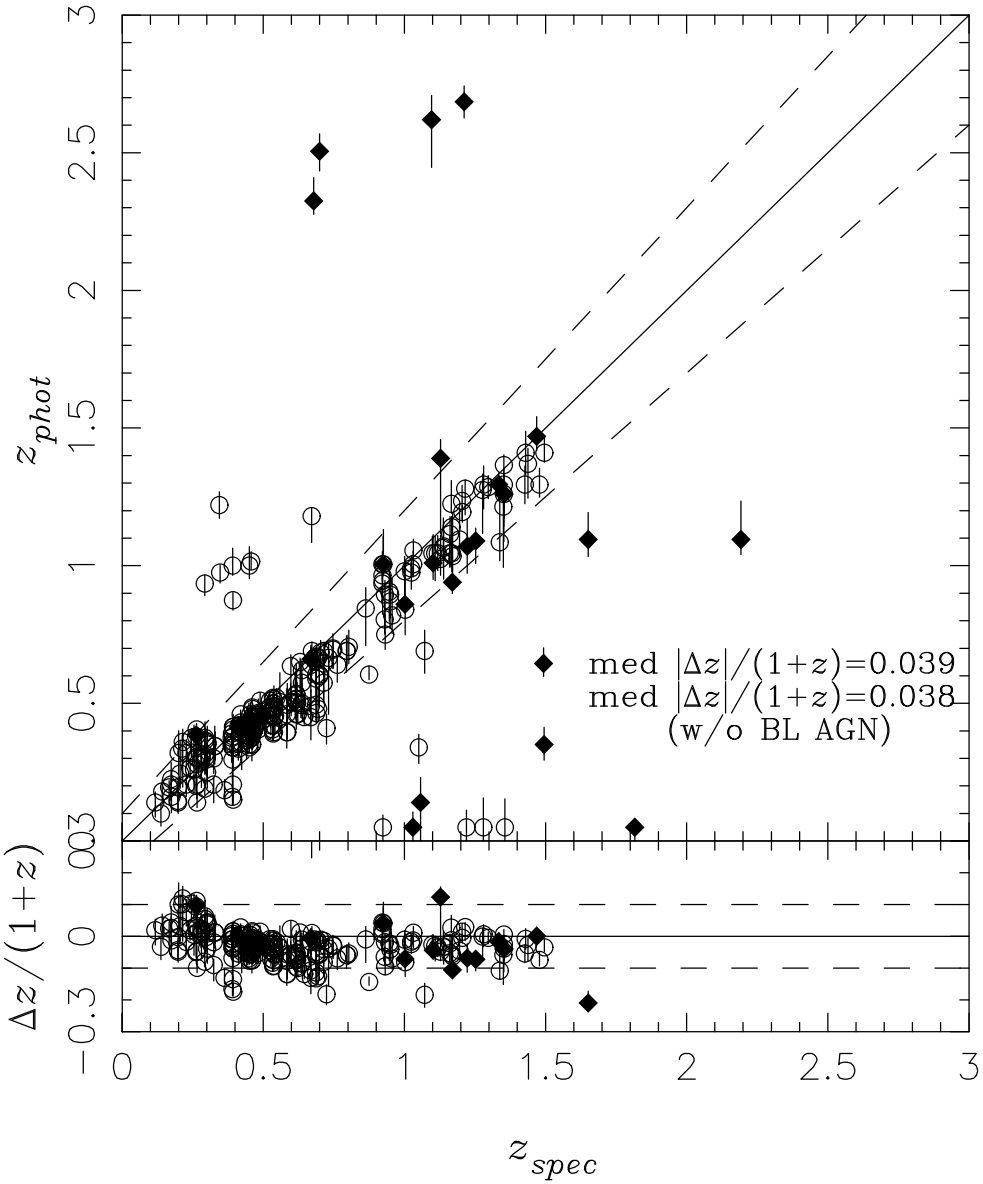
AKARI Deep Field (ADF)-North/NEP

Observatory	Band/Filter	Area	Sensitivity
AKARI/IRC	2-24μm	0.4 deg^2	90μJy(15μm)
Subaru/S-Cam	$BVRi'z'$	$27' \times 34'$	$B < 28.2$
KPNO2.1/FLMG	JK_s	$4 \times 27' \times 34'$	$K_s < 22$
CFHT/M-Cam	$u(g'r'i'z')$	1(2) deg^2	$u < 26$
Subaru/FOCAS	Opt.Spec.	57 sources	$R < 24$
Keck/DEIMOS	Opt.Spec.	420 sources	$R < 24$

Observed:Chandra(PI:M.Krumpe),WSRT&GMRT,GALEX,..

· **Synergy of S-Cam & AKARI**

Spectroscopic Follow-ups with DEIMOS

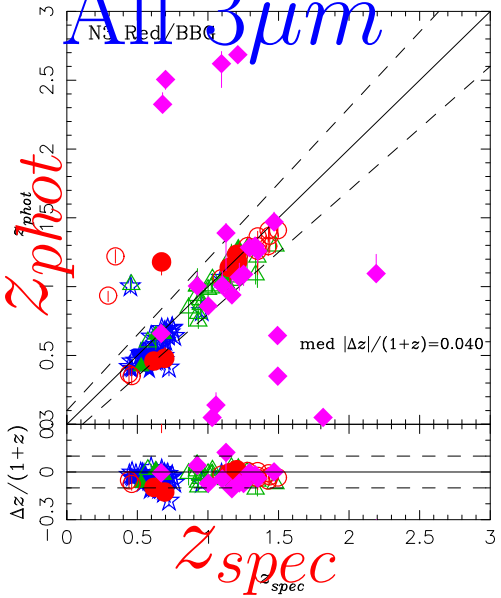


Subaru-Keck T.E.P. S08B (PI:Takagi); Synergy of S-Cam & DEIMOS

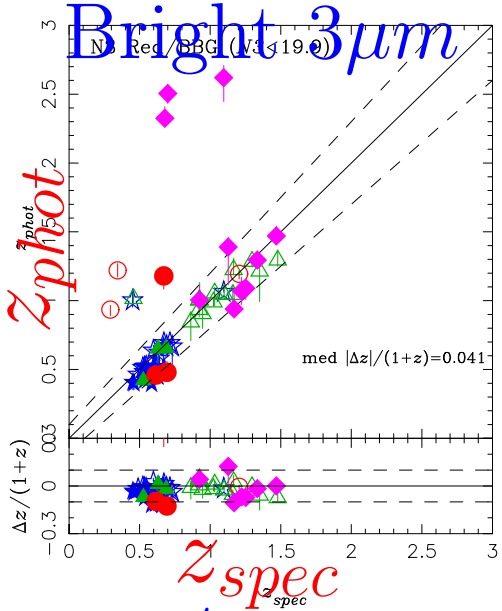
- Determine z_{spec}
  - $\sim$ 100 BBGs
  - $\sim$ 60 LIRGs
- Confirm z_{phot}
- Select **BL AGNs**
- SFR([OII]) etc.

z_{spec} vs. z_{phot} for 3 μm sources & LIRGs

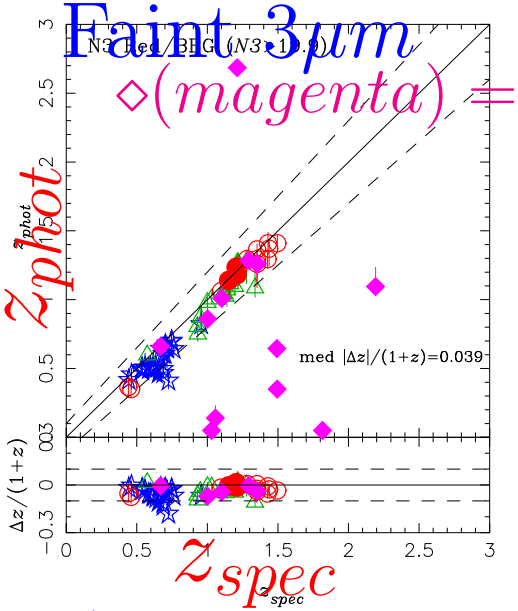
All 3μm



Bright 3μm

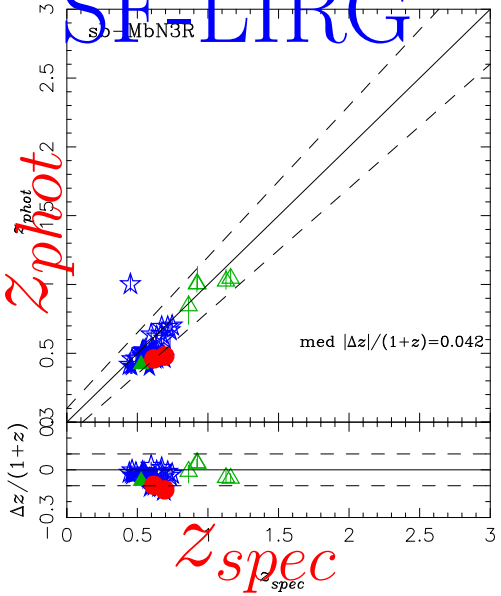


Faint 3μm

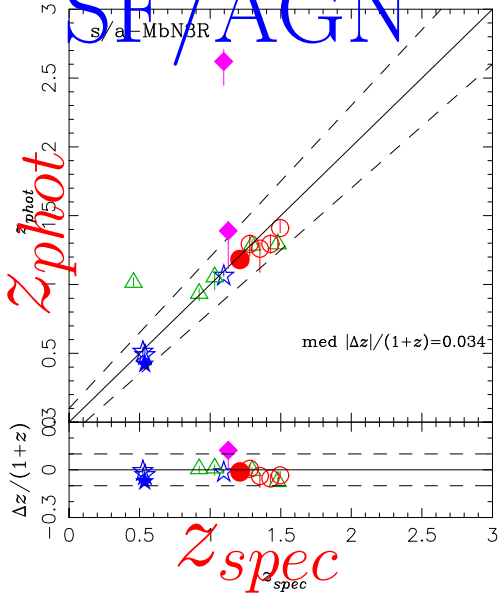


$\diamond(magenta)$ =BL AGNs

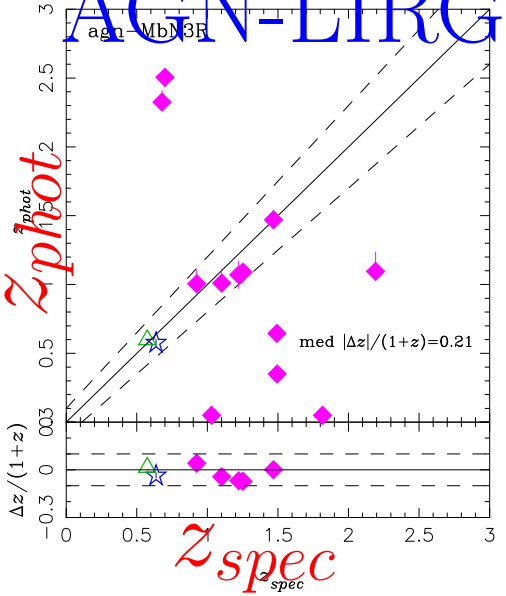
SF-LIRG



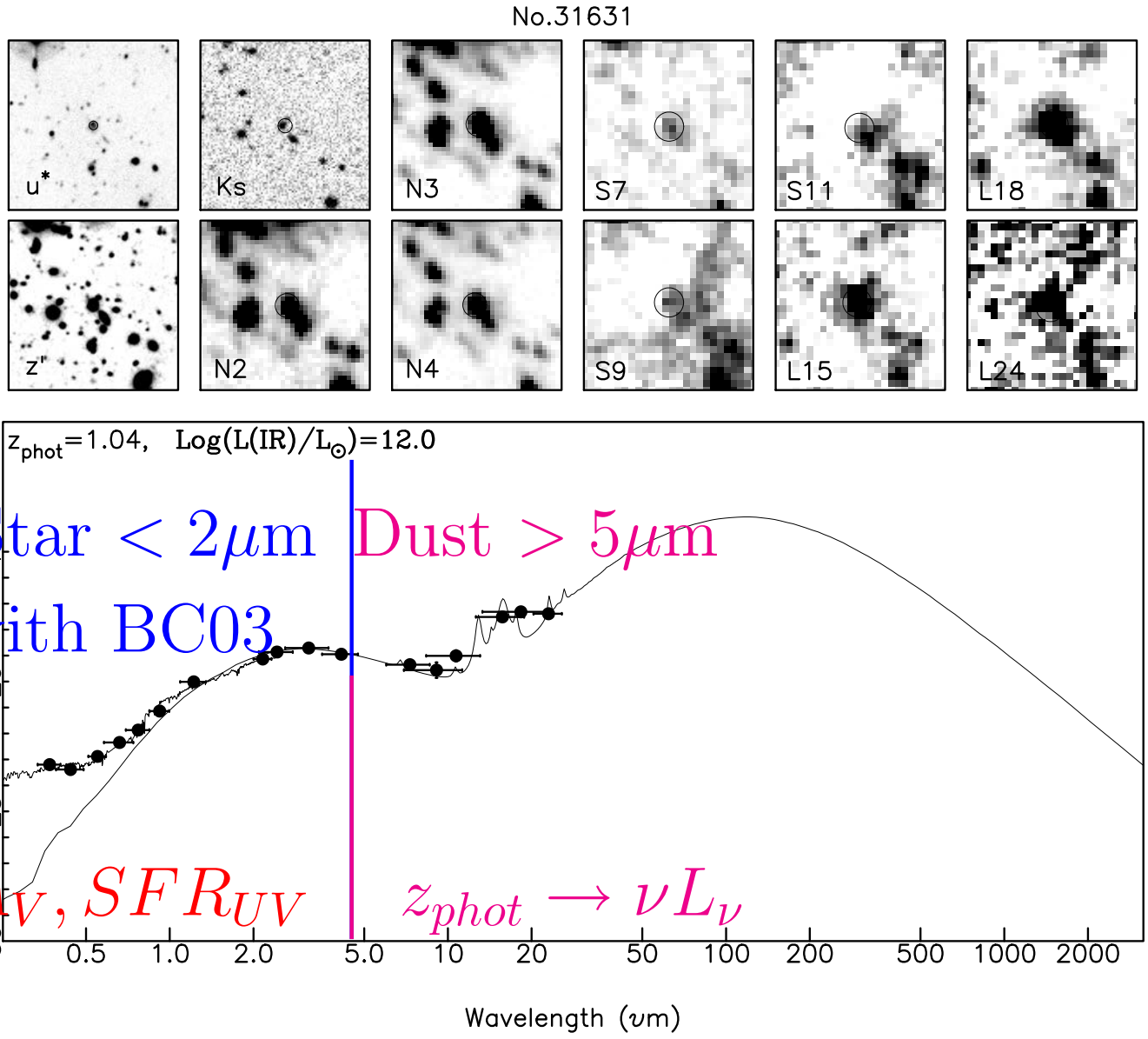
SF/AGN



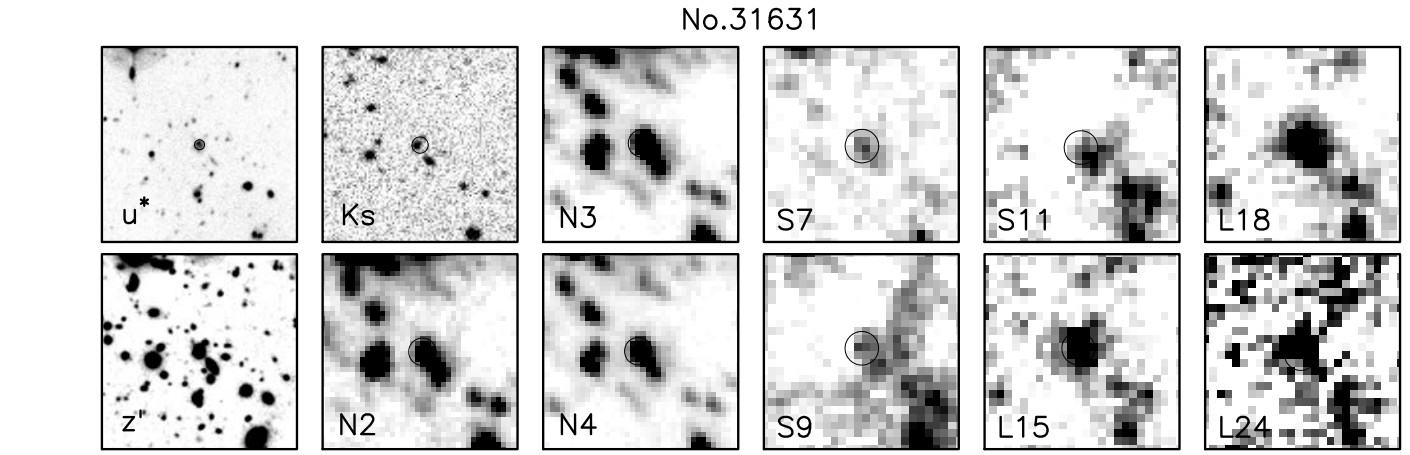
AGN-LIRG

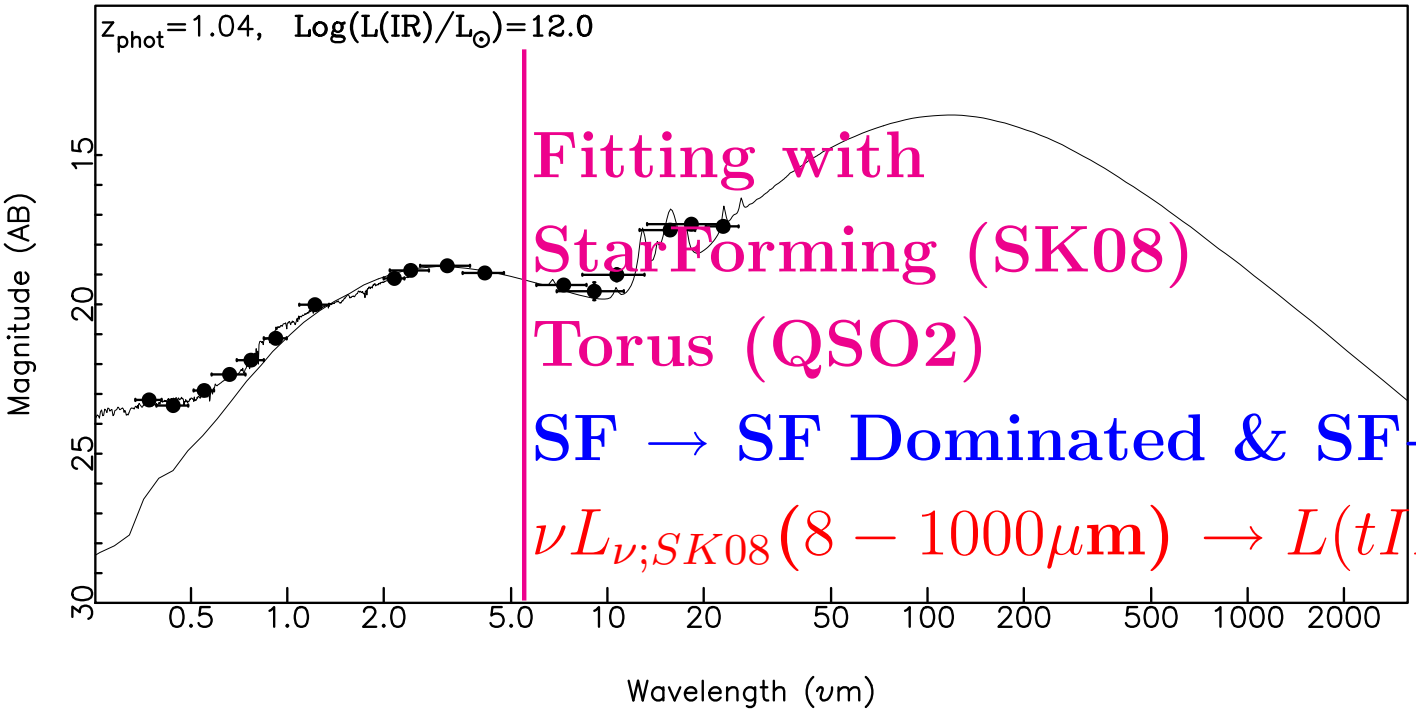


$z_{phot}, M_*, A_V, SFR_{UV}$ for ~ 1000 LIRGs



MIR SED $\rightarrow L(tIR) \rightarrow SFR_{IR}, A_{UV;IR}$





Fitting with

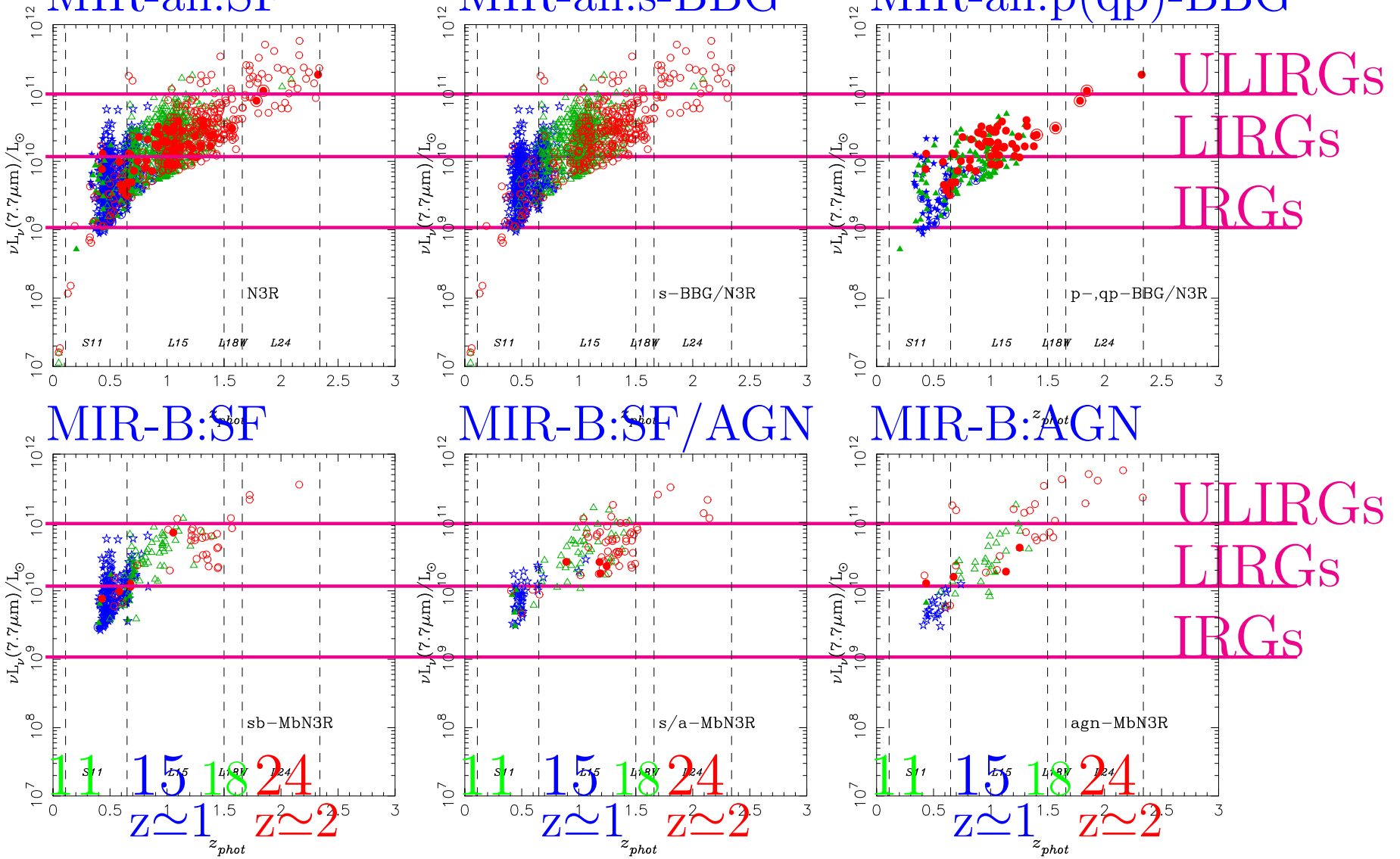
StarForming (SK08)

Torus (QSO2)

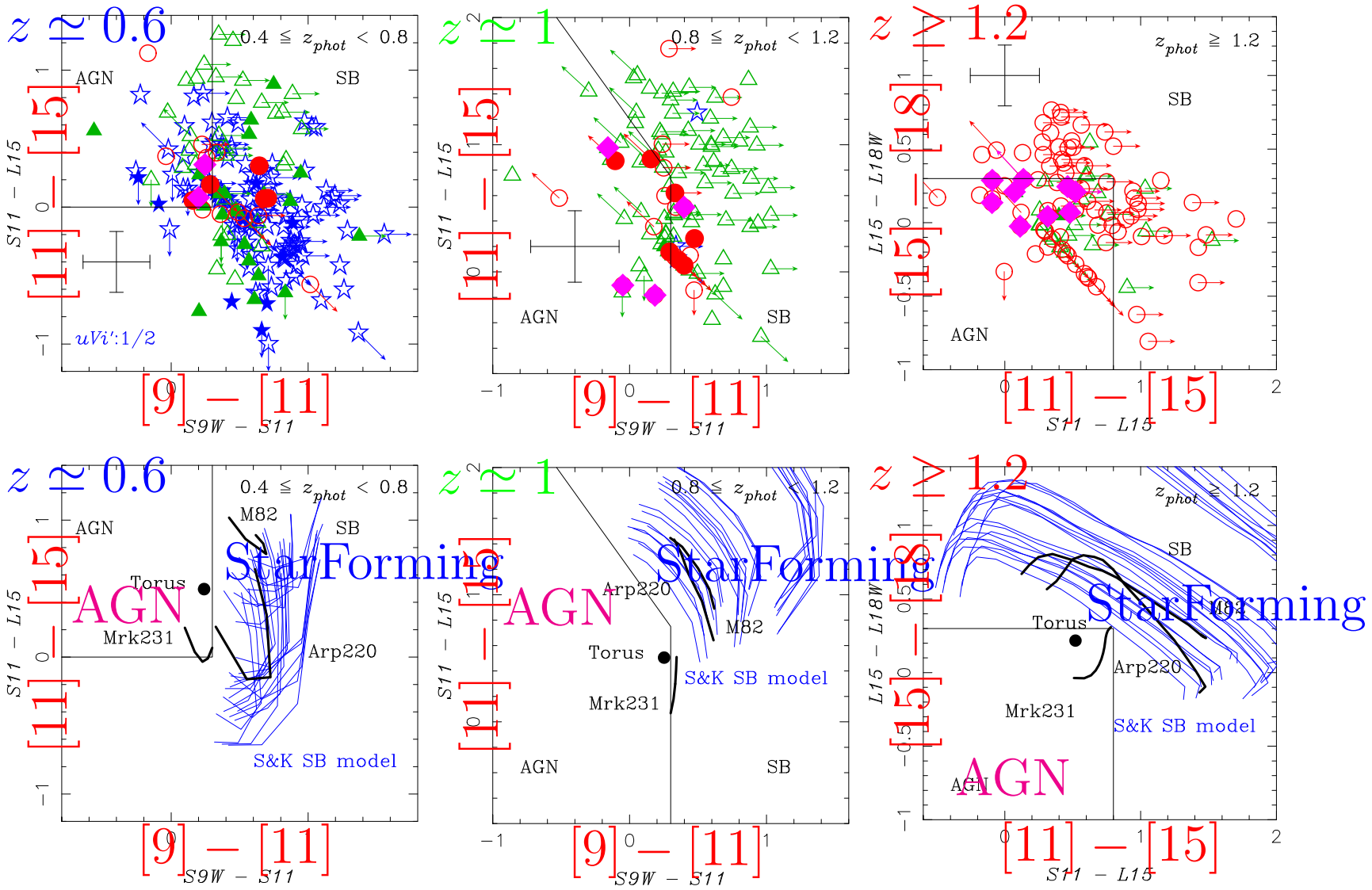
SF $\rightarrow$ SF Dominated & SF+AGN

$\nu L_{\nu;SK08}(8-1000\mu\mathbf{m}) \rightarrow L(tIR) \rightarrow SFR_{IR}$

z vs. $\nu L_\nu(7.7\mu m)$: $\nu L_\nu(7.7\mu m) \simeq 0.1 L_{tIR}$



MIR Color-Color Diag.@$z \simeq$0.6,1.0, $>$ 1.2

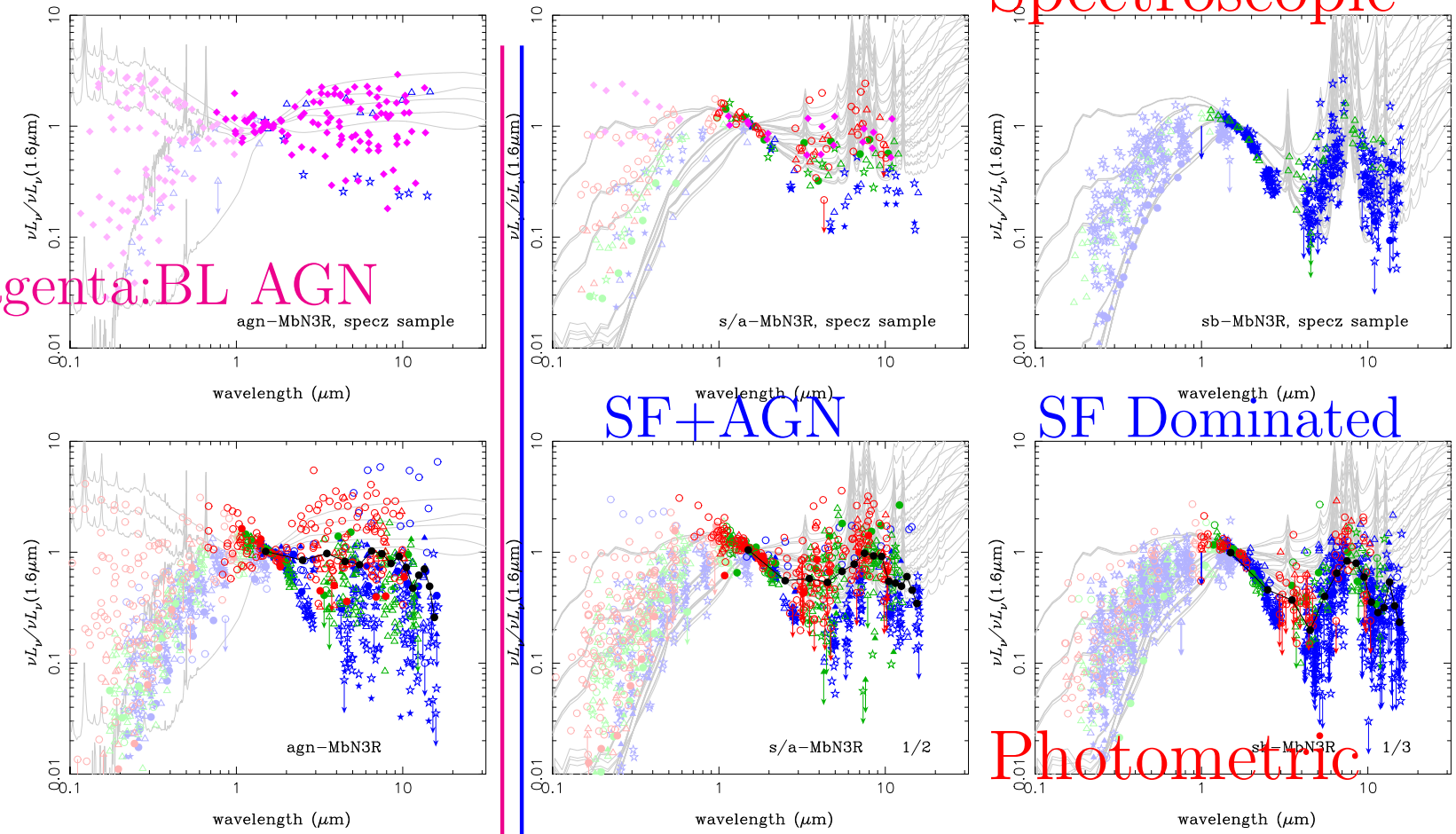


7.7μm PAH @$z \simeq 1(1.5)$ detected with L15(L18W)

Rest Frame SEDs of AGN,SF+AGN,SF

Spectroscopic

magenta:BL AGN



SF+AGN

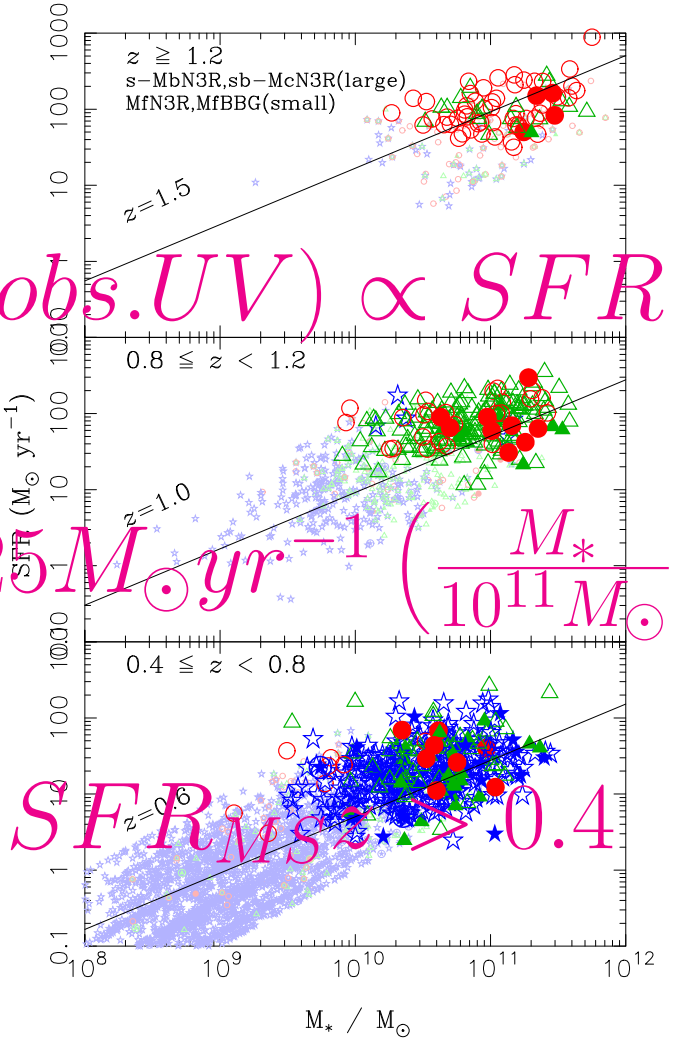
SF Dominated

Photometric

AGN || StarForming

M_* vs. SFR as Main Sequence

Large;SFR(IR+obs.UV), Small;SFR(Corr.UV)



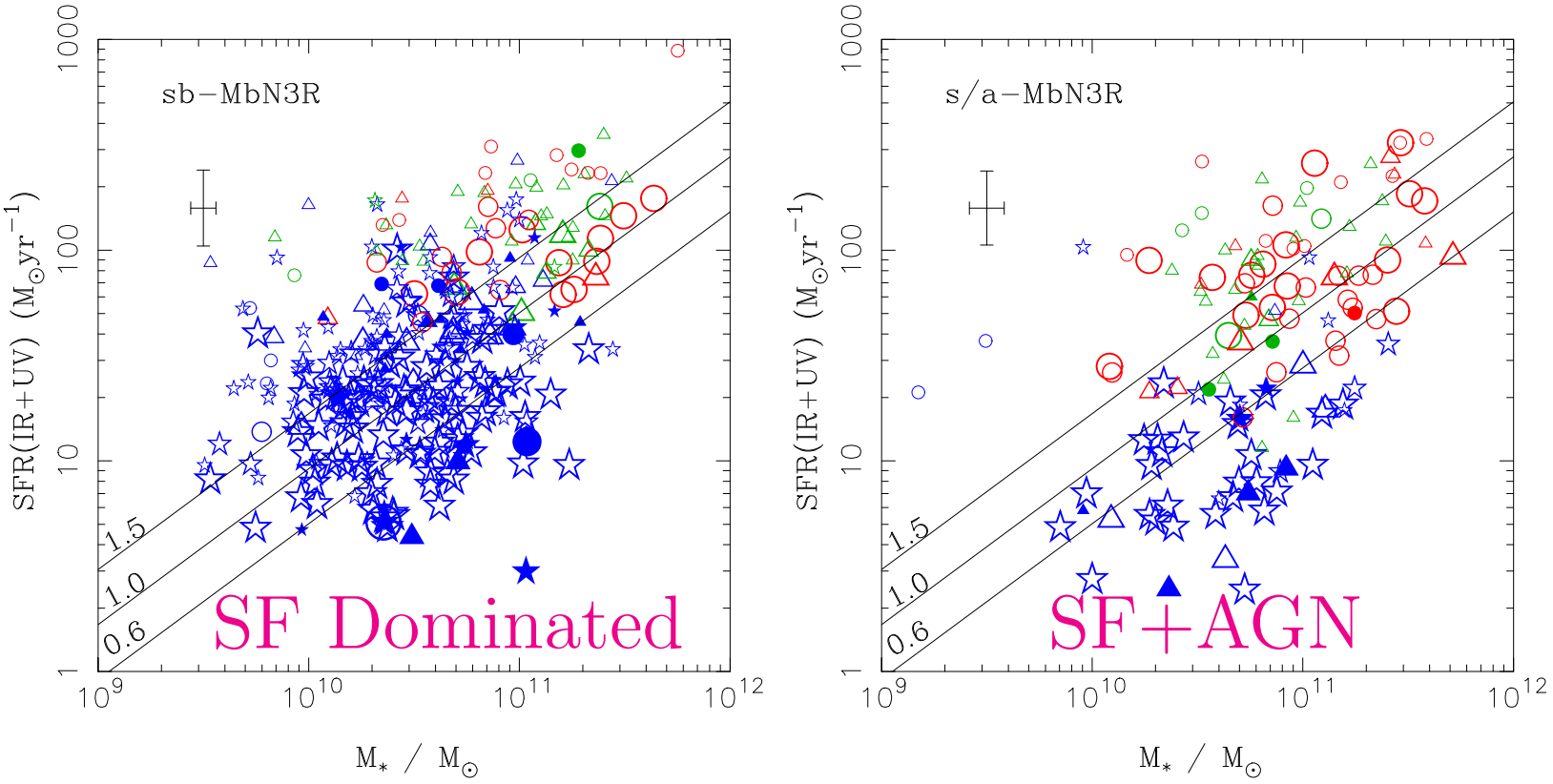
$$SFR(IR + obs.UV) \propto SFR(Corr.UV)$$

$$SFR_{MS} \simeq 25 M_\odot yr^{-1} \left(\frac{M_*}{10^{11} M_\odot}\right)^{0.7} (1+z)^2$$

$$\langle SFR_{IR} \rangle > SFR_{MS} \; z \geq 0.4$$

SF Histories: SF vs. SF+AGN

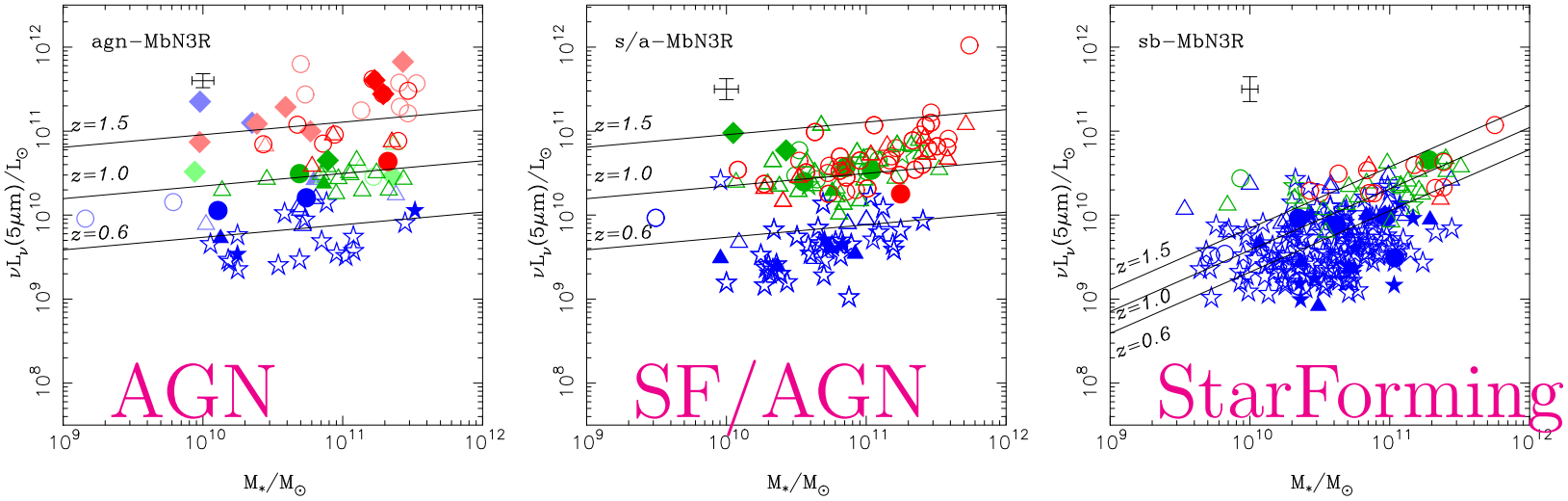
$@z = (.5 - .8), (.8 - 1.2), > 1.2$



· **SFR Rapidlly Decreasing in SF+AGN**

→ **AGN Queches SF?**

5μm as window for AGN @$z \simeq$0.6,1, $>$ 1.2

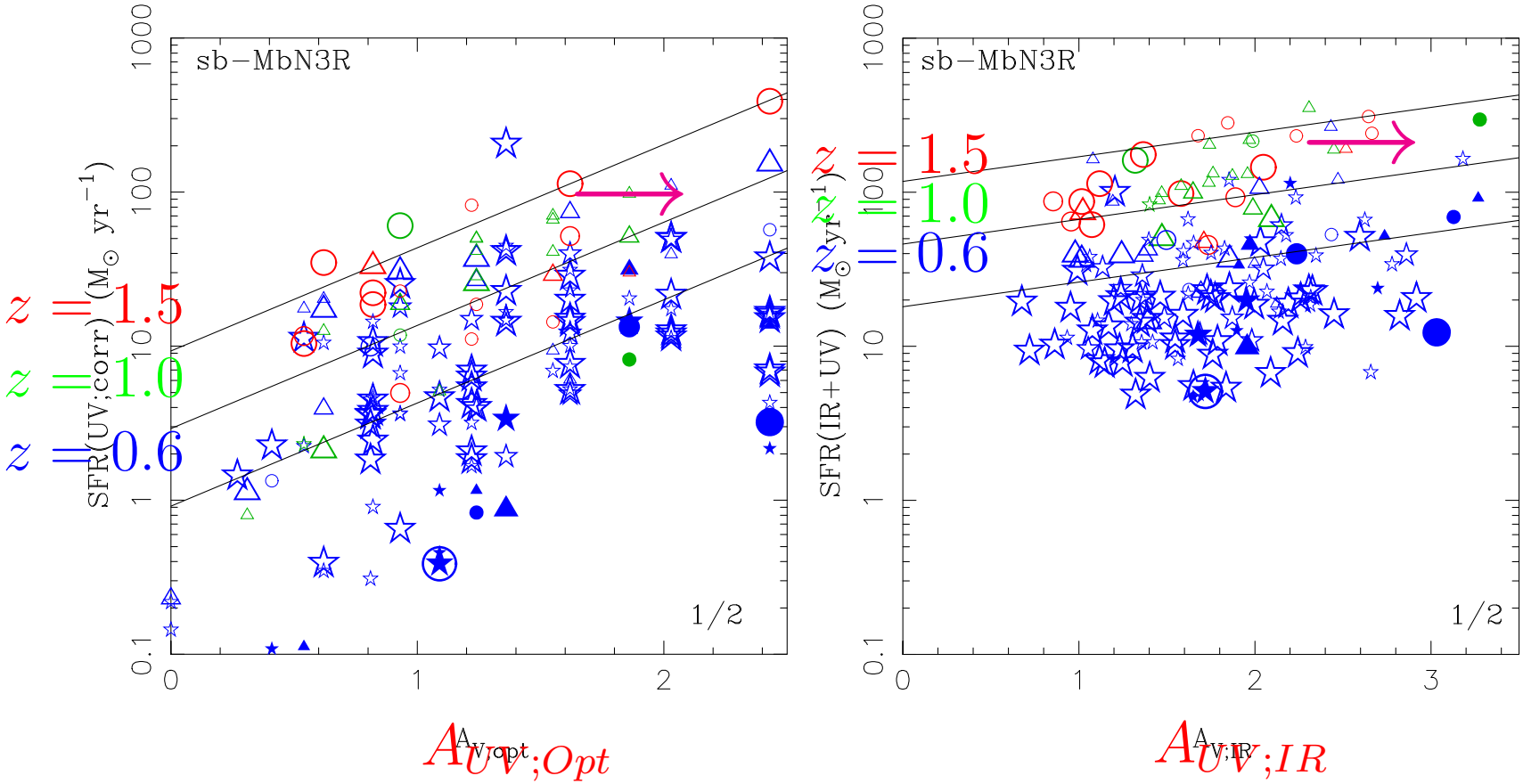


$5\mu m$: Gap between * and dust; excess with AGN

$$\nu L_\nu(5\mu m) \simeq 2 \times 10^9 L_\odot \left(\frac{M_*}{10^{11} M_\odot}\right)^{0.5} (1+z)^4$$

AGN activities are Weak mass depedence, More rapid evolution than SFR

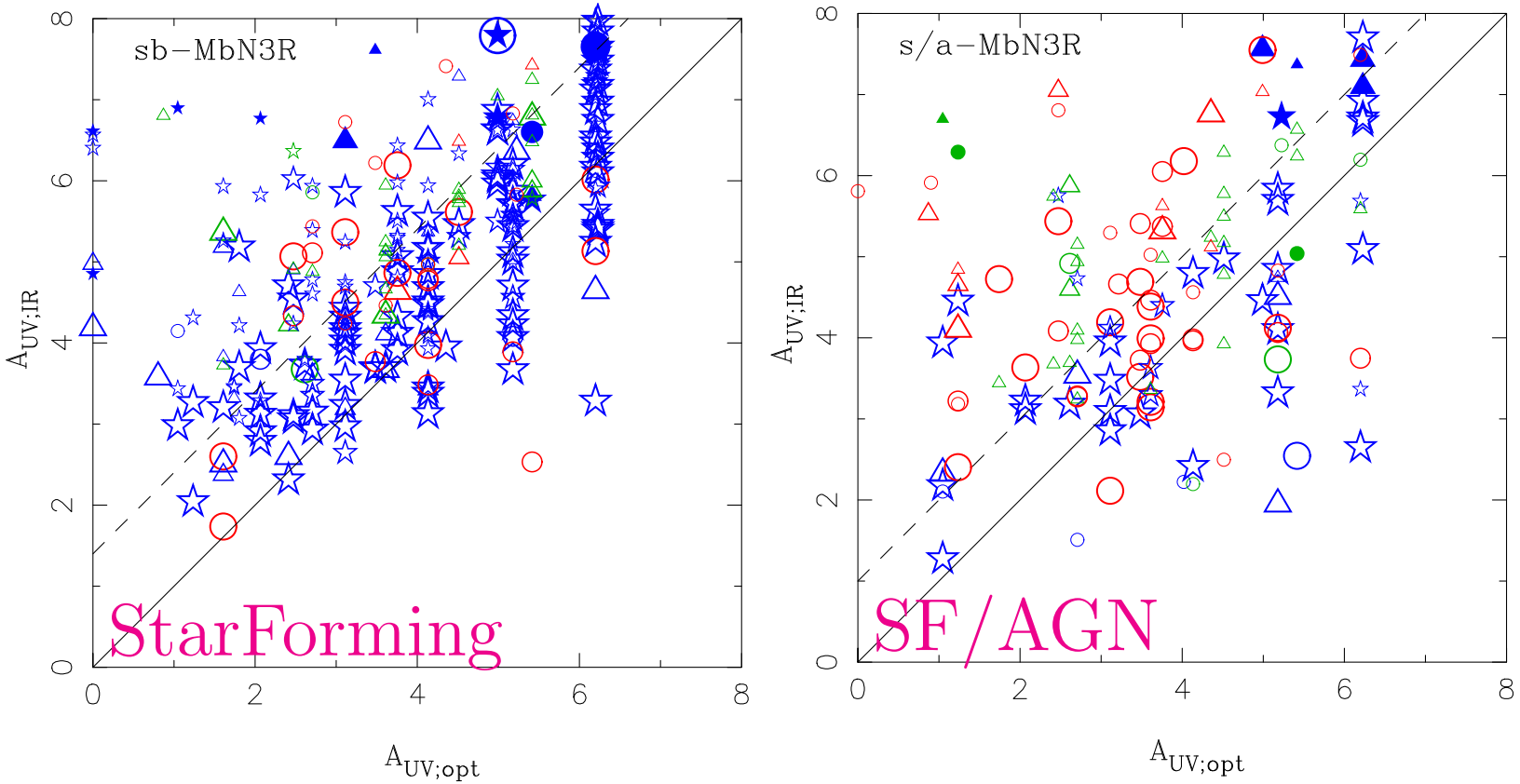
A_{UV} vs. SFR:Evolution of Extinctions



Both A_{UV} increasing ↑ @ a fixed SFR

→ Chemical Evolution

Classical $A_{UV;opt}$ vs. Calorimetric $A_{UV;IR}$



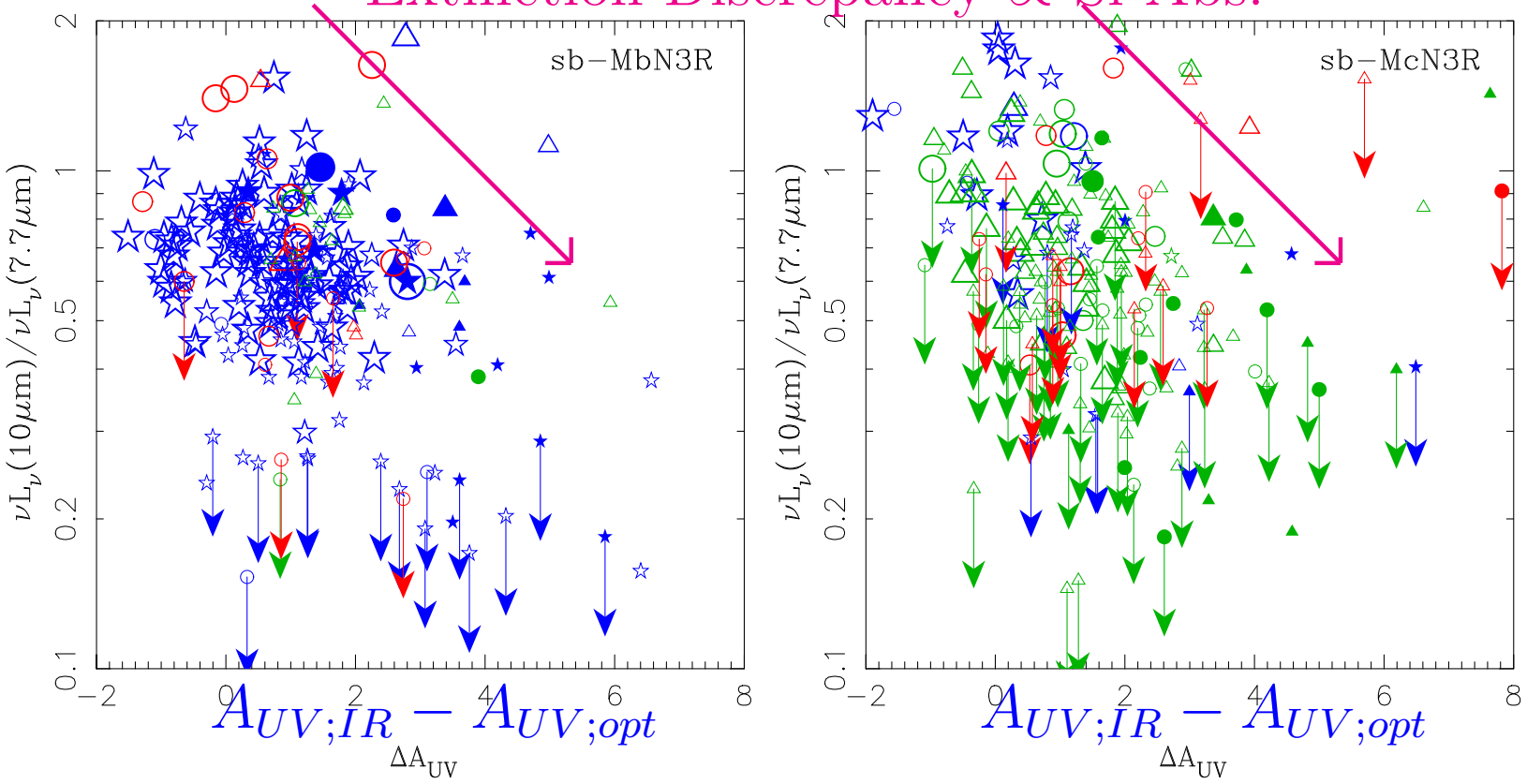
$$A_{UV;IR} = 2.5 \log(\frac{L(IR)}{L(obs.UV)}) \propto A_{UV;Opt}$$

however

$$\langle A_{UV;IR} - A_{UV;Opt} \rangle \simeq 1 - 2$$

$A_{UV;IR} - A_{UV;opt}$ vs. $\nu L_{\nu 10}/\nu L_{\nu 7.7}$

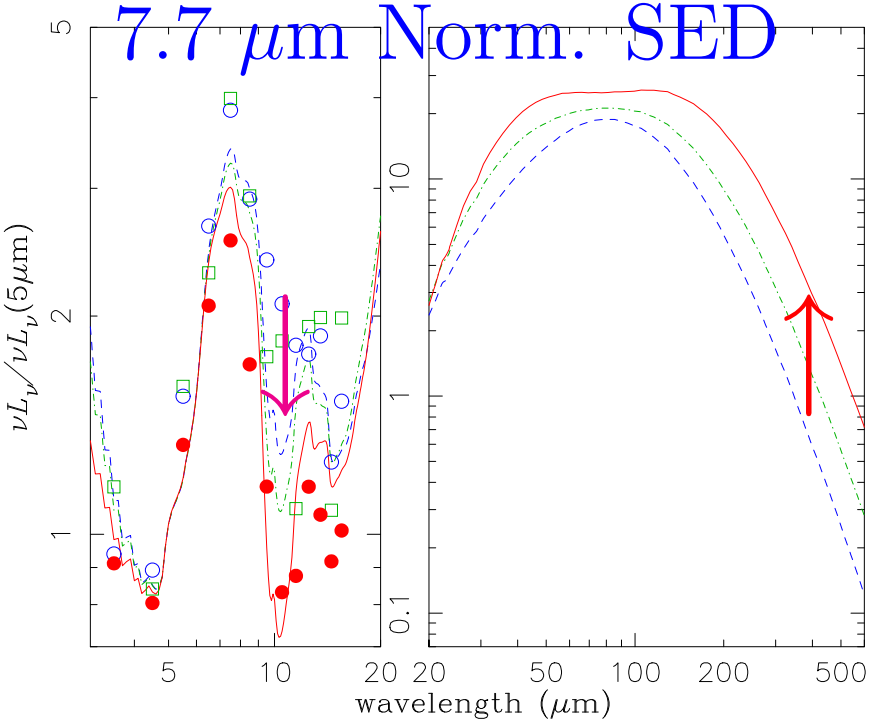
Extinction Discrepancy $\propto$ Si Abs.

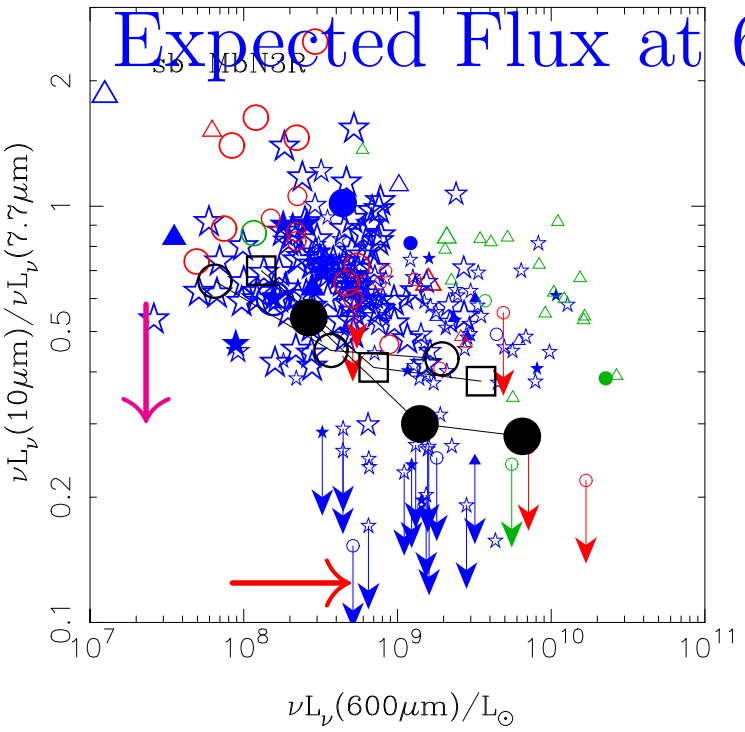


- $A_{UV;IR} \leftrightarrow$ **Dense Regions ($\leftrightarrow$ Si Self Abs.)**
- $A_{UV;opt} \leftrightarrow$ **Diffuse Regions**

Variance in ISM/Dust/Star distributions

MIR ↔ (Expected)FIR/Submm



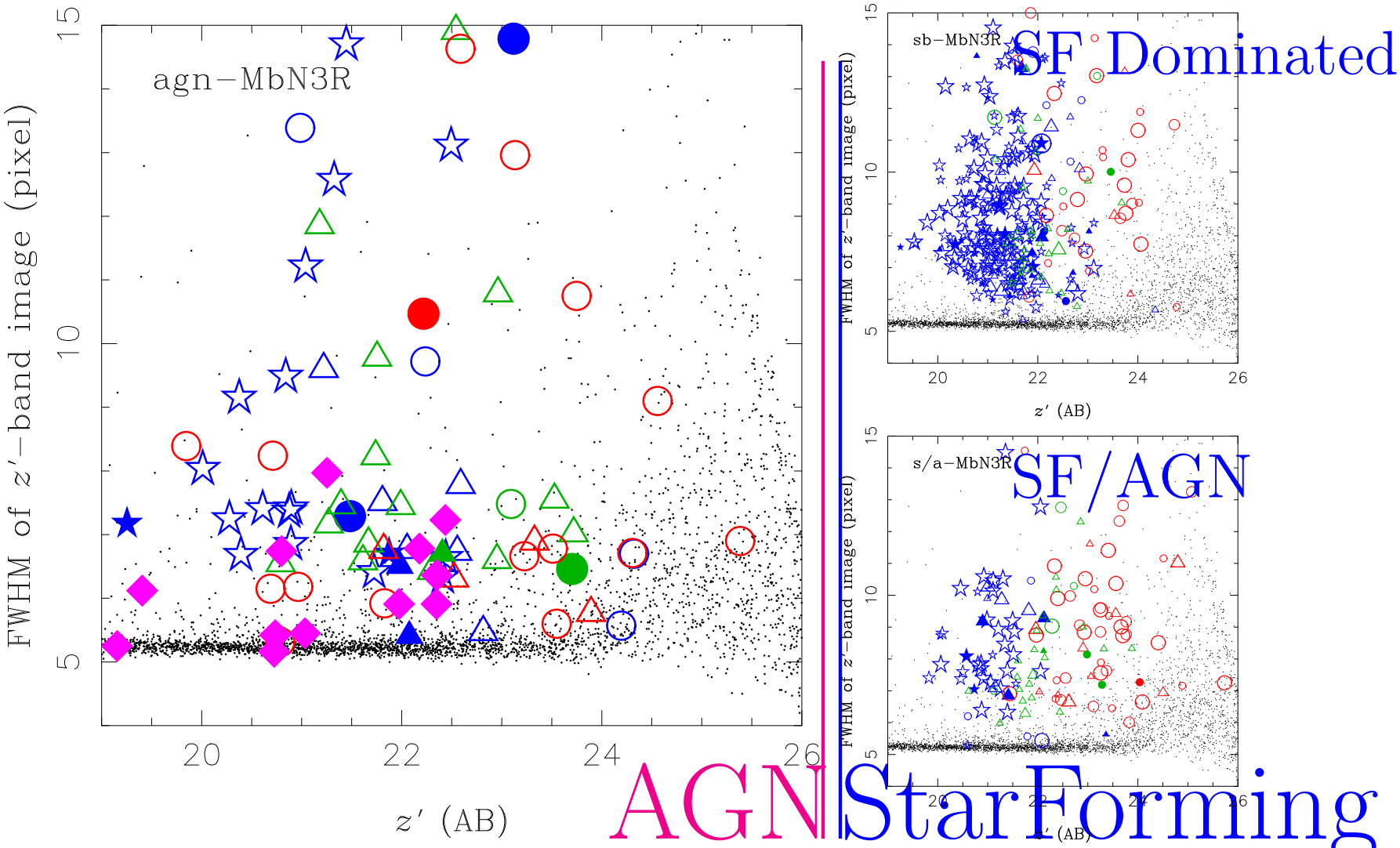


- Si Abs. $\downarrow \rightarrow L_{FIR,Submm}$ $\uparrow$
- Herschel Follow-up becomes Essential!

Summary of SED studies

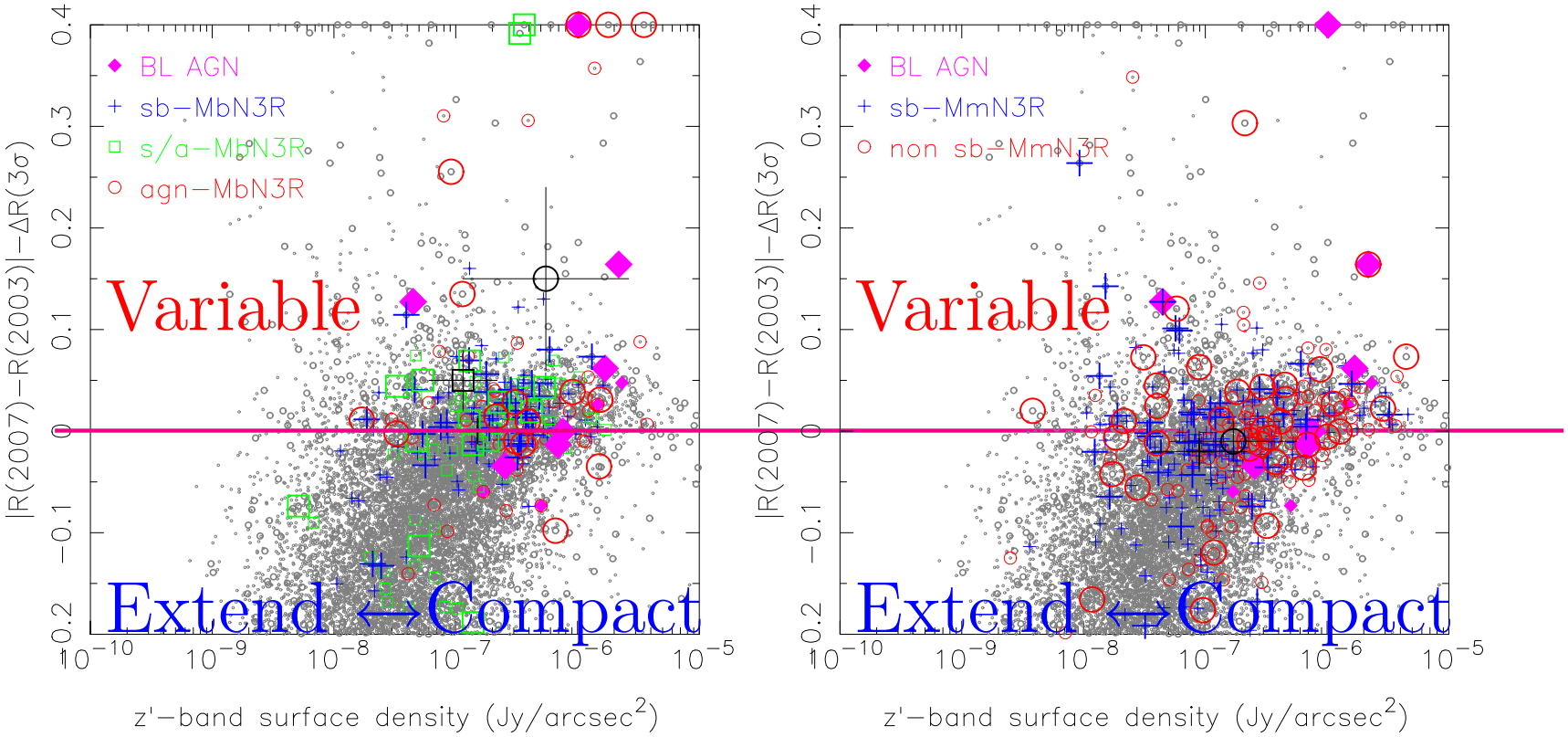
- Confirmation of z_{phot} with DEIMOS
- (U)LIRGs z=0.4-2 Classified into SF,SF/AGN,AGN
- AGN vs. SFR
  - lower SFR in SF+AGN $z < 0.8$
  - **AGN queching SF?**
- $\nu L_{\nu 7.7,\nu 10} \rightarrow L_{tIR}$w/oAGN $\rightarrow SFR(IR+UV)$
  - sSFR Decresing, and Weak M_* dependence
- Extinctions; $A_{UV;Opt}$ but also $A_{UV;IR}$
  - Extinction Increasing $\rightarrow$ **Chemical Evolution**
  - Si Depth $\leftrightarrow A_{UV;IR} - A_{UV;Opt}$
    Geometric Effects

Morphological Difference for AGN/SF



dot:star **AGN:Pointlike**↔ **SF:Extended**

Variabilities of AKARI selected LIRGs

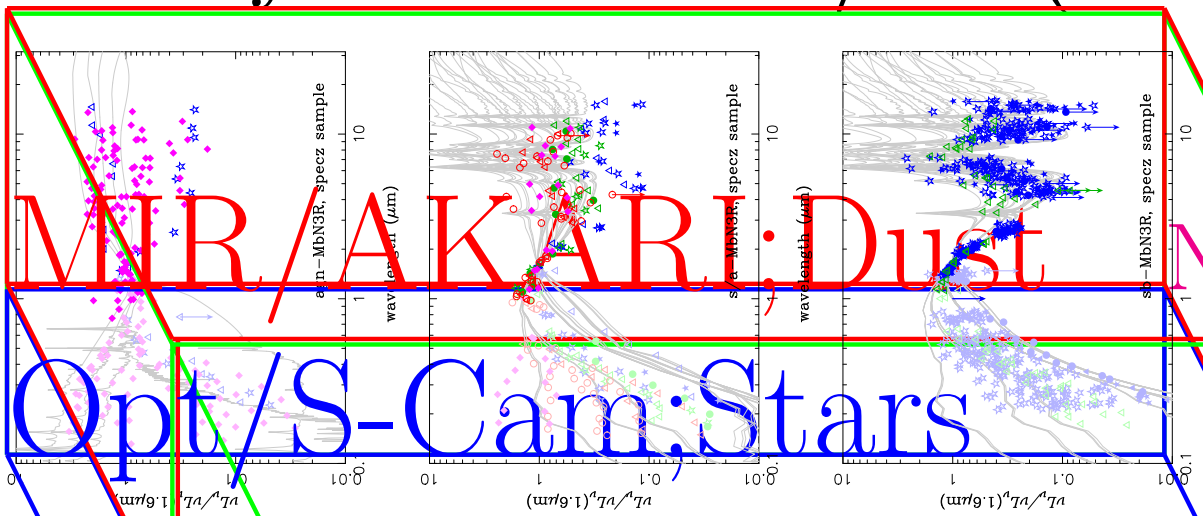


Following to SXDF by Morimoto, Yamada+.

Variable; BL-AGNs, AGN-LIRGs

(AGNs/SBs-LIRGs, SB-LIRGs)

Duality of HSC-NEP/SSP(∼ AdS/CFT?)



MIR/AKARI;Dust

NEP-Deep

Opt/S-Cam;Stars

MIR/AKARI;Dust

NEP-Wide

Morpholgy

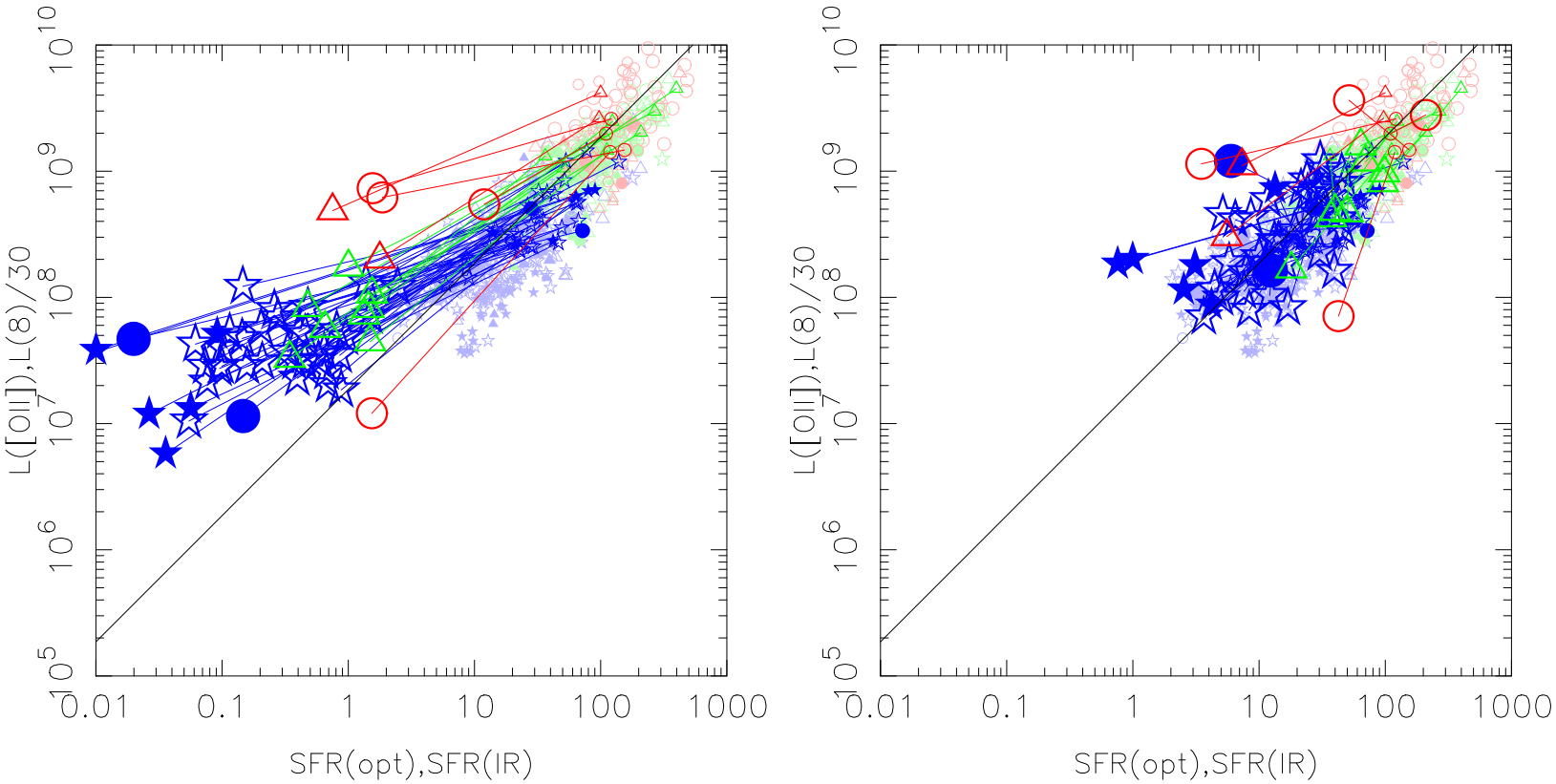
Variability

Opt/HSC;Stars

- HSC-NEP ; < 5 nights → Open Use (June-July)
- SSP ; 情報爆発 → 機械学習（曲がった空間の幾何）

HSC-SSP

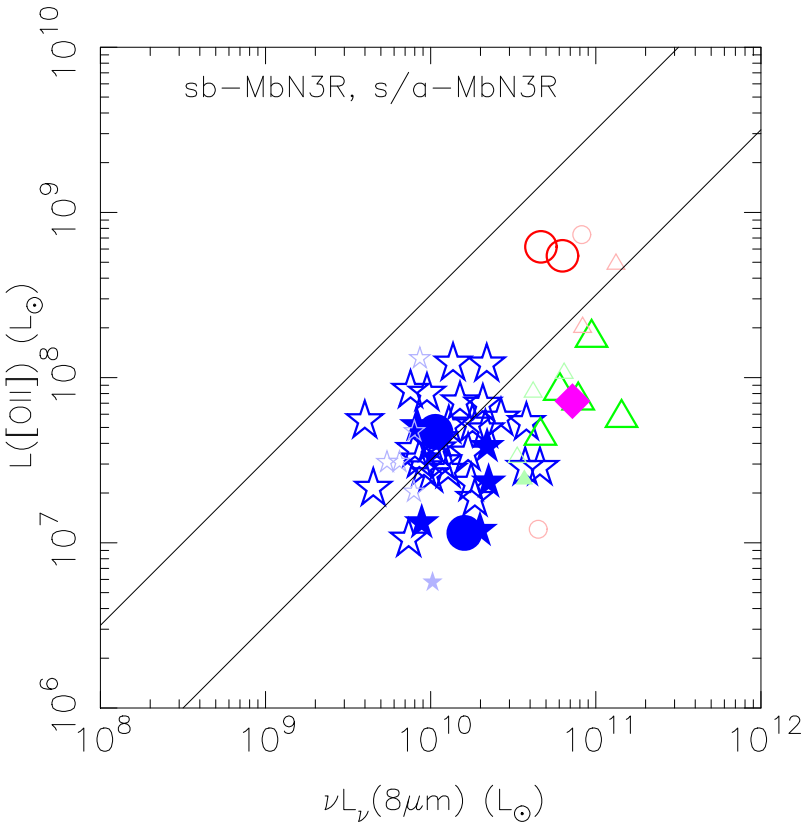
SFR(IR,UV) vs. L(8um,[OII])

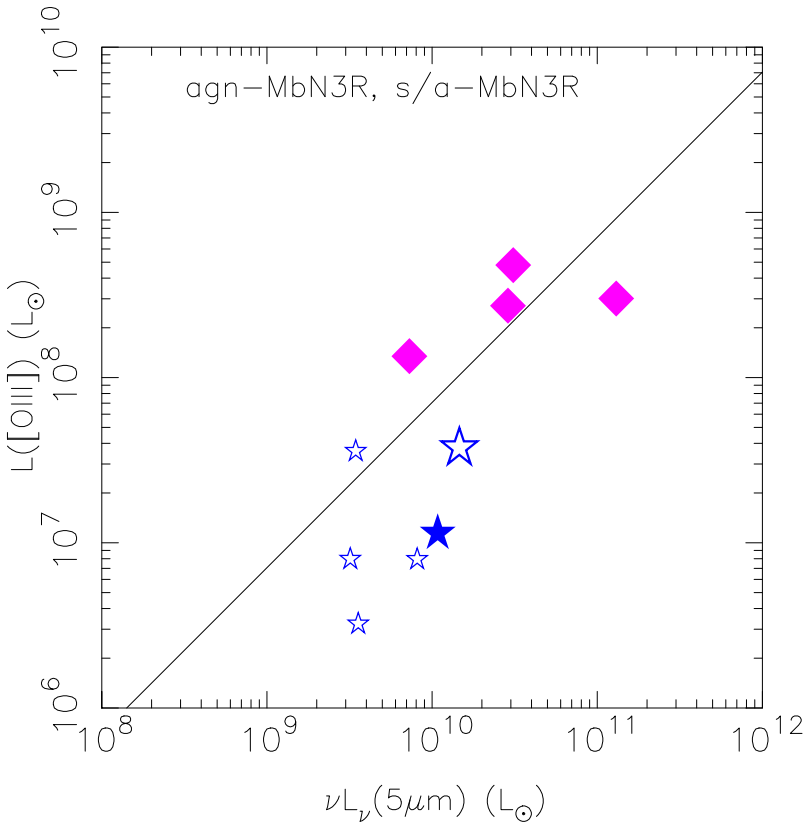


Left; W/O, Right; With Extinction Correction,

- **L(8um) $\propto$ SFR(IR), L([OII]) $\propto$ SFR(UV)**
- **SFR(IR) $\sim$ 3 SFR(corr.UV)**

Line Diagnostics (Preliminary)



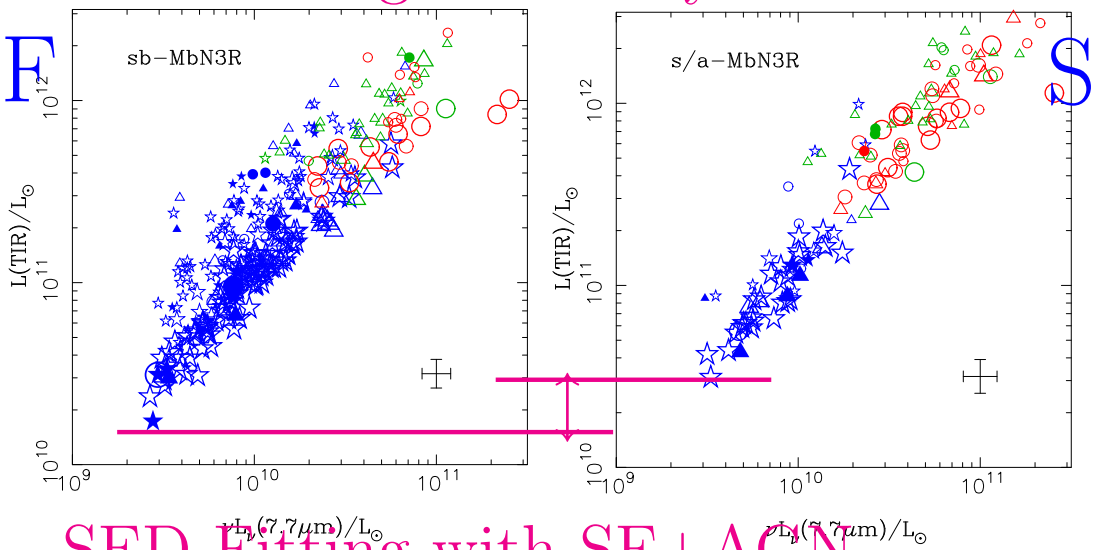


$\nu L_{\nu 7.7}$ vs. L_{tIR}:With excluding AGN

SED Fitting with Only SF

SF

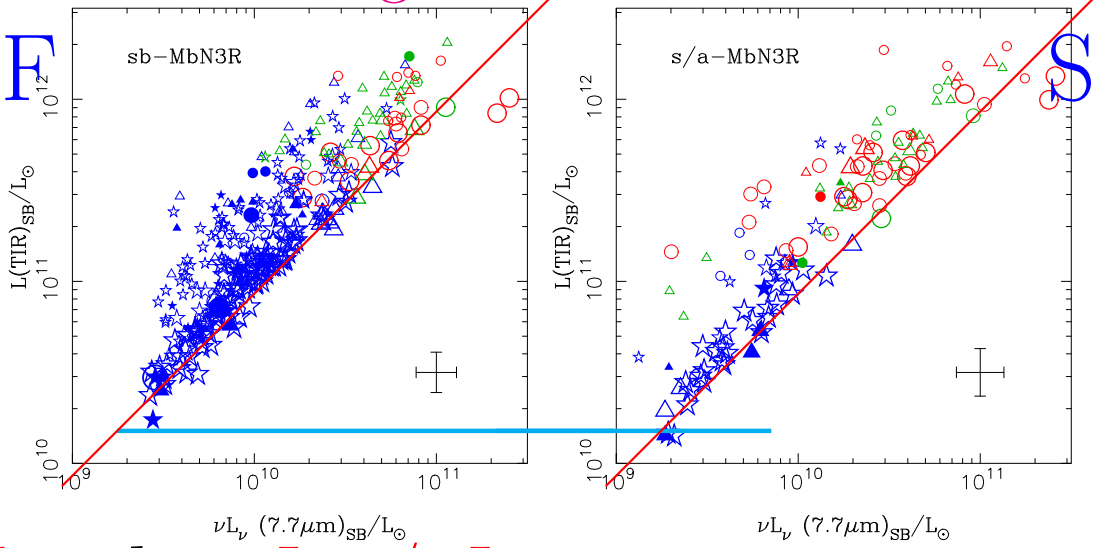
SF+AGN



SED Fitting with SF+AGN

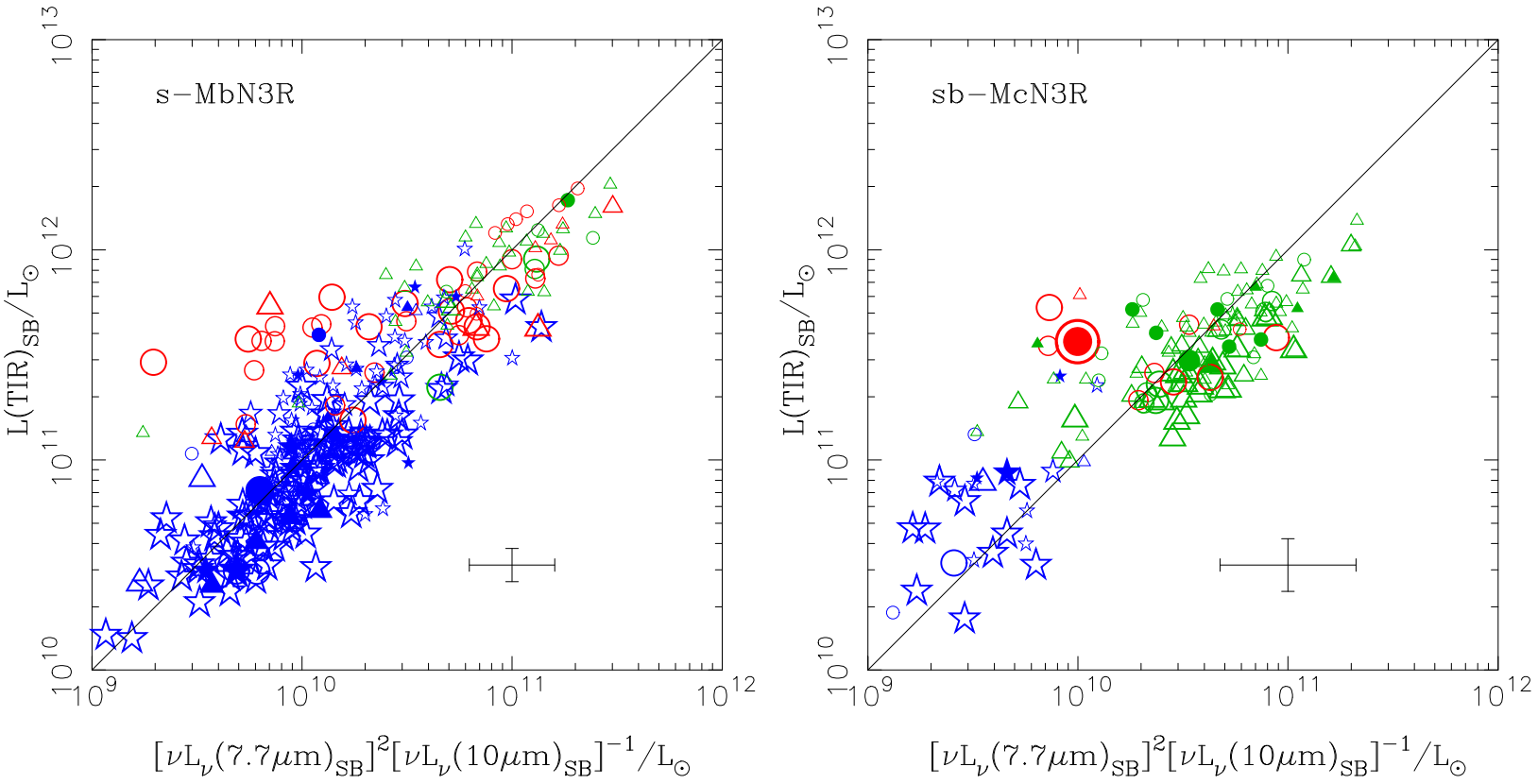
SF

SF+AGN



$L_{tIR} \propto \nu L_{\nu 7.7}$ but $L_{tIR}/\nu L_{\nu 7.7} \simeq 10 - 50$

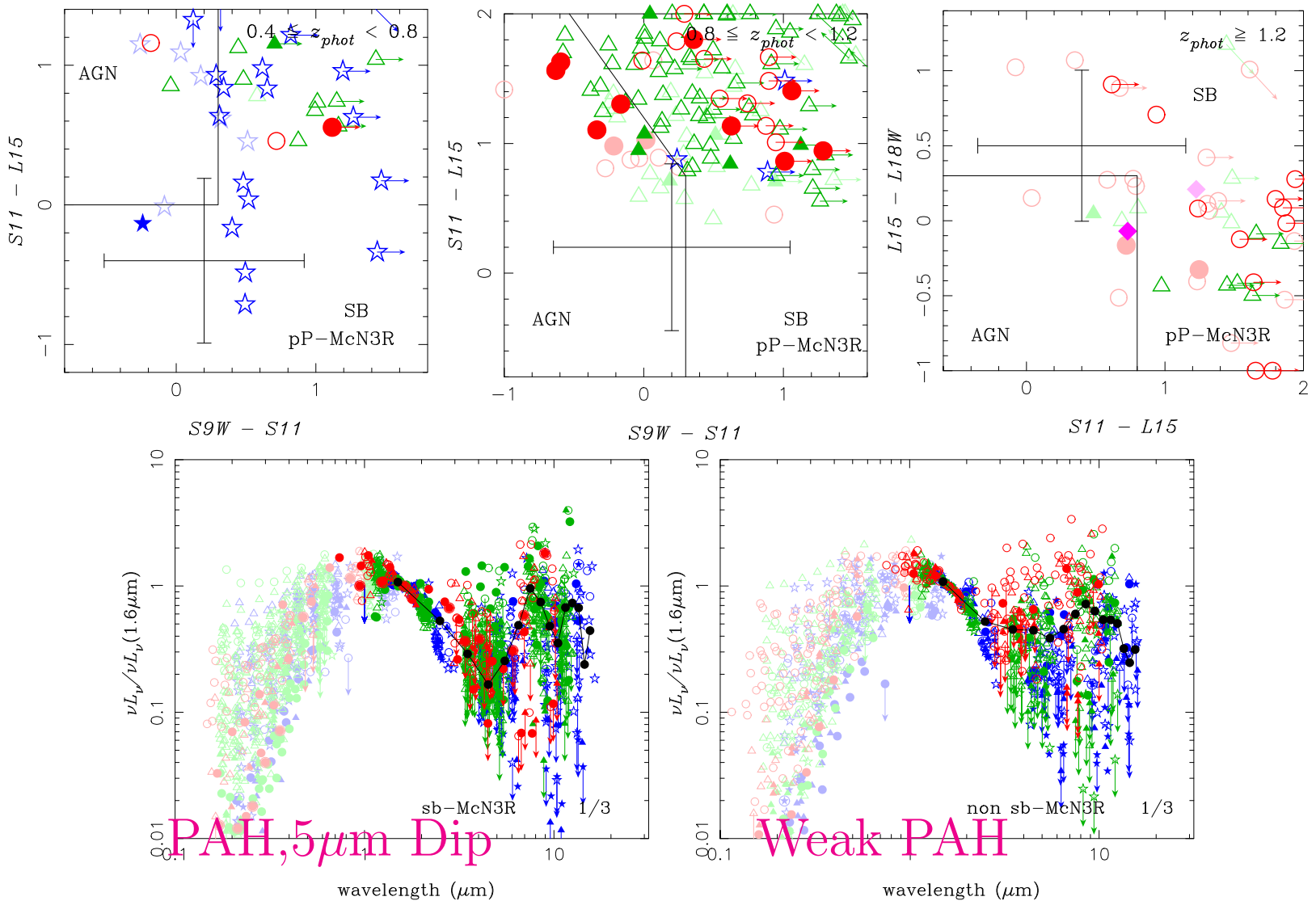
$\nu L_{\nu 7.7}(\nu L_{\nu 10}/\nu L_{\nu 7.7})^{-1}$ vs. L_{tIR}



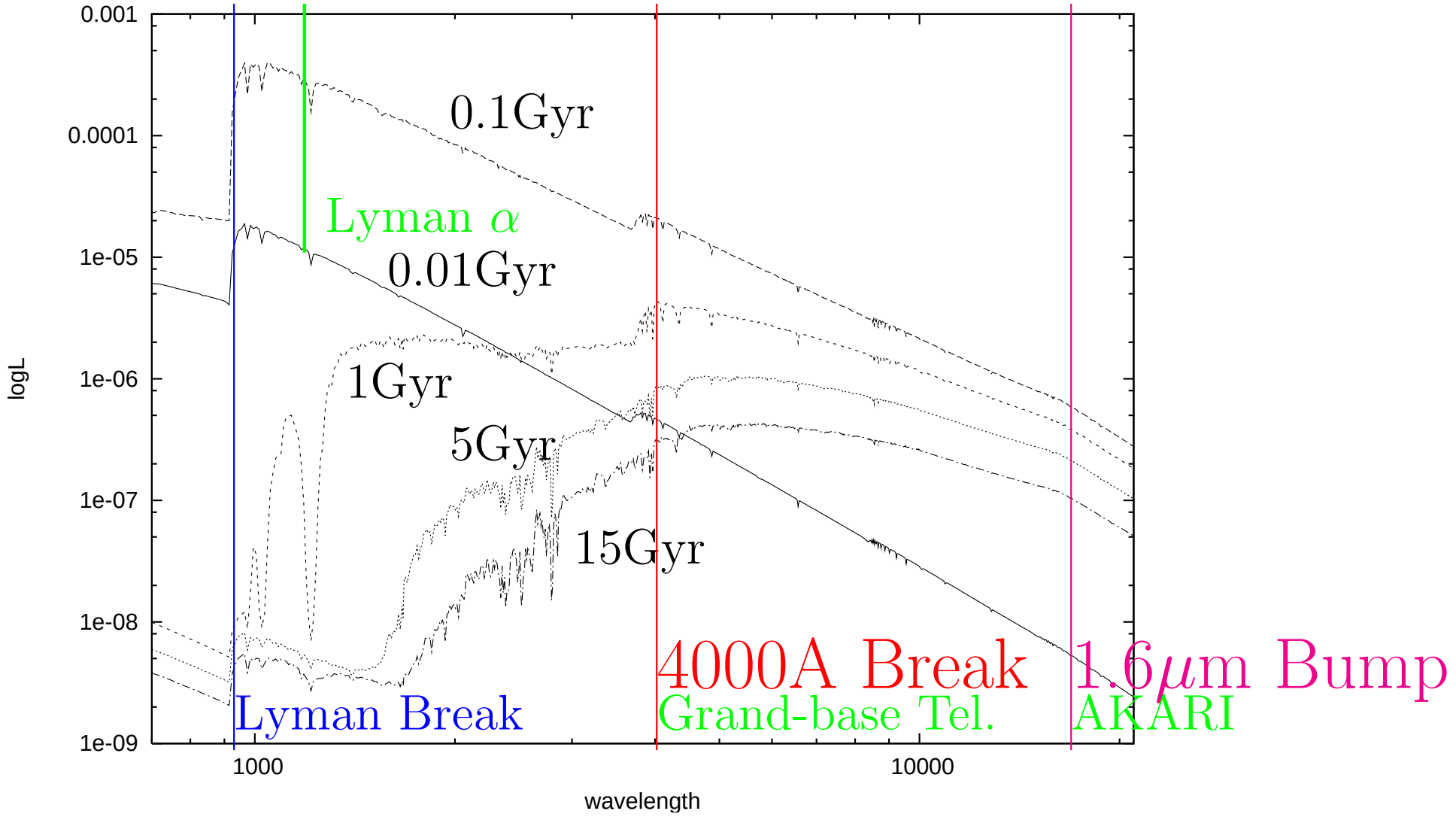
$L_{tIR} \simeq 10\nu L_{\nu 7.7}(\nu L_{\nu 10}/\nu L_{\nu 7.7})^{-1}$

$\cdot \nu L_{\nu 10}/\nu L_{\nu 7.7}$: **Si Self Abs. @10$\mu$m**

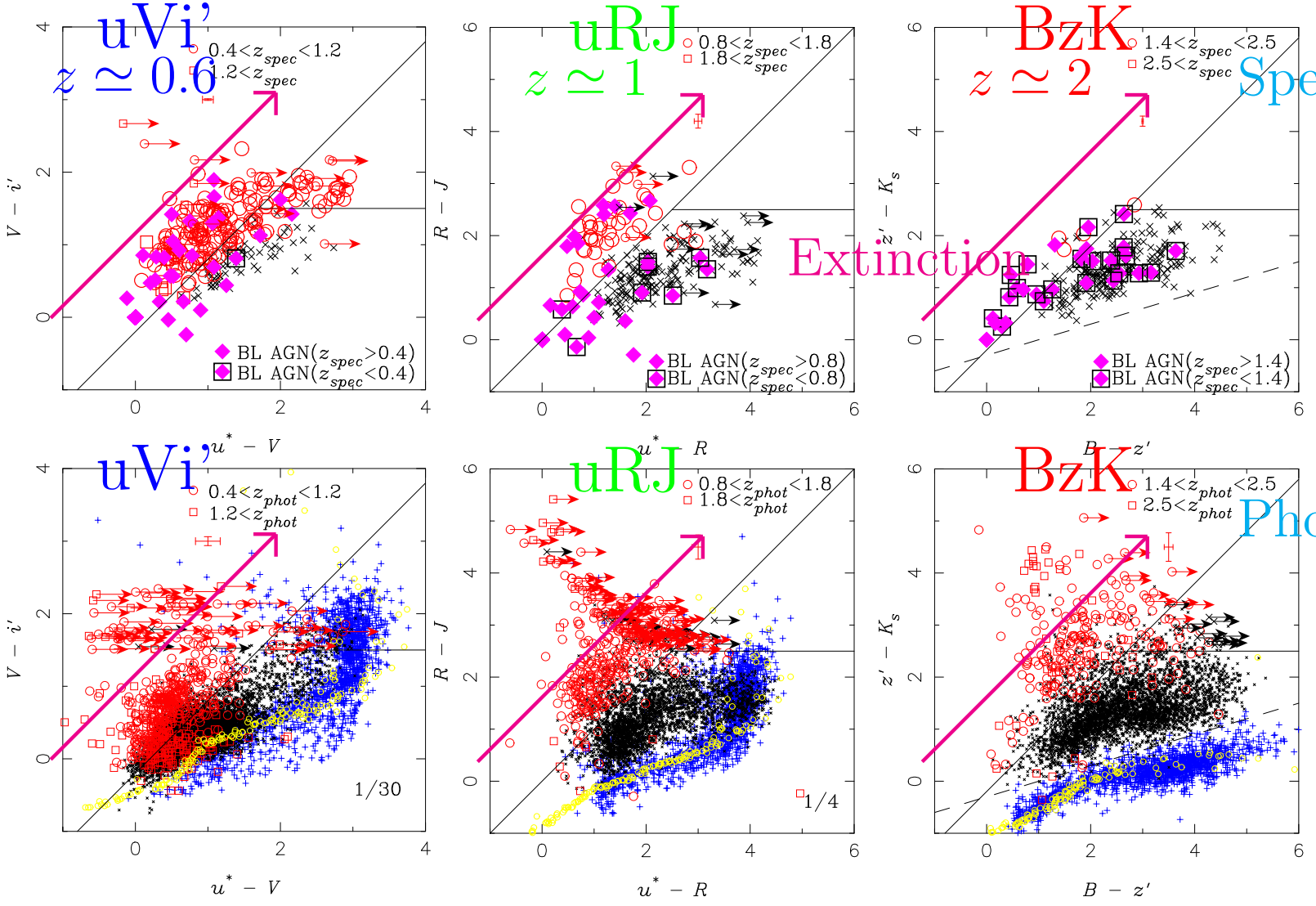
MIR marginally detected populations



4000Å/Balmer Break & 1.6 μm Bump

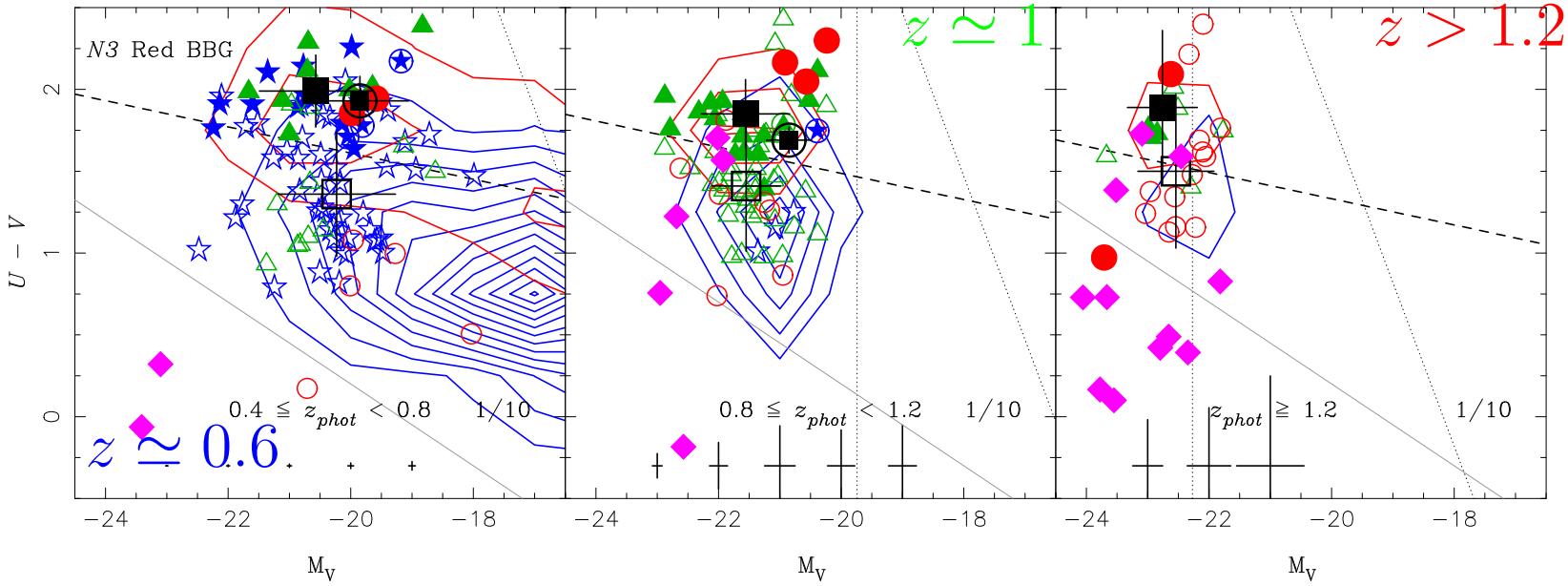


s/p-Balmer Break Galaxies(BBGs) in 3z



uVi/uRJ is $z \simeq$0.6 /1 mimic of BzK

IRBGs BBGs on M_V vs. $U-V$

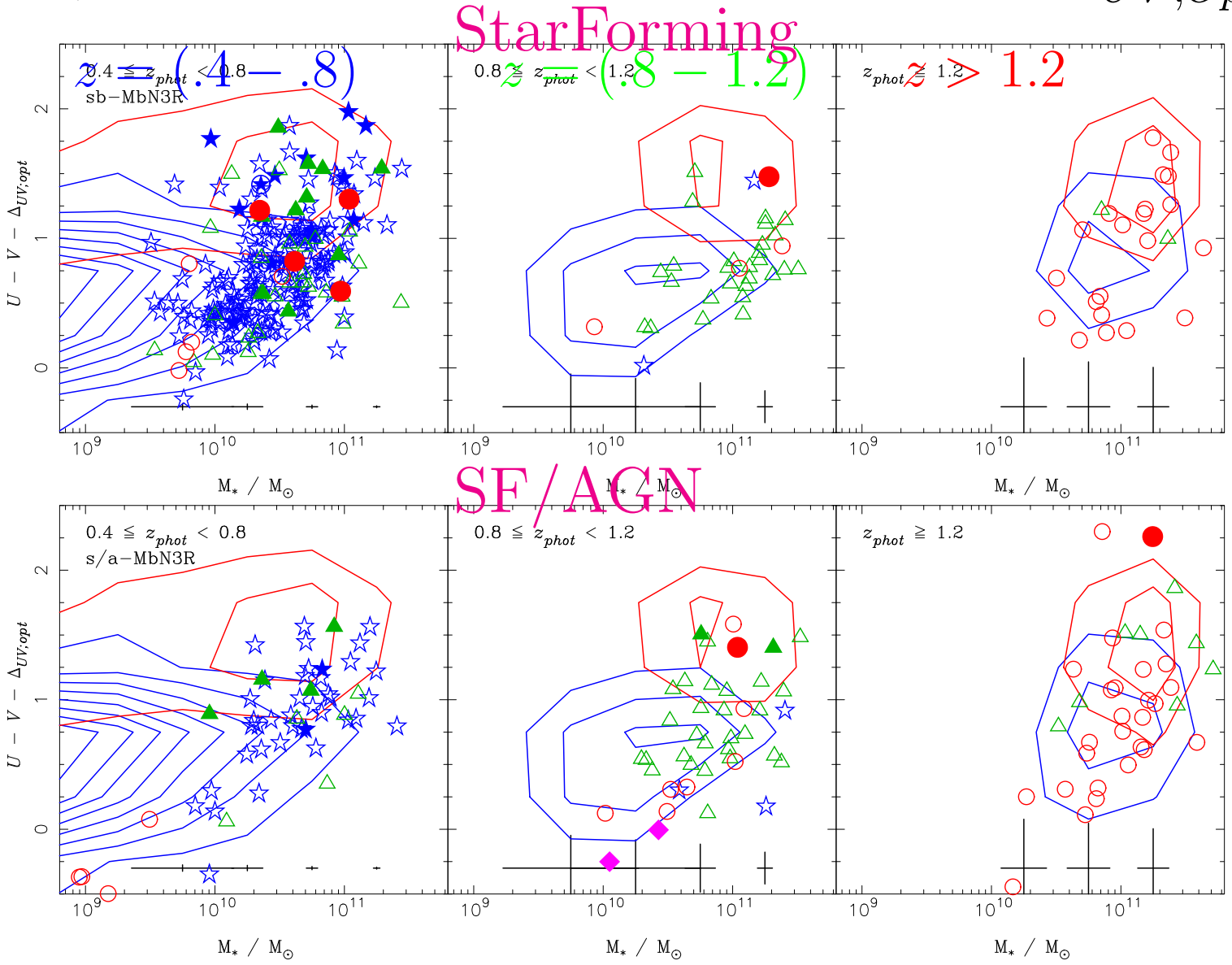


Solid; p-BBGs ↔ Red Sequene

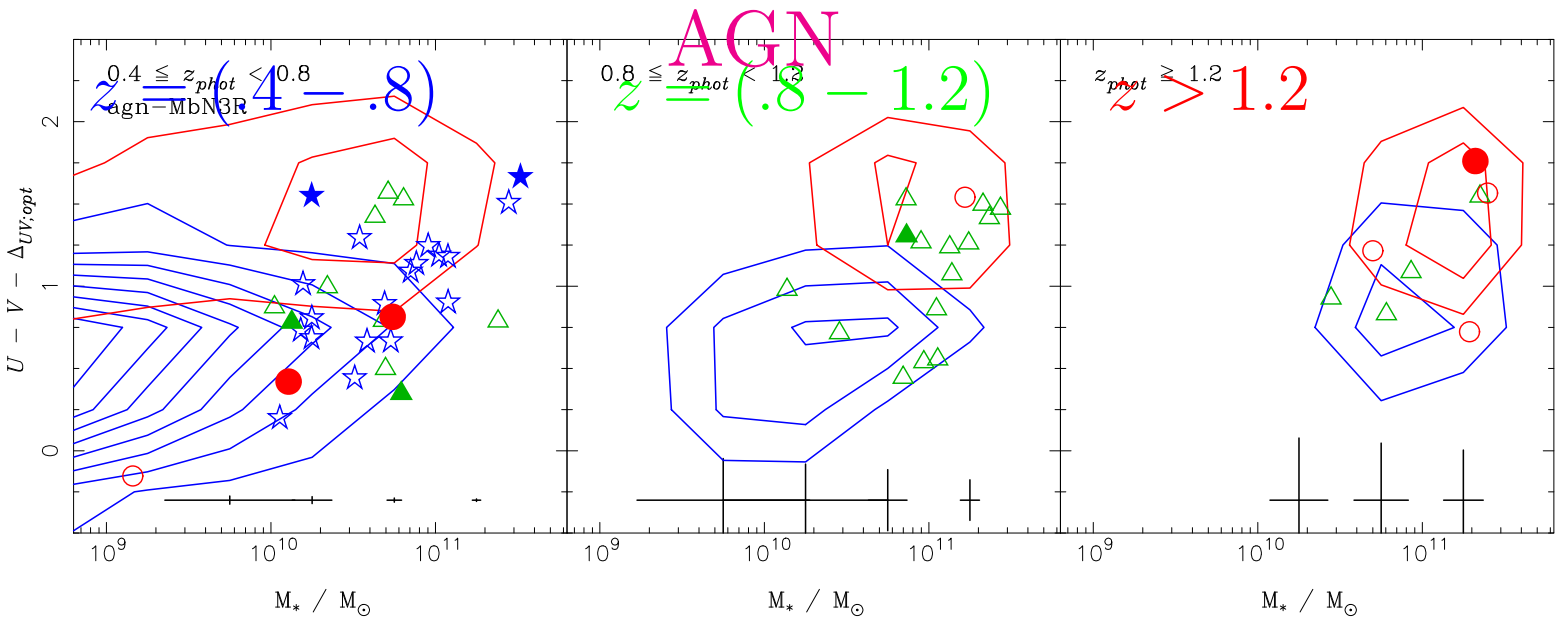
Open; s-BBGs ↔ Blue Cloud

Small Gray; z'-detected galaxies

M_* vs. $U-V-\Delta$ corrected with $A_{UV;Opt}$



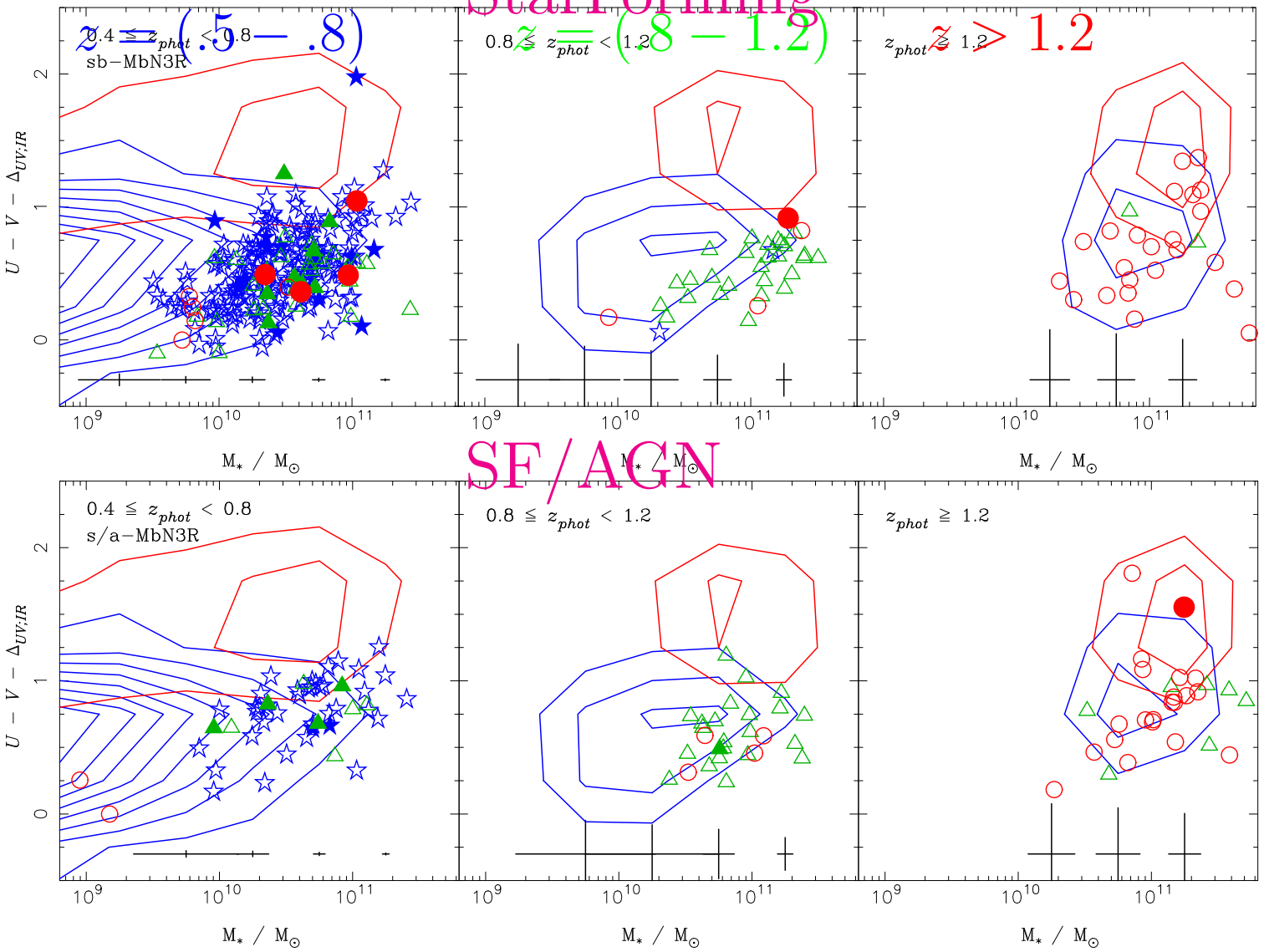
M_* vs. $U-V-\Delta$ corrected with $A_{UV;Opt}$



- **Bimodal S.P.** @$z < 1$: Red S. and Blue Cl.
- **Stellar Pop. in s-LIRGs is Blue** @$z < 1$
- **AGN-LIRGs in Green** @$z \sim 1$

M_* vs. $U - V - \Delta$ corrected with $A_{UV;IR}$

StarForming



$z \simeq (.5 - .8)$ $z \simeq (.8 - 1.2)$ $z > 1.2$

SF/AGN

$A_{UV;IR} \simeq A_{UV:Opt} + 0.4$