To Stack or Not to Stack: Lessons from z=2.1 Lyα Emitting Galaxies

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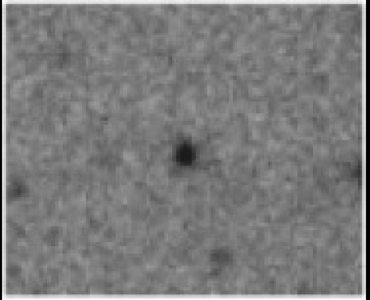
The Significance of Lyα Emitters (LAEs)

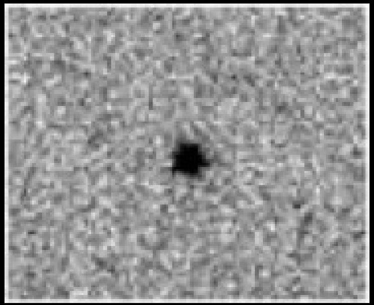
- Strong Lyα emission – detectable at high redshift
- Narrowband filter discovery
- Progenitors of Milky Way-type galaxies

How Do We Find LAEs?

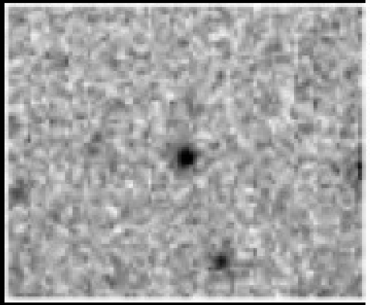
- Signal to noise ratios of a source in a narrowband and two broadband filters are compared
- $$1 + \mathbf{z} = \lambda_{\mathbf{obs}}/\mathbf{1216}\mathring{\mathrm{A}}$$



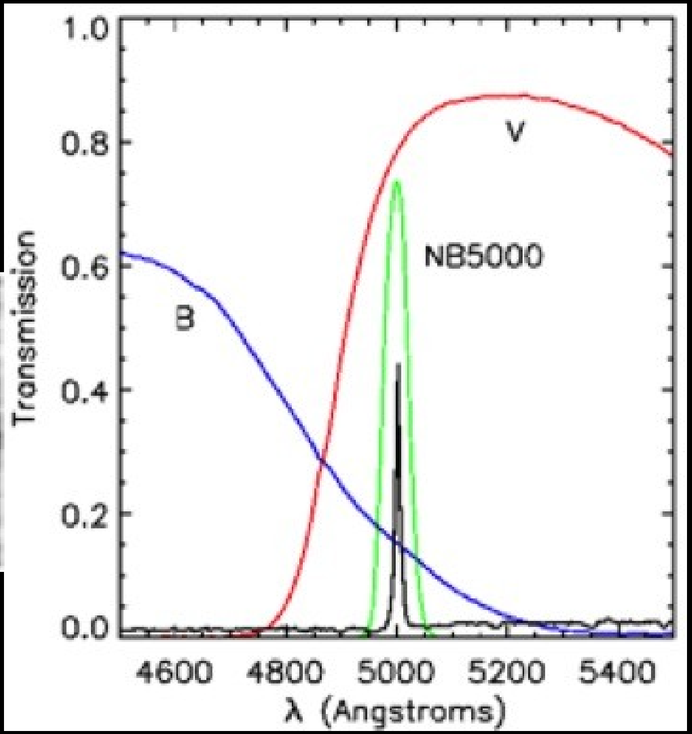
B-Band Filter



Narrowband Filter



V-Band Filter



Confusion in the Literature

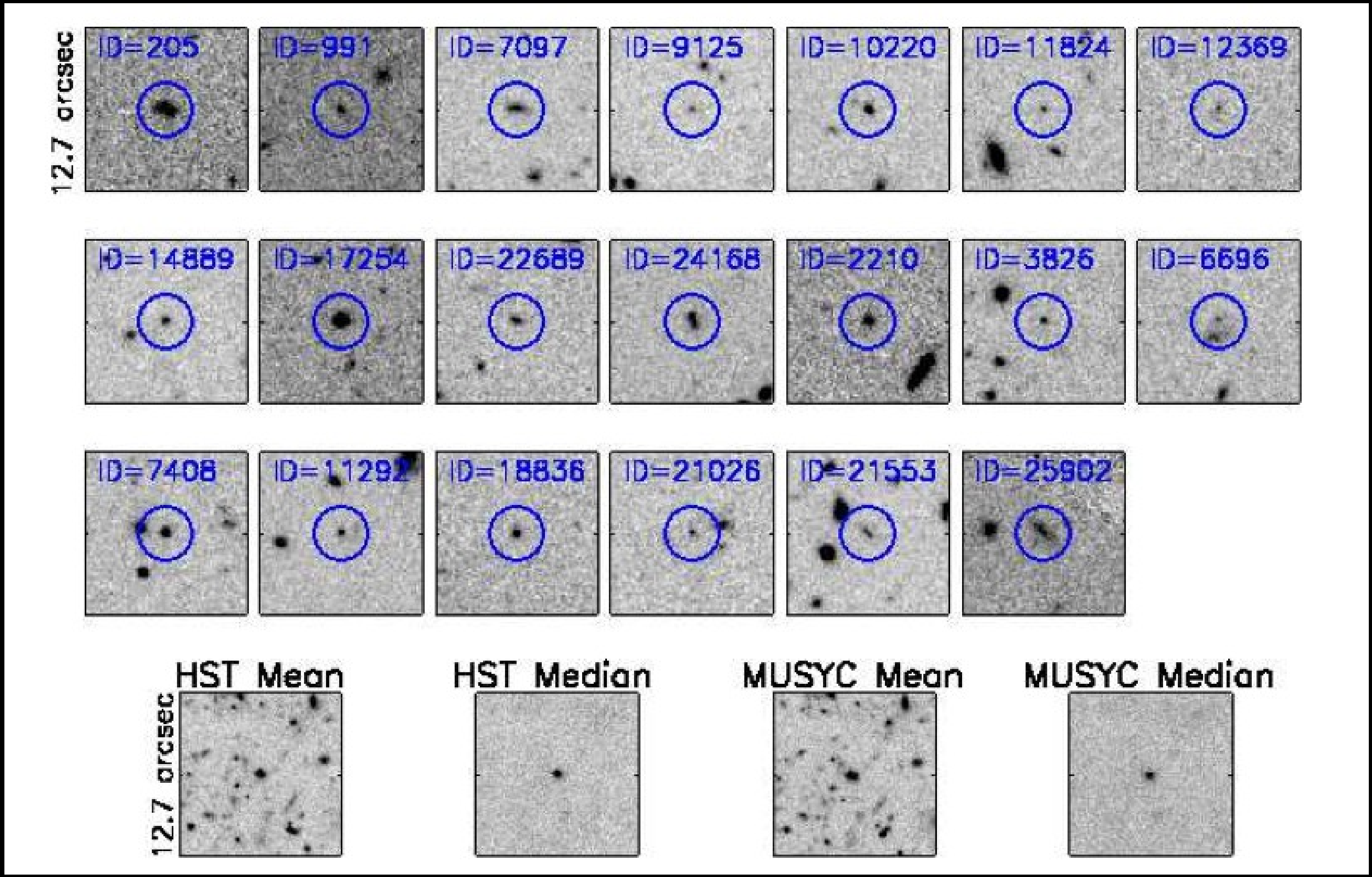
- Past mean stacking analyses find typical LAEs at z=3.1 to have ages as young as 0.15 Gyr and as old as 1.6 Gyr (Gawiser et al. 2007; Lai et al. 2008)
- Using individual LAEs at z=3.1 other studies found these objects to be much younger (age < 0.1 Gyr) (Ono et al. (2010a))
- Another stacking study found LAEs at z=3.1 to be ***older*** than LAEs at z=2.1 (Acquaviva, Vargas, Gawiser, Guaita 2011)

- **We aim to ultimately answer the question: Is stacking an accurate way of analyzing LAEs at high redshift?**

The Data

- MUSYC LAE Catalog (Guaita et al. (2011))
  - 260 LAEs at z=2.1
  - GOODS-S
- CANDELS Multi-wavelength Catalog
  - GOODS-S Deep Region & ERS (~2/3 of entire GOODS-S)
  - Deep Photometry and imaging (UV to IR)
- Catalog Matching produced 20 counterparts (0.5``)

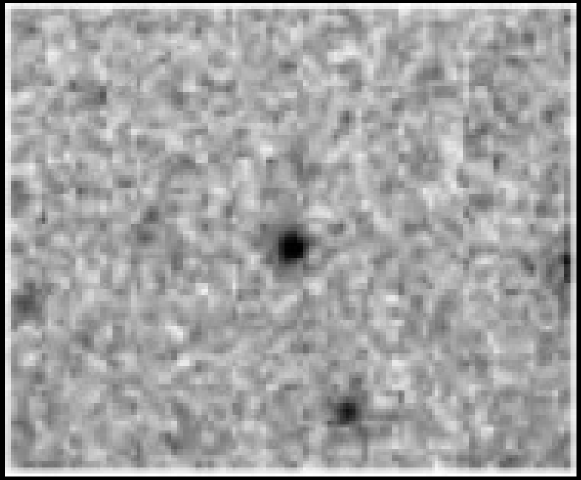
Figure 1 : The sample



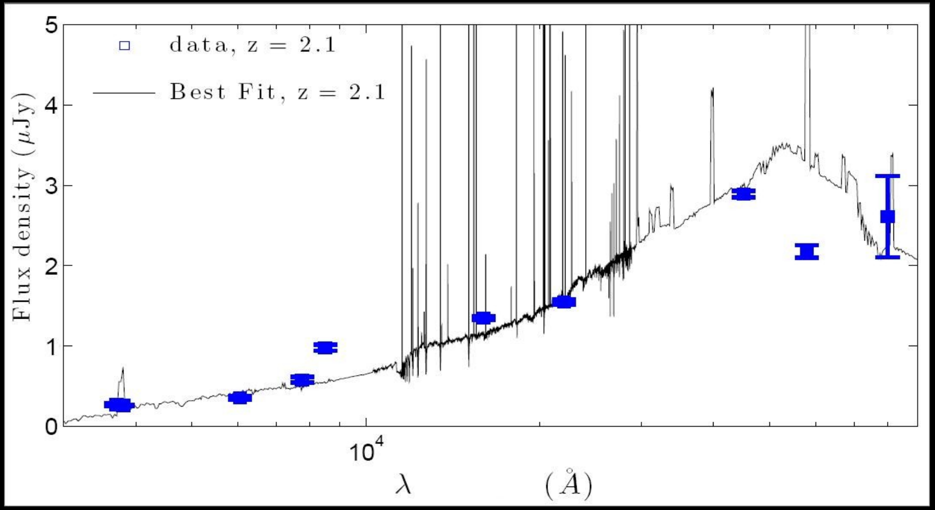
How Do We Study LAEs Despite Low S/N?

Stacking!

Image Stacking

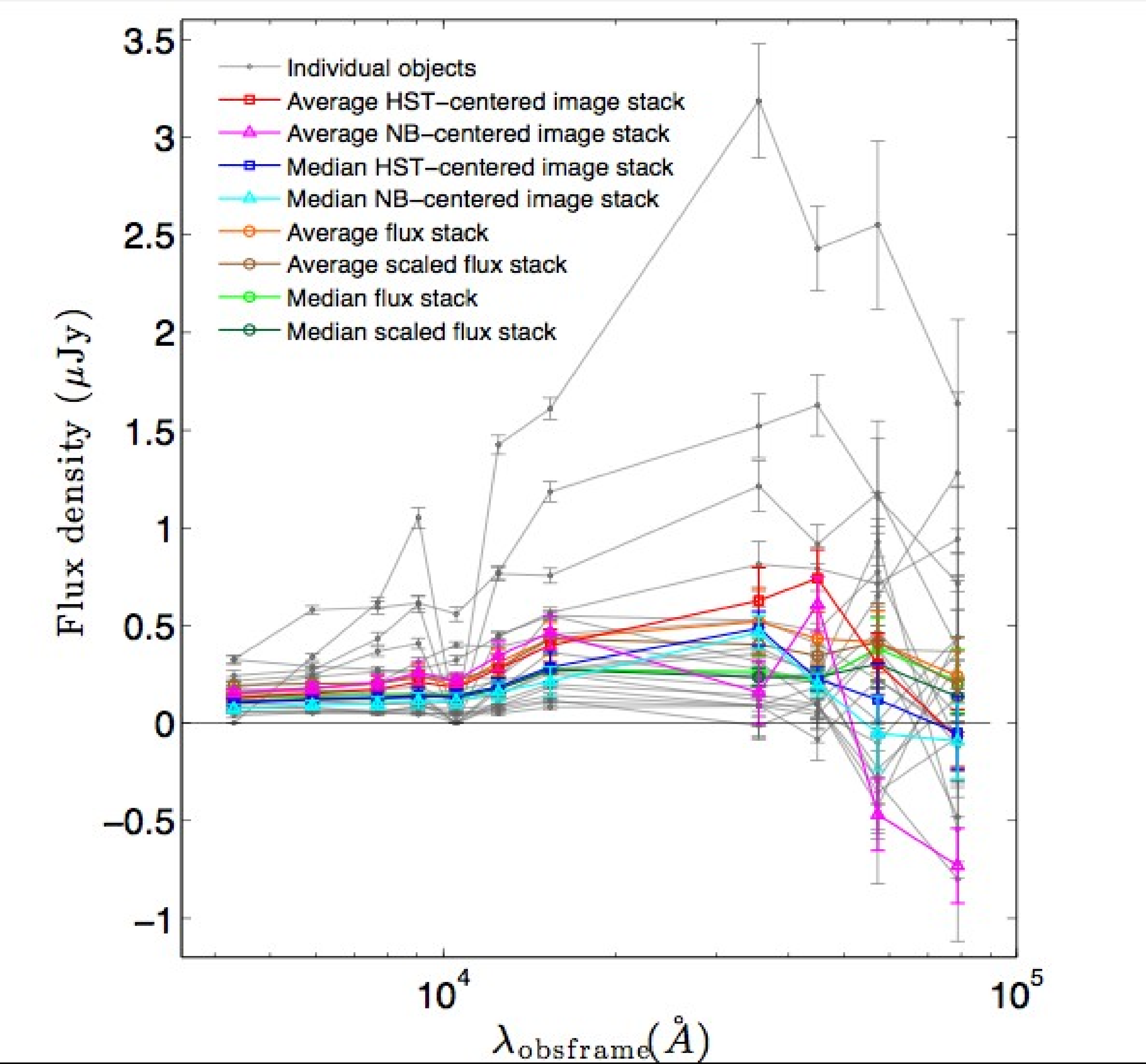


Flux Stacking



Types of Stacks

- Flux Stacks
- Image Stacks
  - HST – Centered
  - NB – Centered
- Scaled Stacks (Flux only, for now)



Individual objects
Average HST−centered image stack
Average NB−centered image stack
Median HST−centered image stack
Median NB−centered image stack
Average flux stack
Average scaled flux stack
Median flux stack
Median scaled flux stack
Flux density (μJy)
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
10^4
10^5
$\lambda_{\rm obsframe}(\AA)$

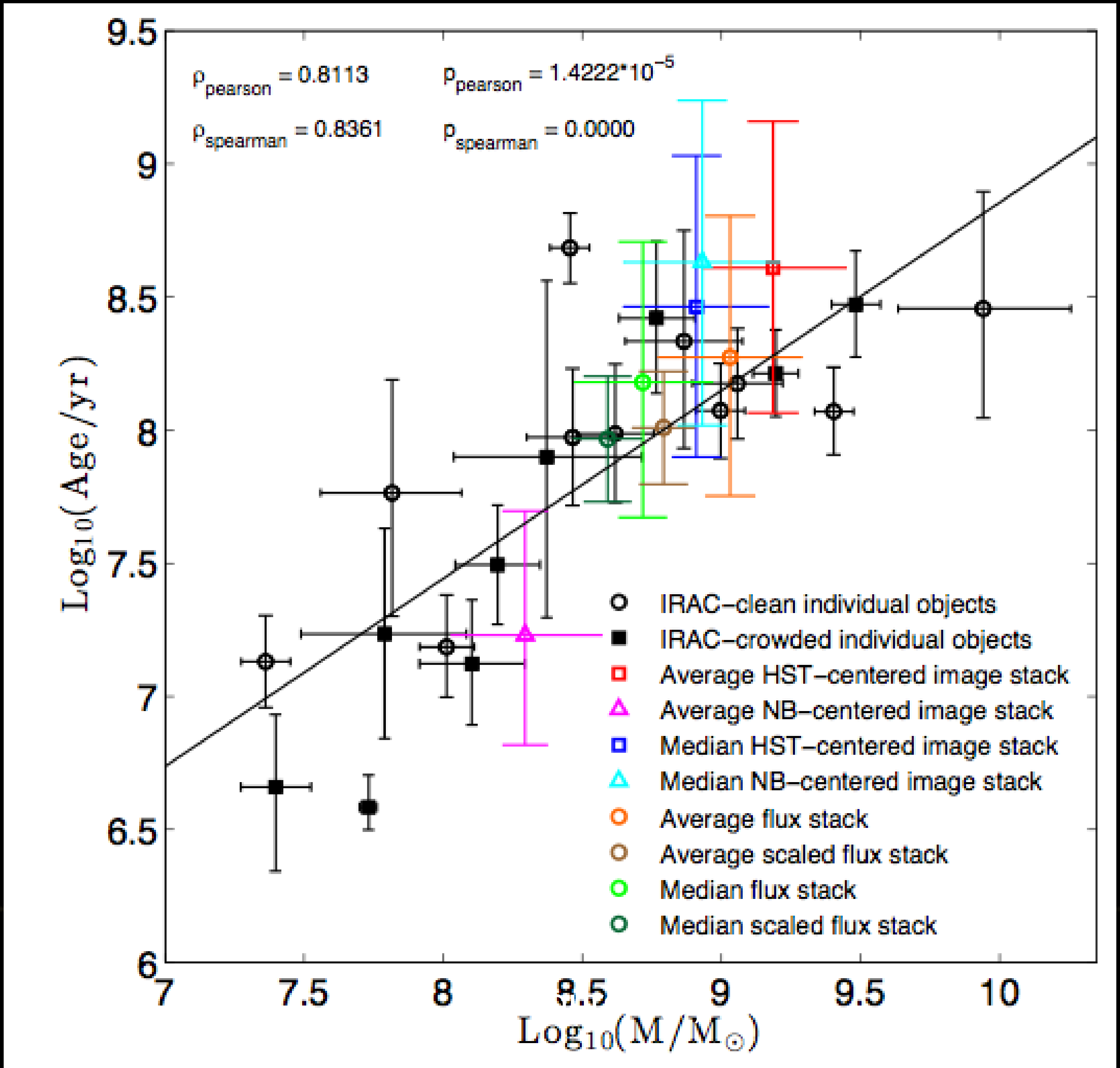
SED Fitting

- MCMC fitting of galaxy Spectral Energy Distributions (SEDs) provides insight to properties
  - SpeedyMC by Dr. Viviana Acquaviva

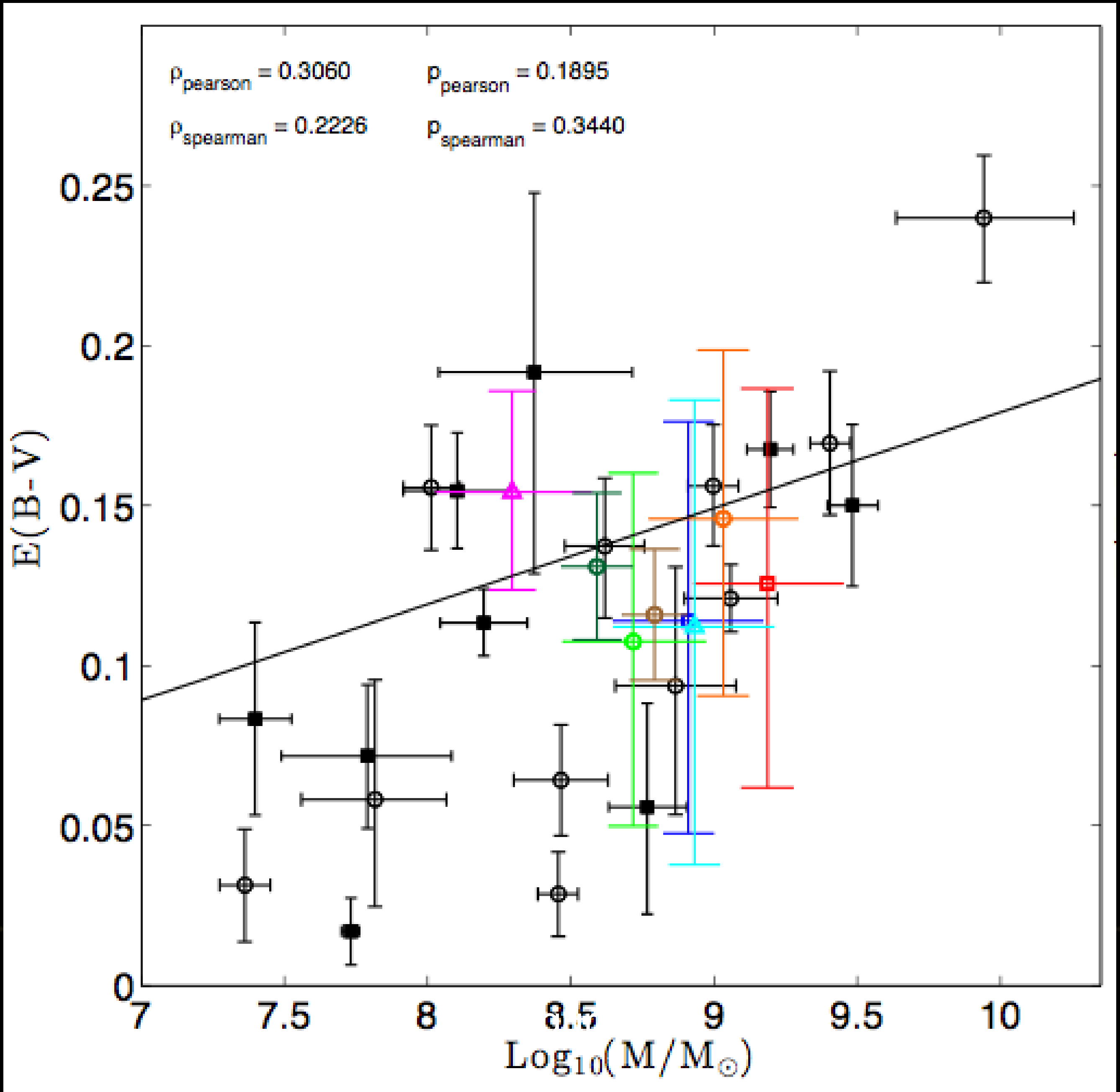
  - Used to compare data to template of known characteristics

  - Products: probability distributions for age, stellar mass, dust content (E(B-V))

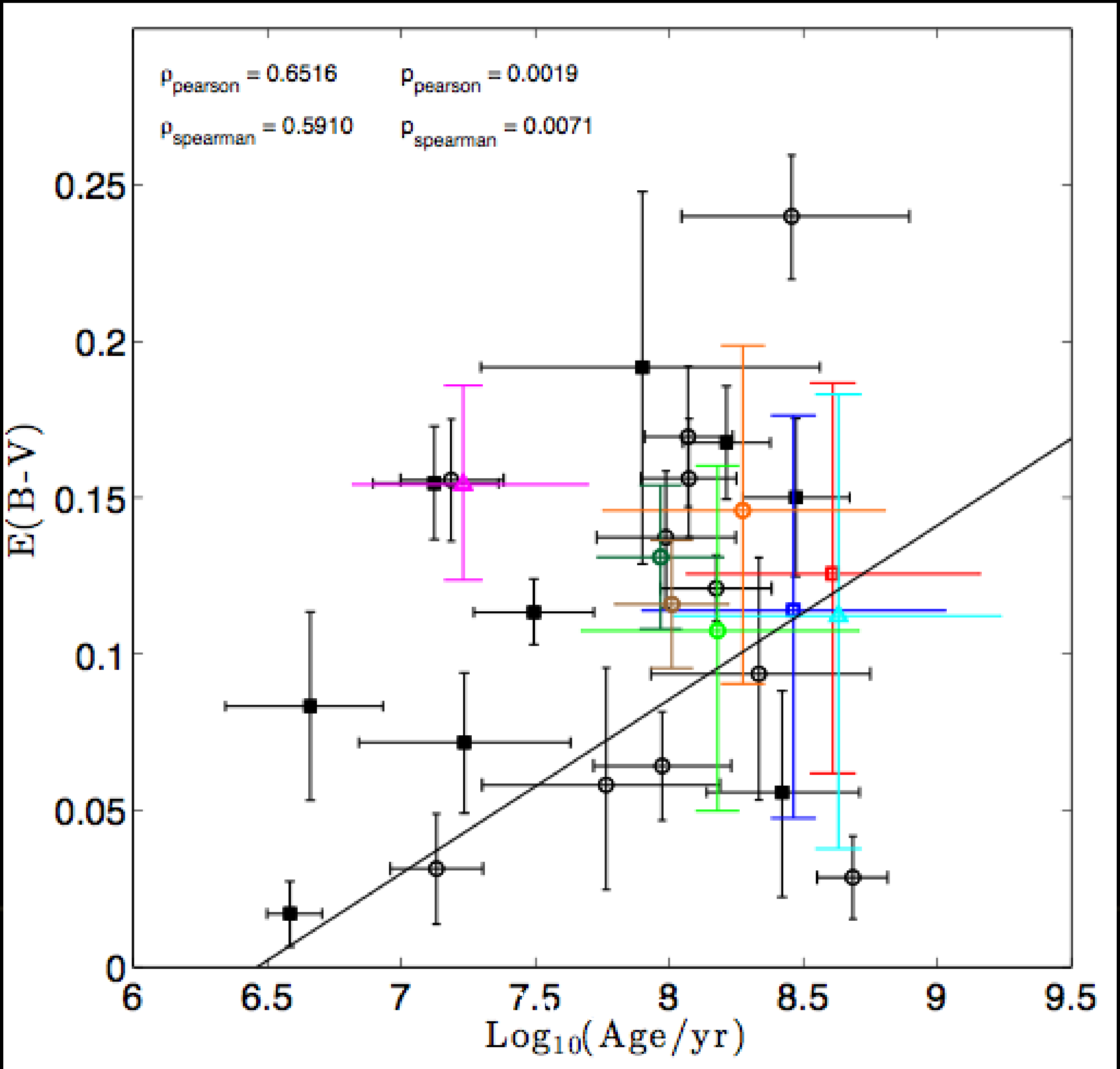
Age vs Stellar Mass



E(B-V) vs Stellar Mass



E(B-V) vs Age



ρpearson = 0.6516
ρspearman = 0.5910
ppearson = 0.0019
pspearman = 0.0071
0.25
0.2
0.15
0.1
0.05
0
E(B-V)
6
6.5
7
7.5
8
8.5
9
9.5
Log10(Age/yr)

Conclusions

- Some stacks are slightly better than others
- ALL stacking misses dispersion of properties
- Scaled Stacks are Recommended

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