



HUNTRESS

# ***Mapping H $\alpha$ -Excess Candidate Point Sources in the Southern Hemisphere Using S-PLUS Data***

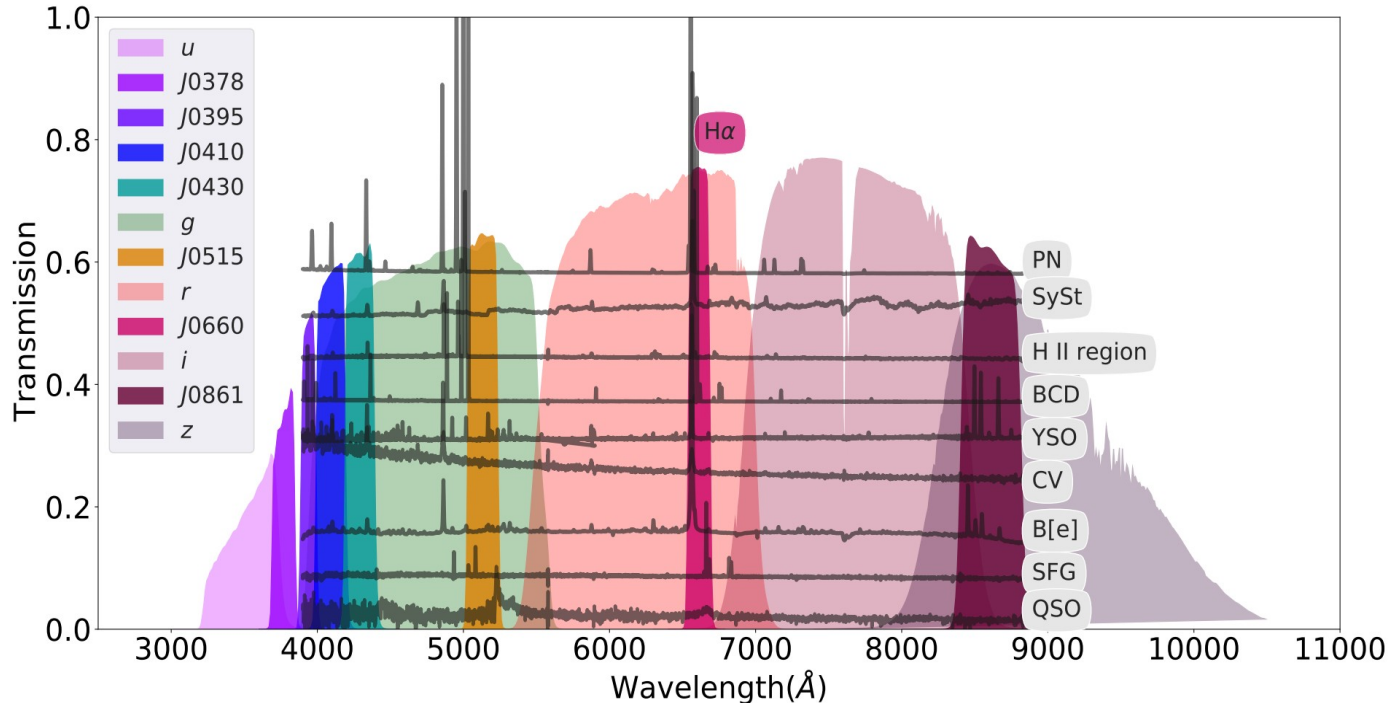
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**Luis A. Gutiérrez-Soto & S-PLUS collaboration**

**19th S-PLUS Collaboration Meeting  
August 19-21, 2024**

## Context

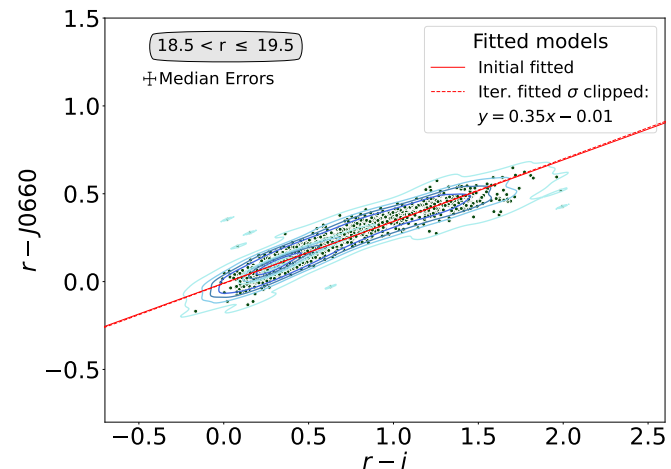
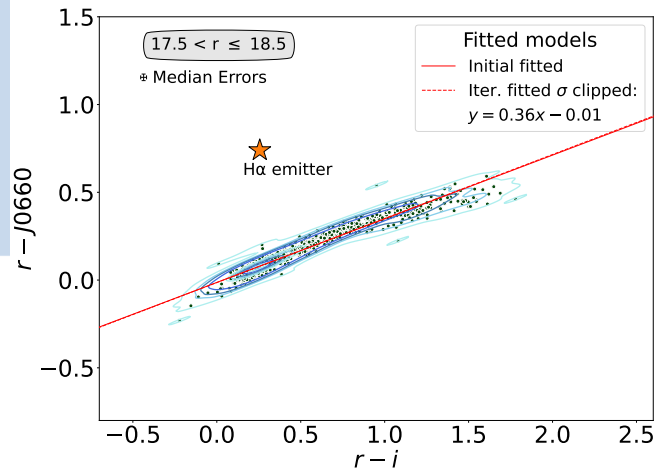
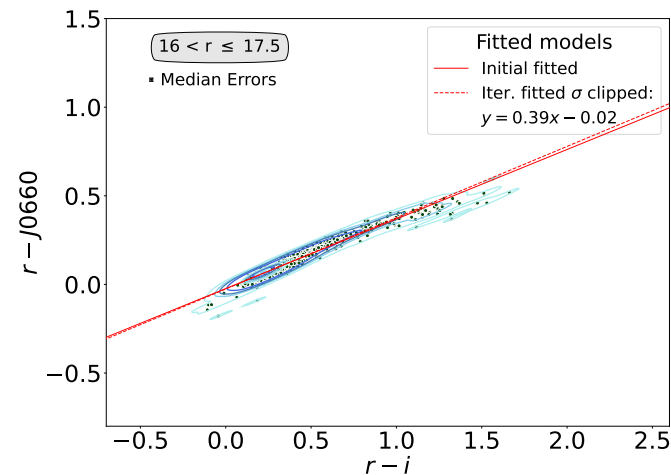
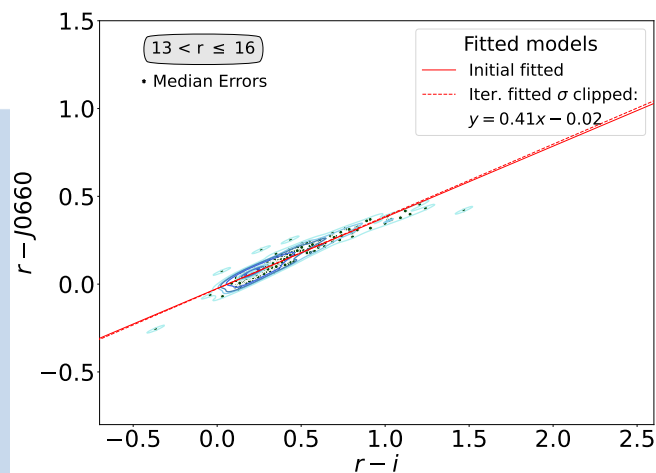
As part of mapping 9000 deg<sup>2</sup> of the Southern Hemisphere, the S-PLUS project surveys the H $\alpha$  transition, capturing a wide range of astrophysical processes. In this study, we utilize DR4 data, covering 171 low-galactic-latitude fields, 341 fields from the Main Survey, and 150 fields in the Magellanic Clouds region, to highlight H $\alpha$ -excess point sources using the  $(r - \text{J0660})$  vs.  $(r - i)$  color-color diagram.



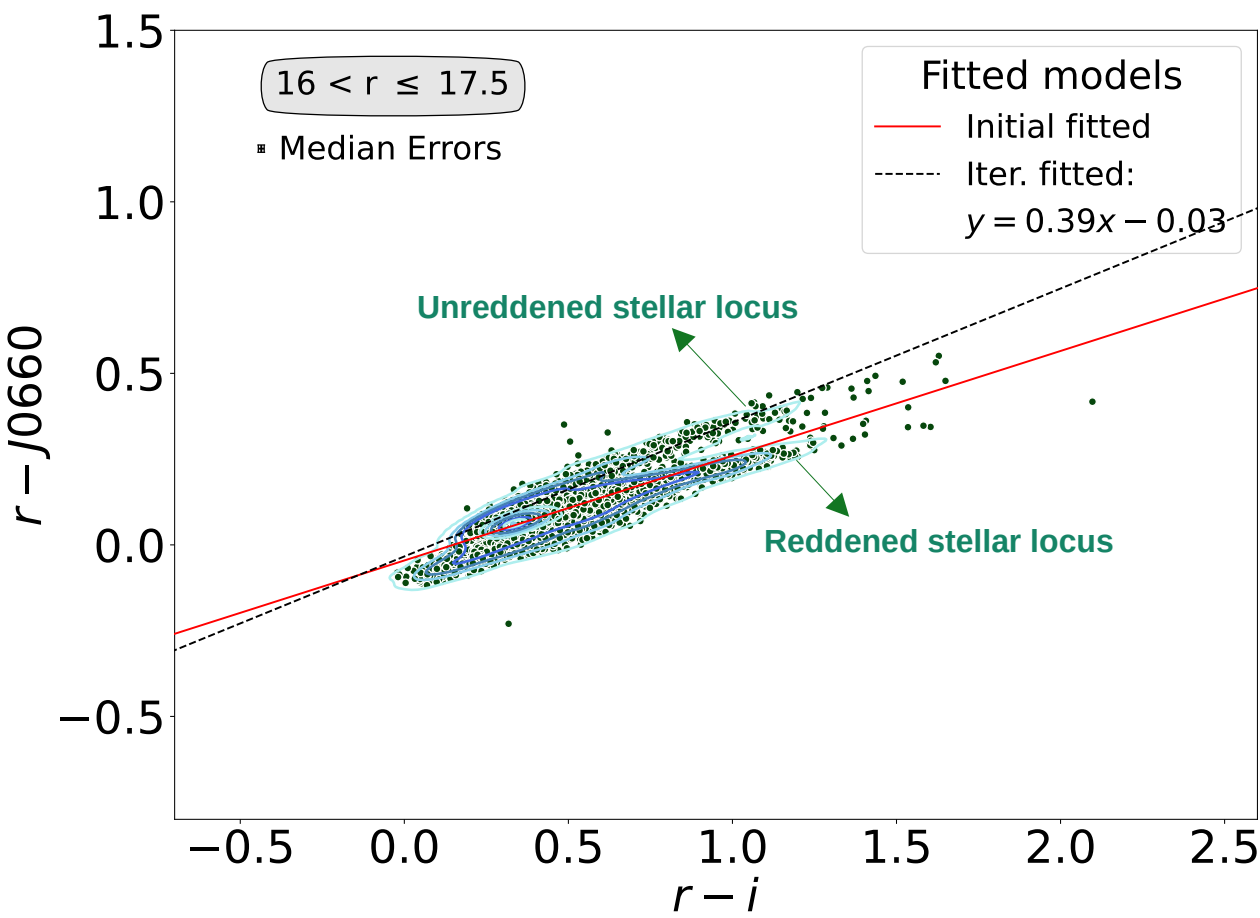
## Selecting the H $\alpha$ Excess Sources

The identification of H $\alpha$  emitters was based on the method applied by Witham et al. (2008)

Iteratively fit the main stellar locus and select all H $\alpha$ -excess sources which lie more than  $4\sigma$  away from the fitted locus



## Selecting the H $\alpha$ Excess Sources



## Galactic Disk Challenges

### Stellar Loci Duplication:

Disk fields show two stellar loci due to differential reddening and mixed populations (**main-sequence stars** and **giants**).

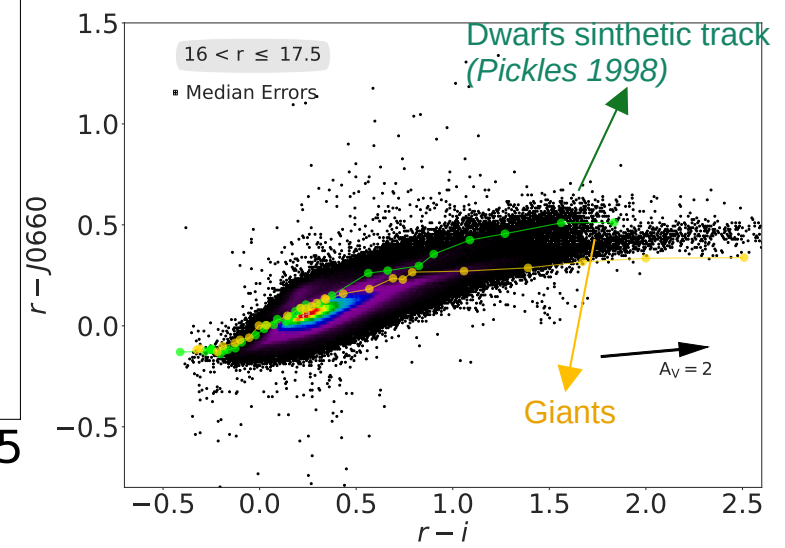
### Fitting Issues:

Initial fit often aligns with the reddened locus, complicating H-alpha excess detection.

### Solution:

Adjusted fit upward to align with the unreddened sequence.

Reverted to the original fit if adjustments worsened the accuracy.



## Selecting the H $\alpha$ Excess Sources

### Identification:

Sources significantly above the locus of main-sequence and giant stars exhibit excess in the J0660 filter, attributed to the H-alpha line.

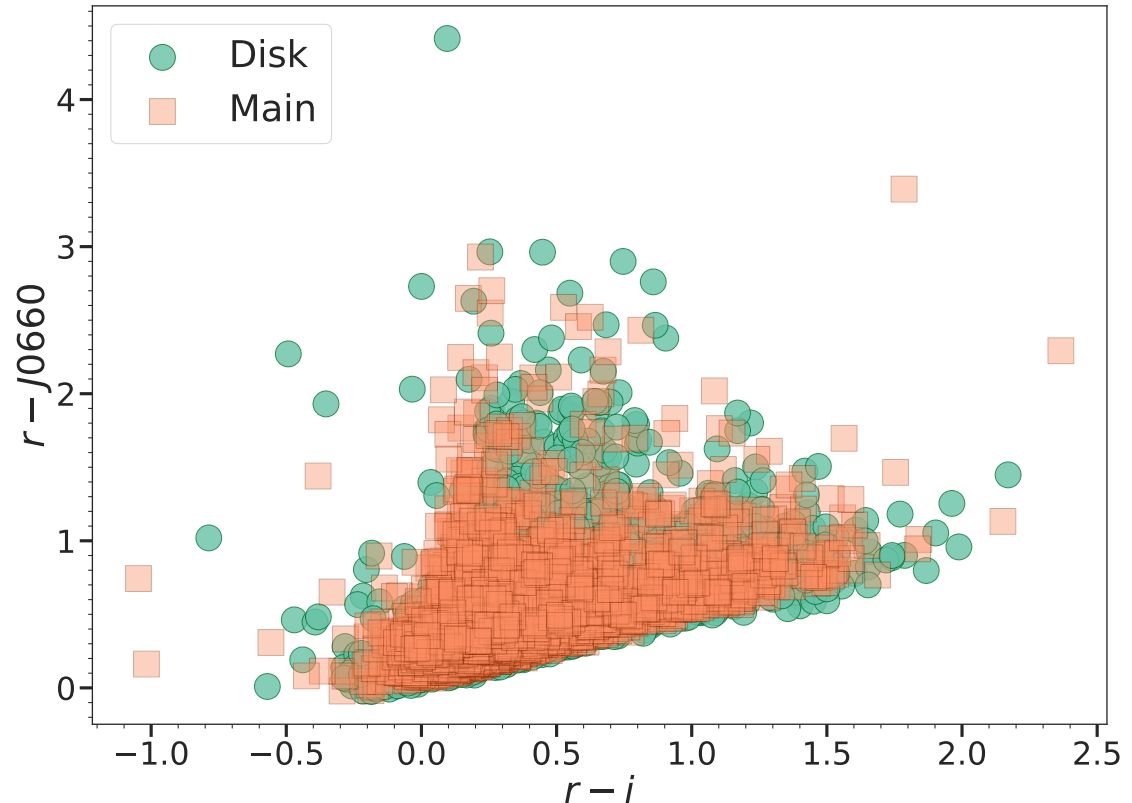
### Current Data:

Main Survey: 3,637 outliers identified.

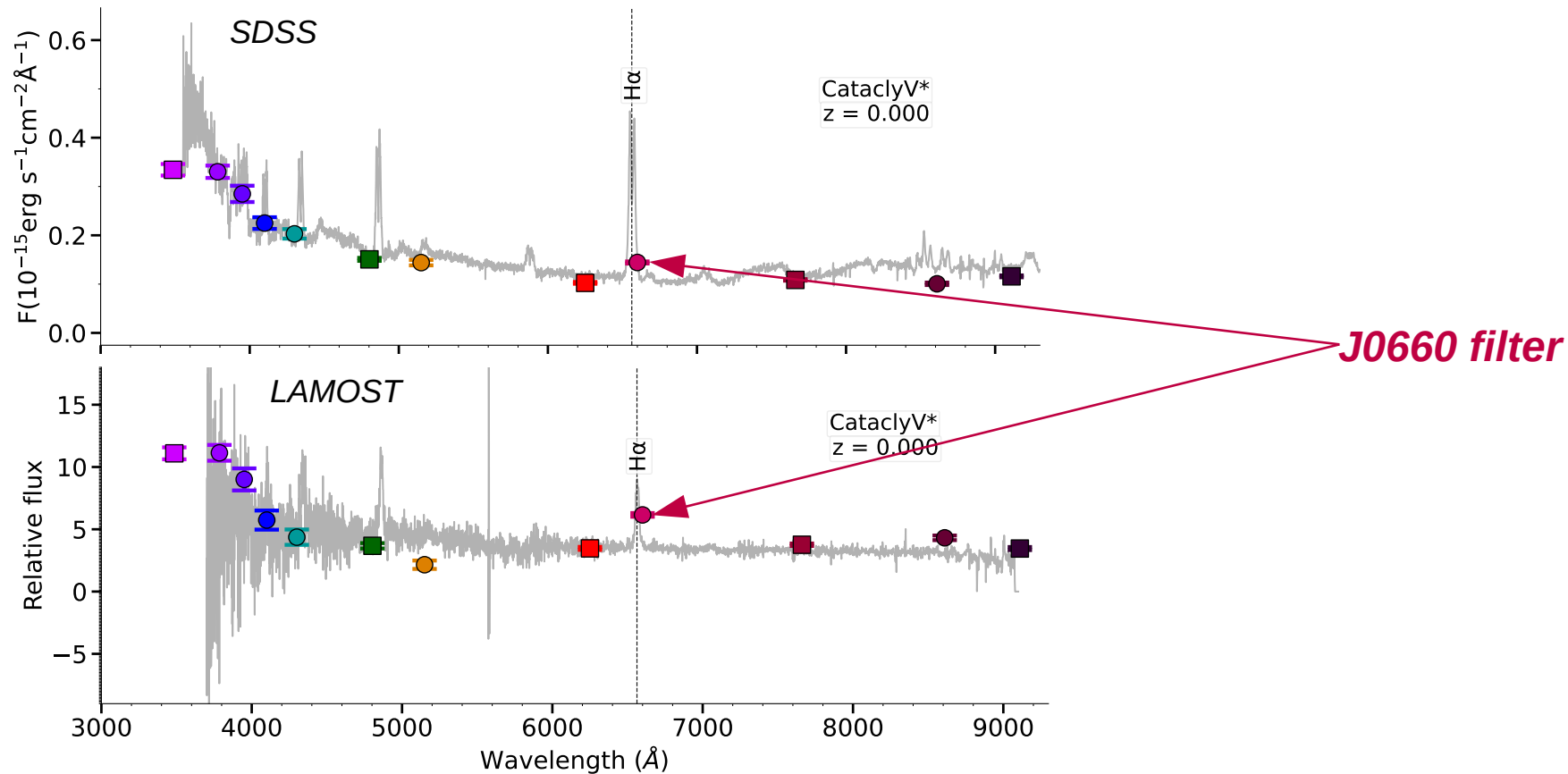
Galactic Disk: 3,734 outliers identified.

### Types of Sources:

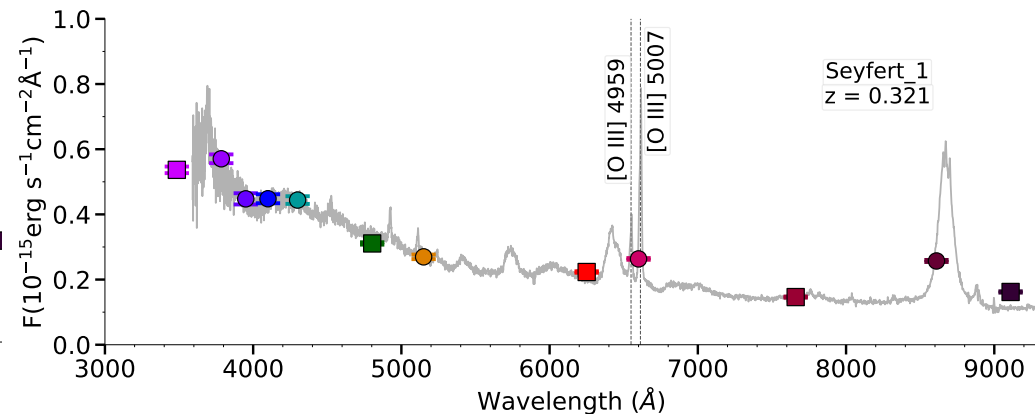
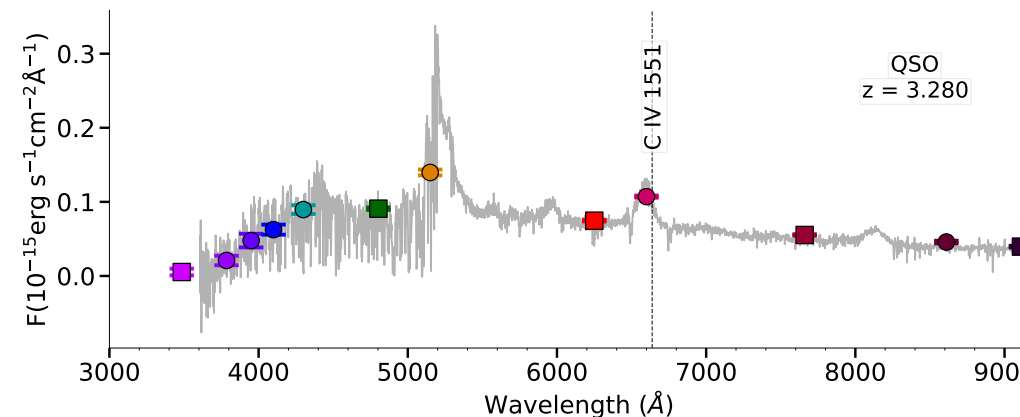
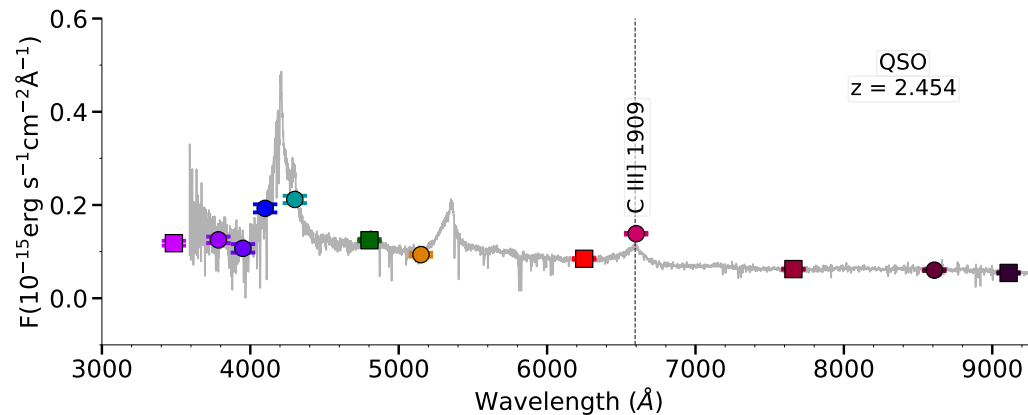
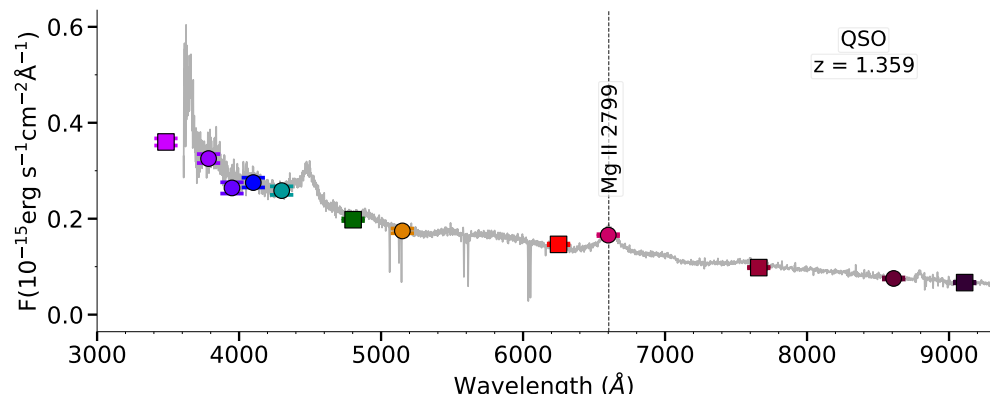
In agreement with SIMBAD, these include emission-line stars, PNe, CVs, SySt, YSOs, Be stars, QSOs, and galaxies.



## Example of two H $\alpha$ Emitters



## Extragalactic Compact Sources

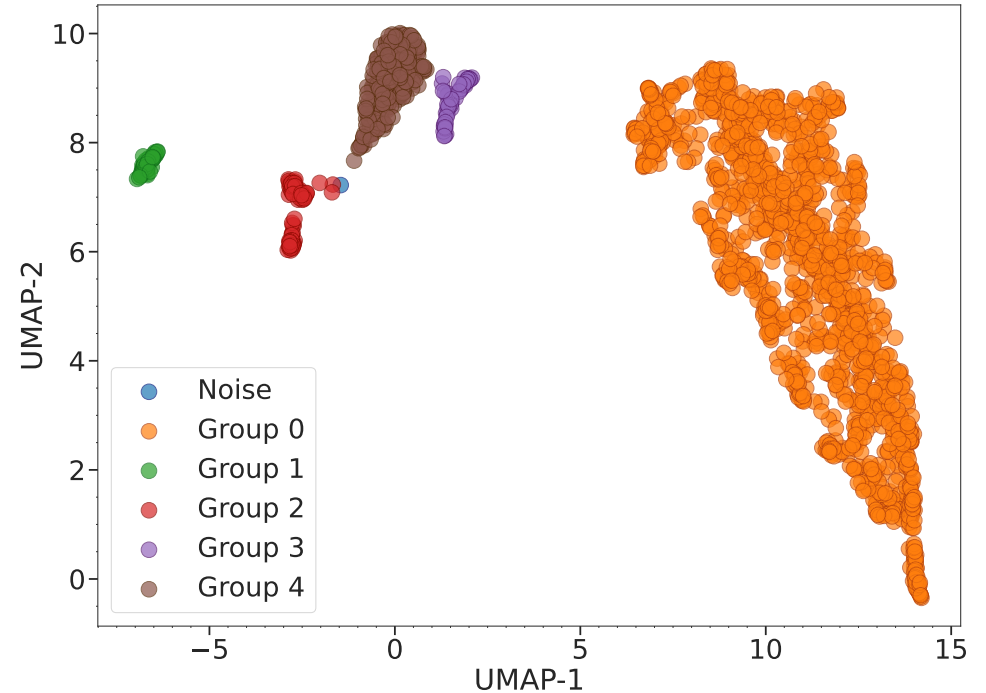
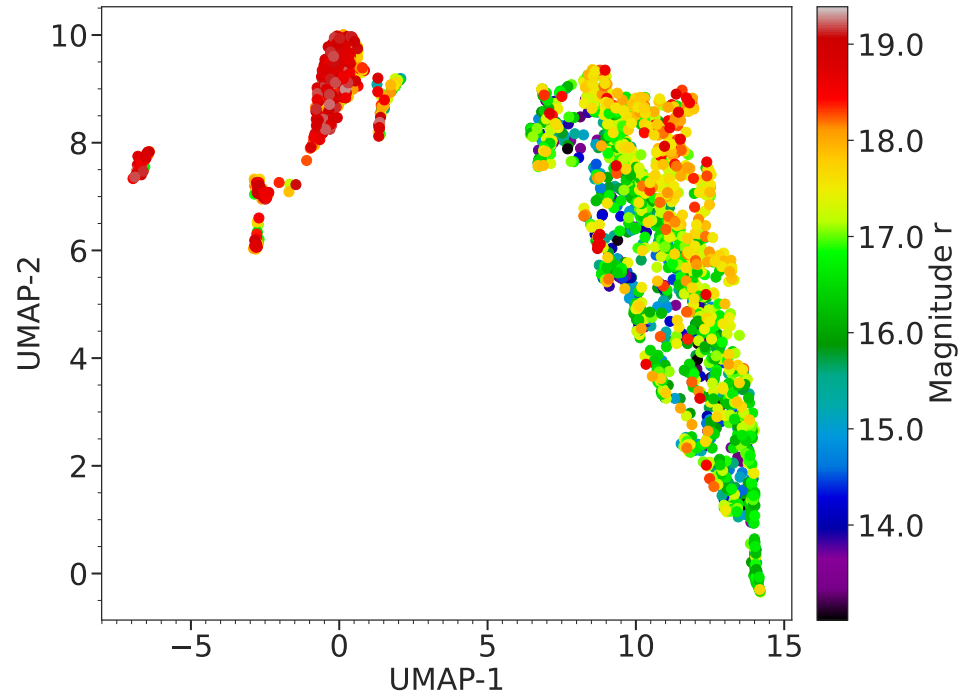


Our selection criteria effectively isolated compact sources, minimizing the inclusion of extended sources. In agreement with SIMBAD, only 23 AGN (3.1%) and 9 galaxies (1.2%) were identified in the main survey, while 143 QSOs (19.6%) were selected. The spectra of these QSOs and Seyfert galaxy show other emission lines that fall into the J0660 filter, resulting in a significant H $\alpha$  excess.



## Machine Learning Approaches

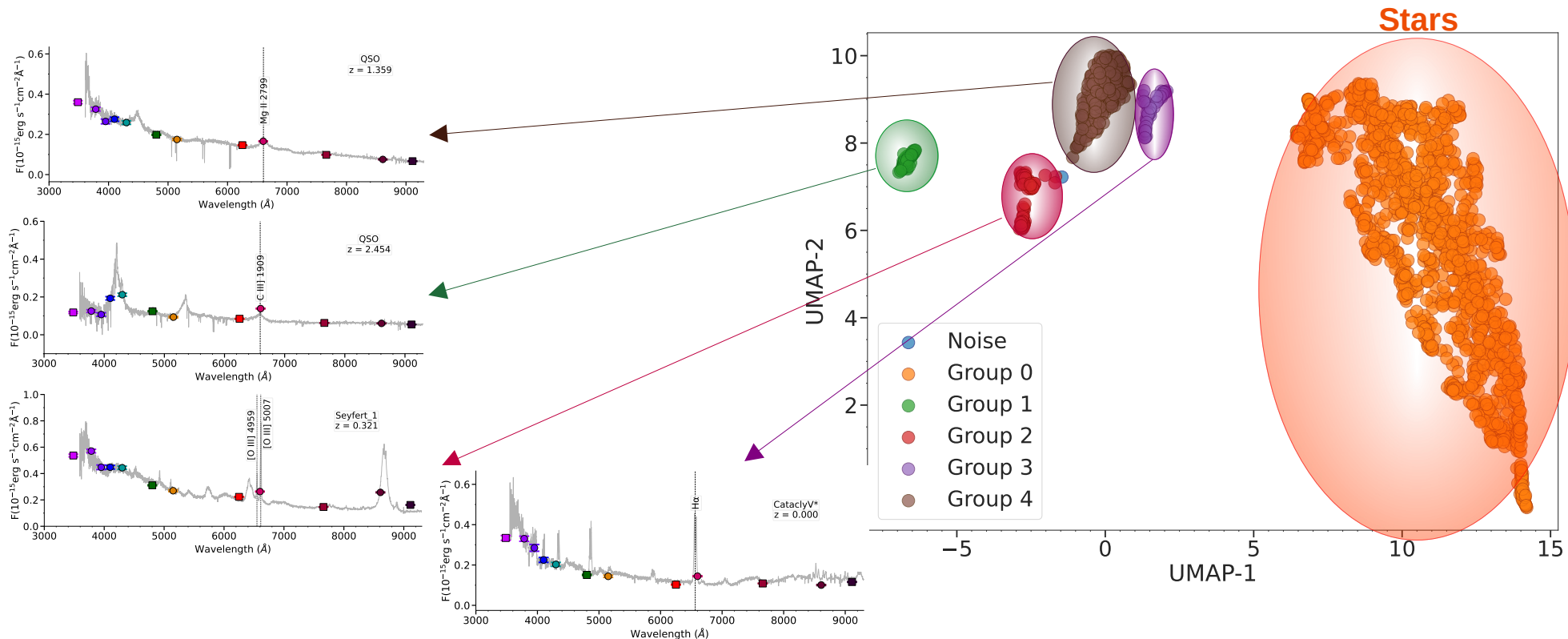
We applied **UMAP** for dimensionality reduction on S-PLUS data and used **HDBSCAN** for clustering H $\alpha$  excess sources. Two experiments were conducted: one using only the **66 S-PLUS** colors and another incorporating WISE bands. The results revealed the formation of five distinct groups, effectively separating galactic and extragalactic sources.





## Machine Learning Approaches

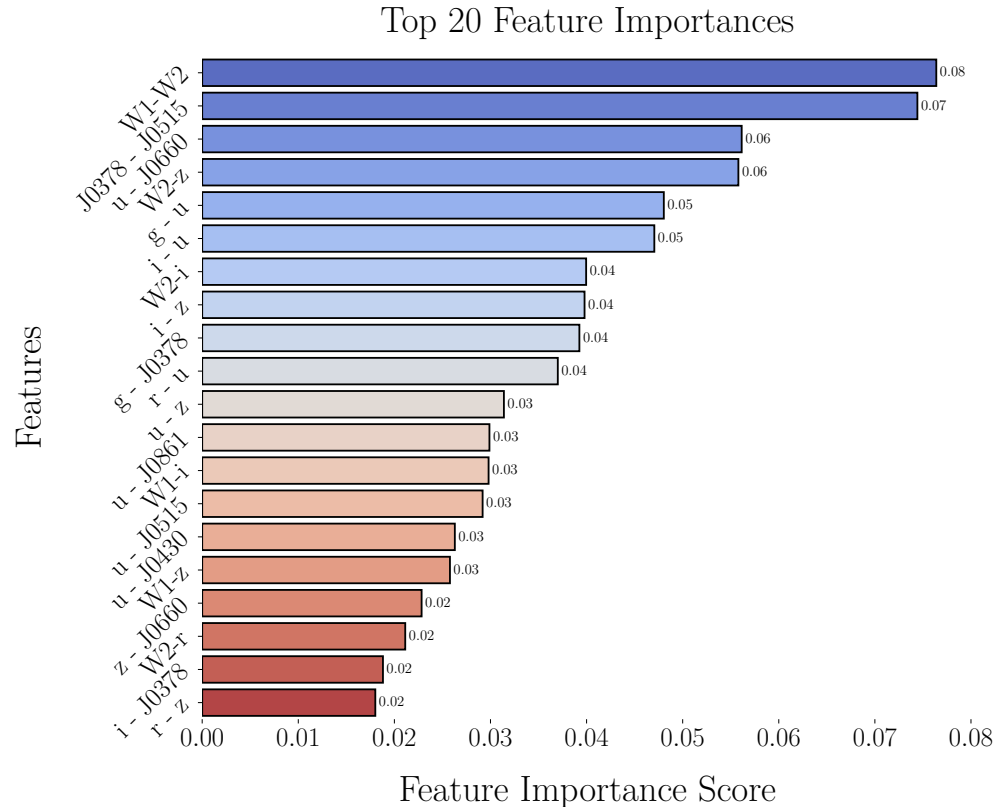
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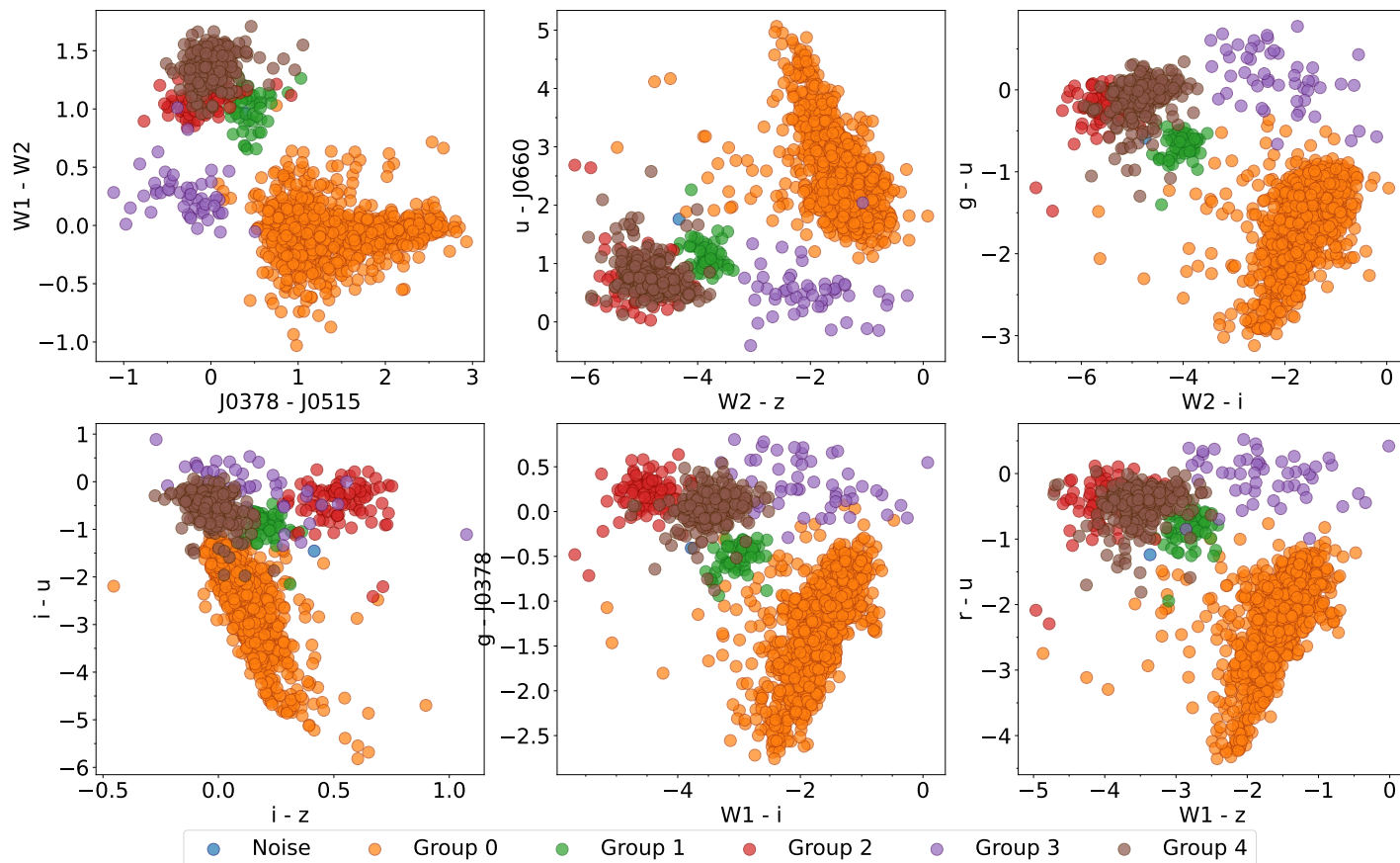
## Extracting Main Features: Color Analysis

Analysis: Key colors from S-PLUS and WISE filters identified by **Random Forest** as most influential in classifying H-alpha excess objects.

Results: **Top 20 features** contribute significantly to distinguishing between different object classes identified by UMAP + HDBSCAN.



## Extracting Main Features: Color Analysis



## Conclusions

- **Identification of H-alpha Excess Candidates:**
  - ✓ 7,371 candidates identified using the S-PLUS J0660 filter.
  - ✓ Distribution: 3,637 in the high-latitude main survey and 3,734 in the Galactic disk.
- **Classification of Objects:**
  - ✓ Cross-referencing with SIMBAD: EM stars, YSOs, Be stars, CVs, PNe, QSOs, non-local galaxies, and RR Lyrae stars.
- **Machine Learning Techniques:**
  - ✓ UMAP and HDBSCAN: Effective differentiation between Galactic and extragalactic objects
  - ✓ Challenges in distinguishing cataclysmic variables from QSOs or AGN with  $z \approx 1.35$ .
- **Integration of WISE Data:**
  - ✓ Improved separation of extragalactic and Galactic sources.
- **Random Forest Model:**
  - ✓ WISE data crucial for identifying significant features.
  - ✓ Improved color-color diagrams and understanding of H-alpha related phenomena.

THANK!!