Characterizing Galaxy Protoclusters

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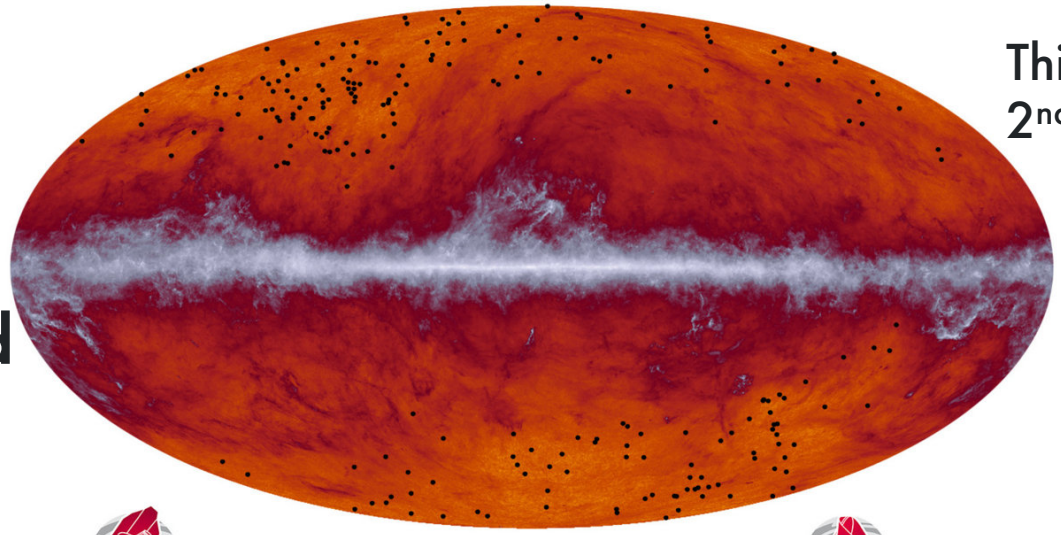
A Case Study of a Planck-selected Candidate



herschel planck

IAS Institut d'Astrophysique Spatiale Orsay

université PARIS-SACLAY

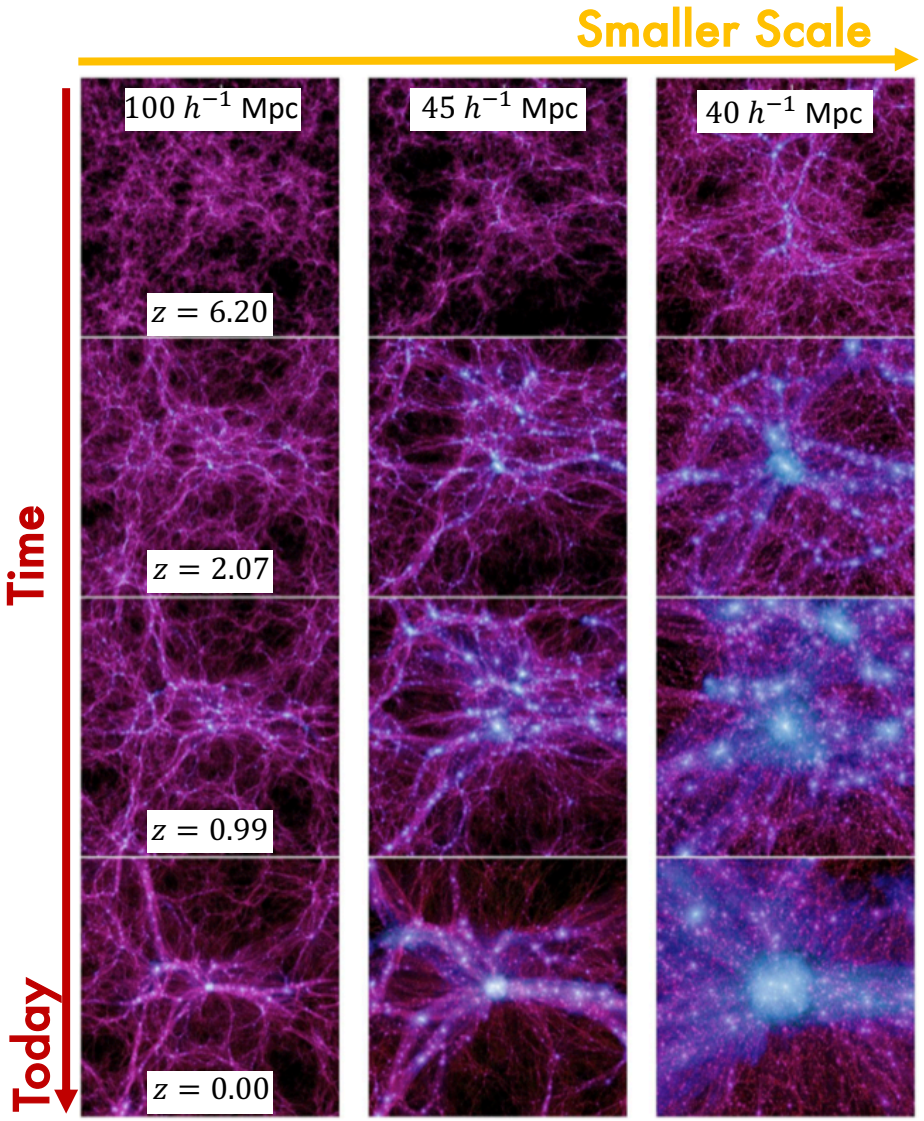
cnrs dépasser les frontières

ED A&A
École Doctorale d'Astronomie & Astrophysique d'île-de-France

I. Scientific Context

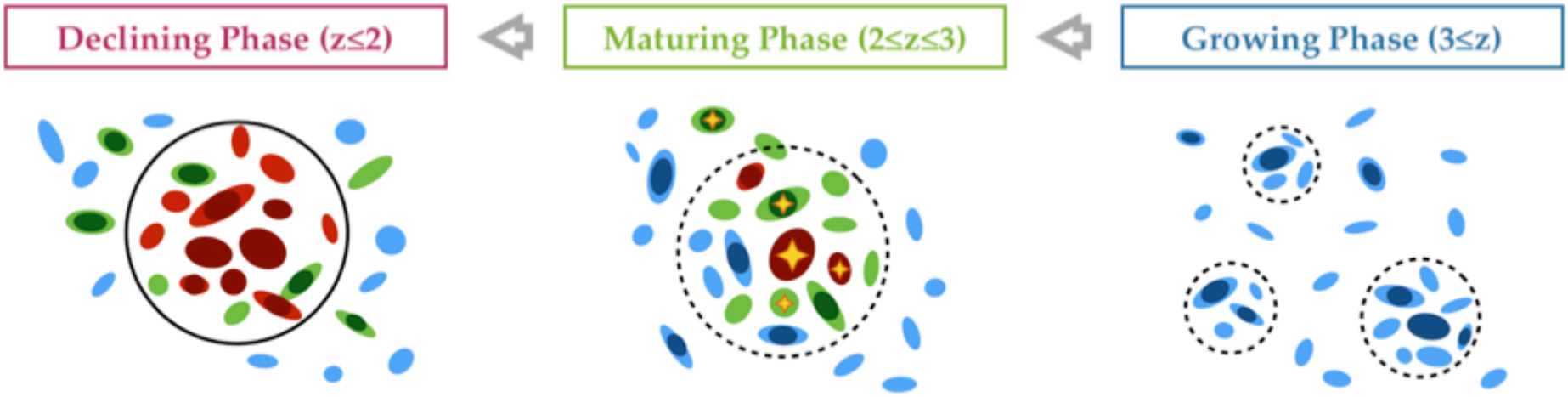
Galaxy Clusters and Proto-Clusters

- Galaxy Cluster
  - Bound Galaxies
  - Virialized System
  - Mass $M > 10^{14} M_{\odot}$
- Proto-Cluster
  - Cluster Progenitor
  - Extented Structure
  - Dark Matter Overdensities



Simulation from Millennium II of a Coma-like galaxy cluster.
Overzier 2016

Protoclusters Formation History



	Declining Phase	Maturing Phase	Growing Phase
Galaxies	Starvation / Environmental quenching	Energetic AGN feedback	Massive galaxy formation
Halo Gas	Cold gas depletion / Superheated plasma	Pre-heating / Core collapse	Cold gas stream in hot gas

Diagram of a possible galaxies and clusters evolution history from MAHALO Deep Cluster Survey data. *Shimakawa et al. 2018*

BLUE = ACTIVE GALAXIES = STAR FORMATION

RED = PASSIVE GALAXIES = NO MORE STAR FORMATION

GREEN GALAXIES

DARK MATTER OVERDENSITY

STARBURST

Interest of Studying Proto-Cluster

- Knowing the history of cluster formation
- Quantify the environment effect on star formation
- Understanding why the star history evolution happens earlier in galaxy proto-cluster

II. SPHerIC: Spitzer Planck Herschel Infrared Clusters

Selection of Proto-cluster Candidates

Planck/HFI (FIR/mm)

Planck int. results XXXIX, Planck Collab., 2016

Herschel/SPIRE (FIR)

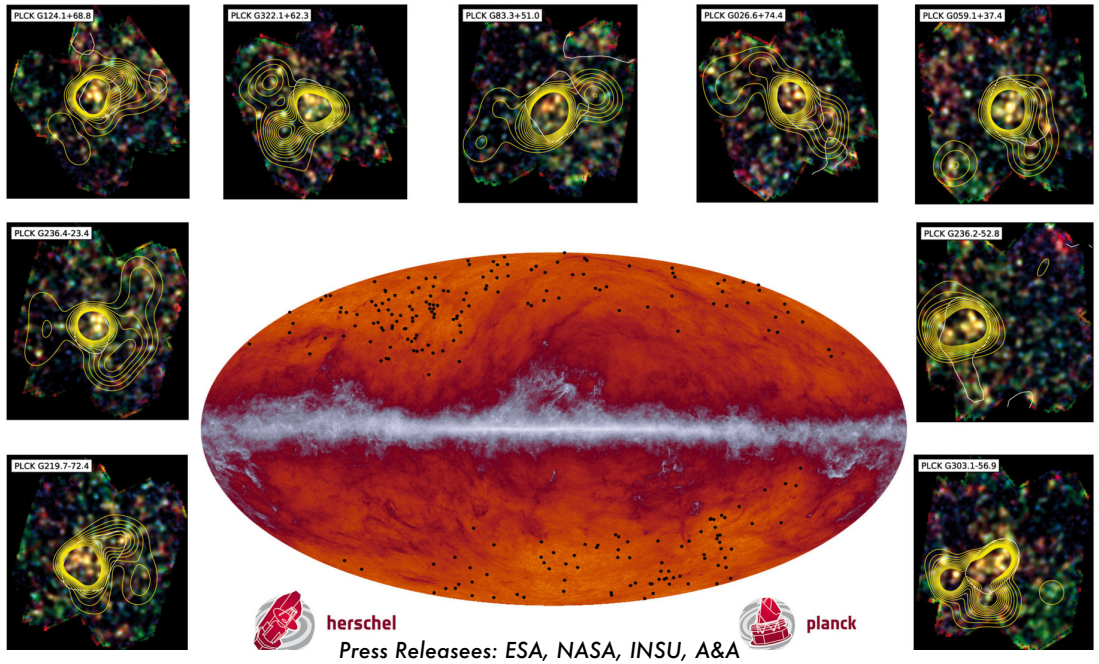
Planck int. results XXVII, Planck Collab., 2015

Spitzer/IRAC (NIR)

Martinache et al. 2018

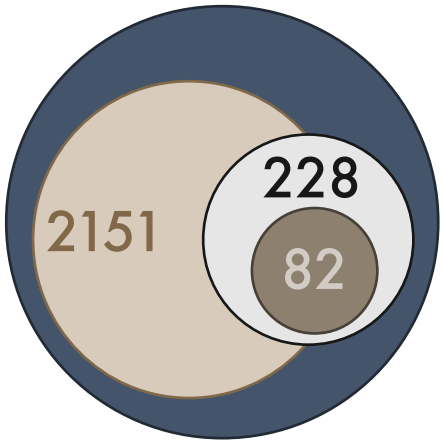
- Selected Galaxies:
  - The Brightest in FIR
  - Star Forming
  - High Redshift:
    $1.3 < z < 3.0$

Promising Protocluster Candidate



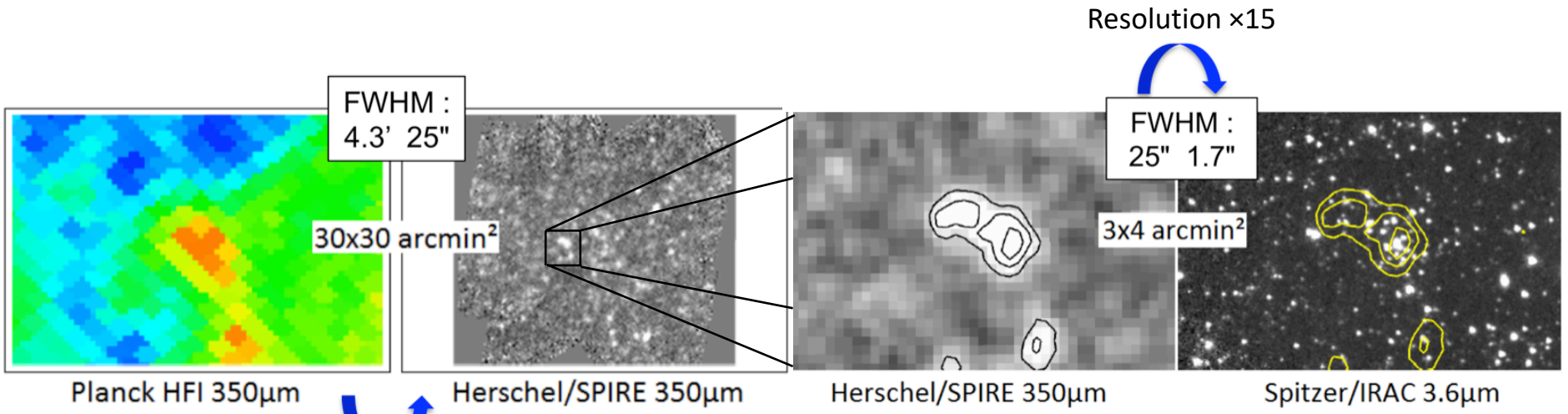
Press Releasees: ESA, NASA, INSU, A&A

From Planck to Spitzer/Herschel



Planck Early
Planck PHz
Herschel
Spitzer

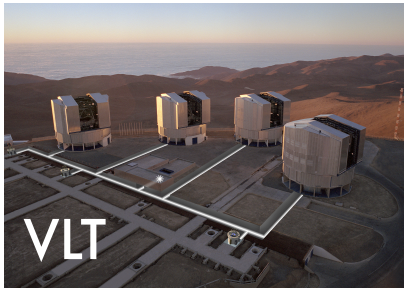
ADVANTAGES	LIMITS
✓ Strong Selection ✓ Better Resolution ✓ More Photometric Flux	✗ Selection Bias ✗ Less Candidates
KEEP PROMISING CANDIDATE	SMALL BIASED SAMPLE

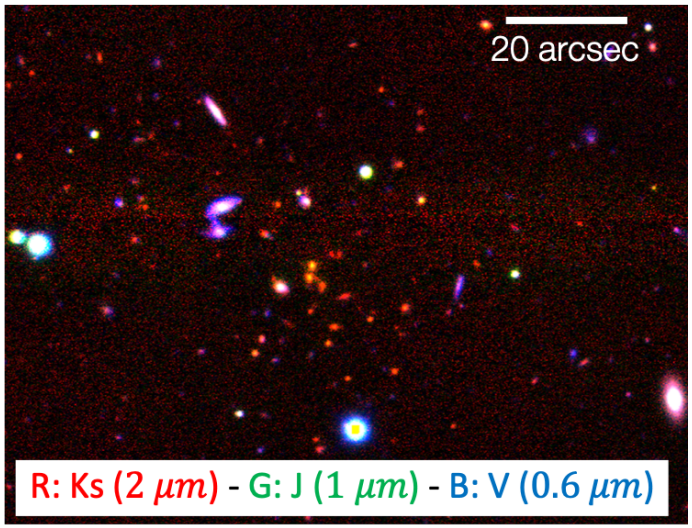


Comparison of HFI, SPIRE and IRAC resolution for the same field.
Courtesy Benjamin Clarenc

Adding Ground Based Telescope

- In Visible and NIR
  - VLT/VIMOS & HAWKI
    Bands: V, R, I, J, Ks
  - CFHT/MegaPrime & WIRCam
    Bands: g, r, I, z, J, Ks
  - TNG/Dolores & NICS
    Bands: r, z, K'



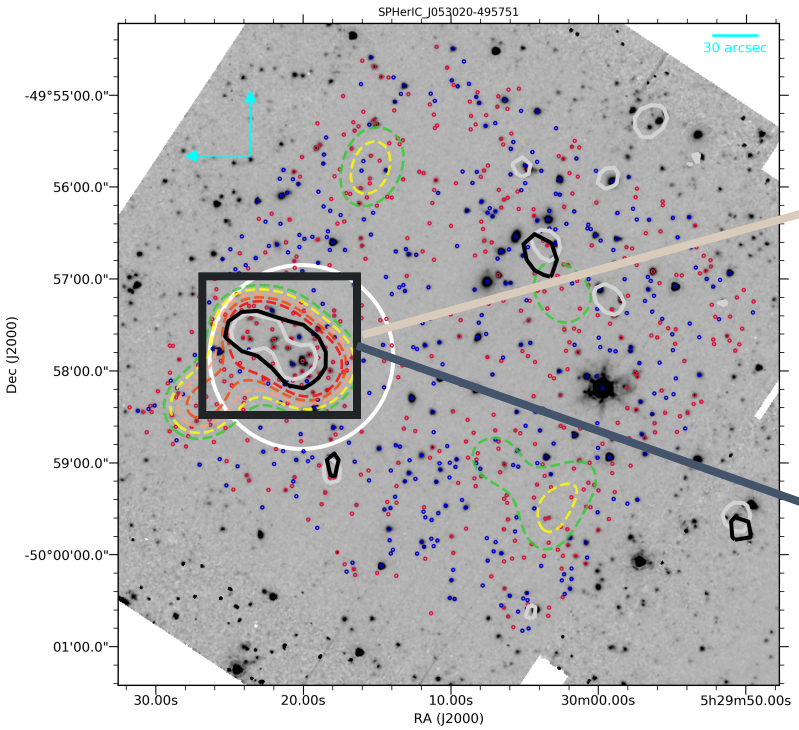


ADVANTAGES	LIMITS
✓ Resolved Galaxies ✓ Wavelength Coverage SPECTRAL ENERGY DISTRIBUTION FOR EACH GALAXIES	✗ Even Less Candidates ONLY 15 CANDIDATES WITH ALL BANDS

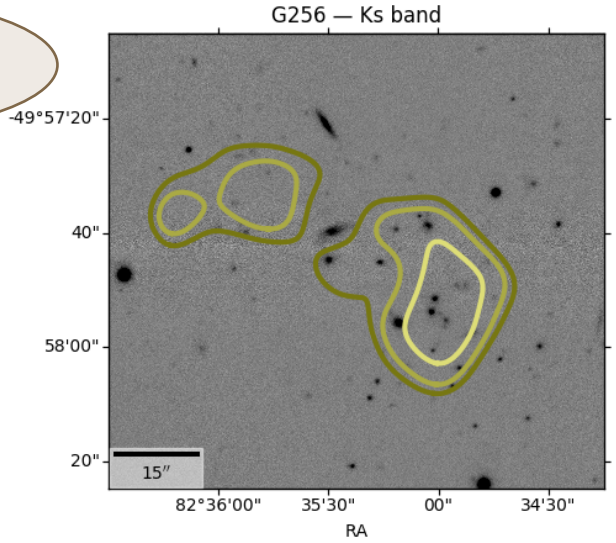
III. PLCK-G256

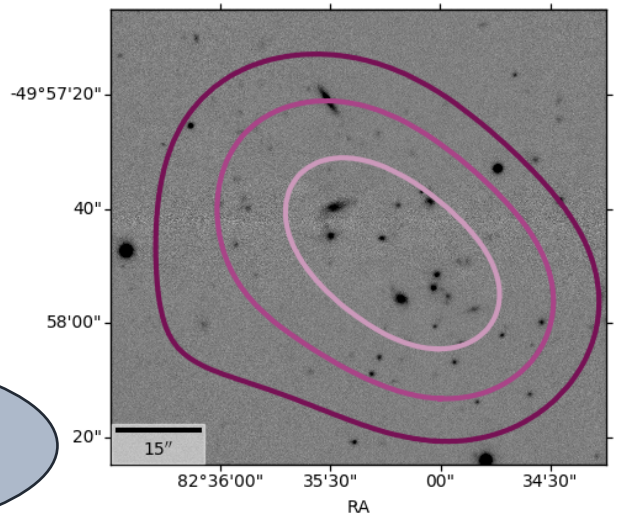
Interest of the Field

Spitzer image of G256 in [4.5]. *Martinache et al. 2018*



Herschel Emissions

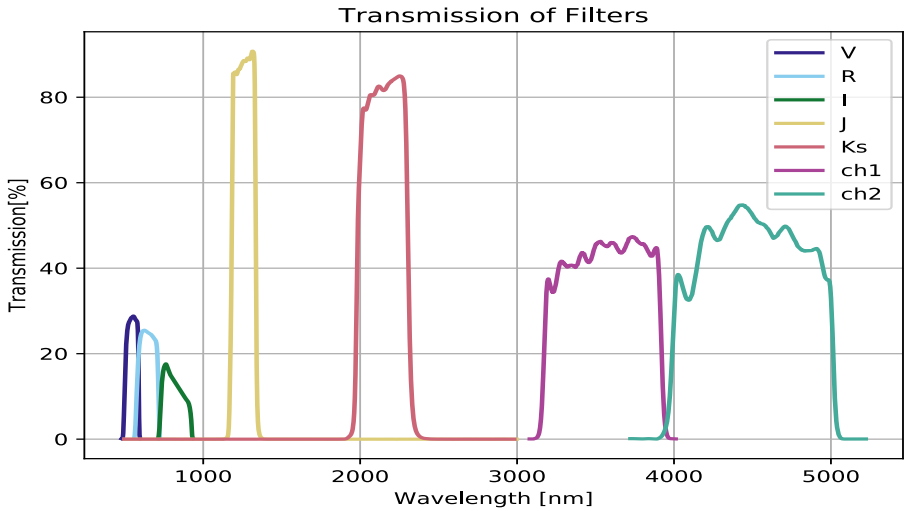


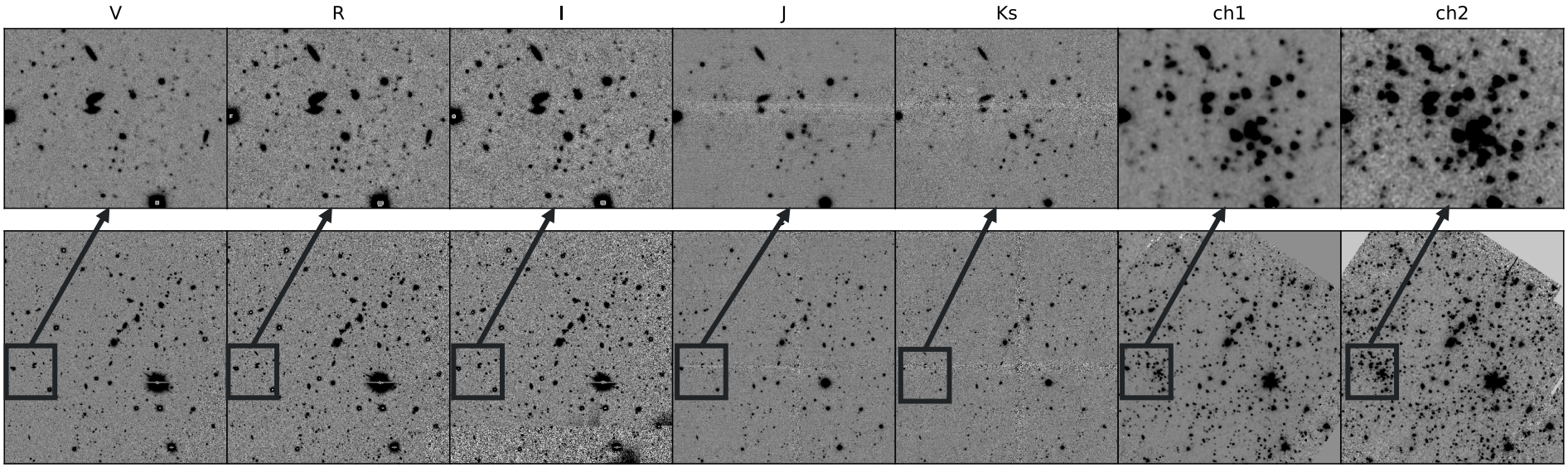


Red Sources Overdensity in Spitzer

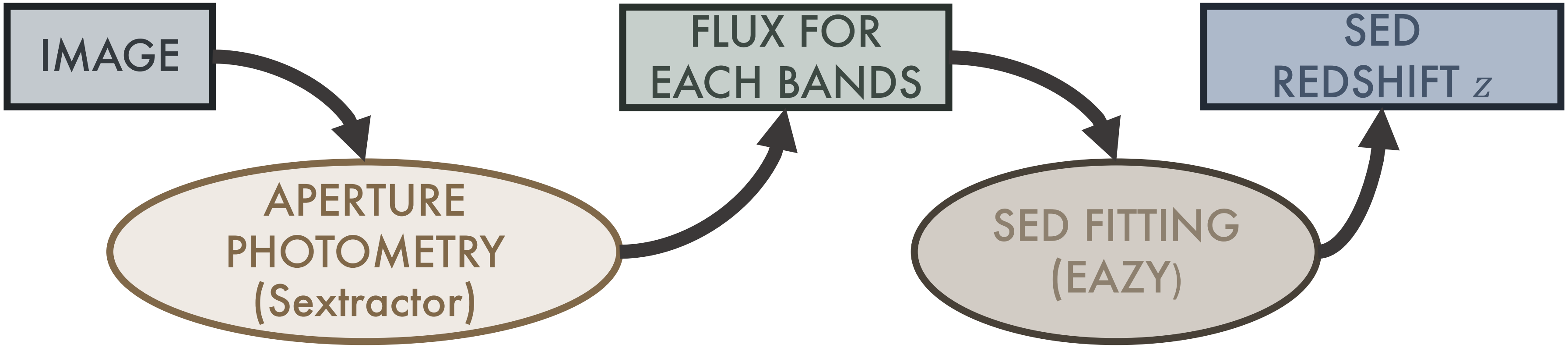
G256 in 7 Photometric Bands

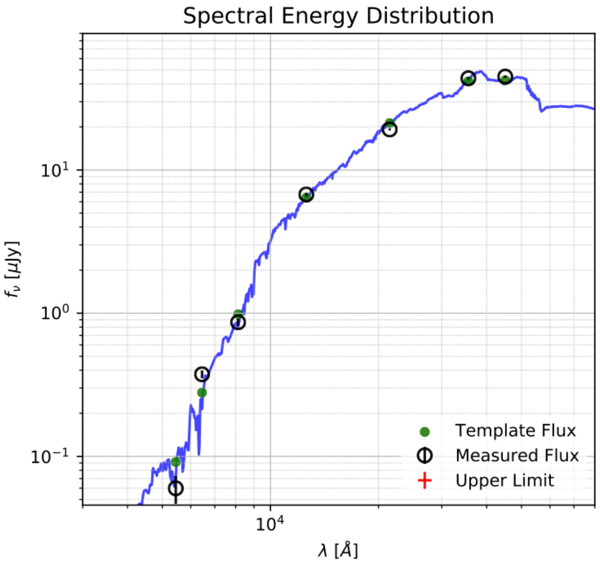
- Observations from:
  - VLT/VIMOS: V,R,I
  - VLT/HAWK-I: J, Ks
  - Spitzer/IRAC: ch1, ch2

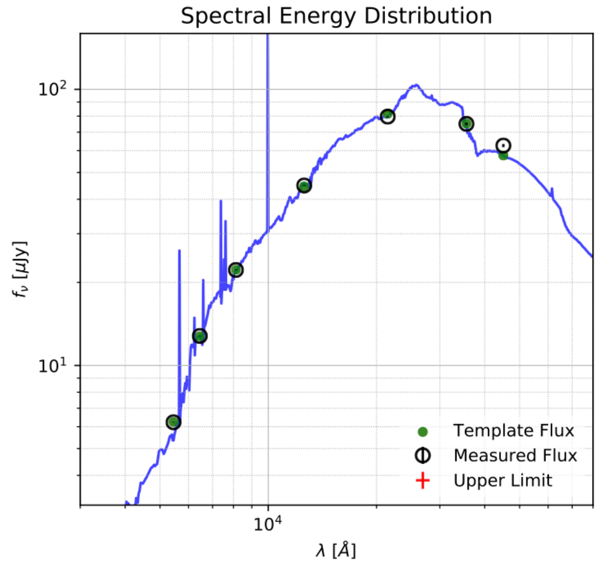


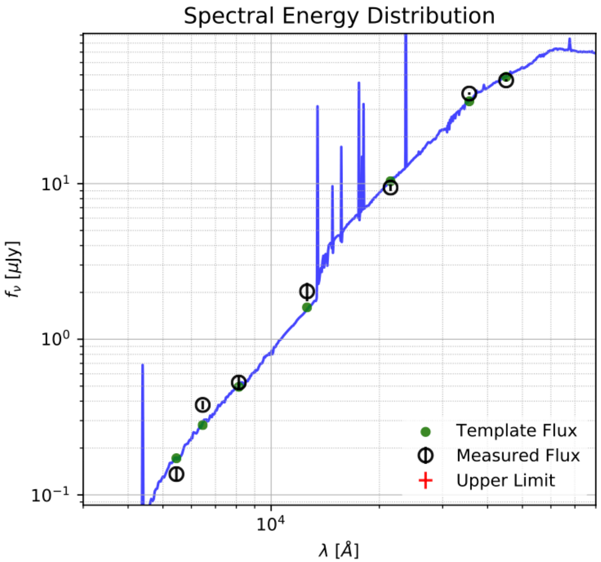


Spectral Energy Distribution Fitting









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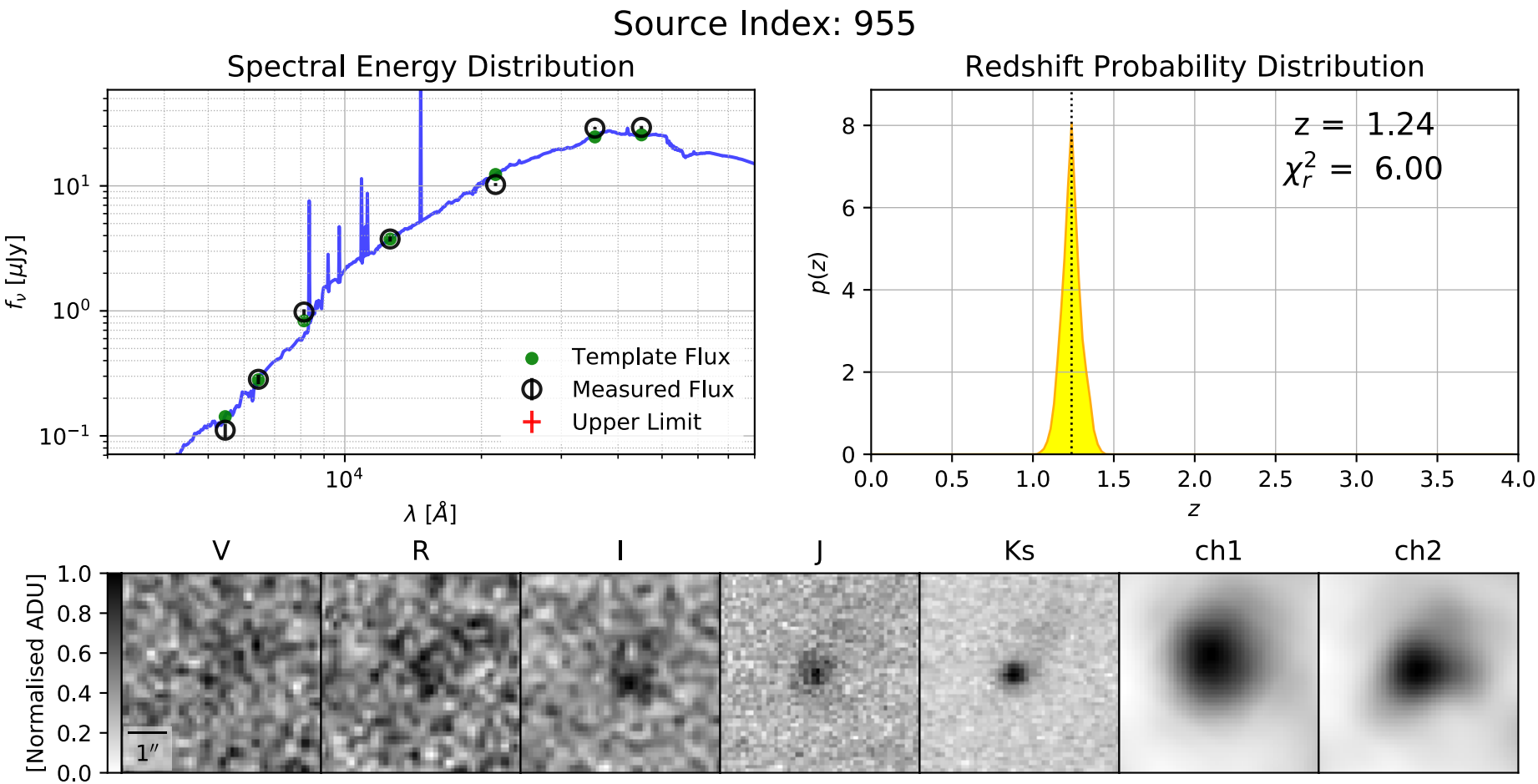
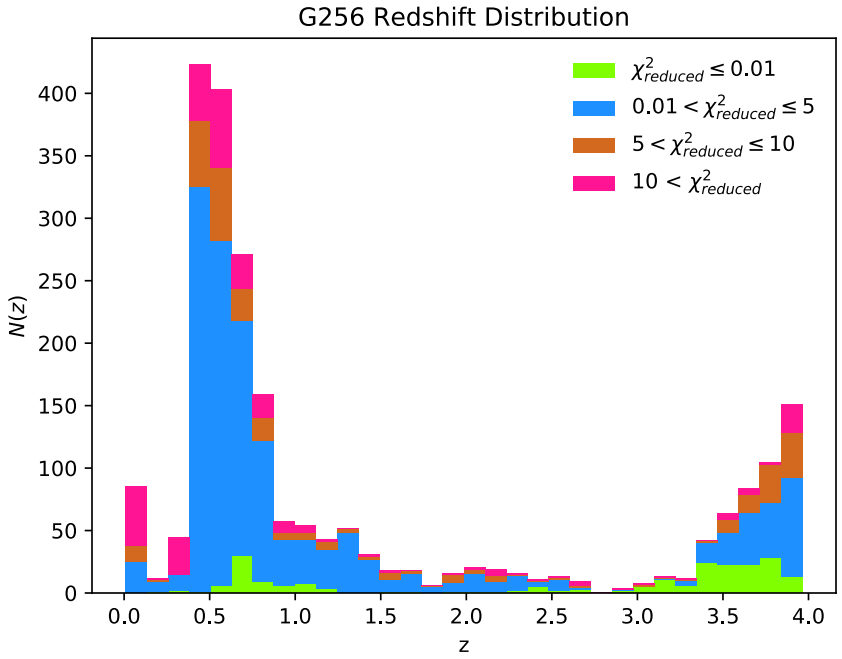
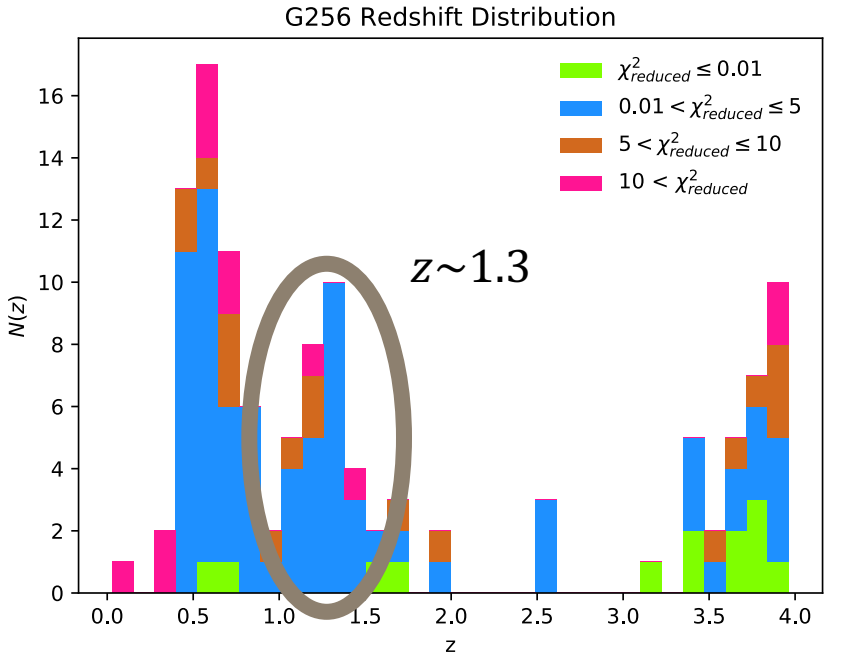
SED Fitting Example



Photometric Redshift Estimation



ALL SOURCES



SOURCES WITHIN THE CANDIDATE

IV. Conclusion

Conclusion

- Studying Proto-cluster is the key to understand cluster evolution and star formation histories
- SPHerIC is one of the largest multi-band photometric data set with 82 protocluster candidates
- PLCK G256 is a promising candidate at $z \sim 1.3$