Constraints on AGN Activity in Massive Compact Galaxies with Ultrafast Outflows

Paul Sell

Texas Tech University

Collaborators:
Christy Tremonti, R. C. Hickox, A. Diamond-Stanic, J. Moustakas,
A. Coil, A. Williams, G. Rudnick, A. Robaina, J. E. Geach,
S. Heinz, E. M. Wilcots

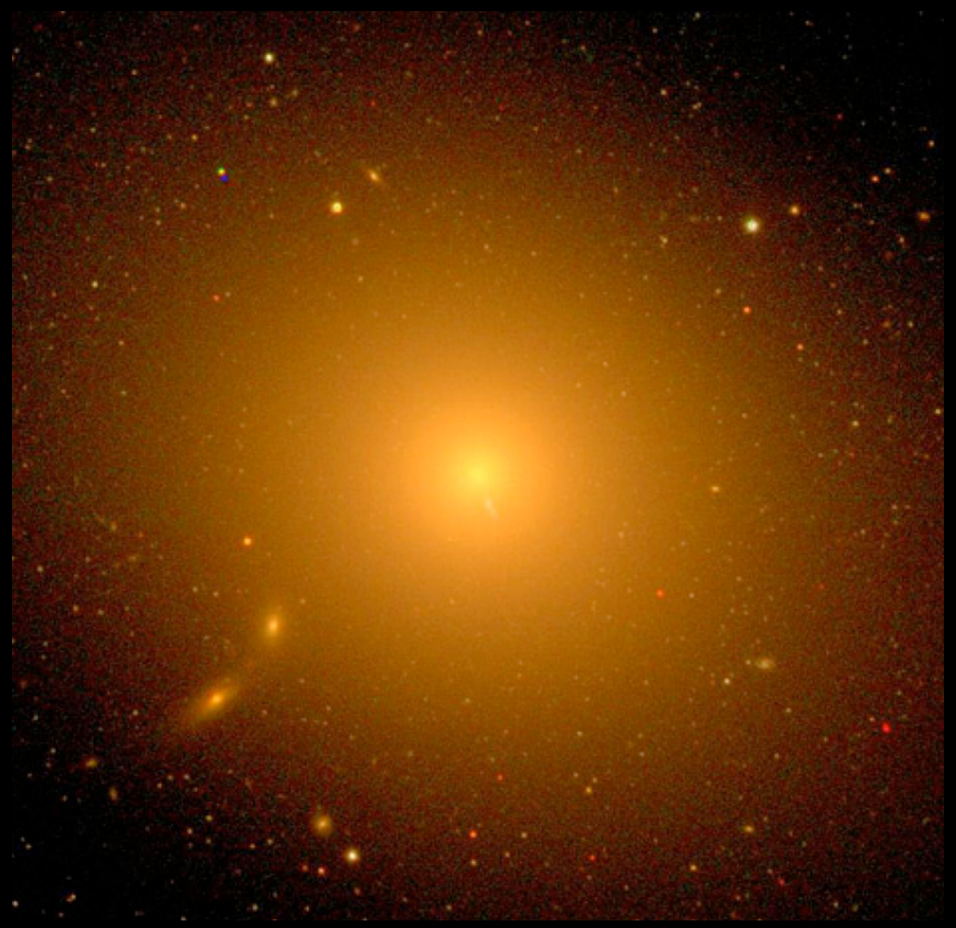
Outline

- Sample of 12 very young post-starburst galaxies

1. Most of the galaxies have little or no AGN activity and yet contain high-velocity outflows.

2. a.) The galaxy remnants are the result of highly-disruptive galaxy mergers.

   b.) The galaxy mergers are highly dissipative, producing extremely compact starbursts capable of driving the very fast galactic-scale winds we observe.



Extreme, Fast Evolution

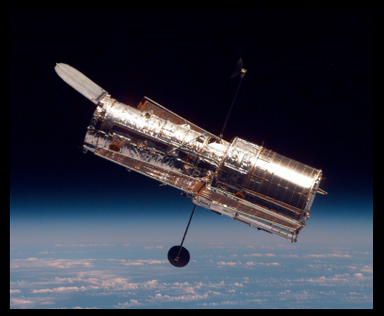
- Gas-rich merger
- Coalesence
- Feedback
  (AGN or starburst?)

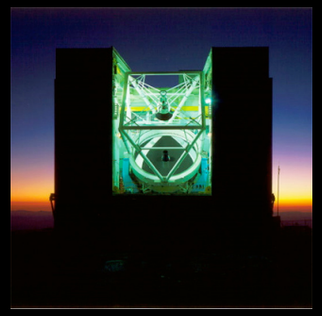
An Extensive Multi-Wavelength Campaign

Probing the Galaxies and Their Supermassive Black Holes

Targeted Observations

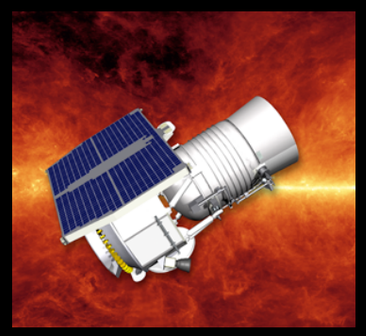
1. Chandra (accretion)
2. VLA (jets)
3. HST (morphology)
4. MMT (spectra)

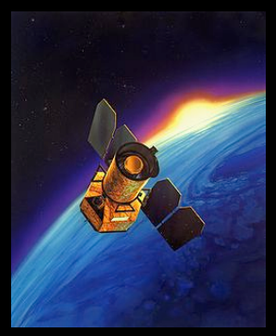


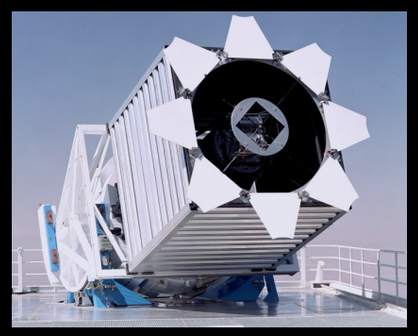


Survey Observations

1. WISE (obscured AGN)
2. Spitzer (stellar mass)
3. GALEX (broadband spectrum)
4. SDSS (broadband spectrum)







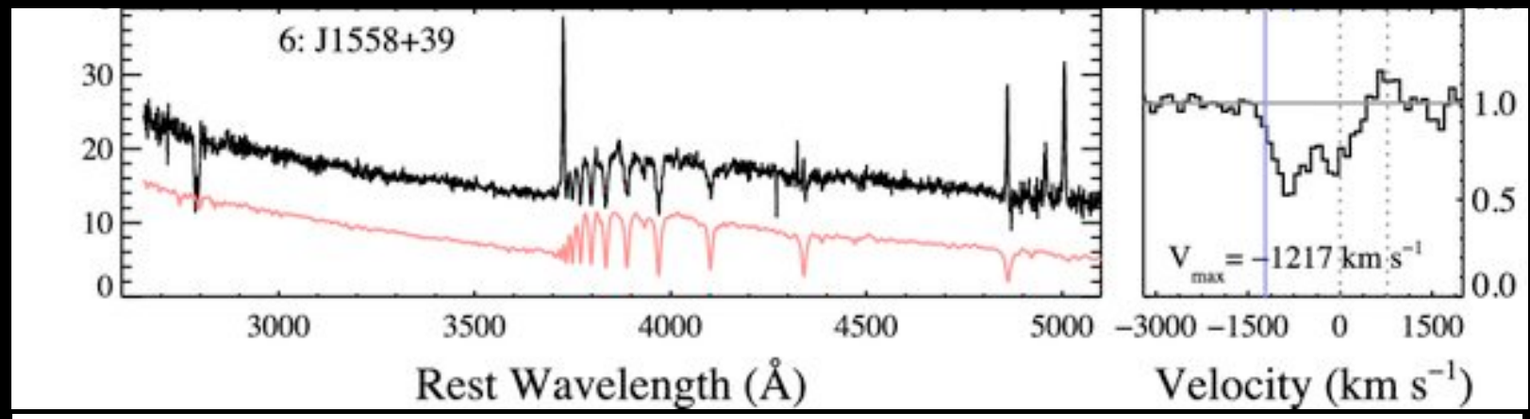
The Sample

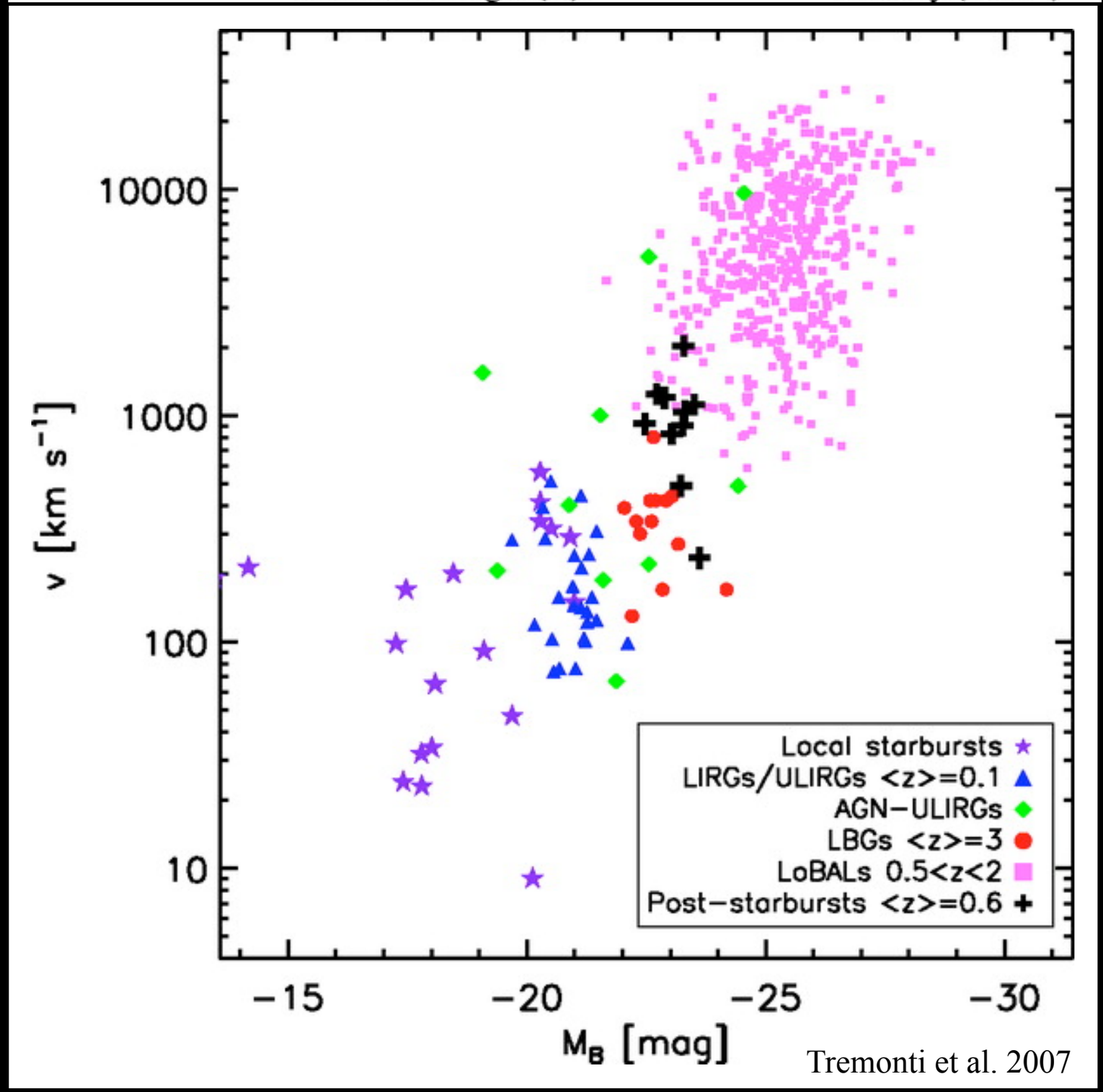
Selection (SDSS):

- Very young post-starbursts
  - $\tau_{burst} \lesssim 100$ Myr
  - B-star dominated spectra
  - Weak nebular emission lines (e.g., O stars evolved away)
- Medium redshift: $0.40 < z < 0.75$
  - ➡ Nearer analogues of higher redshift ($z \gtrsim 2$) objects

Initial Characteristics:

- Massive: $M\star \sim 10^{11}\ M_\odot \gtrsim M\star_{,\,MW}$
- SFR ~ a few hundred $M_\odot$ / yr
- High-velocity outflows (Mg II absorption): $v \gtrsim 1000$ km/s

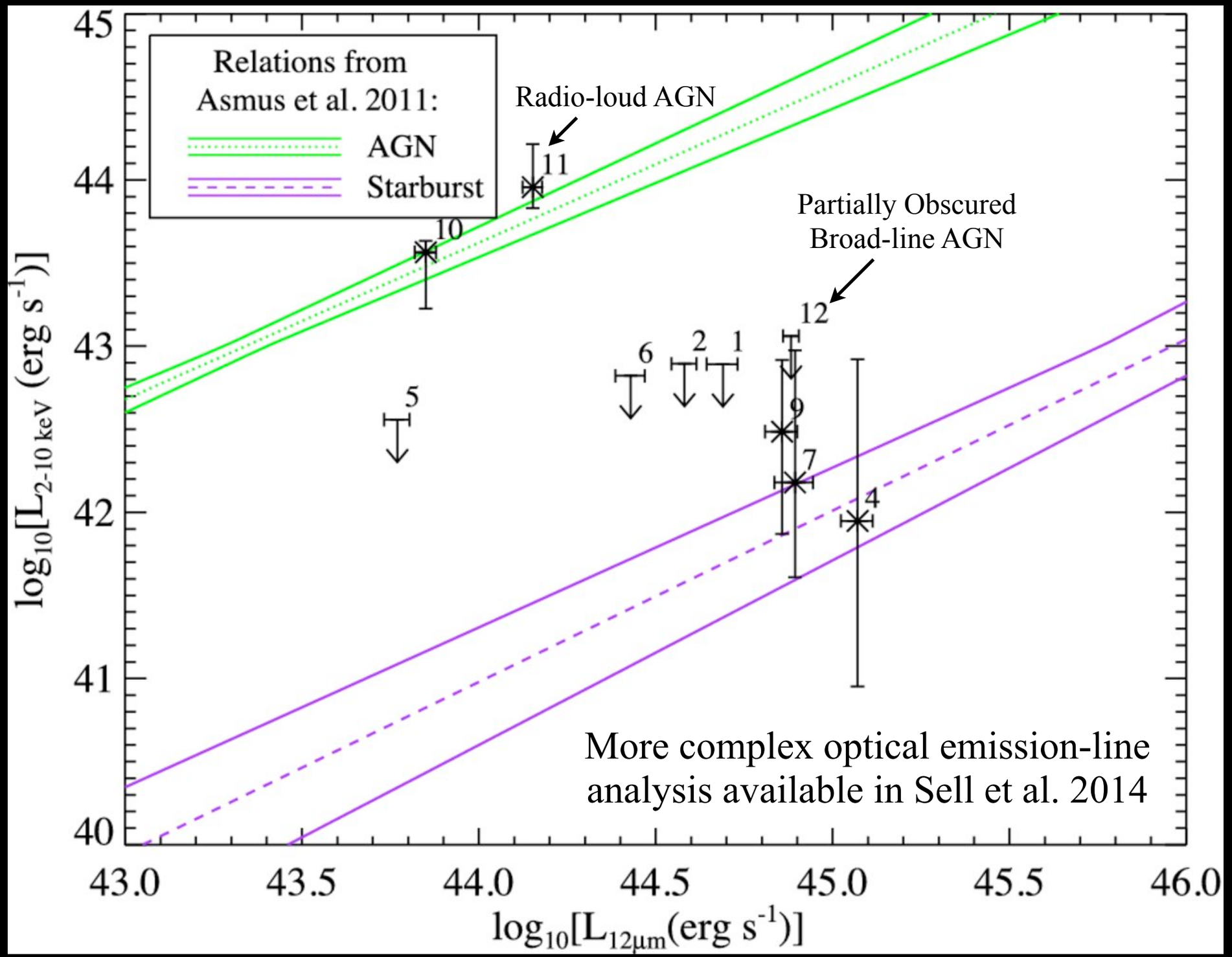




Tremonti et al. 2007

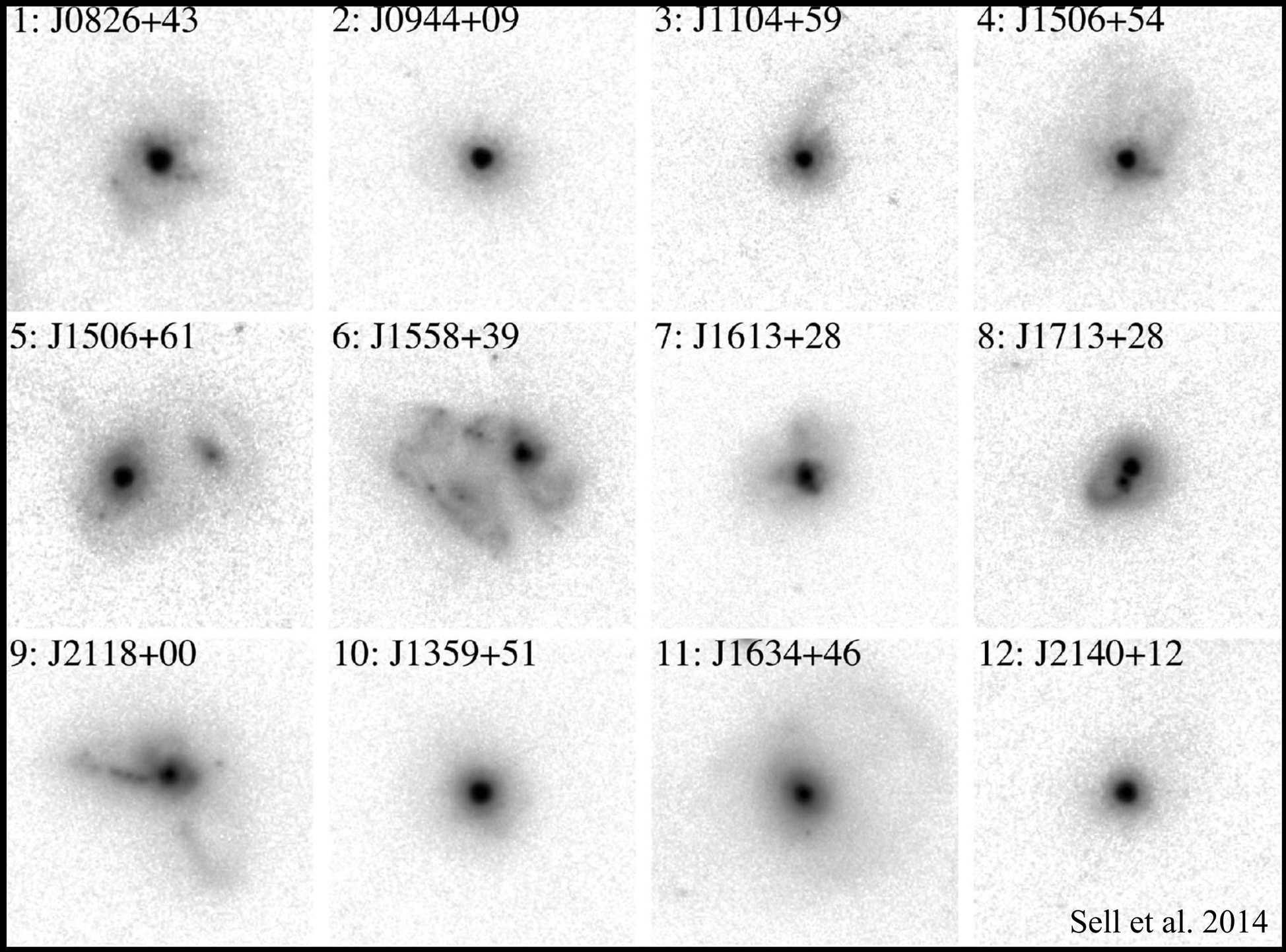
AGN Constraints

X-ray and IR Diagnostics



- 3 BLAGN
  - $M_{BH} = 10^{8-9}\ M_{\odot}$
  - $L_{bol}/L_{Edd} \sim$ a few %
- 3/9 remaining have marginal detections
  - Soft combined spectrum
  - ➡ Star formation (XRBs)
- IR constraints
  - AGN: $3.6 - 4.5\ \mu m > 0.8$ (Stern et al. 2012)
  - Our sample: $3.6 - 4.5\ \mu m = 0.18 - 0.61$

30 kpc × 30 kpc cutouts from HST/WFC3 F814W (rest-frame V)

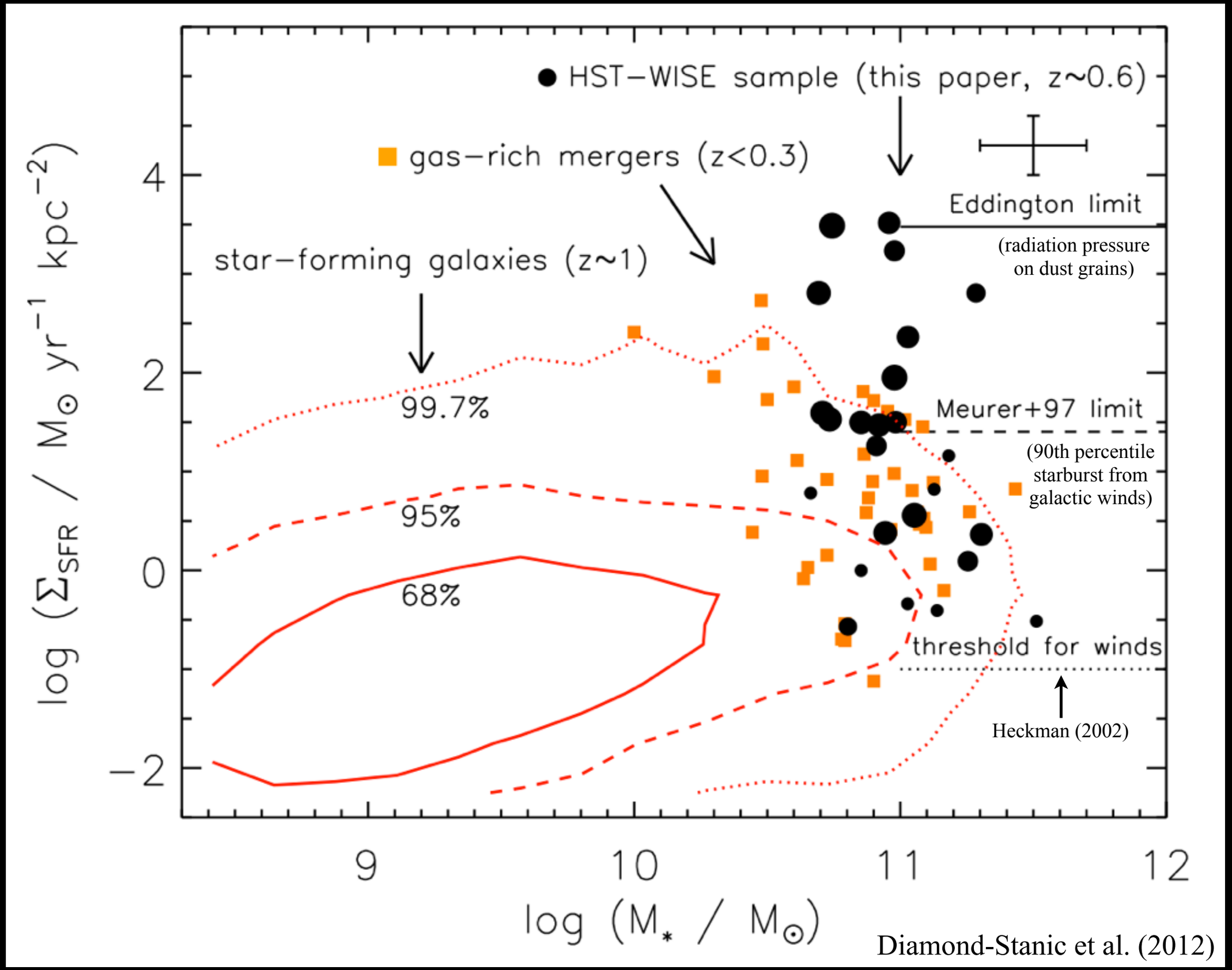


10-12: BLAGN light fraction ~30% (others negligible)

1. Tidal Debris
   - Highly disruptive mergers
   - Very faint (heavily stretched, < 1% of the surface brightness of the cores)

2. Ultra-Compact Cores
   - Most (1/3 - 1/2) of the light from most of the galaxies is unresolved
   - Median r_e = 251 pc
   - Most compact starbursts yet known in the universe (for their mass)

The Most Extreme Starbursts



Diamond-Stanic et al. (2012)

Summary and Conclusions

- Only 5/12 galaxies show signs of AGN activity, which are radiating at ~1–10 % of L_{Edd}
- SMBHs are in the low state or very highly absorbed (Compton-thick)
- There is no correlation between AGN activity and outflow velocity
- $v \sim v_{esc} = \sqrt{2GM_*/r}$

$$= 2100 \left(\frac{M_*}{10^{11}\ M_\odot} \right)^{1/2} \left(\frac{r}{200\ \mathrm{pc}} \right)^{-1/2} \mathrm{km\ s^{-1}}$$

Ultra-compact starbursts can drive the fast outflows

- The punchline:

➡ ***There is no evidence for AGN feedback and it is not required to explain our observations***

Sell P. H., et al. 2014, MNRAS, 441, 3417.