Identification and classification of infrared excess sources in the Spitzer Enhanced Imaging Products catalog (SEIP)

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Abstract

The Spitzer Enhanced Imaging Products catalog (SEIP) stores millions of sources imaged by the Spitzer Space Telescope many of which have never before been individually examined. This project extracted from the SEIP strong infrared excess (IRXS) candidates which had been unknown previously.

The culling process utilized four steps: first, all objects had a signal to noise ratio of at least 10 to 1 in four wavelengths: 3.6, 4.5, 8 and 24 microns. Second, objects from highly studied regions (the galactic plane and formally conducted infrared surveys) were removed. Third, the remaining sources were plotted on a [3.6]–[4.5] vs. [8]-[24] color-color diagram to isolate IRXS candidates. Fourth, multiple images of the outlier points from the extrema of the color-color diagram were examined to verify that the sources had been cross matched correctly and to exclude any sources that may have been compromised due to imaging artifacts or field crowding. The SIRXS subset catalog provides a resource to speed the work of future IRXS researchers. This work was made possible through the NASA/IPAC Teacher Archive Research Program (NITARP) and was funded by NASA Astrophysics Data Program.

Background: Infrared Excess

Infrared excess (IRXS) sources show an excess of infrared flux above the expected blackbody emission. A variety of astronomical sources have been shown to produce IRXS, including young stars, evolved low- to intermediate-mass stars, active galactic nuclei, and interacting galaxies. All four are cases of a central radiation source, with reprocessing by surrounding dust.

The new SEIP catalog presents an excellent opportunity to search for IRXS in a large, previously unstudied sample of objects. By determining how frequently IRXS objects occur in the regions surrounding sources targeted by Spitzer it is possible to set expectations for future pointed observatories, such as the James Webb Space Telescope (JWST) mission. Like Spitzer, JWST will not survey the entire sky. The results of our study should indicate what might be found in a comparable investigation of serendipitous observations.

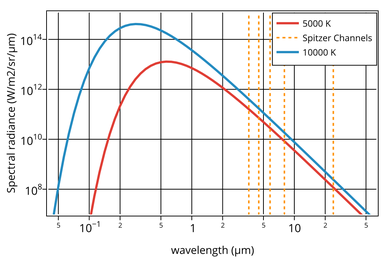


FIGURE 2: Ideal blackbody curves. The slope of the Rayleigh-Jeans tail is independent of temperature. Spectra that rise above this slope exhibit excess infrared.

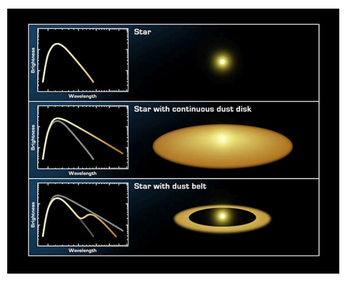


FIGURE 3: Sources embedded in dust are brighter than expected in the infrared, as indicated by a spectrum that rises above the theoretical slope for a photosphere. (NASA/JPL-Caltech/T Pyle (SSC))

Preliminary Classification

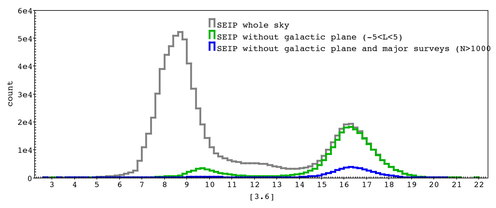


FIGURE 5: Distribution of magnitudes at 3.6 μm for SEIP objects with SNR≥10. Sources exhibit a bimodal distribution primarily corresponding to galactic and extragalactic sources.

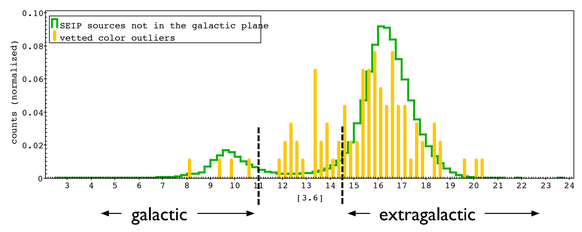
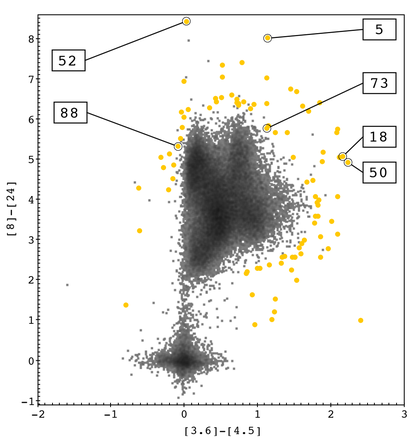
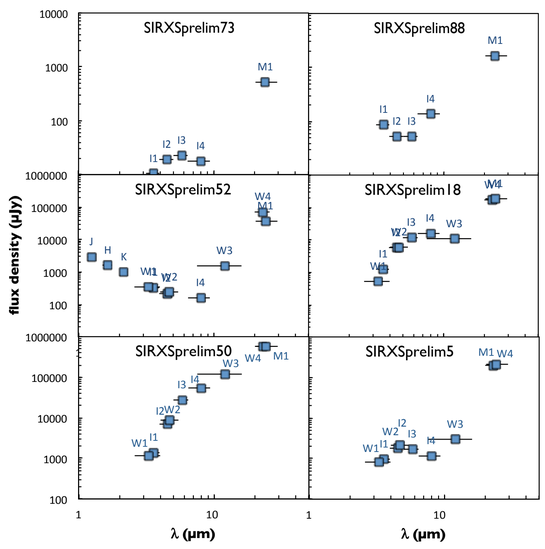


FIGURE 6: Normalized distribution of color outliers. Sources (indicated by yellow spikes) may be roughly classified by magnitude as galactic (bright, and so presumably nearby) or extragalactic (faint, and so presumably far away), with an ambiguous group lying between the two regions.





FIGURES 7,8: Flux density distributions for selected color outliers, and their respective positions on color-color plot.

The SEIP

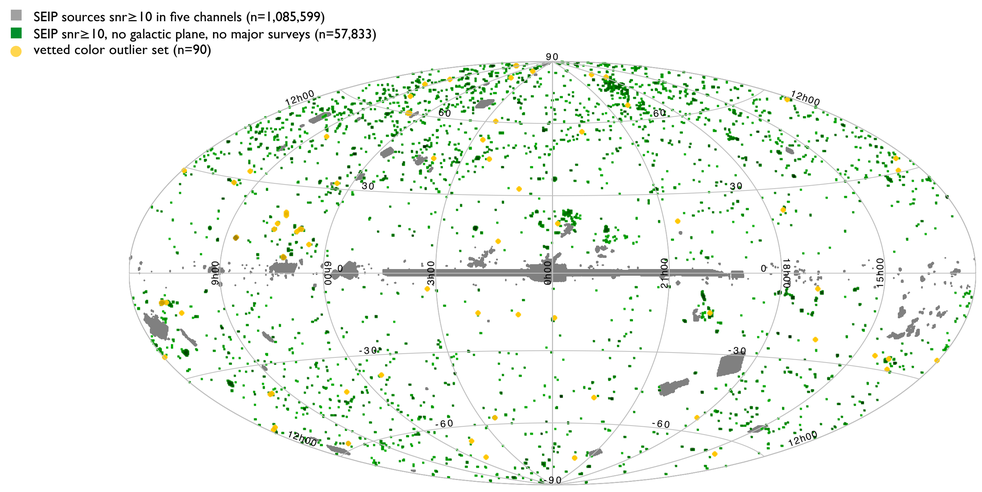


FIGURE 1: SEIP sources with s/n≥10 (galactic coordinates)

The SEIP compiled sources from large surveys, small pointed missions, and everything in between from the course of Spitzer's cryogenic mission. The resulting catalog is comprised of images with wide-ranging exposure times, and hence signal-to-noise. This project examined objects that have an SNR≥10 in four channels, lie outside the galactic plane and are not part of any survey containing more than 1,000 targets. From the remaining objects, the IRXS sources were extracted.

Selection of Color Outliers

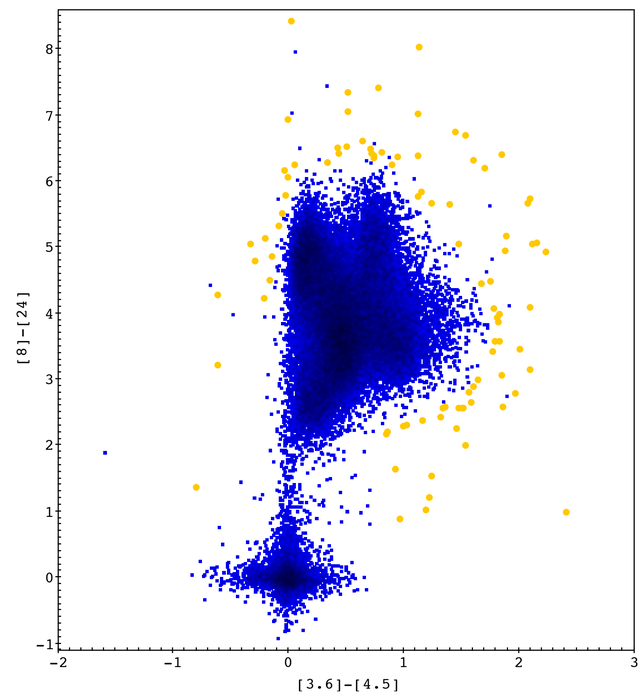


FIGURE 4: Color-color plot of SEIP sources, SNR≥10, not in the galactic plane, and not in major survey areas (blue), vetted color outliers (yellow).

Workflow

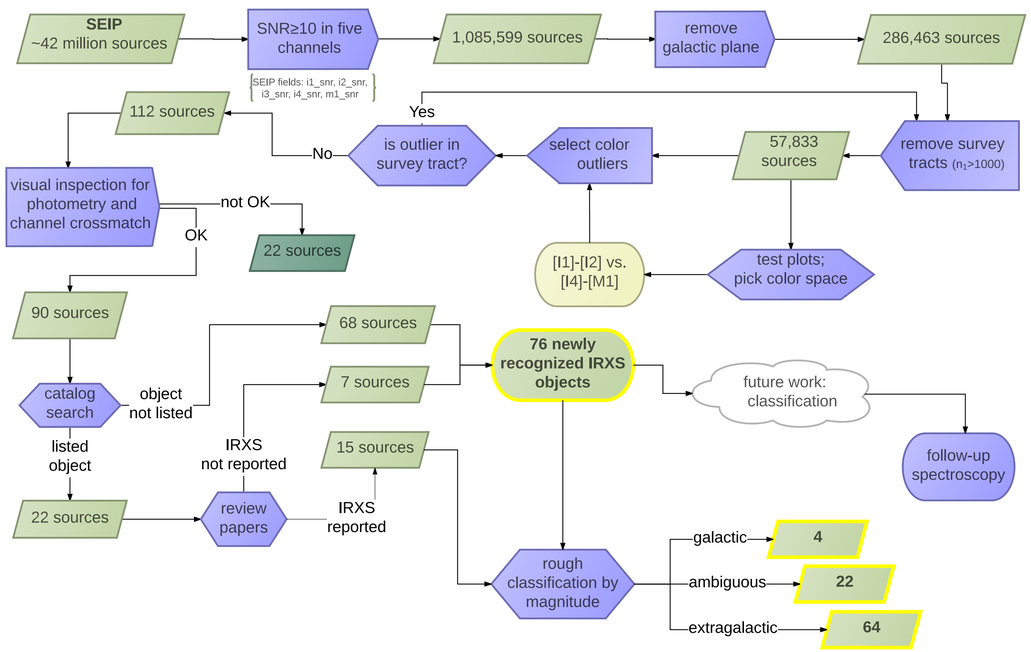


FIGURE 7: SIRXS workflow. Chart shows the process

[1]Noble & Greenough School (Dedham, MA), [2]Caltech (Pasadena, CA), [3]West High School (Torrance, CA), [4]Estes Park High School (Estes Park, CO), [5]Florida Virtual School (FL), [6]Phillips Academy (Andover, MA), [7]Vistamar School (El Segundo, CA), [8]Bert Lynn MS (Torrance, CA), [9]Palos Verdes Peninsula High School (Rancho Palos Verdes, CA)

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