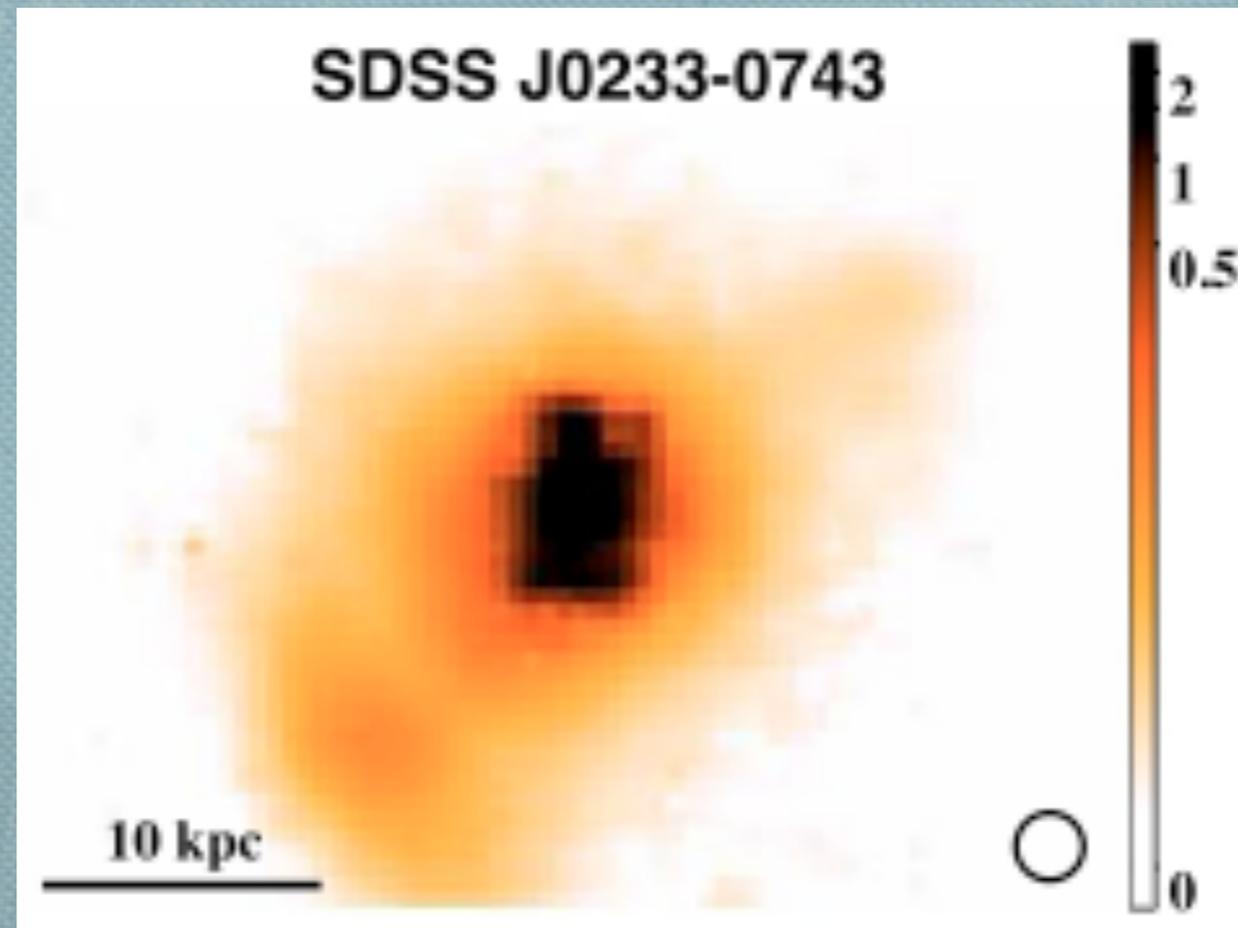


# Poster talk

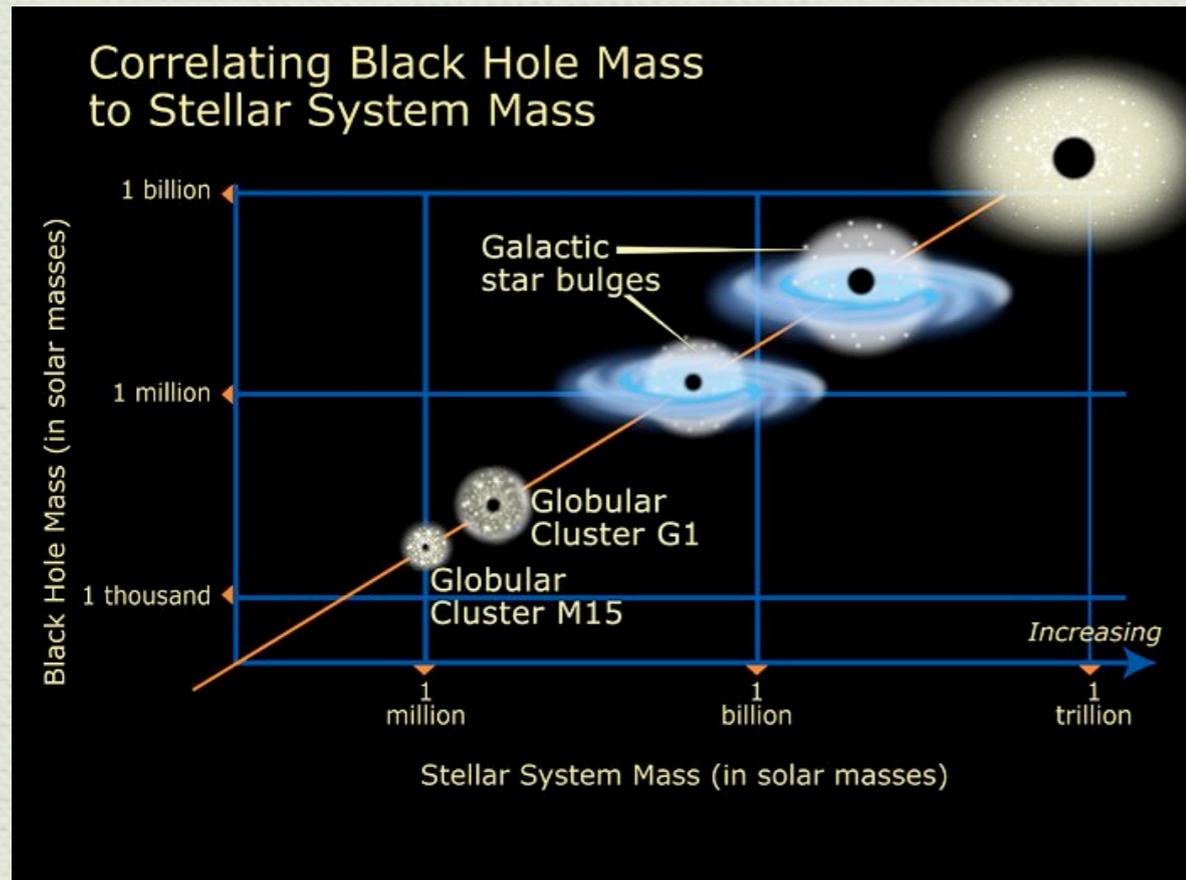


Liu+2014

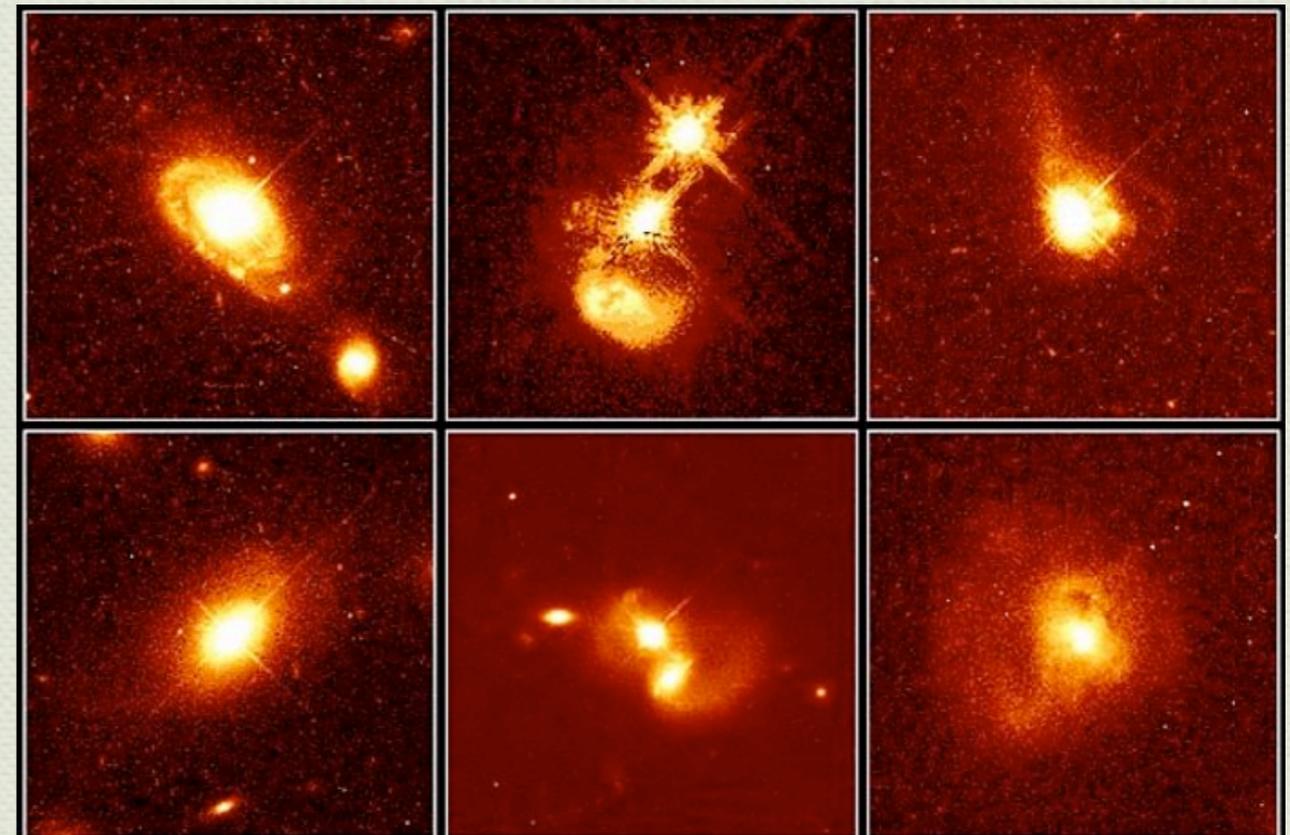
## Ionized gas outflows in $z \sim 2$ WISE-selected Hot Dust Obscured Galaxies

Hyunsung Jun (KIAS), Hot DOG collaboration - Roberto Assef (UDP), Peter Eisenhardt, Daniel Stern (JPL), Chao-Wei Tsai (UCLA), Jingwen Wu (NAOC), et al.

# SMBHs and AGNs



NASA/ESA and A. Feild (STScI)



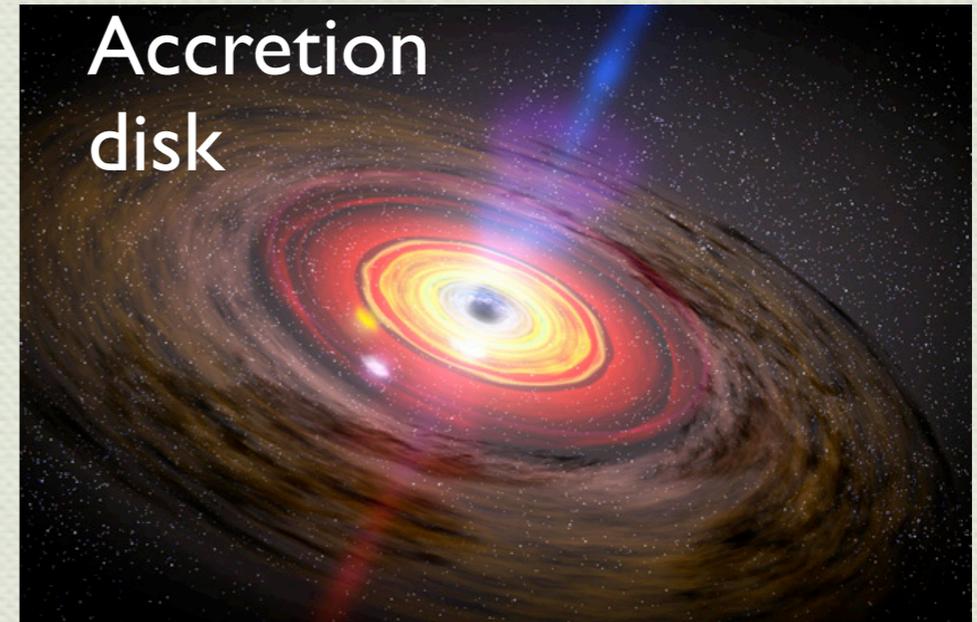
**Quasar Host Galaxies** HST • WFPC2  
PRC96-35a • ST ScI OPO • November 19, 1996  
J. Bahcall (Institute for Advanced Study), M. Disney (University of Wales) and NASA

◆ Supermassive black hole (SMBH) : center of stellar systems and galaxies

◆ Active Galactic Nuclei (AGN) : Galaxy centers where SMBH is accreting matter and shining

# AGN feedback

- ❖ Quasar mode : accretion onto the SMBH produces radiative feedback
- ❖ Radio mode : accelerated jet produces kinetic feedback
- ❖ AGN feedback heats up and pushes away surrounding gas/dust



Accretion  
disk

NASA/Dana Berry, SkyWorks Digital



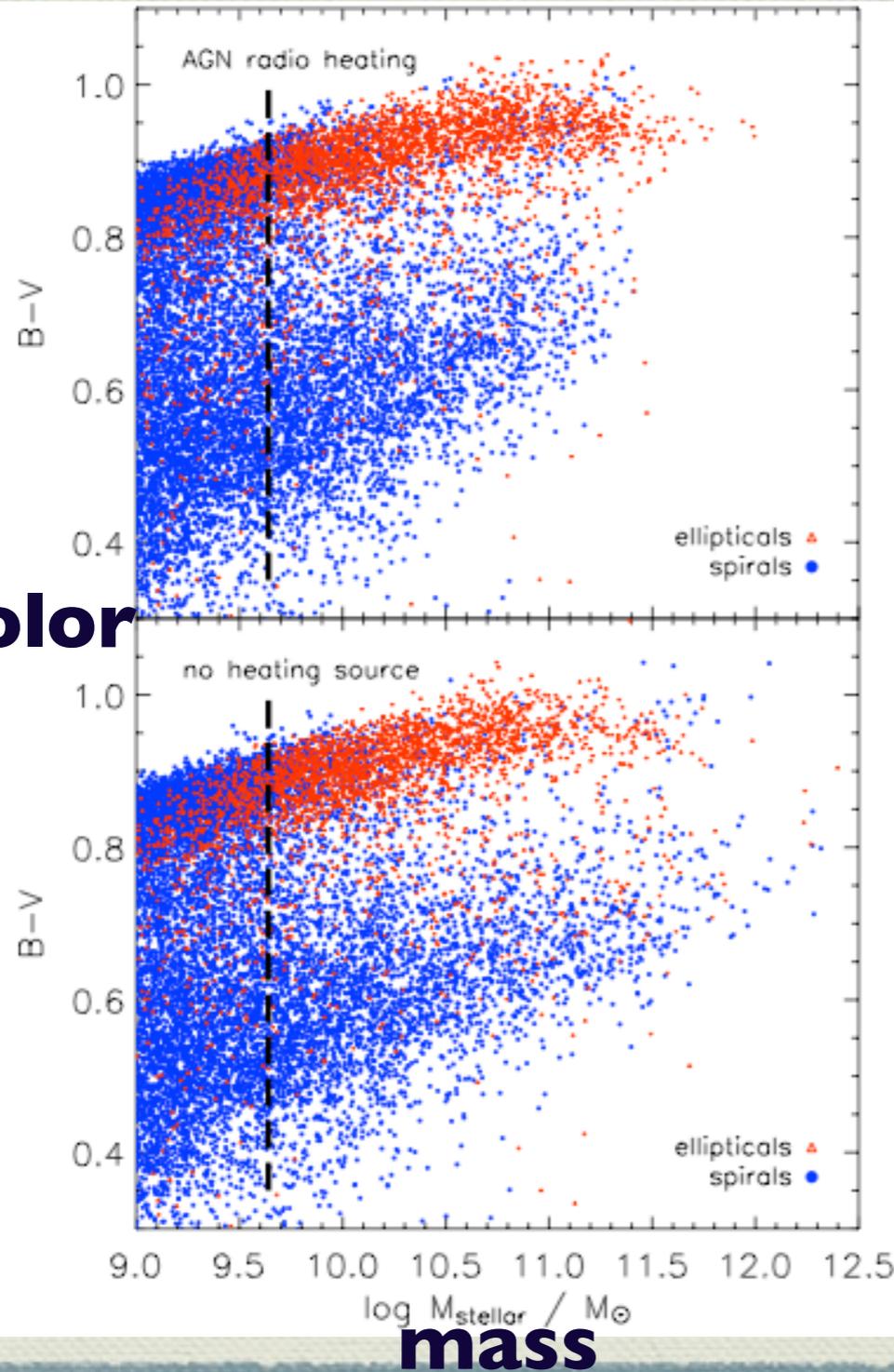
Jet

NASA / SOFIA / Lynette Cook

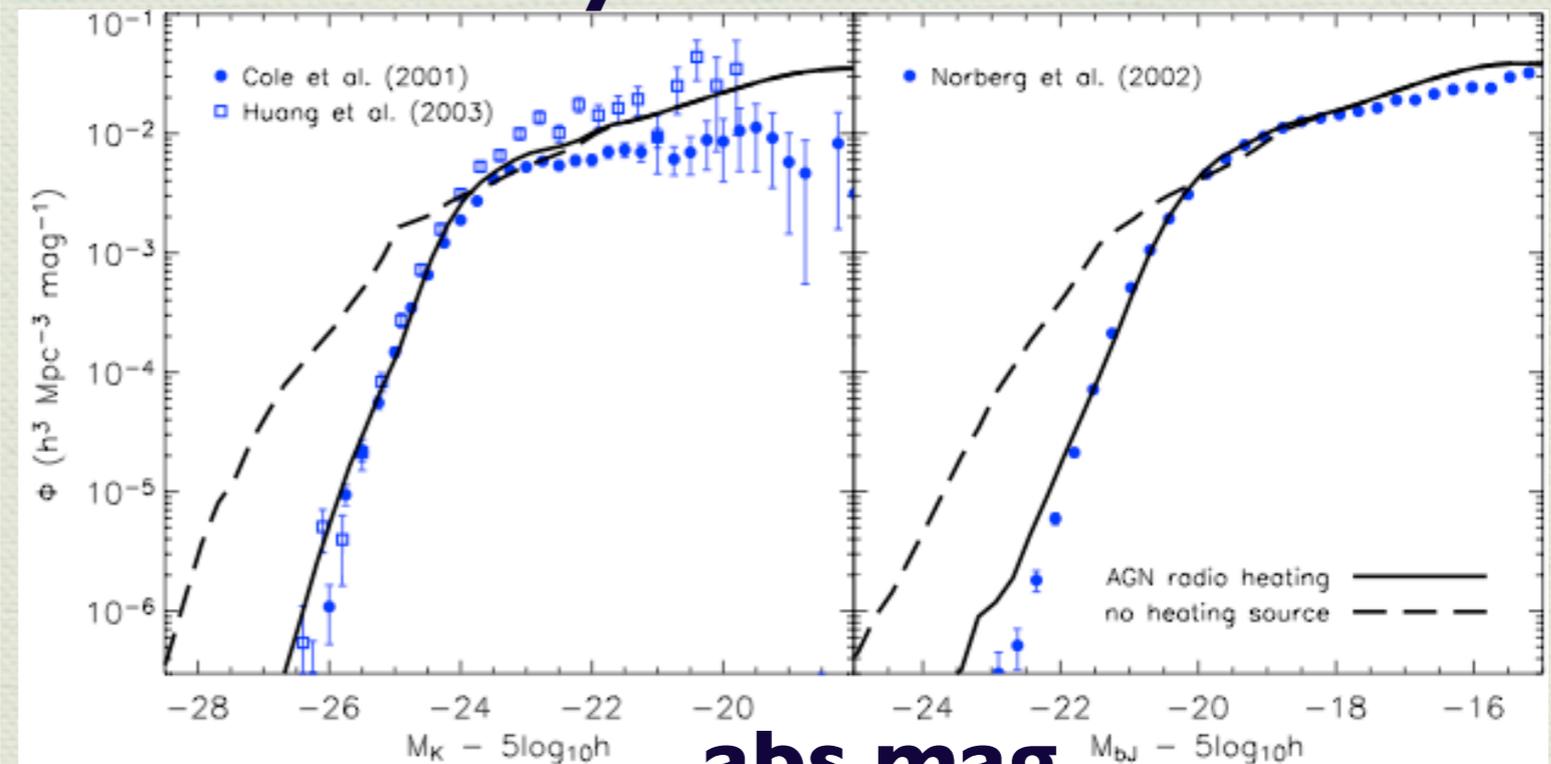
# AGN feedback

number density

color



mass



Croton+2006

abs mag

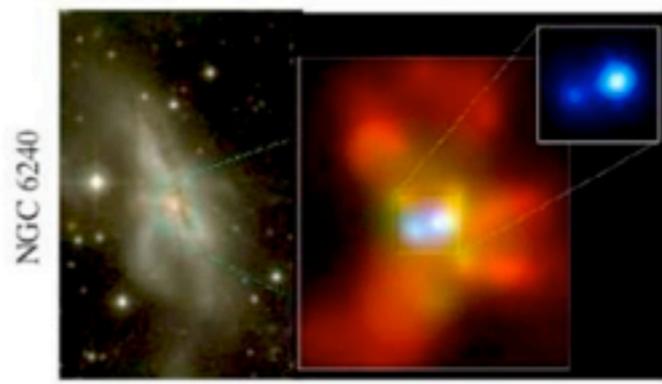
- AGN feedback makes colors redder
- AGN feedback reduces number of massive galaxies

(c) Interaction/"Merger"



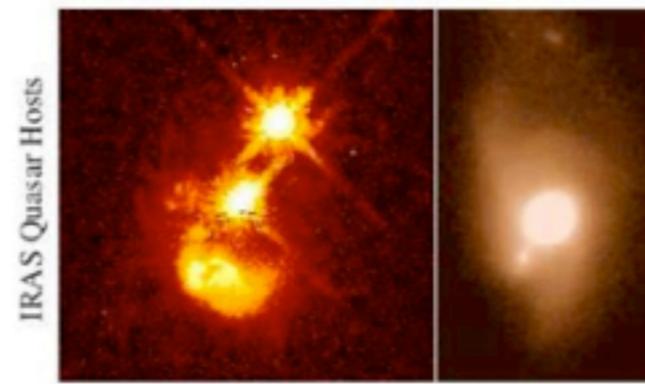
- now within one halo, galaxies interact & lose angular momentum
- SFR starts to increase
- stellar winds dominate feedback
- rarely excite QSOs (only special orbits)

(d) Coalescence/(U)LIRG



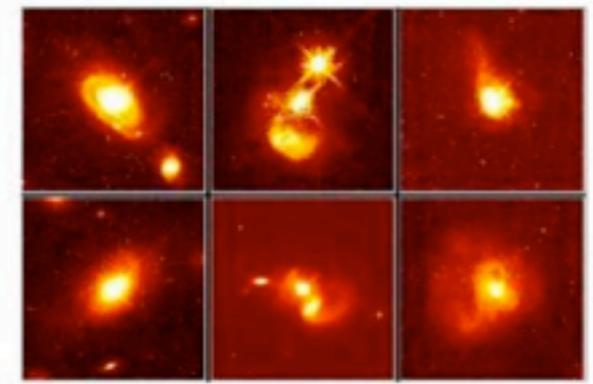
- galaxies coalesce: violent relaxation in core
- gas inflows to center: starburst & buried (X-ray) AGN
- starburst dominates luminosity/feedback, but, total stellar mass formed is small

(e) "Blowout"



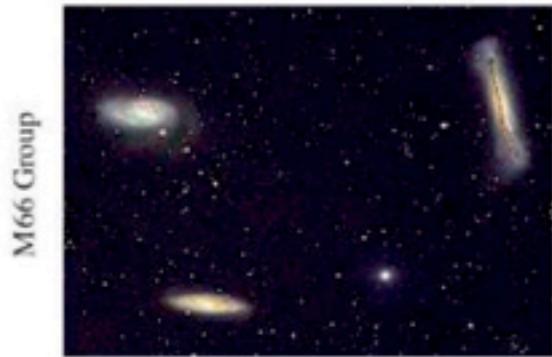
- BH grows rapidly: briefly dominates luminosity/feedback
- remaining dust/gas expelled
- get reddened (but not Type II) QSO: recent/ongoing SF in host
- high Eddington ratios
- merger signatures still visible

(f) Quasar



- dust removed: now a "traditional" QSO
- host morphology difficult to observe: tidal features fade rapidly
- characteristically blue/young spheroid

(b) "Small Group"



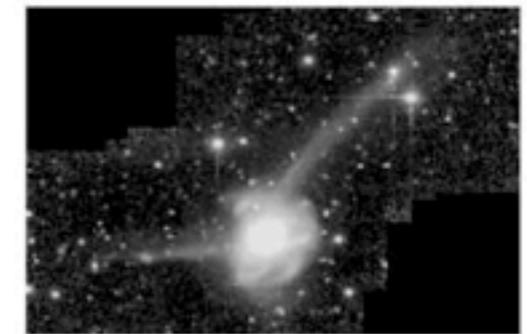
- halo accretes similar-mass companion(s)
- can occur over a wide mass range
- $M_{\text{halo}}$  still similar to before: dynamical friction merges the subhalos efficiently

(a) Isolated Disk



- halo & disk grow, most stars formed
- secular growth builds bars & pseudobulges
- "Seyfert" fueling (AGN with  $M_B > -23$ )
- cannot redden to the red sequence

(g) Decay/K+A



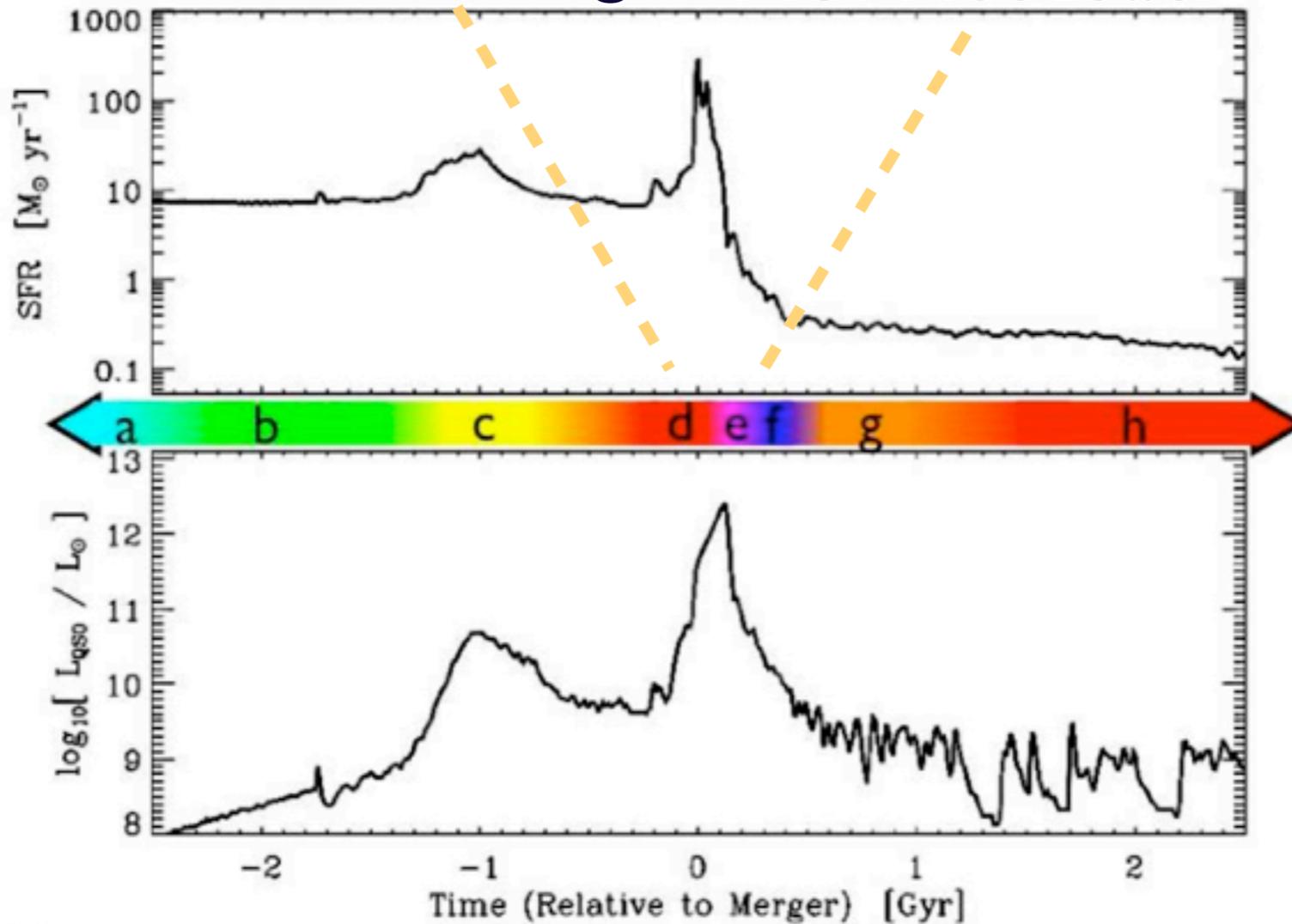
- QSO luminosity fades rapidly
- tidal features visible only with very deep observations
- remnant reddens rapidly (E+A/K+A)
- "hot halo" from feedback
- sets up quasi-static cooling

(h) "Dead" Elliptical



- star formation terminated
- large BH/spheroid - efficient feedback
- halo grows to "large group" scales: mergers become inefficient
- growth by "dry" mergers

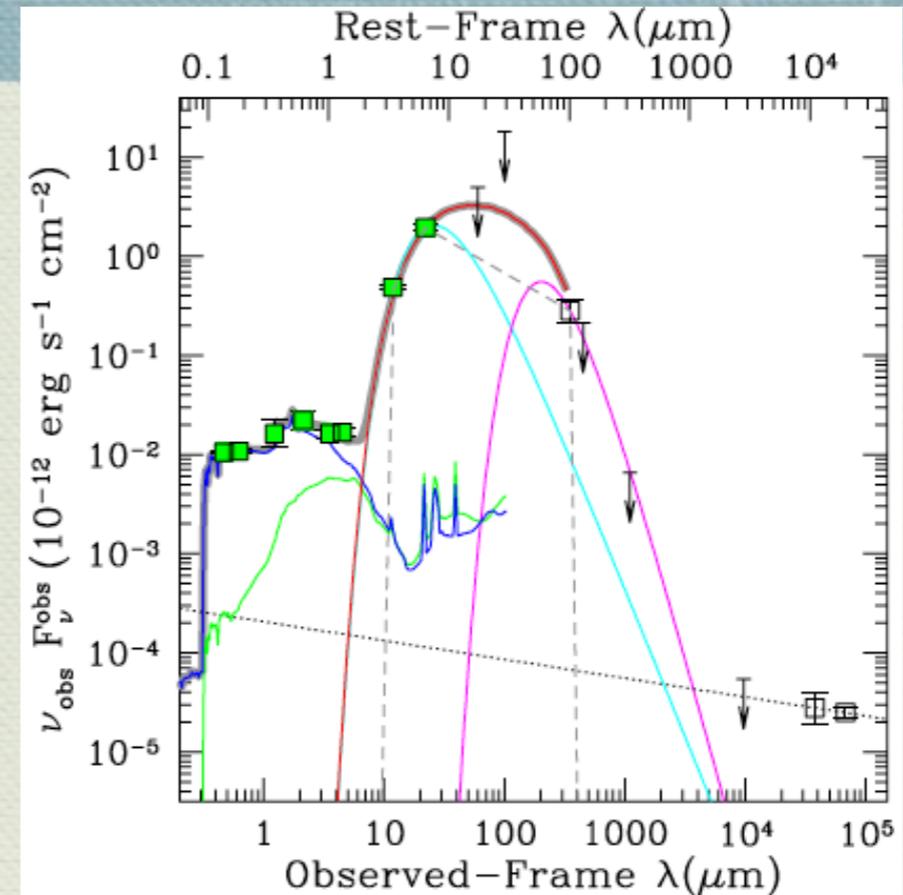
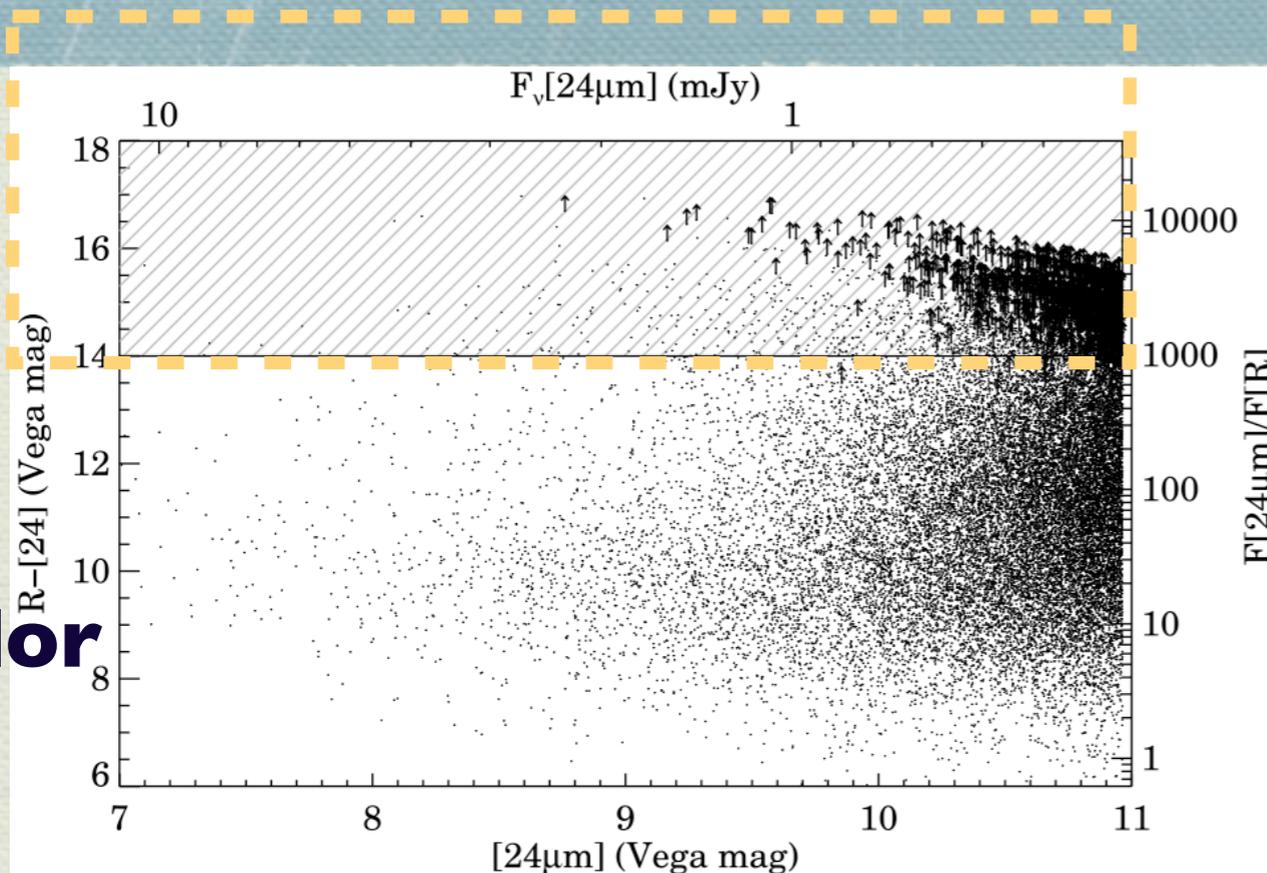
Starburst, AGN feeding, AGN feedback



Hopkins+2008

# Dust-obscured galaxies

color



Spitzer: Dey+2008

**Dust-Obscured Galaxies**  
 $z \sim 2$

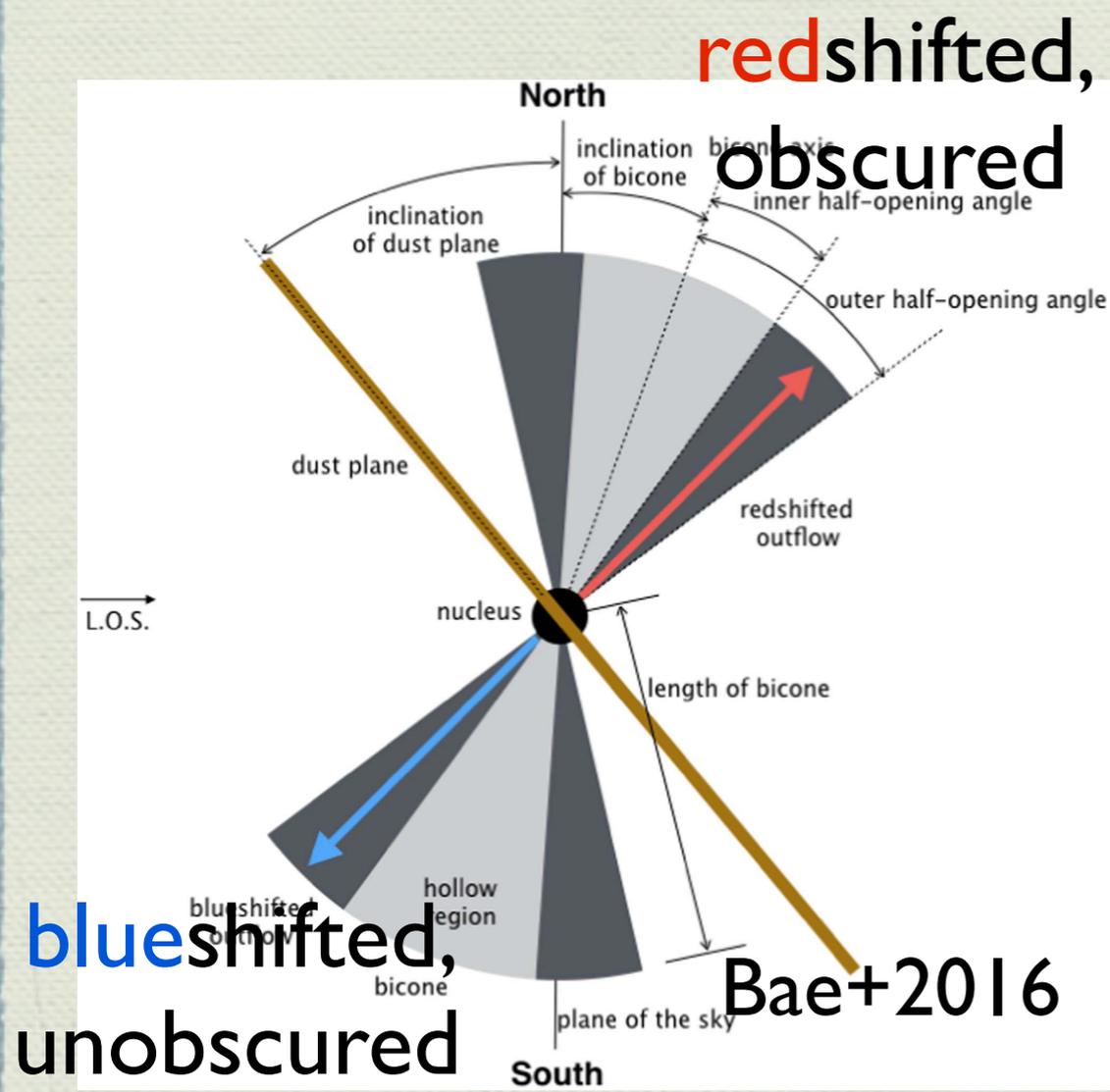
composite SF and AGN  
 $L(\text{IR}) \sim 10^{(12-13)} L_{\odot}$

WISE: Eisenhardt+2012

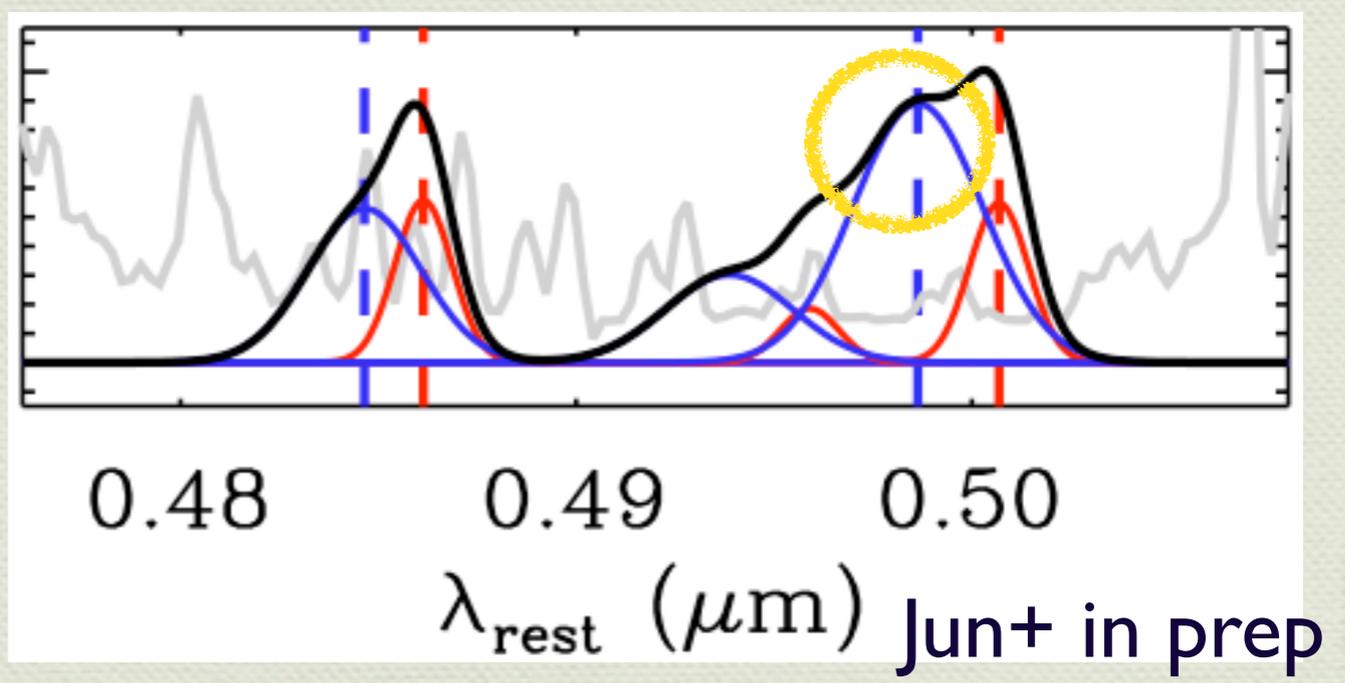
W1W2 dropouts, or **Hot DOGs**,  
 $z \sim 2-3$

extremely red, luminous AGN  
 $L(\text{IR}) \sim 10^{(13-14)} L_{\odot}$

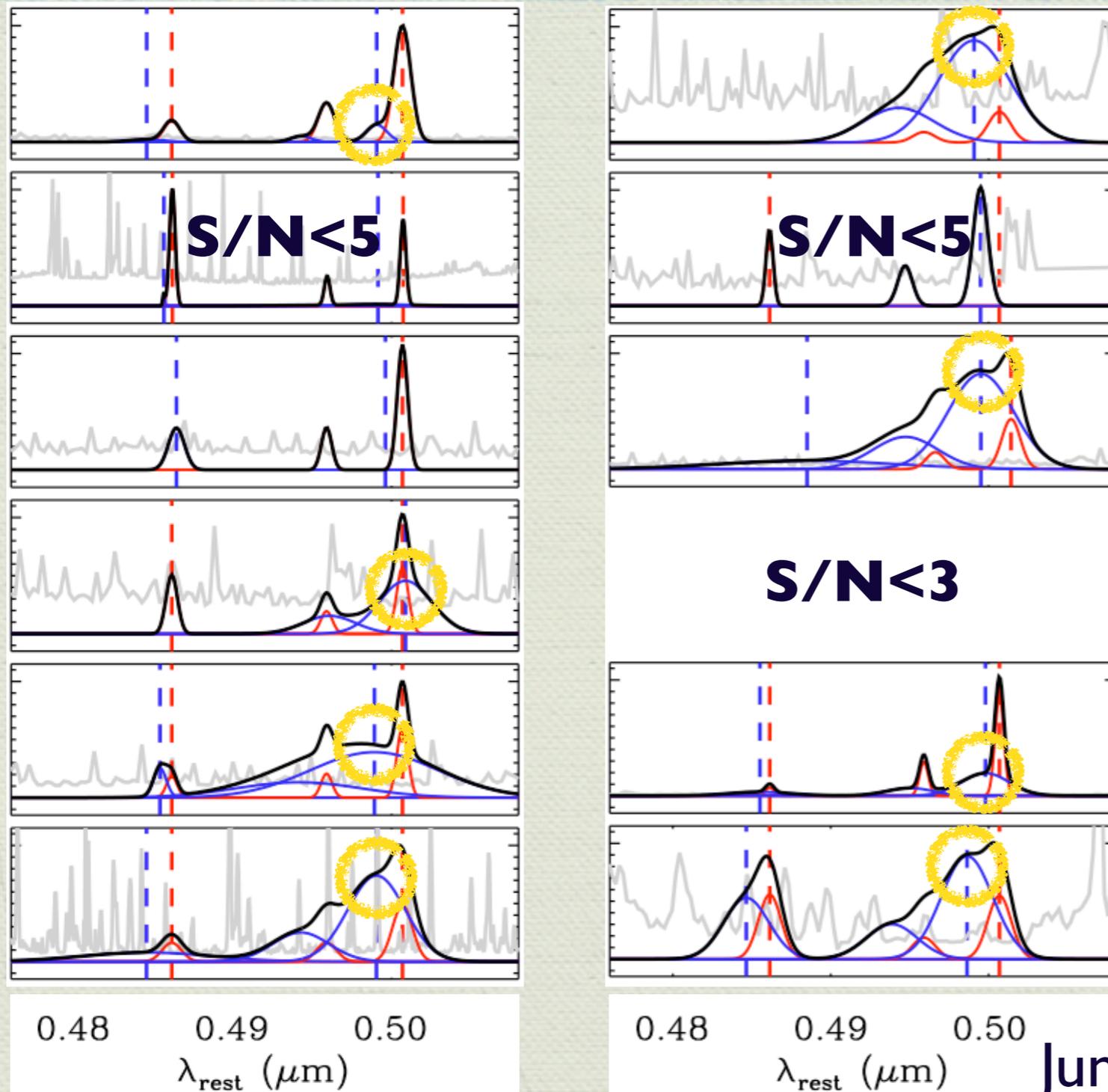
# Ionized gas outflows in Hot DOGs



Spatially extended, broad and blueshifted [OIII] $\lambda$ 5007 profiles, modeled as biconical outward motions



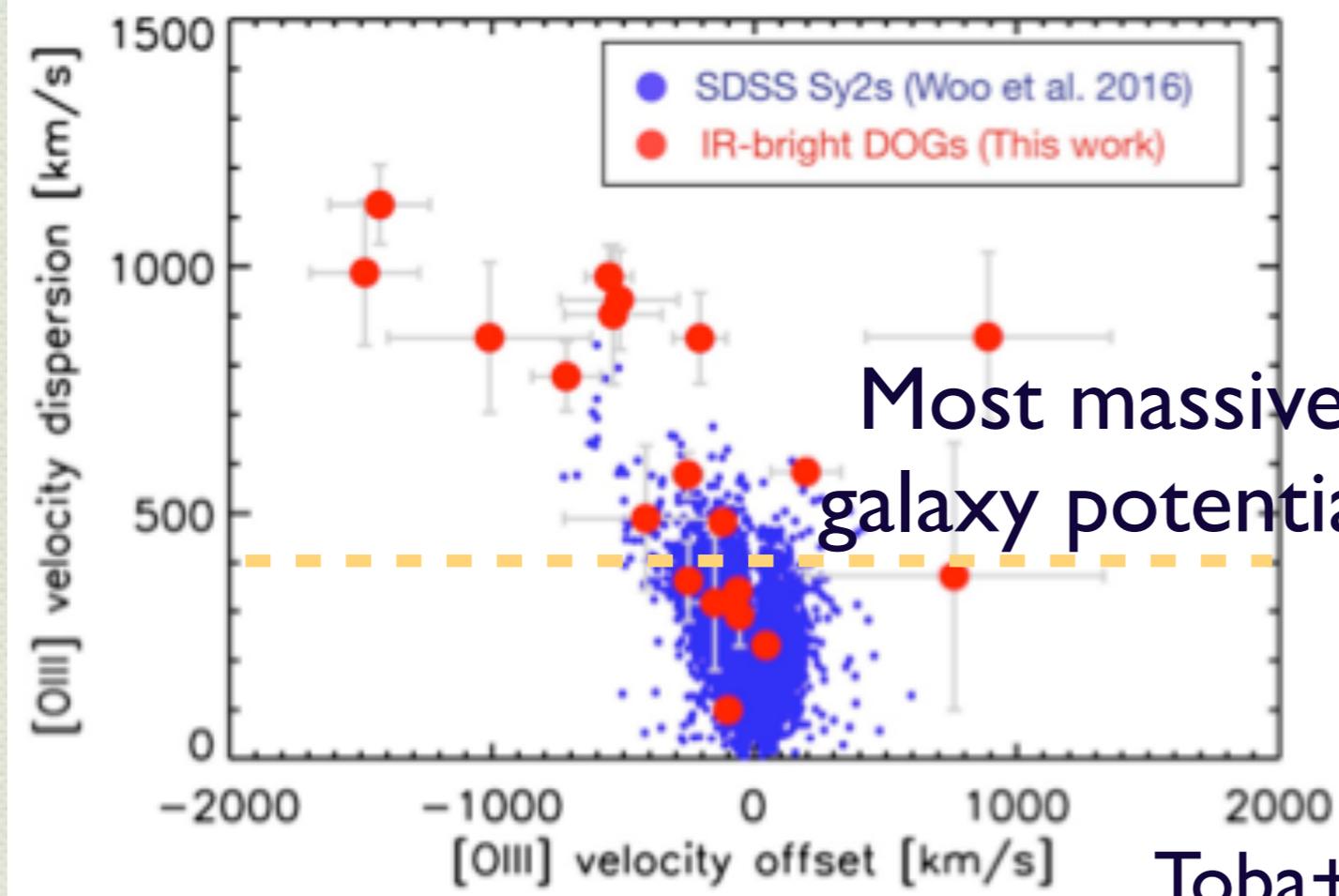
# Observations



- ◆ 12 WISE Hot DOG spectra with 8m-10m telescopes
- ◆ 11/12 are luminous, obscured AGN with moderate SF
- ◆ Model fits reveal 8/9 [OIII]λ5007 profiles with  $\sigma > 400 \text{ km/s}$

Jun+ in prep

# Objective



Toba+2017

Test if luminous AGN activity stops star formation in massive galaxies through radiative feedback

