A Search to Uncover the Infrared Excess (IRXS) Sources in the Spitzer Enhanced Imaging Products (SEIP) Catalog

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Abstract

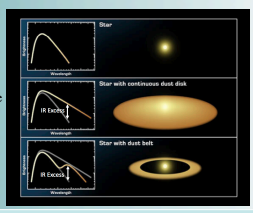
The Spitzer Enhanced Imaging Products catalog (SEIP) is a collection of nearly 42 million point sources obtained by the Spitzer Space Telescope during its 5+ year cryogenic mission. Strasburger et al (2014) isolated sources with a signal-to-noise ratio (SNR) >10 in five infrared (IR) wavelength channels (3.6, 4.5, 5.8, 8 and 24 microns) to begin a search for sources with infrared excess (IRXS). They found 76 objects that were never catalogued before. Based on this success, we intend to dig deeper into the catalog in an attempt to find more IRXS sources, specifically by lowering the SNR on the 3.6, 4.5, and 24 micron channels. The ultimate goal is to use this large sample to seek rare astrophysical sources that are transitional in nature and evolutionarily very important.

Our filtering of the database at SNR > 5 yielded 461,000 sources. This was further evaluated and reduced to only the most interesting based on source location on a [3.6]-[4.5] vs [4.5]-[24] color-color diagram. We chose a sample of 985 extreme IRXS sources for further inspection. All of these candidate sources were visually inspected and cross referenced against known sources in existing databases, resulting in a list of highly reliable IRXS sources.

These sources will prove important in the study of galaxy and stellar evolution, and will serve as a starting point for further investigation.

Introduction

An object that exhibits infrared excess (IRXS) will have a spectral energy distribution (SED) curve with a slope in the infrared wavelengths that does not match the expected blackbody curve of a source at a particular temperature. The figure to the right shows an example of an IRXS for a star with a dust disk and a dust belt. The shorter wavelength radiation emitted by the star is captured by the which are on the right side of the curve (the Raleigh-Jeans tail).

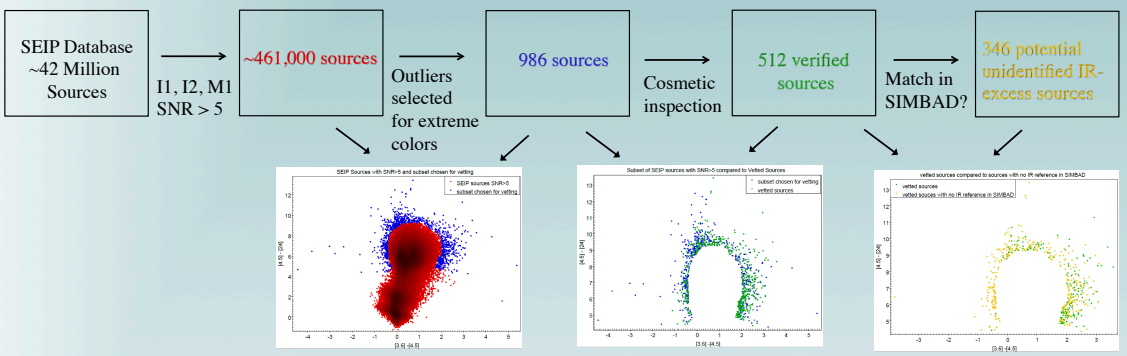


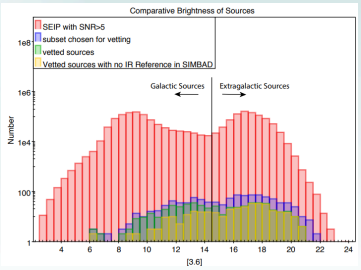
Dust surrounding a hot body results in a Rayleigh_Jeans tail with slope different from that of a single temperature black body. (Artist rendition by T. Pyle (SSC)). IR excess noted with white arrow.

Our project focused on the use of the Spitzer Enhanced Imaging Products (SEIP) to detect both galactic and extragalactic sources with IRXS. The SEIP contain some 42 million source detections collected during the cryogenic phase of the Spitzer Space Telescope's mission. The SEIP include data from the four channels of Spitzer's IRAC instrument (3.6, 4.5, 5.8, 8 μm - designated I1, I2, I3, and 14 respectively) and the 24 μm channel of its MIPS instrument (designated as M1). The SEIP includes data presented in the form of super mosaics which were assembled based on the study of particular target sources. Thus, by searching through the SEIP using data from I1, I2, and M1 at a signal to noise ratio (SNR) of > 5, we expected to identify many previously unknown IRXS sources that had been imaged by the Spitzer mission serendipitously.

These sources could have a great significance for target selection for future observations by any telescope, including the James Webb Space Telescope (JWST). IRXS sources that we have identified as being 'galactic' could be such phenomena as Young Stellar Objects(YSO), planetary systems with debris disks, or Evolved Stars (AGB). Those intergalactic IRXS sources we have identified might represent Active Galactic Nuclei (AGN) or various Luminous Infrared Galaxies (LIRG). Some of these sources may one day be shown to represent previously unobserved stages of evolution.

Digging Deeper





The histograms to the left represent the number counts selected form the color-color diagrams above:

Red: ~461,000 with I1, I2, M1 SNR >5

Blue: 986 source selected for extreme colors

Green: 512 sources verified to be free of cosmetic issues and the same source in all three bands

Orange: 346 Potential new IR excess sources with no IR reference in SIMBAD

Based on the distribution of the I1 magnitudes of the initial dataset, we have assigned a tentative classification of Galactic vs. extragalactic with brighter sources (I1 < 14.5) likely being Galactic and fainter sources (I1 > 14.5) likely being extragalactic.

Conclusion

We used a SNR > 5 cutoff for I1, I2, and M1 magnitudes to isolate extreme infrared excess (IRXS) sources in the SEIP catalog. By doing this, we created a database of 346 extreme infrared sources that have either never been identified at all, or have never been identified as an IR-source in SIMBAD. Of those 346 sources, we believe that 98 are Galactic and 248 are extragalactic, based on their I1-channel magnitudes. These sources could represent rare transitional stages in galaxy or stellar development, and present a ready-to-use database for scientists interested in this area of research.

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