Luminous buried AGNs in the local universe ULIRGs

origin of galaxy down-sizing ?

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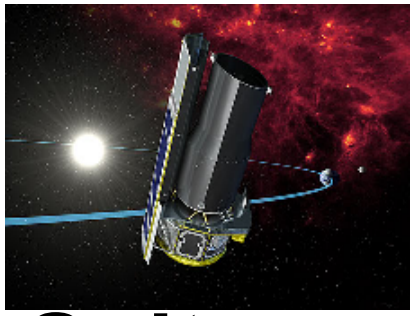
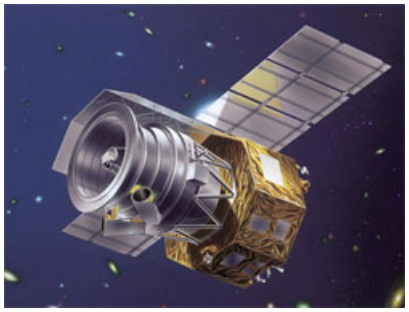
Subaru



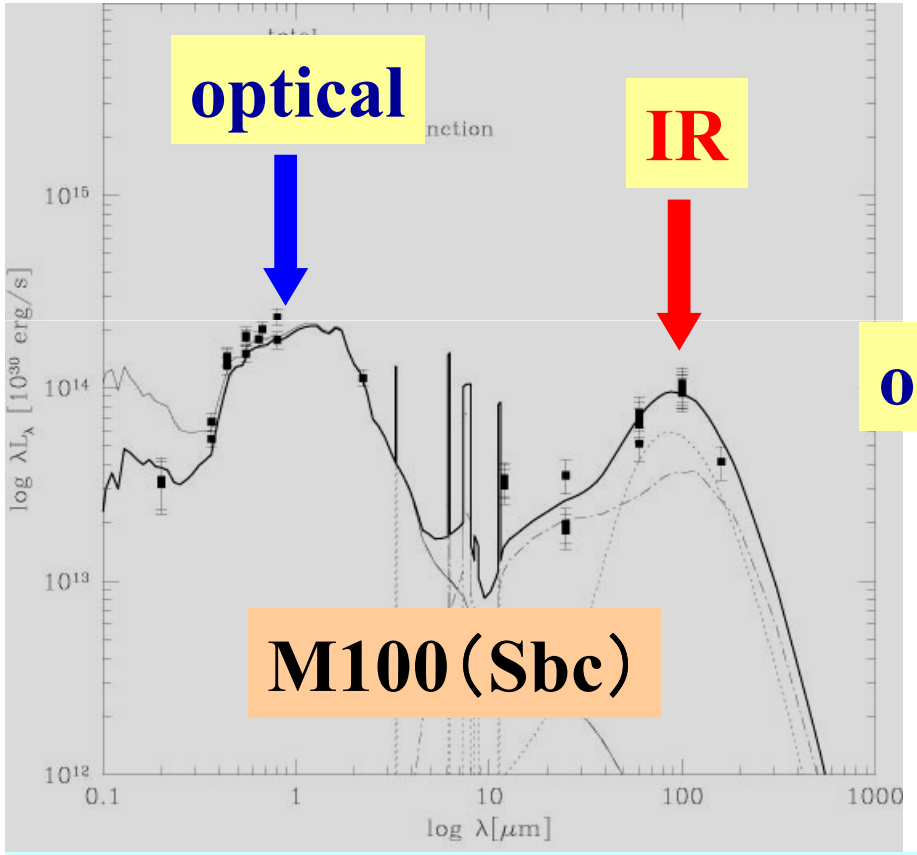
Spitzer

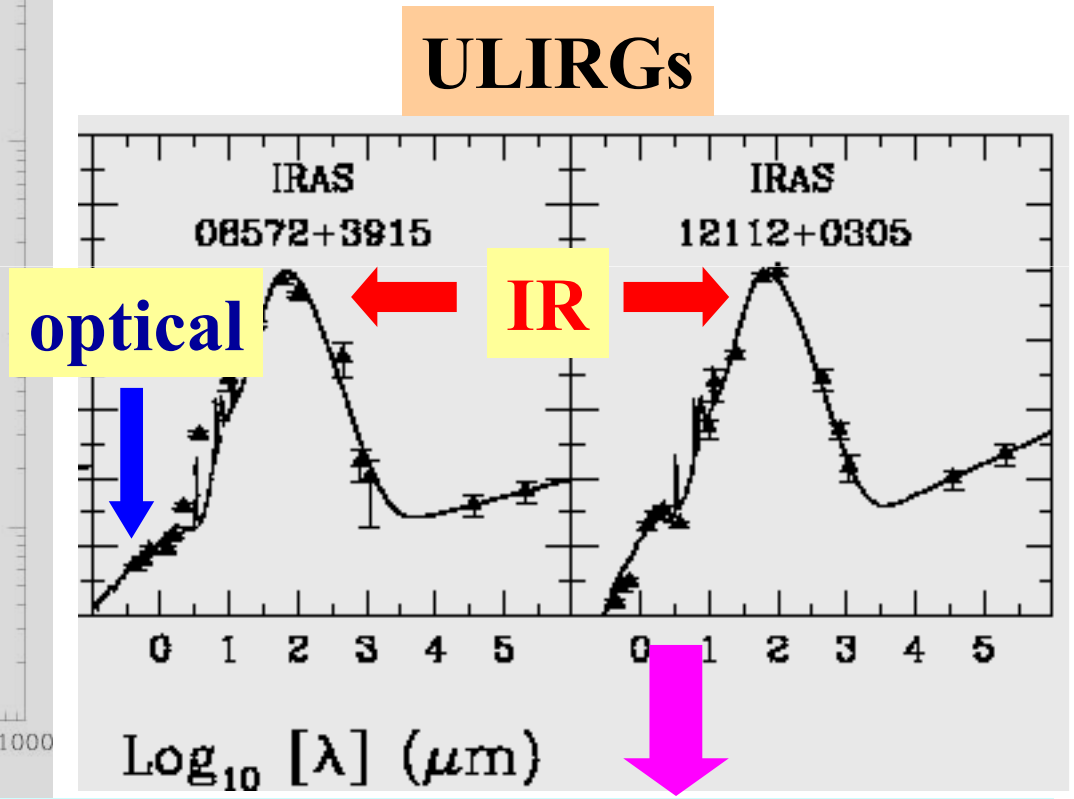


AKARI

Ultraluminous infrared galaxies（ULIRGs）

L(IR) > 10^12 Lsun (Normal spiral ~ 10^10 Lsun)



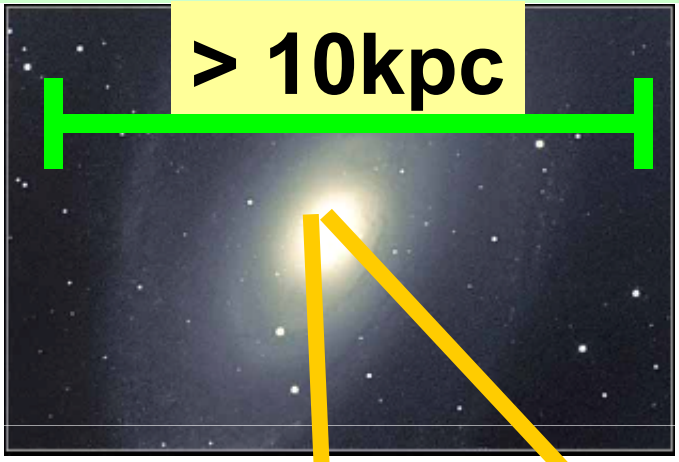


Luminous energy source is hidden behind dust

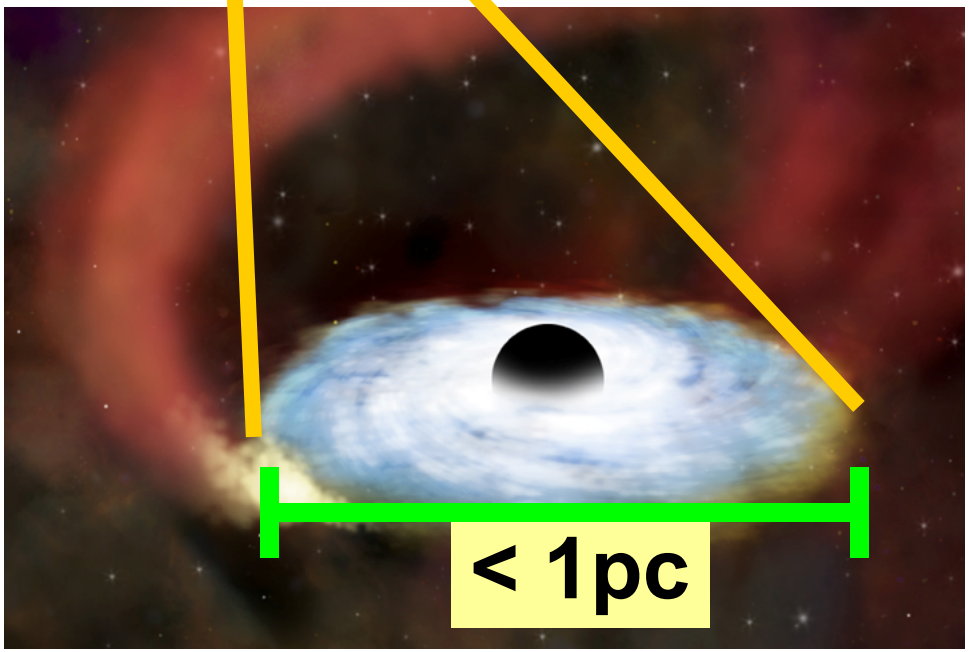
ULIRGs L(IR) > 10^12Lsun

→ Luminous energy sources behind dust

Starburst



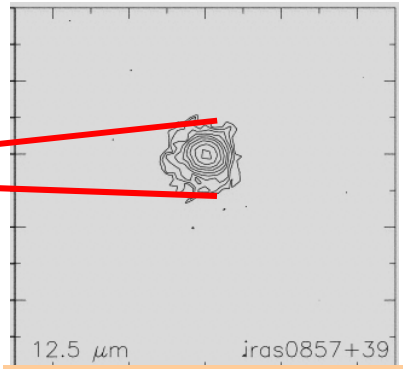
AGN



Mass accretion onto supermassive blackholes（>10^6Mo）

Nearby ULIRGs (z < 0.3)

optical

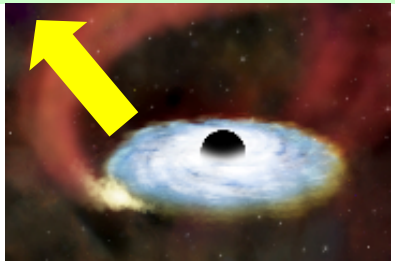


IR(12um)

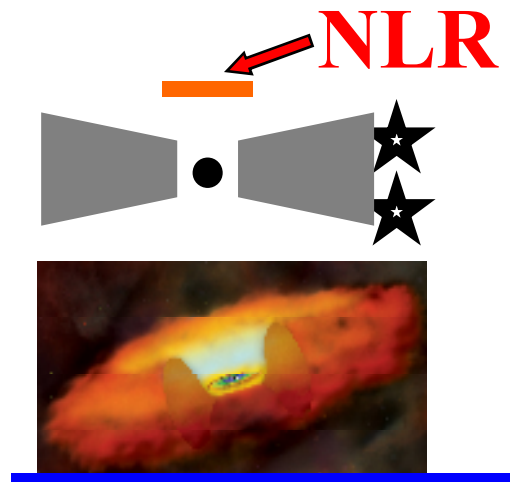
Soifer et al. 2000

Compact cores (<500pc) are energetically dominant

Very compact starburst or AGN ?



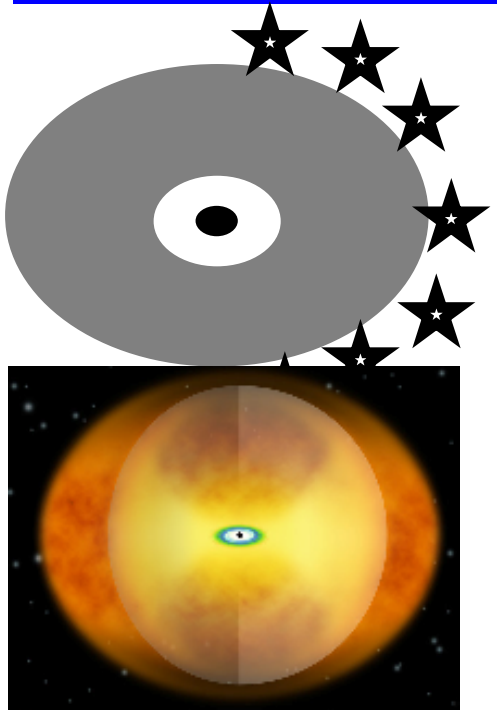
AGNs in ULIRGs are buried



AGNs obscured by torus-shaped dust

Sy2

Detectable via optical spectroscopy



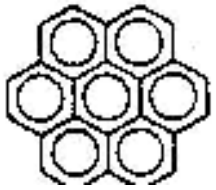
ULIRGs have a large amount of nuclear gas and dust

Buried AGNs are elusive

70% ULIRGs = non-Sy

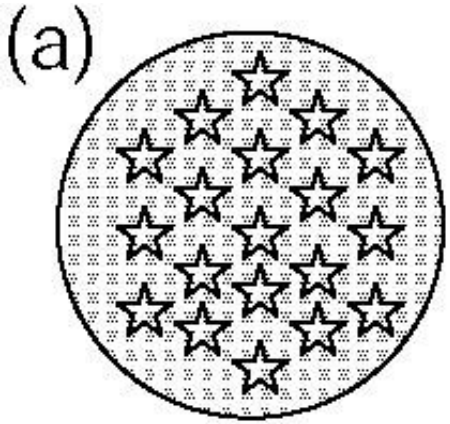
1. Infrared spectral shape

PAH



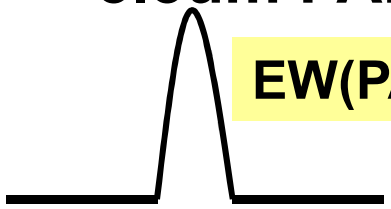
PAHs are excited in starburst PDRs but destroyed near an AGN

Starburst(SB) **Buried AGN** **AGN+SB**

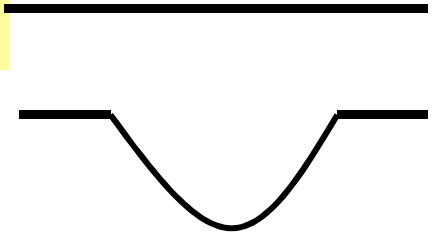


3.3um PAH

EW(PAH)~100nm

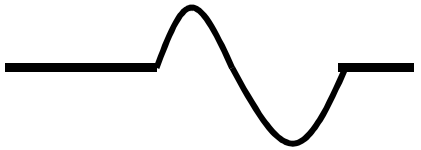


featureless



3.4um/3.1um

EW(PAH)<<100nm



2. Dust absorption feature strength

starburst

Buried AGN

ULIRG core
<500pc

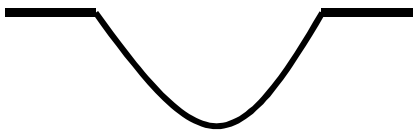
Mixed dust model

$$\frac{1-\exp(-\mathrm{Tau})}{\mathrm{Tau}}$$

Foreground screen dust model

exp(-Tau)

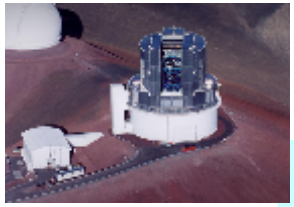
Dust absorption feature: weak



strong

3-4 um

z<0.15

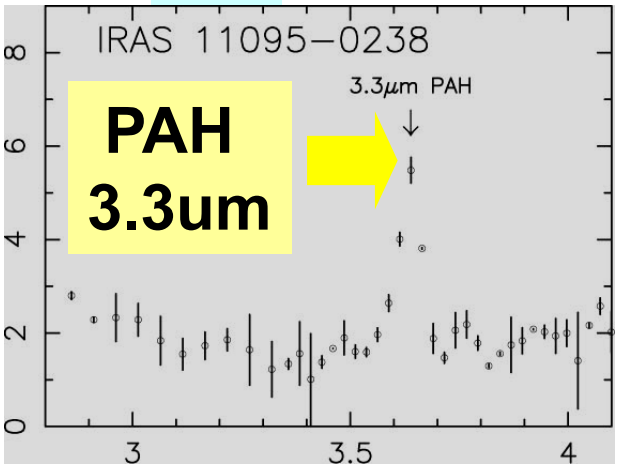


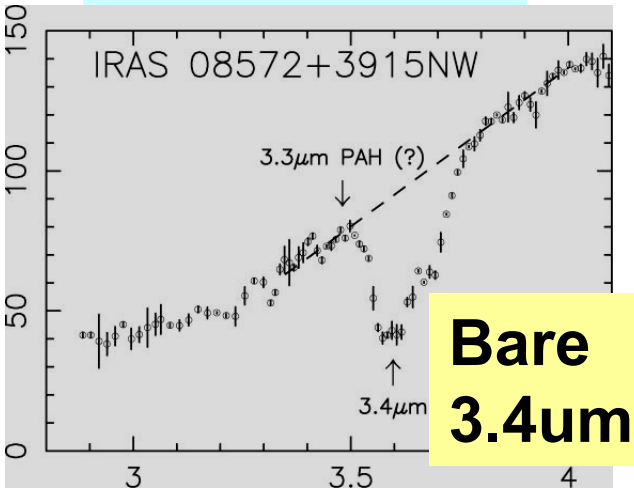
Subaru

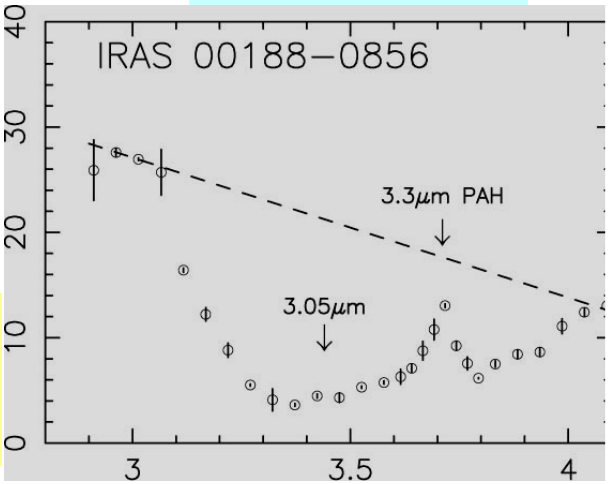
SB

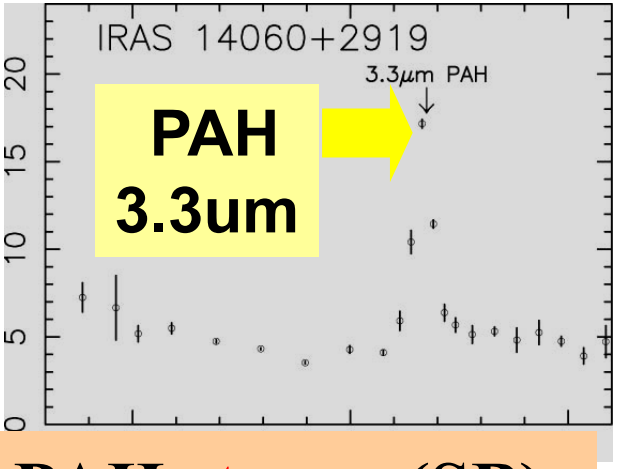
Buried AGN

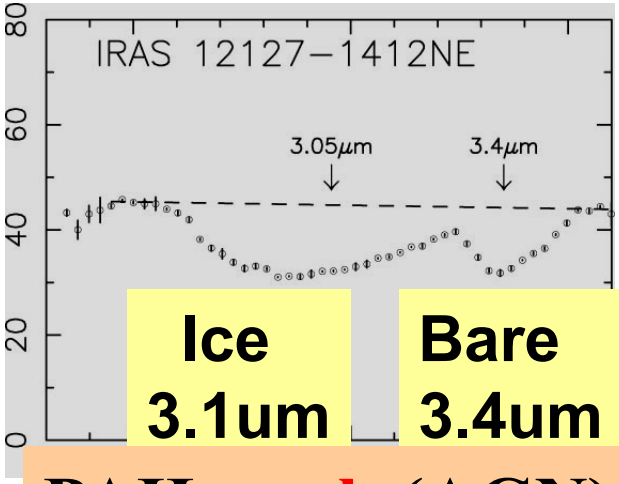
AGN+SB

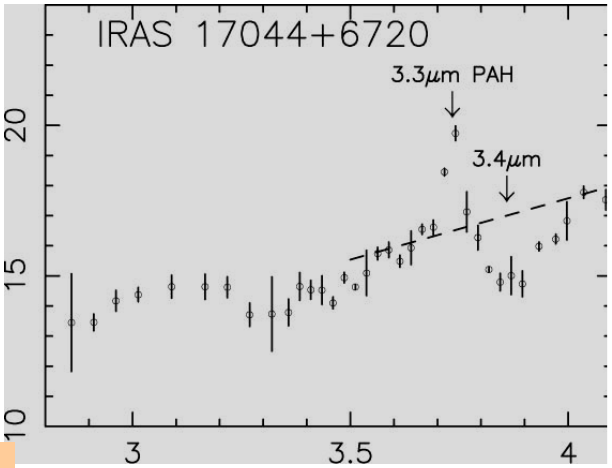












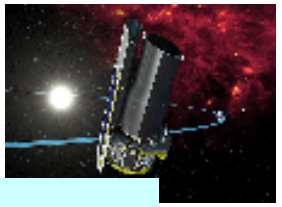
PAH strong (SB):
Dust abs. weak

PAH weak (AGN):
Dust abs. strong

wavelength

5-35 um

z<0.15

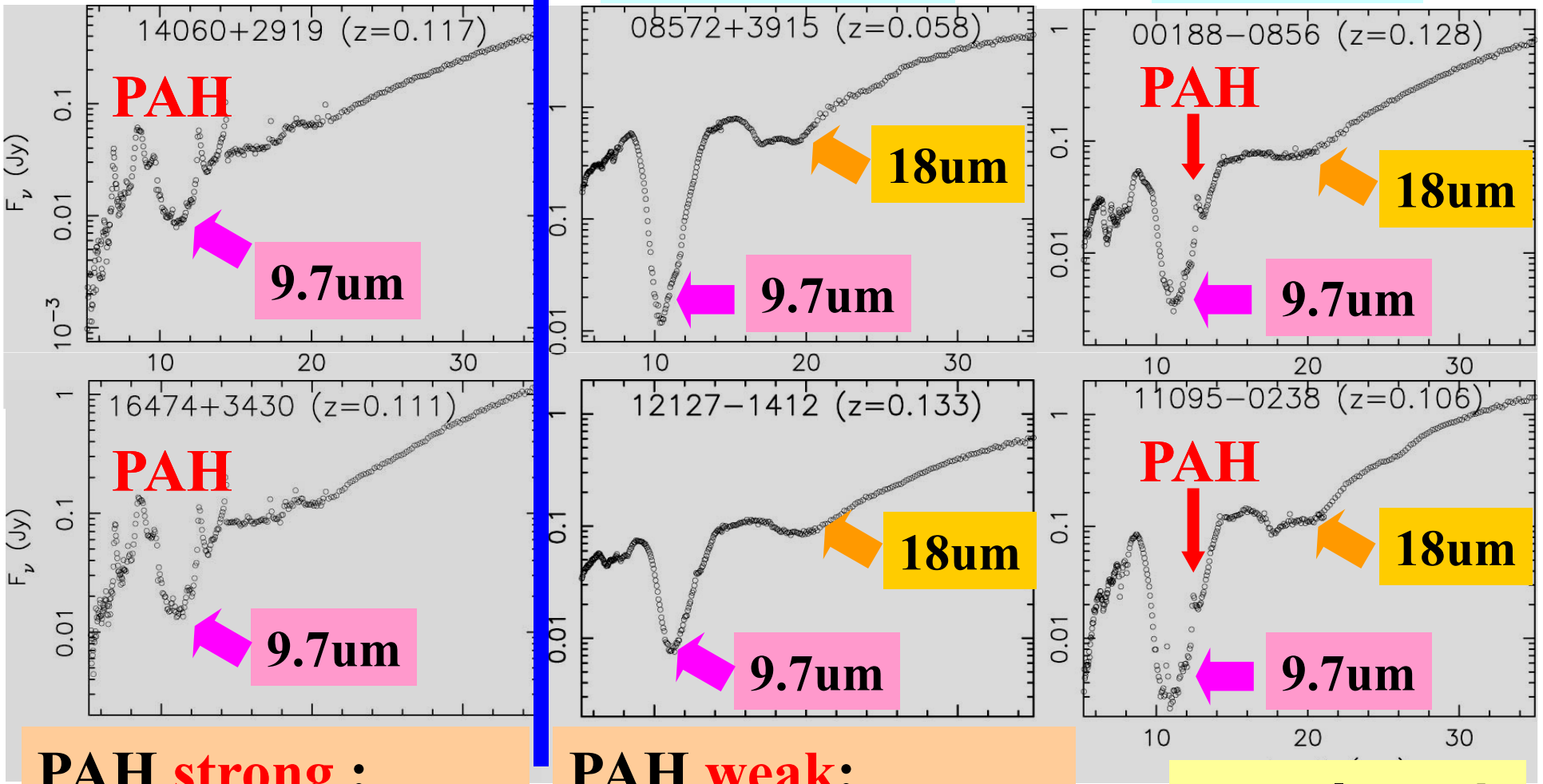


Spitzer GO1

SB

Buried AGN

AGN+SB

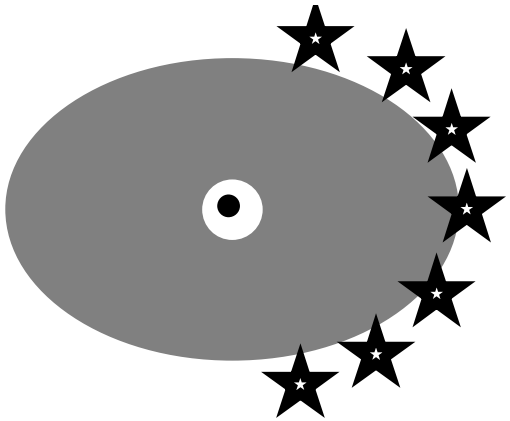


PAH strong :
Silicate Abs. weak

PAH weak:
Silicate Abs. strong

Results

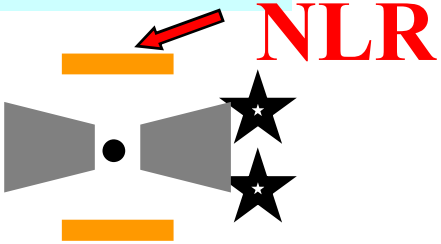
nearby(z<0.15)



Opical non-Seyfert ULIRGs

→ Luminous buried AGNs = 30-50%

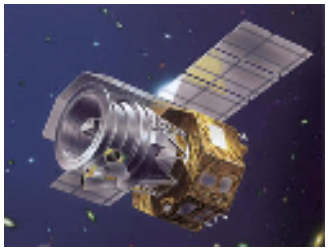
30% ULIRGs = optical Sy (AGN + torus)



↓

>50% ULIRGs = luminous AGN

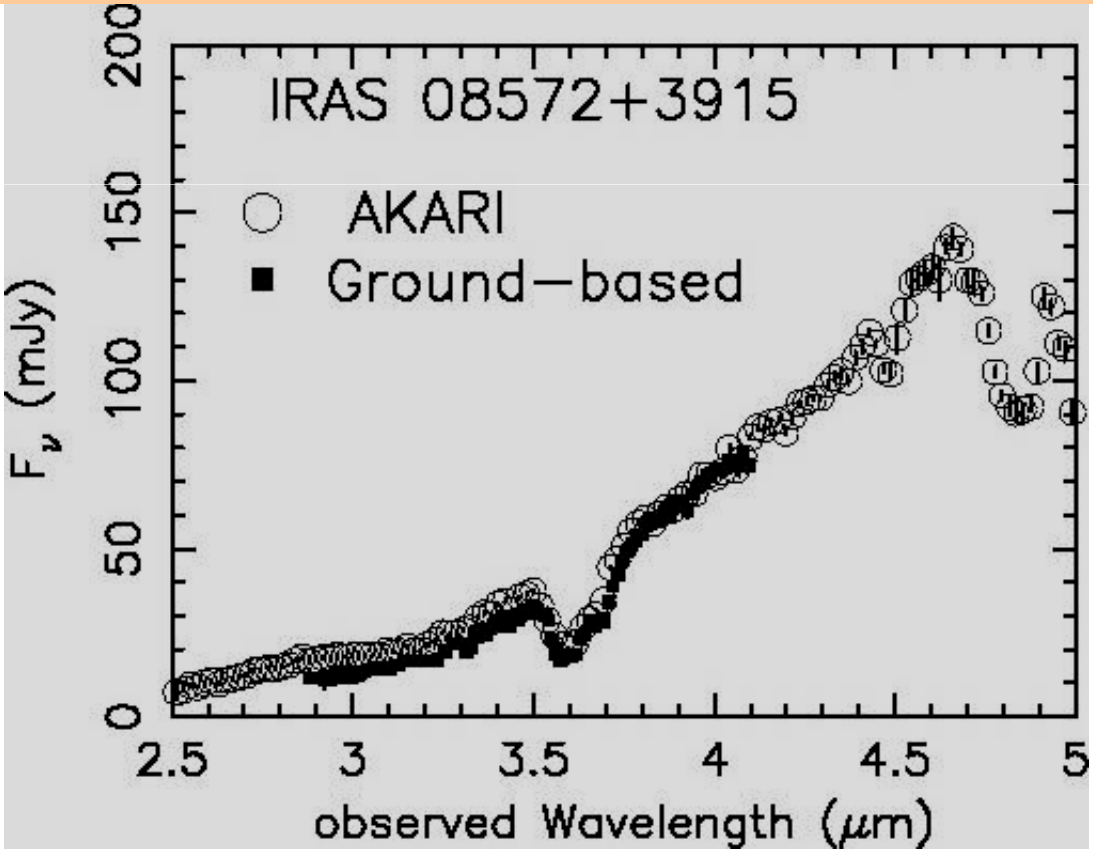
AKARI



2.5-5 um spectroscopy

Unaffected by Earth's atmosphere

z > 0.15
ULIRG



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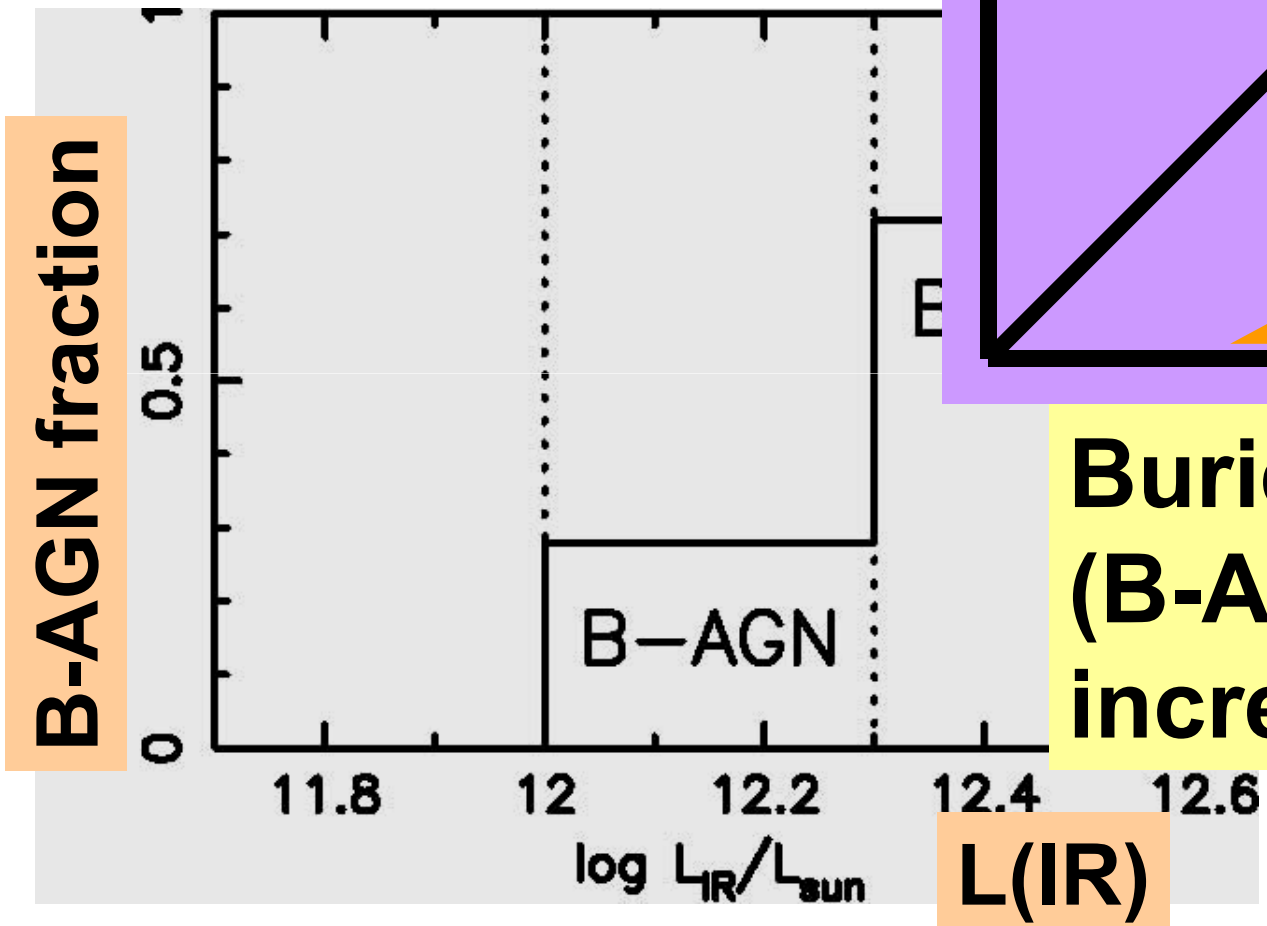
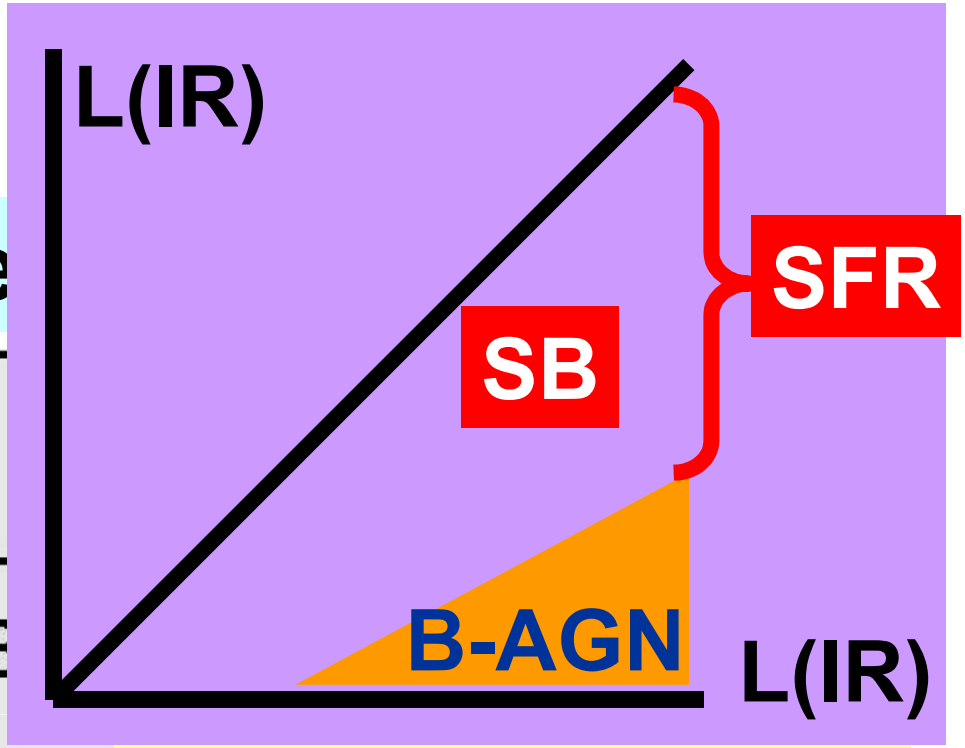
Spitzer

z>0.15

Highe

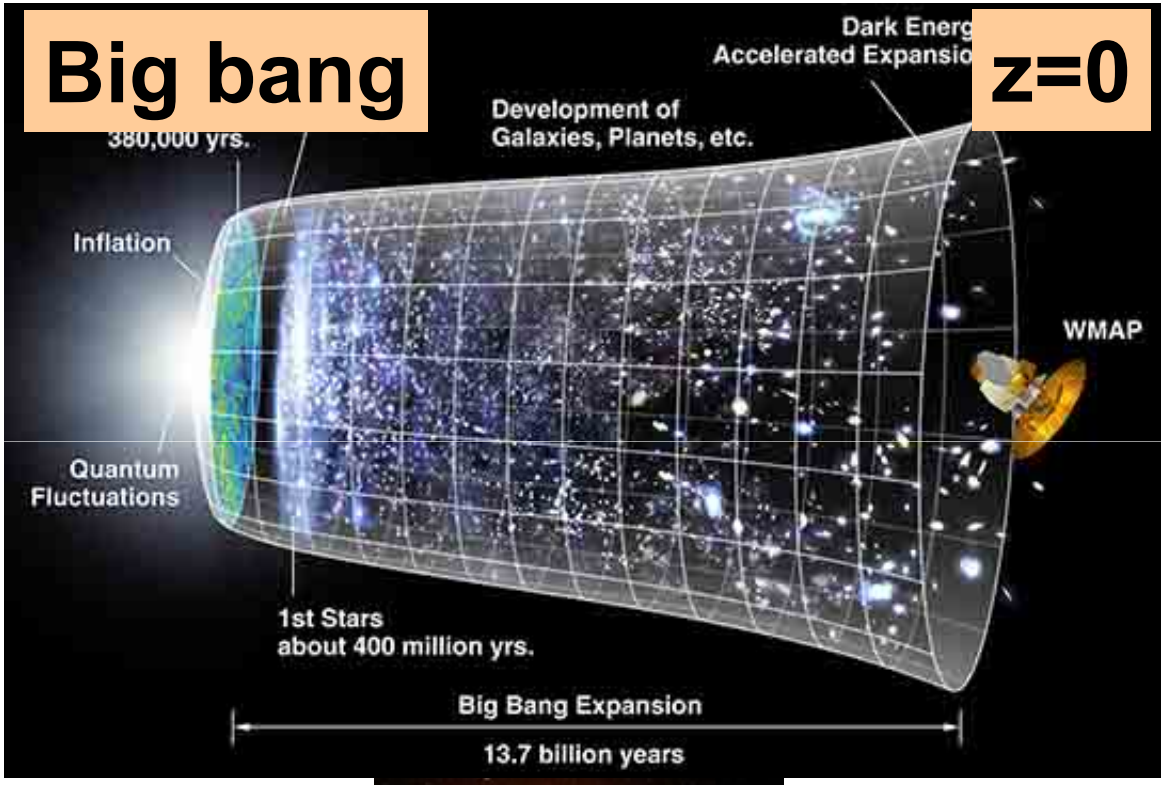




Buried AGNs (B-AGN) increase with L_{IR}

Galaxy down-sizing

More massive galaxies have finished major SF at higher-z

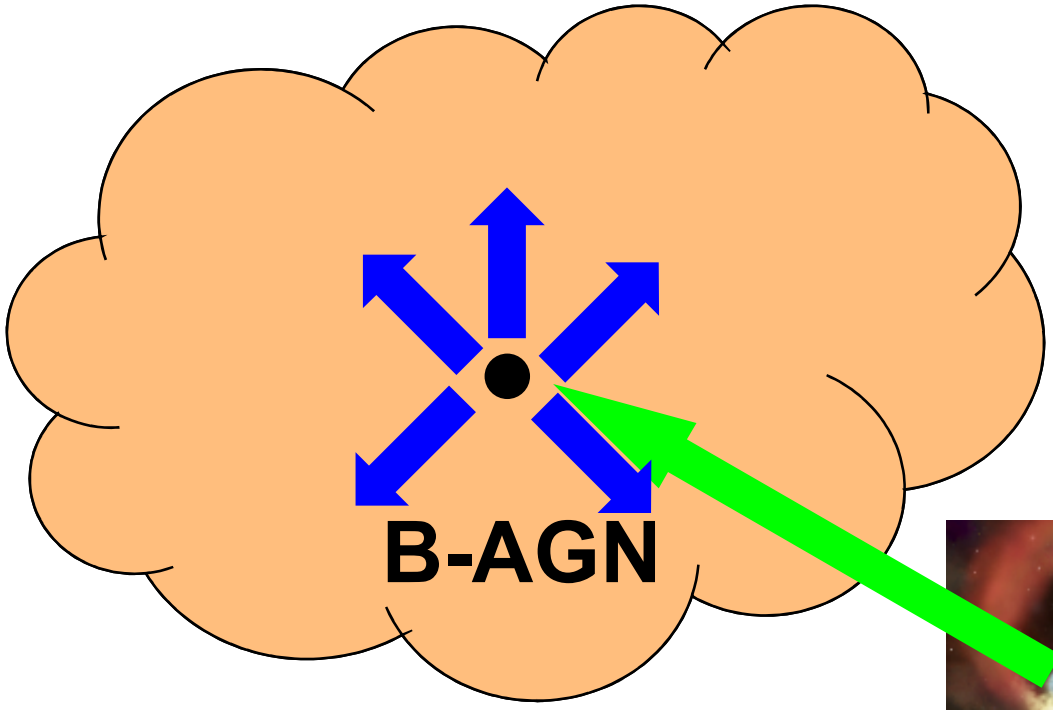


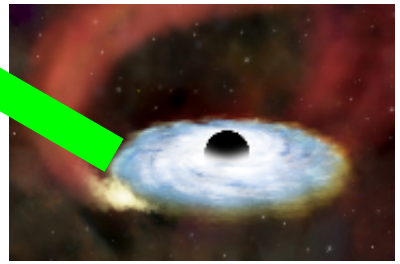
high-z ⬅

➡ **low-z**

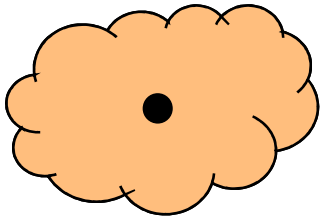
AGN feebback

massive galaxies



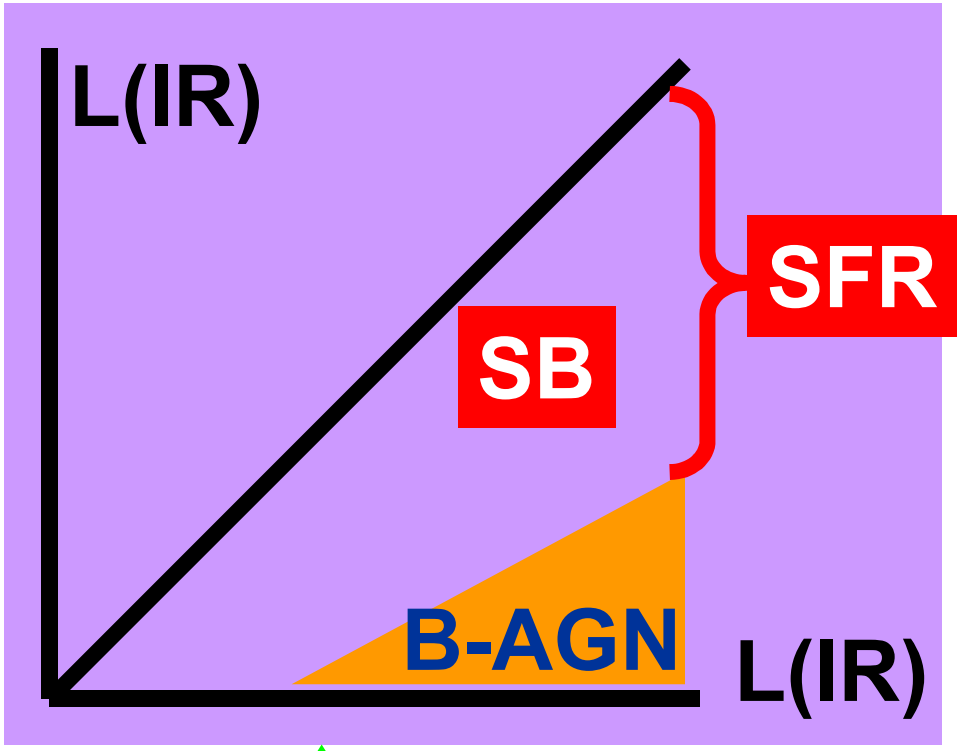


less massive



AGN weak

AGN-feedback for galaxy down-sizing ?



low M(star)

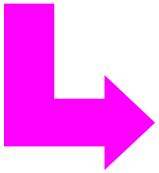
high M(star)

M(star) ~ several x 10^10Msun

Summary

1. Buried AGNs : 30-50% non-Sy ULIRGs

2. B-AGN increase with L(IR) (= high Mstar)



AGN feedback for galaxy down-sizing ?

Imanishi et al. 2006 ApJ 637 114 (Subaru)
Imanishi et al. 2007 ApJS 171 72 (Spitzer)
Imanishi et al. 2008 PASJ 60 S489 (AKARI)
Imanishi 2009 ApJ 694 751(Spitzer2)

End