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ASTRONOMY
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The Evolutionary Perspective of Massive YSOs in the LMC: Part I: Identification and Spectral Classification

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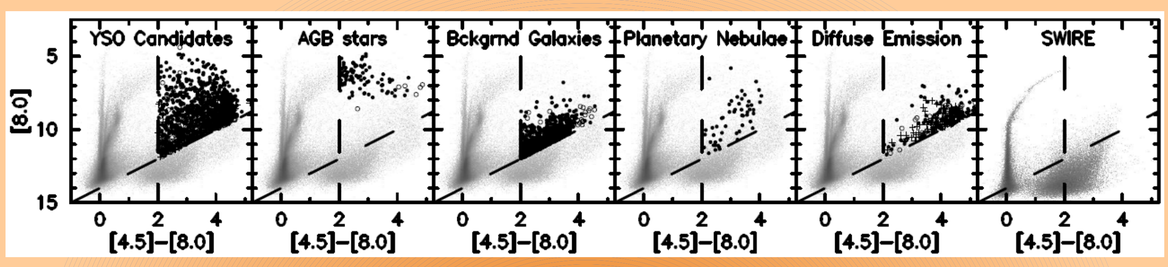
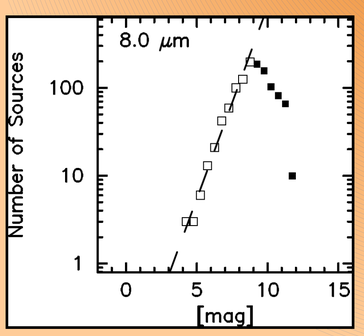
Abstract

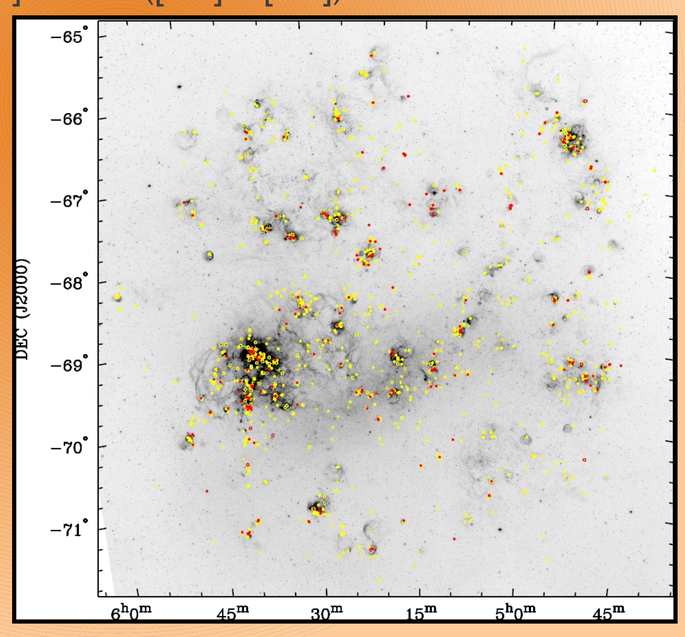
We present and categorize *Spitzer* IRS spectra of 294 objects in the Large Magellanic Cloud (LMC) to create the largest and most complete catalog of massive young stellar objects in the LMC. Target sources were identified from infrared photometry and multi-wavelength images indicative of young, massive stars highly enshrouded in their natal gas and dust clouds. The YSOs show a range of spectral features including polycyclic aromatic hydrocarbon (PAH) emission, deep silicate absorption, fine-structure lines, and ice absorption features. Based upon the relative strengths of these features, we have classified the YSOs into several distinct categories using the widely-used statistical procedure known as principal component analysis (PCA). We propose that these categories represent a spectrum of evolutionary stages during massive YSO formation. Using our catalog we put statistical constraints on the relative evolutionary timescale of processes involved in massive star formation.

I. Source Catalog[a]



- CMD selected
  - [4.5] – [8.0] > 2.0 & [8.0] > 14 – ([4.5] – [8.0])
- Eliminate Sample Contaminants
  - SEDs
  - Morphology
  - Environment





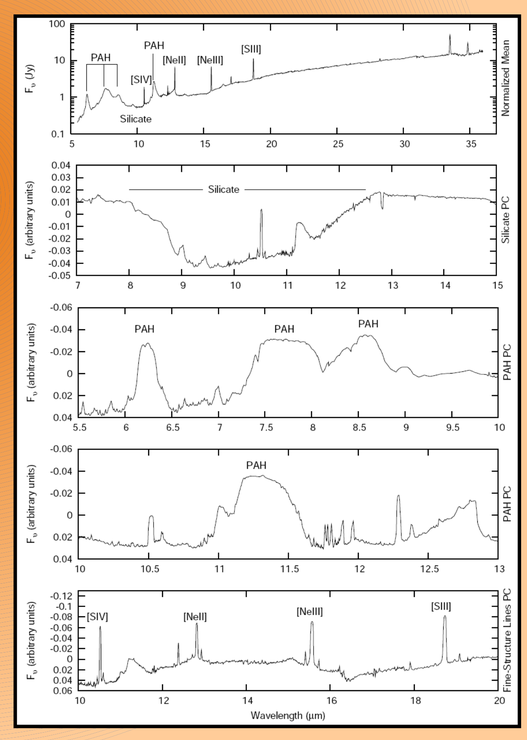
II. Principal Component Analysis

We use PCA to identify and quantify the strength of several spectral features including silicate absorption, PAH emission, and fine-structure lines. We then classify the spectra into several groups based upon the strengths of these features.

Four wavelength regions are chosen that contain the strongest components of a particular species type

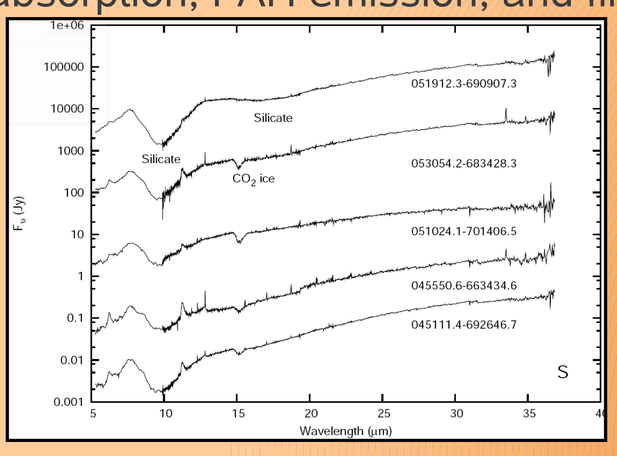
- Silicate absorption
  - 5 – 10 μm
- PAH emission
  - 5.5 – 10 μm
  - 10 – 13 μm
- Fine-structure line emission
  - 10 – 20 μm

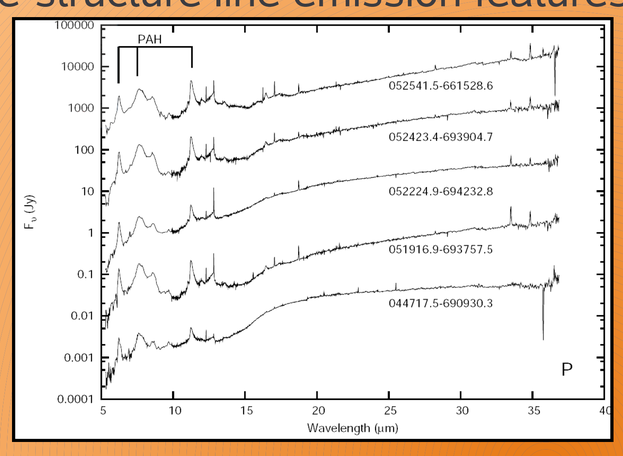
To get a measure of the strength of features in a YSO spectrum, we do a projection of the vector form of the spectrum into the eigenvector of the corresponding principal component.

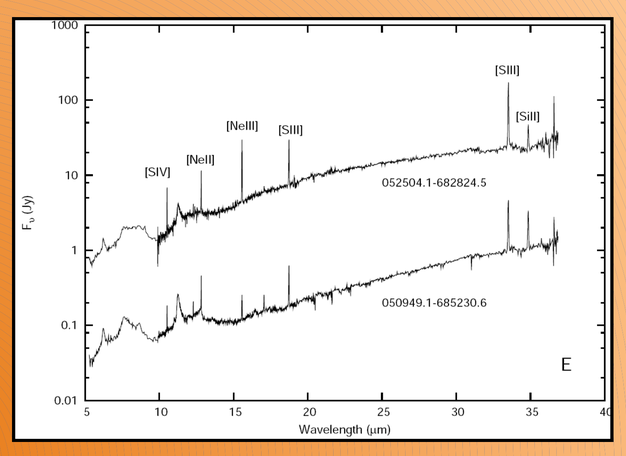


III. Results

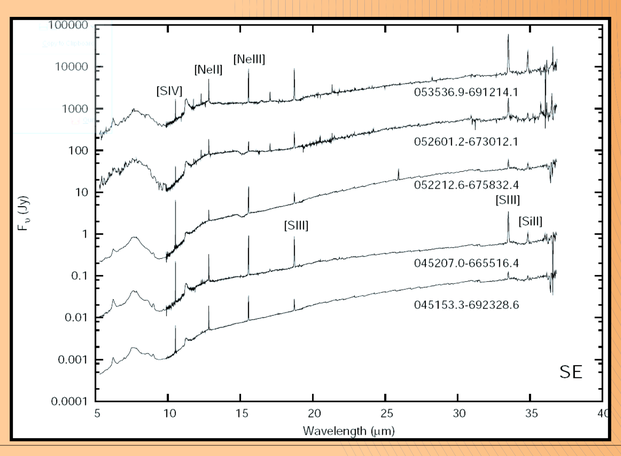
The YSO spectra have been separated into 6 different categorizations depending on the relative strengths of the silicate absorption, PAH emission, and fine-structure line emission features.

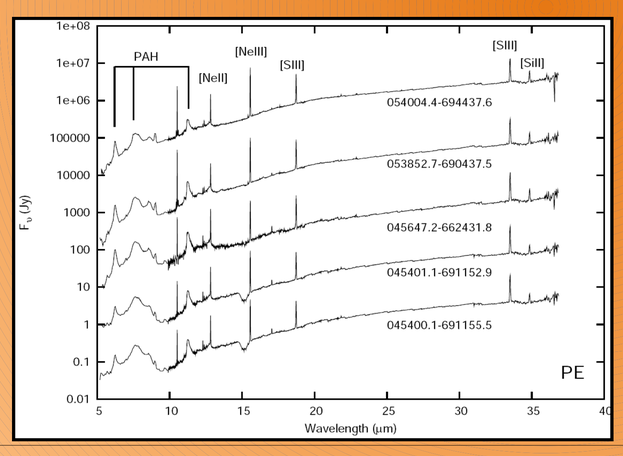


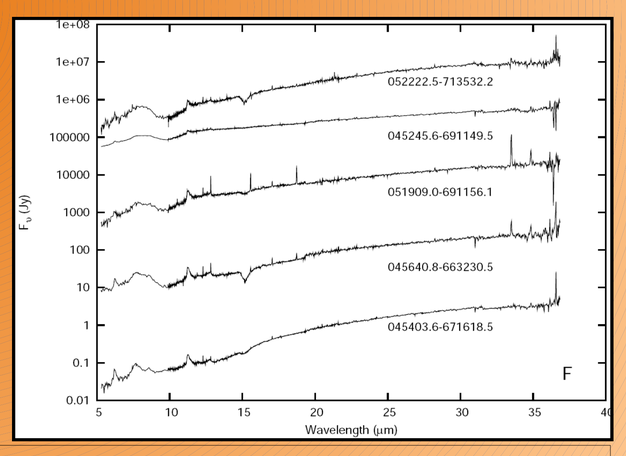




Our Classification	
Group	Total
S	11
SE	5
P	99
PE	144
E	2
F	16







- YSO identification success rate of >97%
- S group represents coldest, youngest stage (CO_2 ice common)
- Silicate absorption disappears relatively quickly: molecular cloud dispersal within 10,000's of years
- >60% have fine structure lines – massive YSOs create detectable compact HII regions quickly

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References: [a]Gruendl & Chu 2008