A Search for Faint Sources of Infrared Excess in the Spitzer Enhanced Imaging Products Catalog

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Abstract

This research focuses on faint sources (magnitude ≥ 8 at 24 μm) in the Spitzer Enhanced Imaging Products (SEIP) Catalog. The SEIP is a unique repository of high resolution infrared data for 42 million point sources acquired during the *Spitzer Space Telescope's* 5-year cryogenic mission. Due to the large field of view of Spitzer's Infrared Array Camera (IRAC) and the Multiband Imager and Photometer for Spitzer (MIPS) camera, many of these objects were imaged serendipitously in the field of view of the intended targets and have never been analyzed. These sources should reveal new objects which show infrared excess not detected by other infrared surveys. The presence of an infrared excess can be used to find a wide range of phenomena, such as young stellar objects, planet-forming regions around main sequence stars, and active galactic nuclei. Filtering of the SEIP database at SNR > 5 in the 3.6, 4.5, and 24 micron channels yielded 459,748 sources. That was then filtered further by comparison with the GAIA DR 2 catalog yielding 3,086 targets in common, of which 181 targets had SNR > 3 parallax data and 58 sources that passed a visual inspection of the *Spitzer* images. This research was made possible through the NASA/IPAC Teacher Archive Research Program (NITARP) and was funded by NASA Astrophysics Data Program.

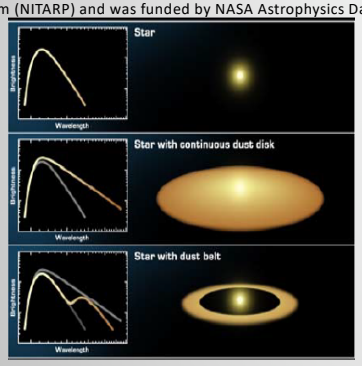

Figure 1. Stellar Infrared Excess Due to a Dust Disk or Belt (Pyle, 2005)

Background

The Spitzer Enhanced Imaging Products (SEIP) catalog (Teplitz et al., 2012) is comprised of images taken during *Spitzer's* 5-year cryogenic mission. Data is available from Channels I1 through I4 (3.6, 4.5, 5.8, and 8 μm) of the Infrared Array Camera (IRAC) and Channel M1 (24 μm) of the Multi-band Imager and Photometer for Spitzer (MIPS). The SEIP database includes both Super Mosaics (combinations of multiple observing frames) and a Source List of photometry for compact sources. The SEIP Source List was constructed with a priority on high reliability with coverage, completeness, and limiting magnitude being secondary considerations. In total, the SEIP catalog encompasses images of approximately 42 million different point sources, many of which were incidental observations included in the field of view of the intended target. Hence, the SEIP catalog potentially contains millions of targets which have yet to be studied and represents a unique opportunity to discover new sources of infrared excess.

We gratefully acknowledge funding via NASA Astrophysics Data Analysis Program.

SEIP Database 42 million sources

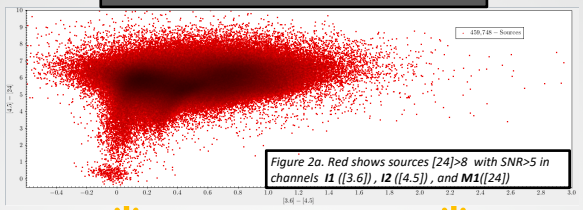

*Figure 2a. Red shows sources [24]>8 with SNR>5 in channels **I1** ([3.6]) , **I2** ([4.5]) , and **M1**([24])*

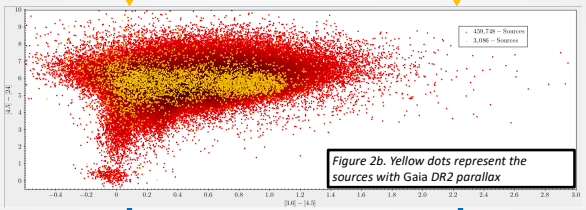

Figure 2b. Yellow dots represent the sources with Gaia DR2 parallax

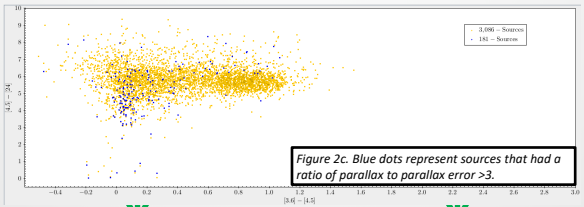

Figure 2c. Blue dots represent sources that had a ratio of parallax to parallax error >3.

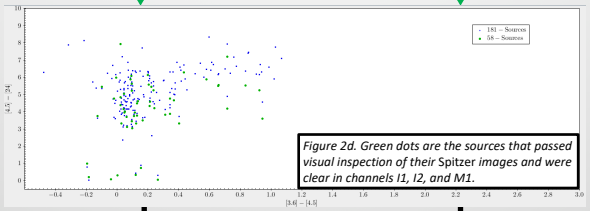

Figure 2d. Green dots are the sources that passed visual inspection of their Spitzer images and were clear in channels I1, I2, and M1.

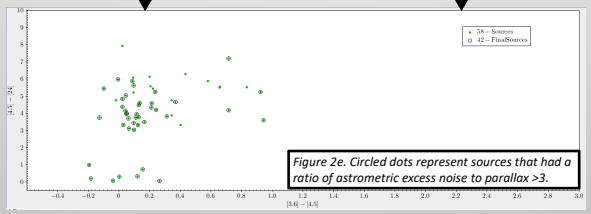

Figure 2e. Circled dots represent sources that had a ratio of astrometric excess noise to parallax >3.

SEIP Filtering Process

This study continued the work of two previous efforts (Strasburger et al., 2015; Rowe et al., 2018) that employed color selection to produce a catalog of sources of infrared excess that can be used for follow-up analysis aimed at improving our understanding of stellar and galactic evolution. In an effort to improve the robustness of the resulting catalog, this study applied filtering options available in the SEIP to minimize contamination by nearby saturated sources and/or crowded fields. Initial constraints of a signal-to-noise ratio greater than five in both the 3.6 micron and 4.5 micron IRAC channels and the MIPS 24 micron channel were applied resulting in 459,748 sources. Those sources were cross-referenced with the Gaia DR2 catalog to determine which ones had parallax measurements. The ratio of the parallax to parallax error was used to calculate a parallax signal to noise ratio and sources with parallax SNR greater than 3 were kept resulting in 181 sources. Those sources were vetted visually by observing all IRAC channels and the MIPS channel to be sure the sources had single, clear and non-contaminated IR images resulting in 58 sources. Finally these sources were checked to see that they had a low astrometric excess noise (noise resulting from the astrometric solution in the Gaia DR2 catalog which is distinct from the parallax uncertainty per source) and those sources with a ratio of parallax to astrometric excess noise greater than three were kept, resulting in our final sample of 42 sources.

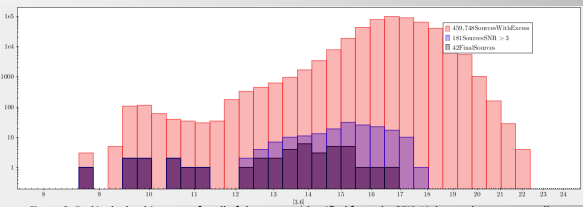

Figure 3. Red is the log histogram for all of the sources identified from the SEIP. Light purple represents all objects that were cross-matched with GAIA DR2. Dark Purple are the sources that passed visual inspection.

Summary of Findings

This research identified new sources of infrared excess using the SEIP catalog. Leveraging the superior sensitivity and resolution the of Spitzer MIPS instrument compared to WISE, this study was able to characterize infrared sources undetected by other infrared surveys. Starting with approximately 42 million point sources, a subset of infrared excess sources was identified by applying filters based on signal and image quality. This subset was cross-referenced with the Gaia DR2 catalog, producing a final set of 42 sources with precise parallax distances. As can be seen in Figure 4, the majority of these sources lie along the galactic plane. Several objects, however, are located outside of the galactic plane, raising interesting questions about their exact natures. The spectroscopic measurements required to further characterize the sources identified in this study are planned for a future work.

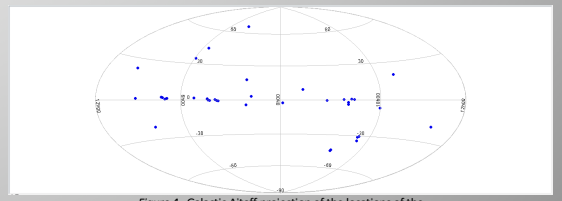

Figure 4. Galactic Aitoff projection of the locations of the 42 sources that passed the vetting process by this effort.