Spitzer Enhanced Imaging Products Explanatory Supplement

SEIP

Cryogenic Release v2.0
January 2013

Contents

Chapter 1. Overview

The Spitzer Science Center (SSC) and Infrared Science Archive (IRSA) have released a set of Enhanced Imaging Products from the Spitzer Heritage Archive (SHA). The SHA contains data spanning a range of Spitzer observations, including both Galactic and extragalactic targets, taken by General Observers, Legacy teams, and the instrument teams. The Spitzer Enhanced Imaging Products (SEIP) were designed to enable a wide range of archival research by providing a uniform processing of most of the SHA imaging data, using the final (best) calibration of the data.

The SEIP can be divided into two categories: images and tables. The images include super mosaics created using data from the four channels (3.6, 4.5, 5.8, 8 micron) of the Infrared Array Camera (IRAC) and the 24 micron channel of the Multiband Imaging Photometer for Spitzer (MIPS), using multiple Astronomical Observation Requests (AORs) where appropriate. These super mosaics support in-depth analysis by allowing extraction of faint sources, studies of extended emission, and stacking classes of objects.

The tables include a Source List (SL) of photometry for highly reliable compact sources. The SL offers an easily searchable database of millions of stars and galaxies, though by design prioritizes reliability over depth. Using IRSA's standard web services, users can select and analyze sources of interest ranging from nearby cold stars to the most distant quasars. In addition to Spitzer photometry, the SL contains photometry for positional associations found in the All Sky Release of the Wide-Field Infrared Survey Explorer (WISE) and in the 2 Micron All Sky Survey (2MASS).

Table 1.1 Photometry included in the Source List

Channel/Filter Name	Wavelength	Telescope/Instrument/Survey
J	1.25	2MASS
H	1.65	2MASS
K	2.17	2MASS
I1	3.6	Spitzer/IRAC
I2	4.5	Spitzer/IRAC
I3	5.8	Spitzer/IRAC
I4	8.0	Spitzer/IRAC
W1	3.3	WISE
W2	4.7	WISE
W3	12	WISE
W4	23	WISE
M1	24	Spitzer/MIPS

Table 1.2 Summary of SEIP images and tables.

Product	Description	Access
**mosaic.fits*	Mean mosaic built across AORs where appropriate. Most users will measure photometry on this product. For IRAC observations taken in HDR mode, there will be two **mosaic.fits* files per band, one with a "*short*" in the filename.	1. Atlas (for full super mosaics) 2. Cutout Service (for 0.005-0.5 deg cutouts)
**unc.fits*	Mean combined uncertainty map which should be used for estimating errors.	1. Atlas (for full super mosaics) 2. Cutout Service (for 0.005-0.5 deg images)
**cov.fits*	Mean coverage map indicating the number of images that went into each pixel, used to determine gain.	1. Atlas (for full super mosaics) 2. Cutout Service (for 0.005-0.5 deg cutouts)
**std.fits*	Measured standard deviation at each pixel.	1. Atlas (for full super mosaics) 2. Cutout Service (for 0.005-0.5 deg images)
Source List	Bandmerged list of photometry for high-reliability compact sources.	1. Catalog Search Tool (Gator) 2. Spitzer Heritage Archive (for access to most important columns and overplotting on super mosaics.)
Traceback Table	List of AORs, Program IDs (PIDs), Super Mosaic IDs (SMIDs), and DCEs for each Super Mosaic.	1. Catalog Search Tool (Gator) 2. Spitzer Heritage Archive

Table 1.3 URLs of IRSA Services that provide access to the SEIP.

Service	URL
Atlas Image Server	irsa.ipac.caltech.edu/data/SPITZER/Enhanced/Imaging/
Cutout Service	irsa.ipac.caltech.edu/data/SPITZER/Enhanced/Imaging/index_cutouts.html
Spitzer Heritage Archive	sha.ipac.caltech.edu/applications/Spitzer/SHA/
Catalog Search Tool (Gator)	irsa.ipac.caltech.edu/applications/Gator/

This Explanatory Supplement provides users with a description of the Cryogenic Release of the Spitzer Enhanced Imaging Products. It includes a description of the generation of the mosaics and tables, as well as a guide to the products that users can download from IRSA. It does not cover the details of the Spitzer instruments or the WISE or 2MASS data. These can be found at the following links:

- IRAC Instrument Handbook
  http://irsa.ipac.caltech.edu/data/SPITZER/docs/irac/iracinstrumenthandbook/

- MIPS Instrument Handbook
  http://irsa.ipac.caltech.edu/data/SPITZER/docs/mips/mipsinstrumenthandbook/

- IRSA WISE page
  http://irsa.ipac.caltech.edu/Missions/wise.html

- IRSA 2MASS page
  http://irsa.ipac.caltech.edu/Missions/2mass.html

1.1 The Cryogenic Release v2.0

This document describes the Cryogenic Release v2.0 (CR2). CR2 is an update to the Prliminary Release v1.1 and features greater sky coverage and an improved processing pipeline. CR2 includes Spitzer data taken during commissioning and cryogenic operations, including calibration data. The galactic plane and some fields that did not pass final Quality Assurance tests were omitted from this release, and will be provided in the next update. In fields with only MIPS data, sources are included in the source list only if they have a 2MASS or high-reliability WISE association. The most obvious omission is SMOG (adsabs.harvard.edu/abs/2008sptz.prop50398), which will be included in the next release.

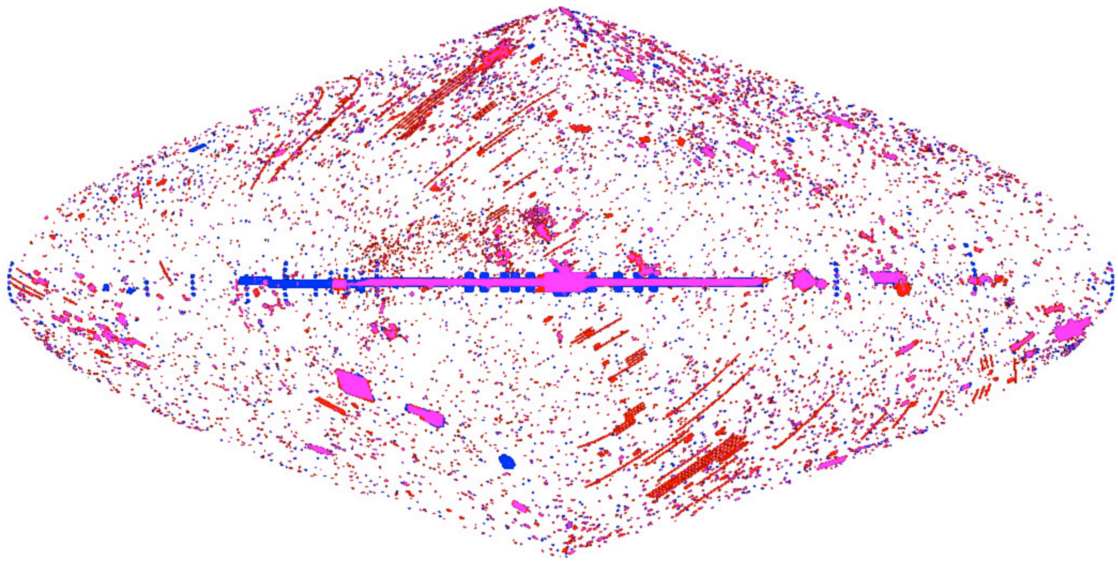


Figure 1.1 Sky coverage by Spitzer in Galactic Coordinates. Red corresponds to regions of the sky observed by only MIPS, red corresponds to regions of the sky observed by only IRAC, and magenta indicates regions observed by both IRAC and MIPS.

1.2 Quick Start Guide to using the Enhanced Imaging Products

Access to the Source List is summarized in Section 4.11. The SL contains only sources detected at the 10-sigma level in at least one channel (I1, I2, I3, I4, M1, J, H, K, W1, W2, W3, W4; see Table 1.1). To retain only the most robust flux densities, apply the following cuts:

1. Make a SNR cut. Each source has 5 columns ending in "FluxType", four for each of the IRAC channels and one for MIPS-24. Flux densities directly detected in an image with SNR>=3 have *FluxType=1.

2. Eliminate IRAC flux densities that may be affected by a nearby saturated source or a nearby extended source. There are four *FluxFlag columns, one for each IRAC channel. Choose *FluxFlag=0.

3. Eliminate MIPS flux densities that may be affected by a nearby saturated source or a nearby extended source by choosing M1_BrtFrac<0.5 and M1_ExtFrac<0.5.

4. Remove IRAC flux densities affected by soft saturation. There are four *SoftSatFlag columns, one for each IRAC channel. Choose *SoftSatFlag=0.

5. As long as you have filtered by *FluxType = 1 (item #1 above), then you can use the following rules. For IRAC, use the 3.8 arcsec diameter aperture flux densities and the associated uncertainties (columns *F_Ap1). For MIPS, use the PSF flux density and the associated uncertainties (M1_F_PSF).

1.3 Enhanced Mosaics

The SEIP include super mosaics for regions of the sky where at least four exposures (DCEs) are present in a given band, and that meet one of the following requirements:

1. The region was observed with at least four exposures in any of the IRAC channels (3.6, 4.5, 5.8, and 8 microns) in high-dynamic range (HDR) or mapping mode. The coverage requirement was set to ensure robust outlier rejection.

2. The region was observed with MIPS channel 1 (24 micron) in scan or photometry mode. All MIPS 24 micron data have sufficient coverage for robust outlier removal.

Some data for a given region of the sky were *not* used to create mosaics. These include:

1. IRAC sub-array mode - This mode was designed to enable very short exposures for bright objects and/or a high temporal sampling. These are very specific experiments that can require a high degree of human intervention to obtain reliable results.

2. MIPS 70 or 160 micron data - These data often require processing with the Germanium Reprocessing Tools (GeRT) to remove artifacts created by bright objects. This processing requires a significant amount of manual intervention. Therefore, MIPS channels 2 and 3 are not included in the Spitzer Enhanced Imaging Products.

3. MIPS Spectral Energy Distribution (SED) mode

4. MIPS total power mode

5. IRS 16 or 22 micron data - IRS Peak-Up Imaging forms a very small subset of the total data in the archive.

6. Observations targeted at moving objects - Moving object mosaics require rejection of background sources and significant manual intervention to achieve acceptable results. Furthermore, moving object observations were specifically targeted at individual objects with little chance for serendipitous discovery.

1.4 Source List

The Source List (SL) provides a list of highly reliable sources extracted from the Spitzer imaging archive. The Source List was designed to prioritize reliability over completeness or areal coverage. In order to make the Source List reliable, many sources were rejected. Therefore, it is not complete at any flux density. At bright flux densities, nearby galaxies may be rejected for being too extended, or for being too close to a neighboring galaxy. At faint flux densities, sources will be missing because they do not meet the signal-to-noise cut. Although the Source List is useful for many science projects, users who require high levels of completeness are encouraged to use caution. If you are interested in a source that does not appear in the Source List, you should consider measuring the photometry on the super mosaics yourself.

Reliability is defined as:

1. There must be fewer than 0.01% spurious sources for extragalactic cases (ObsType = 6), 0.05% for Galactic cases (ObsType = 3 or 4 or 5) without structured extended background, and 0.2% for Galactic cases with structured extended background. (For a description of ObsType, see Section 3.1.) Evidence for structured extended background is taken from the extended source masks (*extmsk) in the Coverage Table (see Section 0), which is reflected in the *ExtFrac flags in the Source List (see Table 4.5.)

2. Photometry should be good to 10% for high signal-to-noise, isolated point sources.

In order to meet these criteria, some sources that were detected in the super mosaics were rejected from the SL according to the following rules:

1. If a source is in a region flagged as extended, flagged as bright, or classified as Galactic (SMID starting in 3,4, or 5), at least two ten-sigma IRAC detections are required for the source to be included in the Source List. All other types of sources must be detected at the ten-sigma level in at least one IRAC band. This eliminates spurious sources that arise from the detection of noise peaks and knots of extended emission from galaxies or the interstellar medium.

2. To appear in the Source List, an object must have a mean coverage over its aperture of at least three for IRAC and four for MIPS. A threshold of three rather than four was adopted for the catalog because outlier rejection and drizzling often reduce the mean coverage to less than four in the coverage maps when there are in fact four exposures present. Note that at the edge of the mosaics the coverage is often much lower than in the center.

3. Sources that were too highly peaked were rejected because they are likely to be cosmic rays. Highly peaked sources were identified by comparing the peak magnitude and the 3.8 arcsec diameter aperture magnitude. Only sources meeting Peak Magnitude – Aperture Magnitude > 2.5 were included in the Source List.

4. Sources that have highly asymmetric spatial profiles are rejected since these are often multiple objects blended together. The Source List requires Peak Position – Centroid < 0.9 arcsec.

5. The following flags were applied if a source was only detected at >10 sigma in one IRAC band or if the source was in a bright or extended source mask:

    - Sources with FWHM < 1.2 arcsec were rejected because they are likely to be cosmic rays or other artifacts, and therefore spurious.

    - Sources with FWHM > 3.6 arcsec were rejected because they are too large for accurate photometry to be measured and are likely artifacts.

    - Sources with spatial profiles that are very broad are rejected because they are likely artifacts. The Source List requires Peak_Magnitude – Aperture Magnitude < 3.7, where magnitude is measured in a 3.8 arcsec diameter aperture.

6. Moving objects were minimized by performing source detection on the median images.

Chapter 2. Cautionary Notes

The Spitzer Enhanced Imaging Products were created from a large, inhomogeneous set of data, with the mandate that the number of spurious and poorly measured sources be minimized. This section summarizes some limitations due to these requirements.

2.1 Source List

2.1.1 The Source List may not agree with Legacy Catalogs

The Source List differs from Legacy Catalogs in a number of ways, including:

The Source List was designed to be reliable rather than complete, as described in Section 0. In contrast, Legacy Surveys have a variety of (typically more lax) requirements.

The uncertainties in the Source List are typically different (often more conservative) than those in the Legacy surveys.

The calibration used for the Source List is the final calibration derived by the Spitzer Science Center, while that used by the Legacy Teams was current at the time of delivery of their products.

The photometric analysis used for the Legacy Surveys differs team by team. The Source List uses a consistent system for all the data included, but this will differ from any given Legacy Survey product.

When all of these differences are accounted for, the Source List appears to be consistent with the Legacy Survey products.

2.1.2 Saturated sources

Fully saturated sources in IRAC data have been rejected from the Source List. However, IRAC data become non-linear at high count levels, before full saturation. While the IRAC cBCD pipeline attempts to account for this non-linearity, the correction is imperfect. Objects in the Source List that are potentially non-linear are flagged with the "SoftSat" flag. The minimum exposure time in a mosaic is used to estimate the DN in the original images, and hence the non-linearity level. However, the process of calibration and background matching causes the conversion from MJy/str in the mosaics to DN in the raw images to vary as a function of position, so the estimate will typically be an underestimate. To account for this uncertainty, the "Soft Saturation" level is empirically set at 15,000 D/N based on inspecting the 2MASS K-IRAC flux densities for stars in the SWIRE and SMOG data. The value recorded in the SoftSatFlag is the number of pixels in a 3.8 arcsec diameter aperture that are potentially non-linear.

Extremely saturated MIPS sources are rejected from the MIPS single-band Source List. Sources that are mildly saturated will be included in the MIPS single-band Source List. The PRF-fit photometry for these mildly saturated sources accounts for saturated pixels. Aperture flux densities are not corrected for saturated pixels.

2.1.3 Bandmerged multiwavelength catalogs are associations, not identified counterparts

Each row in the Spitzer Source List contains columns that deal with IRAC channels 1-4, MIPS channel 1, 2MASS *JHK*, and WISE channels 1-4. The multiwavelength information was compiled by using a simple positional search. See Section 4.3 for details. There is no guarantee that the long wavelength information is physically associated with the short wavelength data.

2.1.4 Incorrect bandmerging in close pairs

When there are two IRAC sources very close to one another, sometimes only one of the pair is bright enough to make it into the Source List. It is possible that the spectral energy distribution of the second object in the pair rises to higher flux densities at longer wavelengths and gives rise to the MIPS 24 micron source. In these cases, the 24 micron source will be associated with the bright (wrong) IRAC source.

2.1.5 The Source List is incomplete

Extended sources are not included in the Source List because their flux densities are difficult to measure in an automated way. Because of the difficulty in automatically measuring photometry for extended sources at a level better than 30%, extended sources have been rejected from the Source List. Users interested in photometry for extended sources should use the enhanced mosaics to derive their own photometry.

Column pulldown is an artifact that occurs in IRAC images. The IRAC s18 cryogenic pipeline identifies and corrects this artifact. To preserve information about the presence of the original artifact, the pipeline flags the entire column, and sets the associated cBCD uncertainties very high. The Source List pipeline interprets these flags as fatal, and does not report any sources along these columns. Some of these sources may be real, but the masking is conservative to avoid reporting spurious sources.

2.1.6 Spurious Sources

Although spurious sources have been minimized as much as possible, some do appear in the Source List. These include some bright latents in MIPS channel 1 mosaics that are spuriously reported as detections. Similarly, some row strip peaks are spuriously reported as detections. The spurious sources also include moving objects in MIPS channel 1.

2.1.7 Photometry near bright and/or extended sources may be unreliable: check the flags.

The pixels within a source may be contaminated by flux from a nearby bright and/or extended source. This contamination may lead to an overestimate in the flux reported for a source. Users can identify such problem sources by examining the *FluxFlag column in the Source List. This flag is set to 0 if the source lies in a normal region, 1 if the sources lies in the vicinity of an extended source, and 2 if the source lies in the vicinity of a bright source. If the source lies in the vicinity of a source that is both bright and extended, *FluxFlag is set to 2.

Table 2.1 Definition of *FluxFlag

*FluxFlag	Description
0	normal region
1	extended region
2	bright region
2	extended and bright region

2.1.8 Structured backgrounds

In regions with complex backgrounds, PSF errors will be underestimated in the Source List. Structured background is not well-subtracted by the default median subtraction, and this is not accounted for in the uncertainty estimates.

2.2 Super Mosaics

2.2.1 The Spitzer Enhanced Mosaics differ from Legacy images

The Spitzer Enhanced Imaging Mosaics will differ from the mosaics deliver by Legacy Teams for the same fields. There are several reasons for this:

1. The Spitzer Enhanced Imaging Mosaics use the final pipeline versions for the IRAC and MIPS BCD pipelines. The Legacy Teams used a variety of pipeline versions.

2. The Spitzer Enhanced Imaging Mosaics used all of the DCEs available for a given position. The Legacy Teams typically used only the data associated with their own programs. The result is that some Enhanced Mosaics are deeper than their Legacy counterparts.

3. Artifact mitigation was handled differently in the Enhanced Mosaics relative to the various Legacy Surveys.

2.2.2 Bright source masks may suffer from proper motion effects

The WISE catalog is used to identify bright sources for constructing bright source masks for the Source List. Since there can be a time differential between the WISE survey and data in the Source List, unknown or uncertain proper motions for WISE stars can cause bright source masks to be placed incorrectly.

2.2.3 Variable sources are averaged out

All the AORs available for a given part of the sky, even if they were observed years apart, are used to create the Enhanced Imaging Mosaics. This procedure has the advantage of achieving the greatest depth possible. It has the disadvantage that the flux from variable sources is averaged out. For users interested in variable sources, the mean MJD of all DCEs in a mosaic are included in the Traceback Table and the mosaic header.

2.2.4 IRAC HDR Mode

IRAC observed a subset of cryogenic data in High Dynamic Range (HDR) mode. In this mode, a short and a long exposure were taken at each position. The Spitzer Enhanced Imaging Products include two mosaics at each position that was observed in HDR mode. However, the short exposures are not used in the generation of the Source List.

2.2.5 Latent images in MIPS 24 micron data

Latent images fall in predicable positions based on the locations of bright objects in previous exposures. As a result, they can be masked by finding bright objects and then masking that array position in subsequent exposures. However, latents are not corrected if they come from previous AORs.

Chapter 3. Super Mosaics

The Enhanced Imaging Products include super mosaics, which combine all BCDs for a given object or contiguous area within a program. If the combined image is larger than two square degrees, multiple mosaics are created.

3.1 Observation Types

To ensure appropriate MOPEX parameters (namelists) were used for each mosaic and disparate AORs were not combined into a single mosaic, AORs were divided into six different Observation Types. The Observation Type for a given source is recorded in the ObsType column of the Source List, as defined in Table 3.1:

Table 3.1 Encoding of ObsType column in Source List.

ObsType column in SL	Observation Type
2	Zodiacal Background Observation
3	Galactic Plane Observation
4	Galactic Object Observation
5	Extended Object
6	Extragalactic Observation
7	Extremely deep extragalactic observations embedded in shallow fields

An overview of how ObsType was assigned is provided in . The proposal science class input by the Principal Investigator (PI) for each program was used as the primary way to identify AORs. However, a significant number of AORs were re-classified based on other criteria. Objects with NGC numbers, Messier numbers, or in the 2MASS extended source catalog were re-classified as extended sources. However, extended sources were re-classified as Galactic or extragalactic if the extended sources corresponded to an existing Galactic observation or were part of a larger extragalactic program that happened to overlap the extended source (e.g. MIPSGAL and SWIRE). Calibration data and ambiguously classified data (e.g. gamma ray burst observations in a Galactic Plane field and observations of nearby stars at high Galactic latitude) were initially assigned an unknown flag. If these observations spatially matched a classified AOR they were assigned that science class. Otherwise, they were assigned a class based on the mean ISM emission in the AOR. “Stellar population” observations targeting nearby galaxies or globular clusters were re-classified as extended source observations. All MIPSGAL, Galactic Center, SMOG, GLIMPSE, GLIMPSE2, and GLIMPSE-3D observations and galactic observations that overlapped with them were classified as Galactic Plane observations rather than Galactic observations to make the process of matching and dividing up the Super Mosaics into Regions simpler and more practical.

Zodiacal light measurements were separated from all other classes of observation because they typically consist of very long scans with MIPS that intersect a wide variety of other programs and hence would create a heterogeneous set of mosaics. Flat field calibration frames were also classified as Zodiacal light measurements because they typically contain much higher background levels than science observations.

If a given Super Mosaic is larger than 2 square degrees, it is broken up into 30 arcminute by 30 arcminute Regions. Each Region overlaps its neighboring Regions by 2.6 arcminutes (approximately 50% of an IRAC frame) on each side. This overlap ensures that all frames covering a given Region are included in the outlier rejection procedure. It also allows objects smaller than 2.6 arcminutes to be analyzed on a single mosaic. Super Mosaics that are divided into multiple Regions have SMIDs that end in 1, while Super Mosaics that are smaller than 2 square degrees have SMIDs that end in 0.

Each Region is labeled by a REGID. The REGID always begins with the SMID followed by a "-", followed by a Tile Number. For example, a REGID of 40002981-108 has an SMID of 40002981 and a Tile Number of 108. Two sets of mosaics are created per position for IRAC data taken in High Dynamic Range (HDR) mode. The short frames are assigned a REGID with "–short" suffix. An example is 40002981-108-short.

3.2 Image Artifact Mitigation

3.2.1 IRAC

IRAC BCD data contain several artifacts, including mux-bleed, mux-stripe, column droop, and bright star ghosts, all of which are described in detail in the IRAC Instrument Handbook. The IRAC pipeline produces cBCD images which are an attempt to mitigate these artifacts. The Spitzer Enhanced Imaging Mosaics are built from cBCD data.

Problematic cBCDs were removed before generating mosaics. The first frame of all IRAC AORs has decreased sensitivity and was not included in the mosaics. The second frame of some IRAC observations has a short exposure time relative to the majority of exposures and was removed in these cases. Finally, observations taken in High-Dynamic-Range (HDR) mode were split into short and long exposure mosaics.

However, since mux-bleed is not completely corrected in the cBCDs, sources found in regions where mux-bleed is likely affecting photometry were rejected from the Source List. See Figure 3.1.

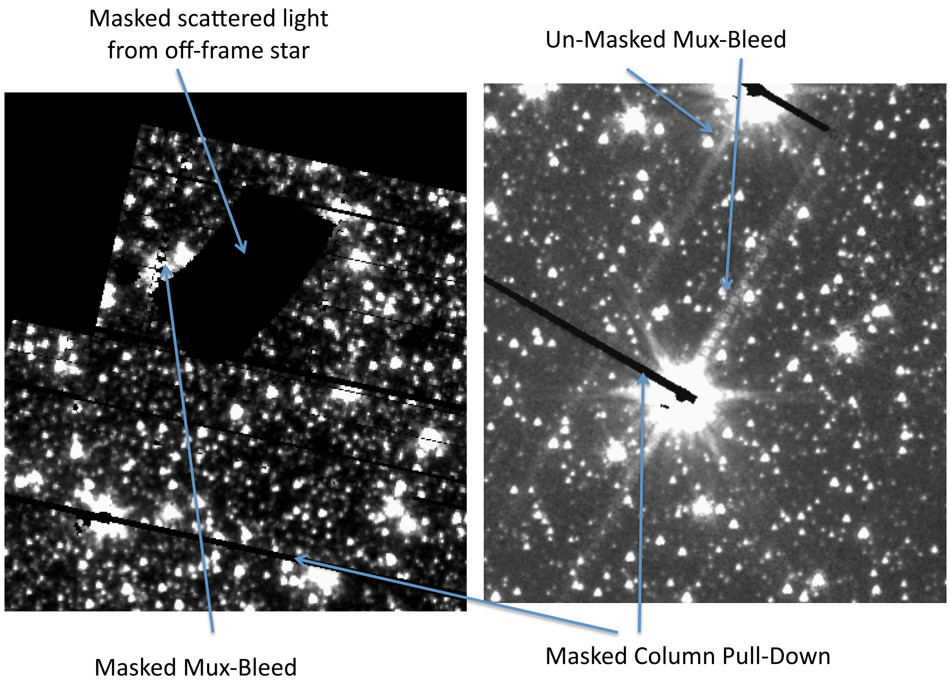


Figure 3.1 Example Region Mosaic created from IRAC cBCD data.

3.2.2 MIPS

MIPS data suffers from various artifacts, including jailbars and latent images. See the [MIPS Instrument Handbook] for details, and Figure 3.2, Figure 3.3, and Figure 3.4 for examples. The MIPS BCD images were run through a new MIPS Corrector module to mask latent images and correct the flat field. In the following, we refer to the output of this MIPS Corrector module as MIPS CBCDs.

The first frame of all MIPS AORs has decreased sensitivity and was not included in the mosaics. In addition, the second and last frame of MIPS fast scan observations are also problematic and were removed.

The MIPS instrument relies on a movable mirror to dither observations in photometry mode and to track in scanning mode. The position of this mirror cannot be precisely measured or repeated, creating observation-to-observation differences in the instrument flat field. This is particularly problematic for 24 micron photometry mode data taken in parallel to 70 or 160 micron observations since the scan mirror position is poorly understood in this mode. These flat fielding errors typically create significant gradients across parallel mode observations and a grid-like artifact in primary mode observations. Furthermore, the response of any individual pixel suffers hysteresis effects that can change its response from observation to observation and create residual images of bright objects that can persist for a significant amount of time.

The flat field artifacts can be corrected by creating a median flat using the background light in science observations. However, this will fail for photometry mode observations that are not sufficiently dithered if they contain a significantly extended object or a significant amount of structure from Galactic cirrus. To create a median flat, objects are first found and masked using the APEX package, then the dithered or scanned observations are combined to create a median flat. A separate median flat is created for each Field of View (FOV) in photometry mode or each scan leg in scan mode. These median flats are then divided into the data images.

Latent images fall in predictable positions based on the locations of bright objects in previous exposures. As a result, they can be masked by finding bright objects and then masking that array position in subsequent exposures. However, latents are not corrected if they come from previous AORs.

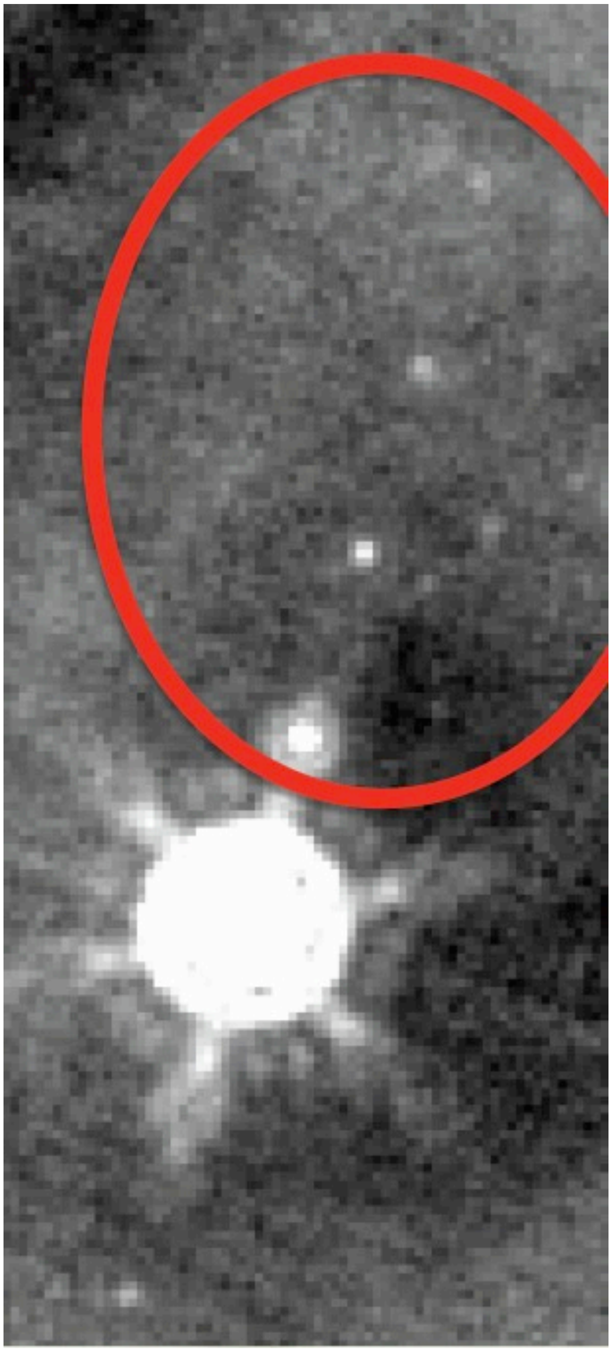


Figure 3.2 Example of MIPS artifacts. Note flatfielding issues and latent images. A new MOPEX corrector module fixes these.

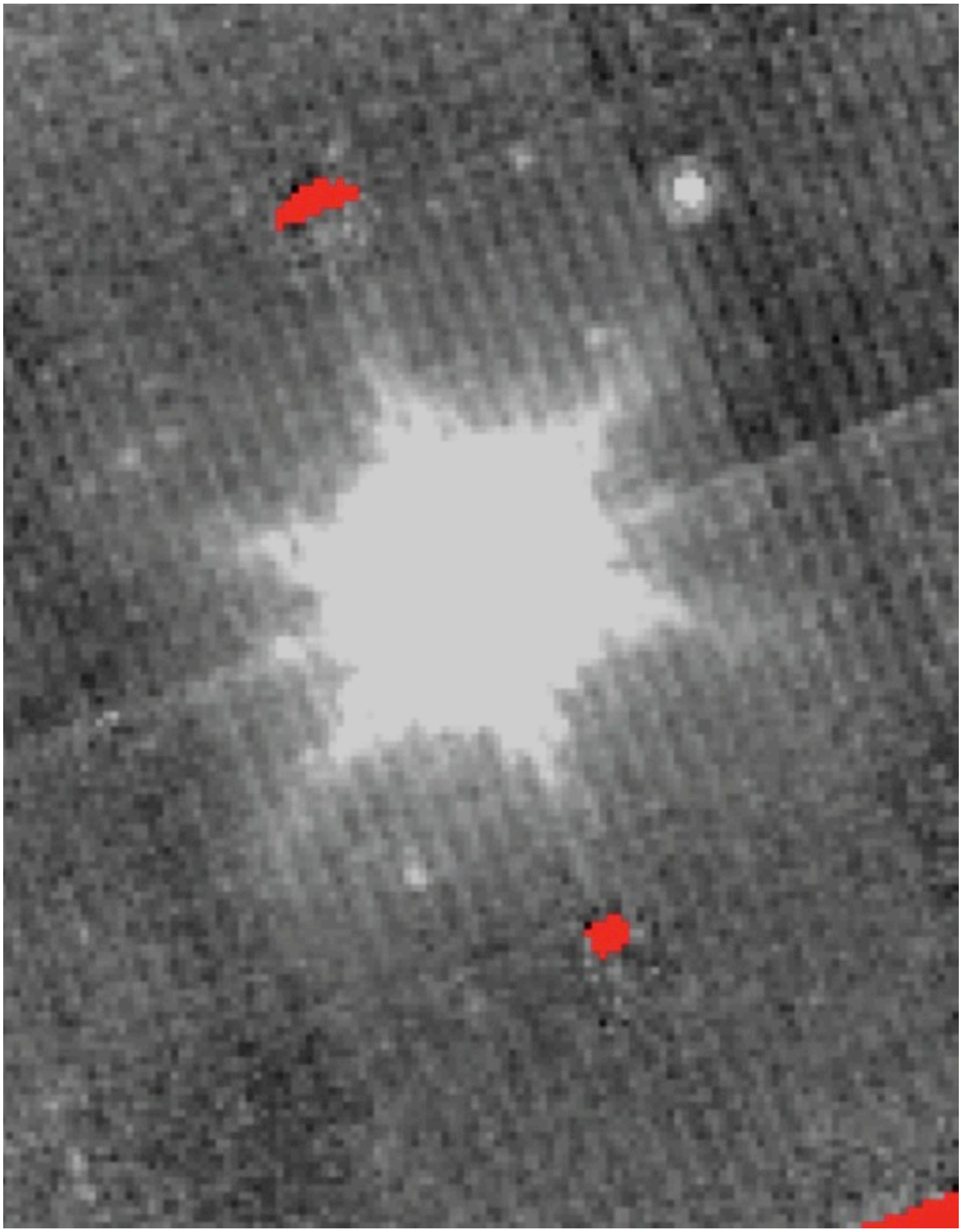


Figure 3.3 Example of MIPS artifact.

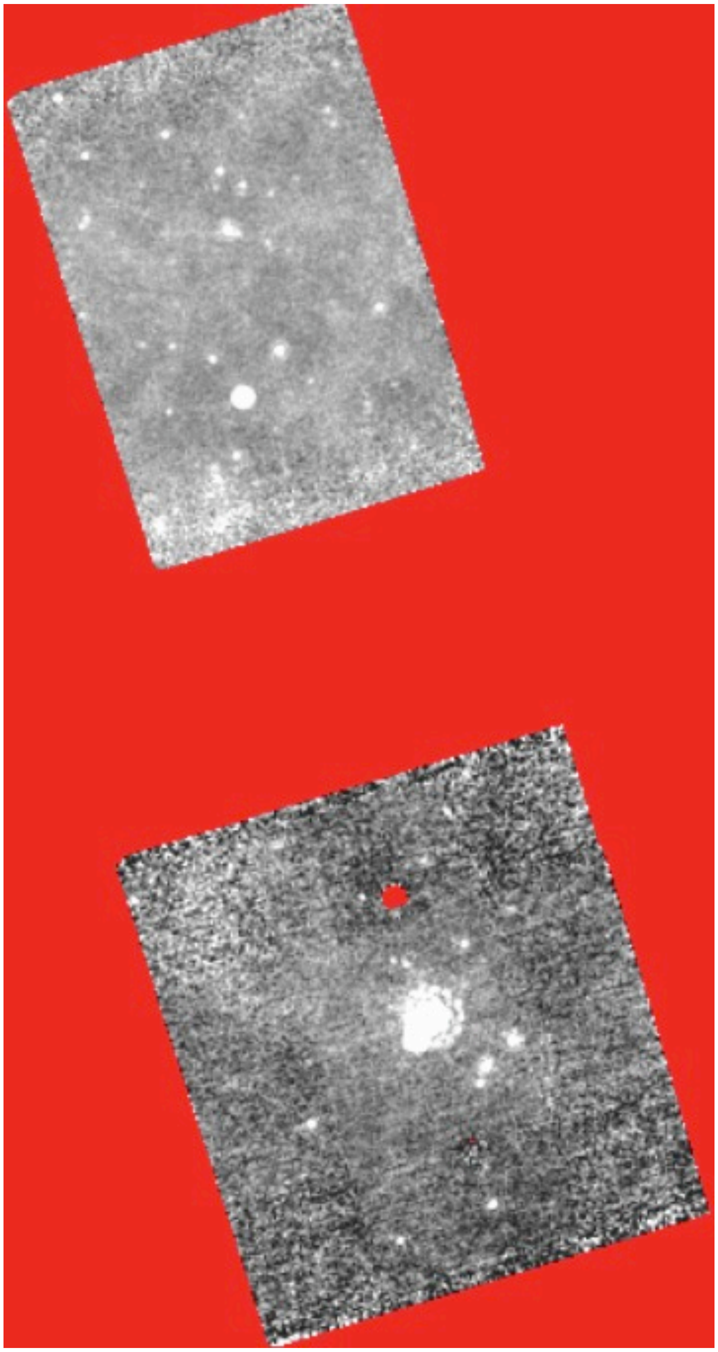


Figure 3.4 Example of MIPS artifact.

3.3 Mosaicking Parameters

All mosaics were generated using the Spitzer MOsaicker and Point source EXtractor (MOPEX) package. The MOPEX Overlap pipeline subtracts the estimated background from Zodiacal light from each CBCD and then matches the background level in all frames with an additive correction. Starting with the background matched BCDs, the MOPEX Mosaic pipeline performs outlier rejection to remove cosmic rays, moving objects, and other artifacts, then re-samples the images onto a common reference frame and combines the images to produce a weighted mean and median mosaic along with associated coverage, uncertainty, and standard-deviation maps.

The parameters for both the Overlap and Mosaic pipelines are sensitive to extended emission from the interstellar medium and to the number of exposures per pointing (coverage). In general, IRAC coverages of less than 10, 10 to 50, and greater than 50 frames require different outlier rejection and interpolation kernel settings. For MIPS the coverage does not make a signicant difference in the choice of outlier rejection or interpolation kernel settings. For both IRAC and MIPS Galactic observations with structured backgrounds required different outlier rejection settings than extragalactic fields with uniform backgrounds.

Due to the large volume and heterogeneous nature of the data included in the Spitzer Enhanced Imaging Products, the reduction parameters were limited to six cases rather than an optimizing each data set individually. The six cases are:

1. Extragalactic Shallow (coverage < 10)

2. Extragalactic Medium Coverage (10 < coverage < 50)

3. Extragalactic Deep Coverage (coverage > 50)

4. Galactic Shallow Coverage (coverage < 10)

5. Galactic Medium Coverage (10 < coverage < 50)

6. Galactic Deep Coverage (coverage > 50)

Table 3.2 Summary of MOPEX module setups for creating IRAC mosaics

Module	Shallow	Medium	Deep	Galactic
Overlap	X	X	X	X
Dual Outlier	X			X
Box Outlier	X	X	X	X
Temporal Outlier	X	X	X	X
Pixel Size	0.6 arcsec	0.6 arcsec	0.6 arcsec	0.6 arcsec
Interpolation	Linear	Drizzle=0.75	Drizzle=0.25	Linear
Refine Outlier	Yes	No	No	Yes
Temporal Outlier Threshold	4	3	3	6
IRAC Source Detection/Extraction	SExtractor	SExtractor	SExtractor	SExtractor

Table 3.3 Summary of MOPEX module setups used for creating MIPS 24 micron mosaics.

Module	Extragalactic	Galactic
Flat Field	X	X
Overlap	X	X
Dual Outlier	X	X
Box Outlier	X	X
Temporal Outlier	X	X
Pixel Size	2.45 arcsec	2.45 arcsec
Interpolation	Linear	Linear
Refine Outlier	No	Yes
Temporal Outlier Threshold	3	6
IRAC Source Detection/Extraction	APEX	APEX

3.4 Mosaic Products

There are four FITS files associated with each Region. The type of file is denoted by the suffix before "*.fits*" in the file name. The file types are described in Table 3.4. The calibration offset required for S18.18 IRAC data has been applied to all Spitzer Enhanced Imaging mosaics.

Table 3.4 Types of Mosaics

Suffix	Description
mosaic	mean mosaic which should be used for measuring photometry
unc	mean combined uncertainty map which should be used for estimating errors
cov	mean coverage map indicating the number of images that went into each pixel, used to determine gain
std	measured standard deviation at each pixel

In addition to the FITS images listed above, a list of all DCEs used in a mosaic is provided.

3.4.1 Uncertainty Maps

The uncertainty maps represent the best guess at the combined background and Poisson noise at the given pixel position based on the basic calibrated data (BCD) products produced by the Spitzer calibration pipeline. They were produced by the MOPEX mosaic pipeline and include corrections due to interpolation and outlier rejection in addition to the noise expressed in the BCD pipeline. The mean uncertainty mosaics reflect the noise in the final mosaics, and the standard deviation maps reflect the measured standard deviation of the input data pixels that were included in the mean mosaic at this point.

3.4.2 Coverage Maps

The coverage maps represent the number of input DCE images that were included at each pixel of the output image. If a pixel was rejected due to outlier rejection or masking, it is not included in this count. If Drizzle interpolation was used, input pixels are mapped to less than a full input pixel (determined by pixfrac), resulting in reduced coverage. Even if mages with different exposure times were combined in one mosaic, the coverage is still one per image.

3.5 Mosaic Access

The Mosaic products described above can be accessed in three ways: Atlas, the Cutout Service, and the Spitzer Heritage Archive (SHA). Atlas provides access to the full super mosaics and ancillary images. The Cutout Service provides access to small portions of a given super mosaic, as well as to the analogous portions of the ancillary images. The SHA provides access to only the full super mosaics. All three services are described in more detail in the following sections.

3.5.1 Mosaic Access through Atlas

Atlas provides access to full super mosaics and associated FITS files. You can access Atlas to search for and download mosaic products using the form at the top of the page at
`http://irsa.ipac.caltech.edu/data/SPITZER/Enhanced/Imaging/`

It looks like this:

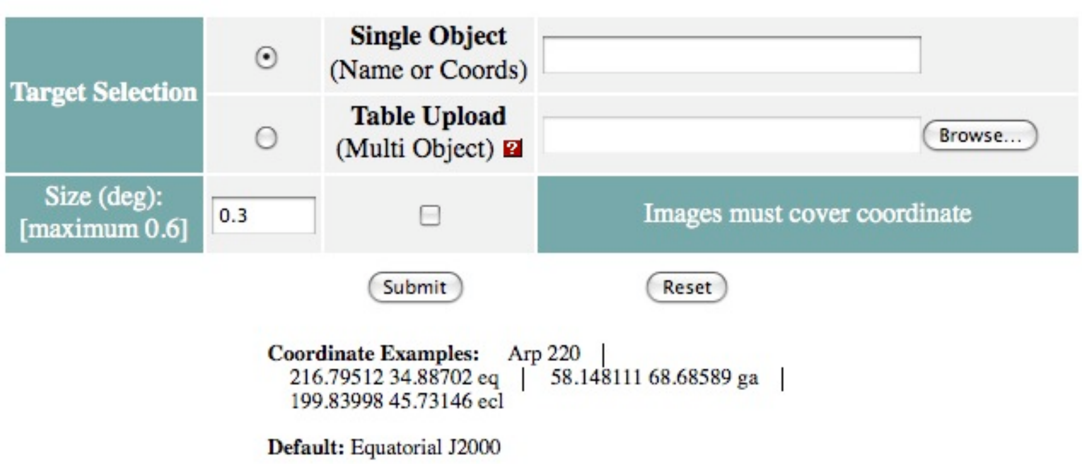
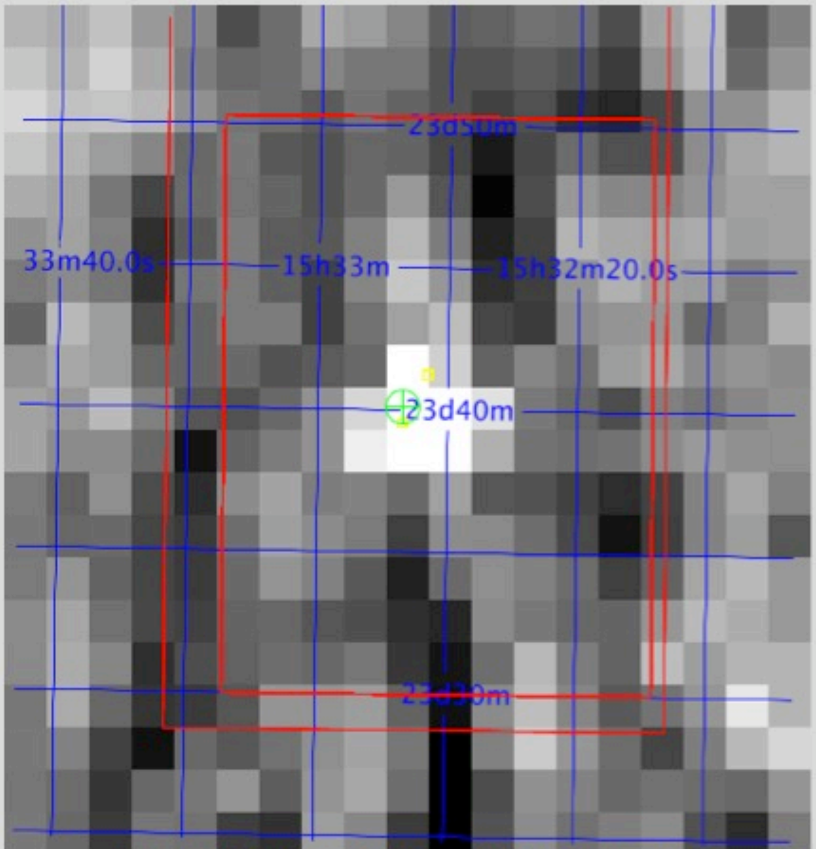


Figure 3.5 Atlas interface to Super Mosaics.

After searching for a super mosaic, you have the option to download the mosaic and/or its associated ancillary FITS files. For example, entering "Arp220" in the "Single Object" field and clicking "Submit" in the GUI represented above will yield a results page with four separate sections: a 12 micron IRAS background image with the search position marked with crosshairs, "Source Table Results", "Listing of Image Metadata Table Results", and "Download Images (Overlays)". Screenshots of these sections are shown in the figures below.

Collection: Imaging, Object: IC 4553



Your selected position (or click) is marked by the green crosshairs.
Click on above image to re-center, or fine tune your Region Size and/or Coordinate below. See results tables below for key to color overlays.

Coordinate/Object:	15h 34m 57.27s +23d 30m 10.5s Equ J2000		
Size (deg): [maximum 0.6 deg]	0.3	☐	Images must cover coordinate
Source Search Radius: [maximum 0.3 deg]	0.15 deg	☐	Search whole region

Submit   Reset

Back to Imaging Front Page

15h 34m 57.27s +23d 30m 10.5s Equ J2000	Image Metadata: (red overlays) [column key]	Download Image Metadata (36 image footprints) Oasis	Background Image: (factor of 1.5 larger than search size) Download Oasis

Data Tag string for Publication: ADS/IRSA.Atlas#2012/0110/111022_19295

Bulk Download Script of all results using WGET

Figure 3.6 Atlas search results: a 12 micron IRAS background image marked with crosshairs at the search position. Users will find it very useful to use the "Bulk Download Script" link above.

Listing of Image Metadata Table Results

Image Metadata Table	Count	Type	Column Key	
science.tbl [rectangular **red** footprints]	9	Original	Column Key	Oasis
ancillary.tbl [rectangular **red** footprints]	27	Original	Column Key	Oasis

Figure 3.7 Atlas search results: metadata tables.

Download Images (Overlays) [column key]

ra	dec	naxis1	naxis2	dataset	cutout	fname	Cutout_Image	Entire_Image
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.2.std.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.3.mosaic.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.4.unc.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.1.std.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.3.cov.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.1.mosaic.fits	To disk /To OASIS	same
233.7299292	23.5464437	430	684	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.MIPS.1.unc.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.1.mosaic.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.3.unc.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.3.mosaic.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.4.cov.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.2.cov.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.1.cov.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.3.std.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.1.unc.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.4.std.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.2.unc.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.4.std.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.2.unc.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.1.unc.fits	To disk /To OASIS	same
233.7163964	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0- short.IRAC.4.mosaic.fits	To disk /To OASIS	same
233.7164184	23.5036487	1512	2028	Enhanced	NO	images/5/50053/50053890 /50053890.50053890-0.IRAC.4.mosaic.fits	To disk /To OASIS	same

Figure 3.8 Atlas search results: Images for download (truncated). Thirty-six images are available for download. For this Arp220 example, there four fits files *(*mosaic.fits*, *unc.fits, **std.fits*, **cov.fits*) files for each of IRAC channels 1, 2, 3, and 4; IRAC channels 1, 2, 3, and 4 short HDR frames, and MIPS channel 1.

3.5.2 Mosaic access through the Cutout Service

The Cutouts Service provides access to small sections of a Super Mosaic. You can access the Spitzer Enhanced Imaging Mosaic data using the Cutouts Service at `http://irsa.ipac.caltech.edu/data/SPITZER/Enhanced/Imaging/index_cutouts.html`

It looks like this:

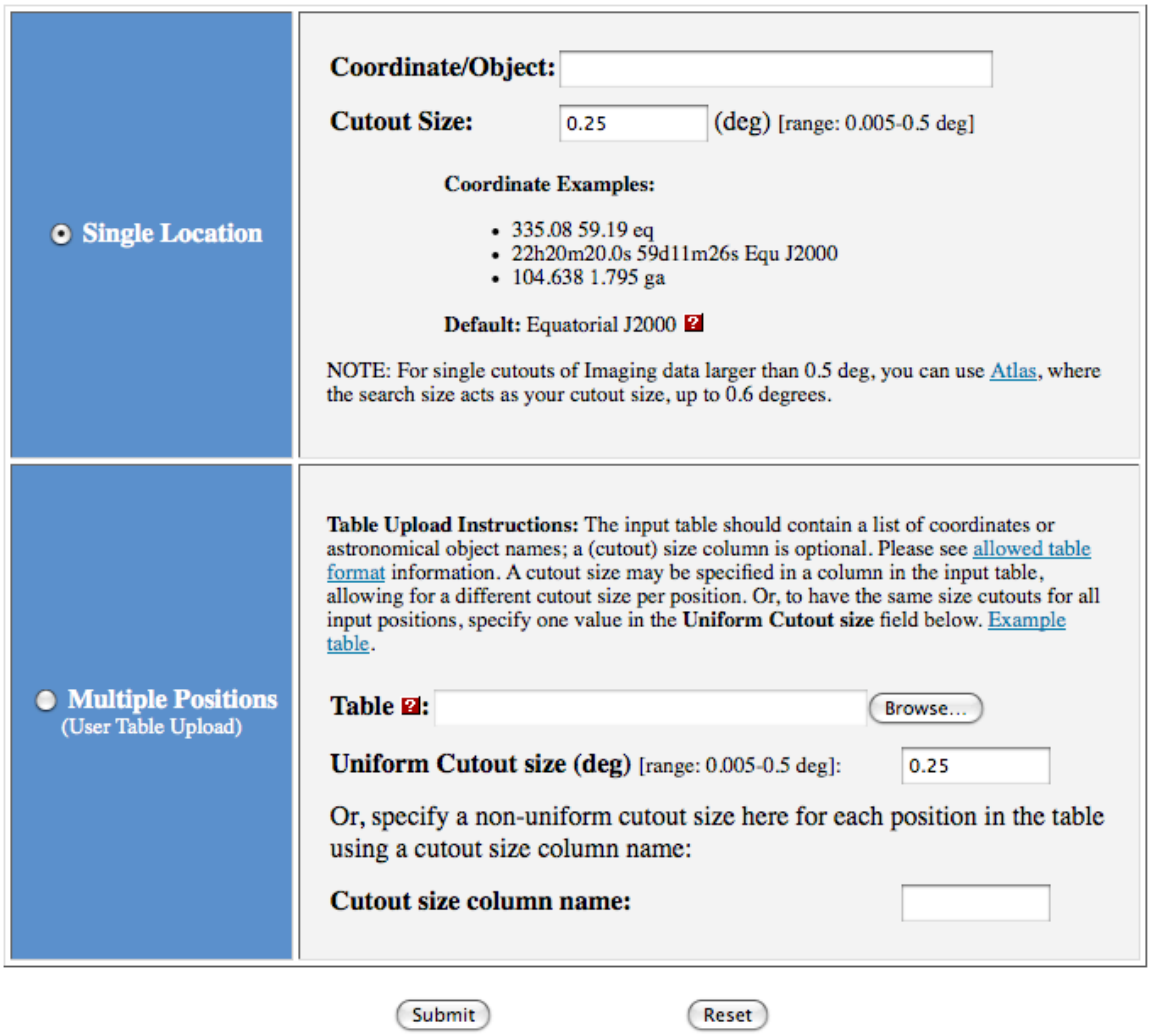


Figure 3.9 Spitzer Enhanced Imaging Cutouts Service.

If "Arp220" is entered into the "Coordinate/Object" field in Figure 3.9, nine cutouts are returned. These include the **mosaic.fits* files for the four IRAC channels, for the four IRAC channels with short HDR exposures, and for MIPS 24 micron. There would have been 36 files total if the IRAC and MIPS ancillary products (*unc, cov, std*) had been requested (see Figure 3.9).

3.5.3 Mosaic Access through the Spitzer Heritage Archive

The Spitzer Heritage Archive (SHA) provides access to full super mosaics, but not to the ancillary FITS files. The SHA can be found at:

`sha.ipac.caltech.edu/applications/Spitzer/SHA/`

To access the SEIP super mosaics, simply check the box labeled "SSC Enhanced Mosaic Images (Super Mosaics)" under "Display search results in tabs for:" Please be aware that any options you select under "More options" do not apply to the super mosaics.

On the results page, the super mosaic results will be displayed under the tab labeled "super mosaics". After selecting a super mosaic of interest, you can view it within the SHA by clicking on the "Data" tab. To download the super mosaics as FITS files, click on "Prepare Download".

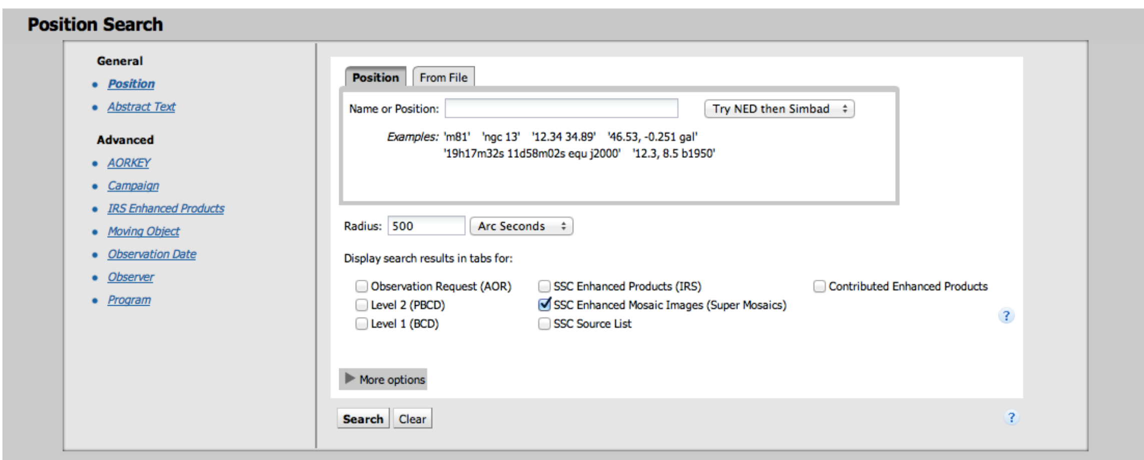


Figure 3.10 Screenshot of Spitzer Heritage Archive position search with the box labeled "SSC Enhanced Mosaic Images (Super Mosaics)" checked.

3.6 Quality Assurance

Each super mosaic was inspected by eye to check for defects in the processing. These include inadequate background subtraction, poor overlap correction, and flatfielding issues. Some examples are provided in the figures below.

Chapter 4. Source List

This chapter describes the generation and characteristics of the Source List that is created from the Enhanced Super Mosaics. The procedure starts with the generation of single-band source lists for each of the IRAC channels and for MIPS 24 micron data. These single-band Source Lists are then bandmerged together and associated with the 2MASS Point Source Catalog to produce the final Spitzer Enhanced Imaging Source List. Each of these steps is described in the sections below.

4.1 Single-Band Source Lists

Single-Band Source Lists are created for each of the four IRAC channels. A flowchart describing the procedure for generating a Single-Band IRAC Source List is provided in Figure 4.2 **A** . First, the WISE Point Source catalog is queried for each mosaic, and a bright source mask is generated for each band. Then SExtractor is run on the images with a very large smoothing kernel and detection size and the segmentation map is used to mask extended sources and extended emission. Next, SExtractor is run on each set of images three times, with different detection settings tuned for detecting sources in "normal" regions, regions of bright extended emission, and regions around bright sources. The bright and extended source masks are used to select sources from the appropriate SExtractor run for the final IRAC Single-Band Source Lists. The SExtractor setting for each object is recorded in the FluxFlag columns: 0 = normal 1=extended, 2=bright. If a source is in both a bright star and extended source mask, FluxFlag=2.

Extended sources in the single-band IRAC lists are then flagged by separately running SExtractor on the mean images with settings tuned to detect large objects. The SExtractor segmentation map from this process is then used to create an extended source mask. For each source, the fraction of pixels falling within an extended source mask is computed and recorded in the ExtFrac columns of the Source List. Any source which has most of its pixels within an extended source mask is flagged in the FluxFlags columns of the Source List.

Bright sources are also flagged in each single-band list. Assuming that bright WISE stars will also be bright in all IRAC bands, bright WISE sources are used to generate bright source masks for the IRAC mosaics. The mask consists of a circular region of a size determined by the WISE band flux closest to the IRAC band along with a rectangular region aligned along the mean PA of the mux-bleed for the brightest sources.

Objects that were detected in regions covered by a bright source mask were flagged in the Source List. For each source, the fraction of pixels falling within the bright mask is recorded in the BrtFrac columns of the Source List. If over fifty percent of the pixels within a given source fall within a bright mask, then the source is flagged in the FluxFlag columns of the Source List.

SExtractor is run using the median images as the detection image, the uncertainty image as the absolute RMS noise map for the detection image, and the mean mosaic and uncertainty map as the photometry measurement and absolute RMS noise map for the photometry respectively.

4.2 Creation of MIPS Source List

The MIPS Source List was created using MOPEX/APEX rather than SExtractor. This is because SExtractor does not provide PSF-fit photometry, while APEX does. PSF-fit photometry on mosaics is not recommended for IRAC because the PSF is not axisymmetric and is under-sampled by the pixel scale. As a result, it can not be generically performed on combined data.

SExtractor was used to generate an extended source mask in the same way as the IRAC catalog by detecting on the mean mosaic and using the segmentation map to create an extended source mask and the bright sources were masked with WISE in the same way as for IRAC.

APEX takes three images as input: the mean, uncertainty, and coverage mosaics. The output list of APEX detections is then fed into IMCAT "apphot" to measure the FWHM of the detections on the mean mosaic. The FWHM is used to flag detected sources that are too small, large, peaky, or asymmetric. Sources that are affected by a nearby extended source are flagged in the ExtFrac column of the MIPS Source List. Along with the positions of bright WISE sources, the results are used to create a bright source mask. Sources affected by a nearby bright source are flagged in the BrtFrac column of the 24 micron Source List. The ExtFrac and BrtFrac flags are used to create a MIPS analog to the FluxFlag column even though only a single detection pass is conducted.

4.3 Bandmerging Single-Band Source Lists to create the final Spitzer Source List

Once the Single-band Source Lists are created using the procedures described above, they are merged together, along with the 2MASS catalog, to create the final Source List.

First, detections with S/N >3 in the Single-Band IRAC Source Lists are matched together, based on position. The closest match within 1 arcsec is selected. The following flags are set:

Table 4.1 Criteria for IRAC Sources in Source List.

Source List Requirement	Explanation
FWHM>1.2 arcsec.	Rejects small objects that are likely spurious.
FWHM < 3.6 arcsec.	Rejects large objects that are likely extended.
Peak Mag - AP Mag > 2.5.	Rejects highly peaked objects that are likely spurious.
Peak Mag - AP Mag < 3.7.	Rejects broad source that are likely extended.
Peak - Centroid < 0.9 arcsec.	Rejects asymmetric source that are likely blended.

If MIPS data exist, the MIPS detections with S/N>3 are then merged to the best IRAC positions (shortest-wavelength IRAC detection with S/N > 10) within 3 arcsec. Again the closest positional match is used. Objects are then flagged based on the S/N, coverage, and FWHM of the MIPS detection along with the presence of an IRAC detection. If an object passes the IRAC flagging and has a S/N of >10 in either an IRAC channel or MIPS it is placed in the "object" list and the shortest wavelength detection is used as the position.

Next the 2MASS and WISE catalogs are merged with the "object" list using a 1" match radius, with the closest object being chosen. After merging with 2MASS and WISE, all detections in the "object" list are placed on a grid.

If a source in the multi-band Spitzer Source List is deemed real, but not detected individually in all bands, the flux density is measured in the remaining bands using the APEX-1-frame module to provide measurements and/or upper limits. After matching the various detections, APEX in user-input mode is used to perform aperture photometry on all images, and PSF fit photometry on the MIPS image in a similar way to the direct detection catalogs. The entire "object" list is used to ensure the best possible de-blending. Any object that does not have a direct detection in a given band but has a flux measured at a S/N>3 has this flux placed in the "BandFill columns". If the object is not detected at a S/N >3 then the 3 sigma upper limit is placed in the "limits" column. Note that any given channel with have either a detection flux density, a bandfill flux density, or an upper limit; never more than one of these. The type of flux is recorded in the FluxType column.

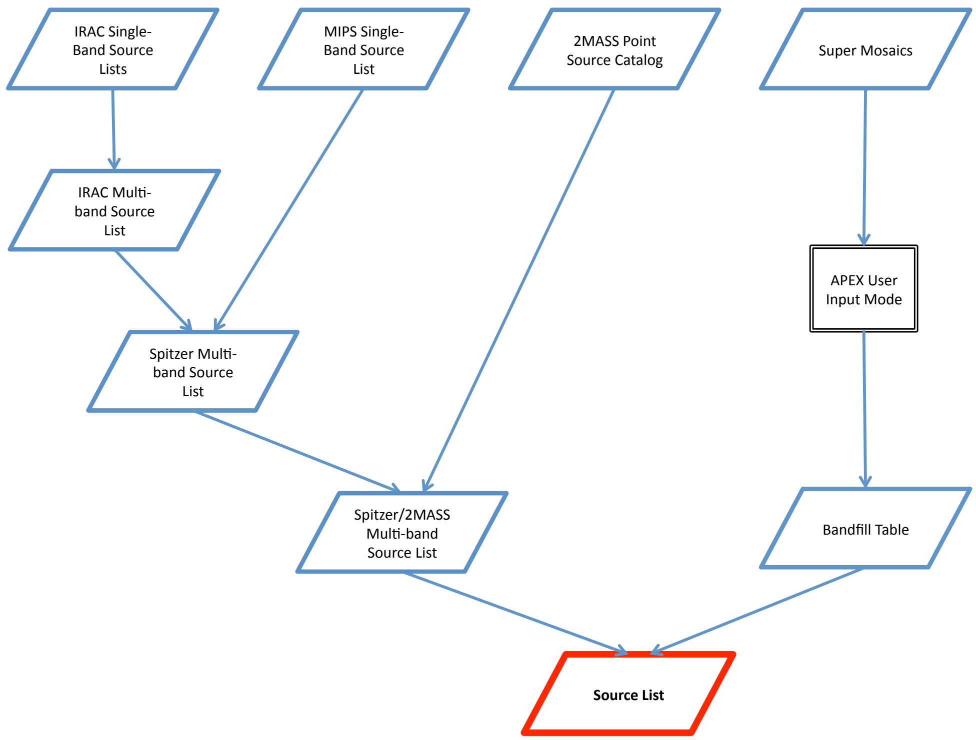


Figure 4.1 Flowchart describing processing steps required to bandmerge IRAC and MIPS lists.

4.4 APEX versus SExtractor

APEX is needed for MIPS PSF fitting. Otherwise, SExtractor was used while being careful about the noise calculations.

	APEX	SExtractor
Speed	Now Fast (improved)	Fast
PSF fit photometry	Yes	No
Aperture flux correction for blending	No	Yes
Shape parameters	No	Yes
Use coverage map for gain	Yes	No

Table 4.2 Summary of differences between APEX and SExtractor.

APEX and SExtractor produce similar results for corrected aperture photometry.

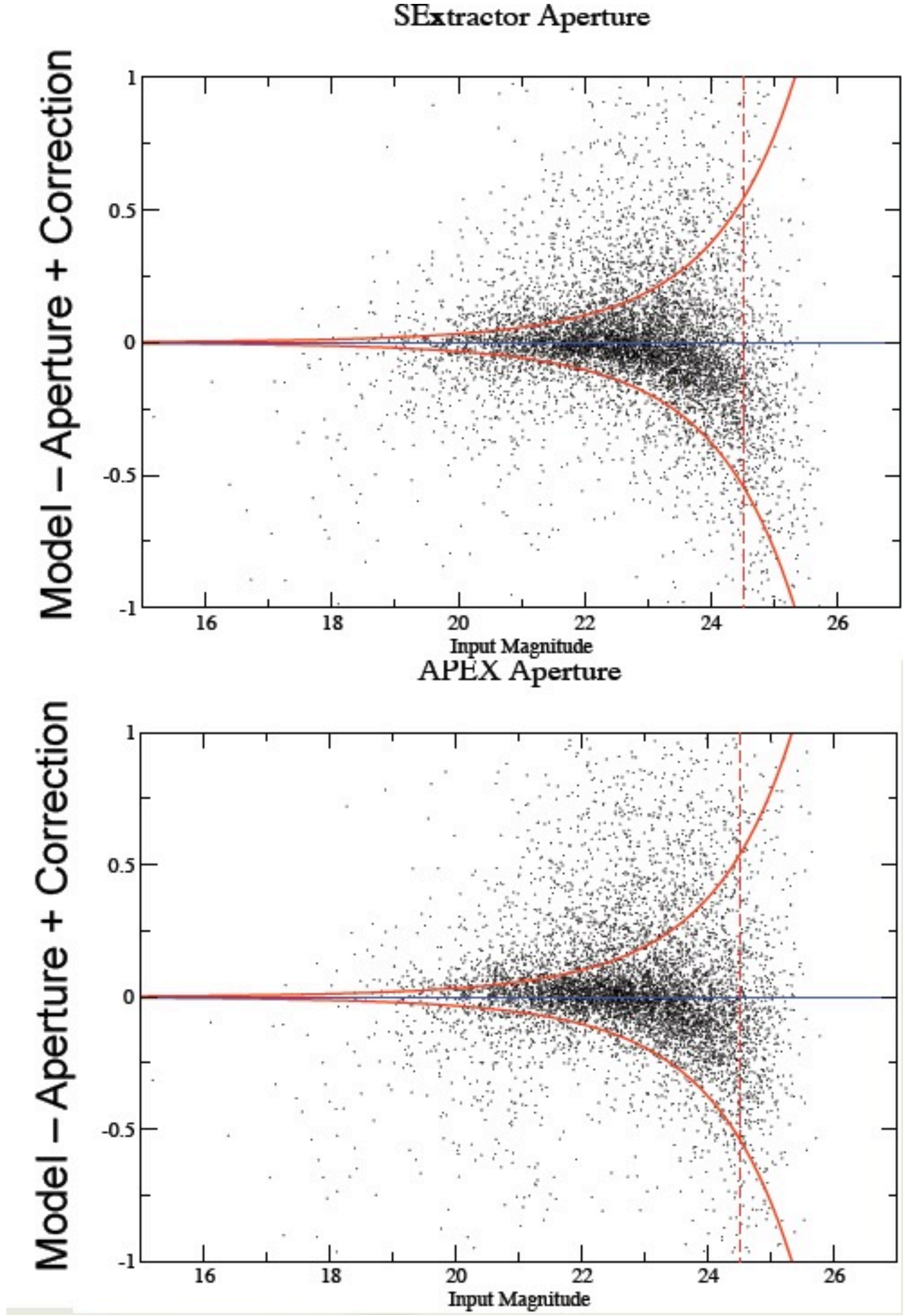


Figure 4.2 A comparison between SExtractor (top) and APEX (bottom) corrected aperture magnitudes. The two programs produce very similar results. SExtractor produces fewer sources above the 1-sigma line due to deblending. The turn-down at faint magnitudes is due to confusion affecting background subtraction. This is unavoidable without detailed simulations and a high-resolution prior.

Millennium Simulation sizes and magnitudes were used to simulate IRAC data. SExtractor was used to calculate several types of photometry: corrected aperture photometry, "Best" magnitudes, Auto magnitudes, and ISOPHOTAL magnitudes. Fixed aperture magnitudes corrected to total magnitudes were found to provide the best flux estimate. The only way to do better is if an HST prior is available or if the source is known to be a point source.

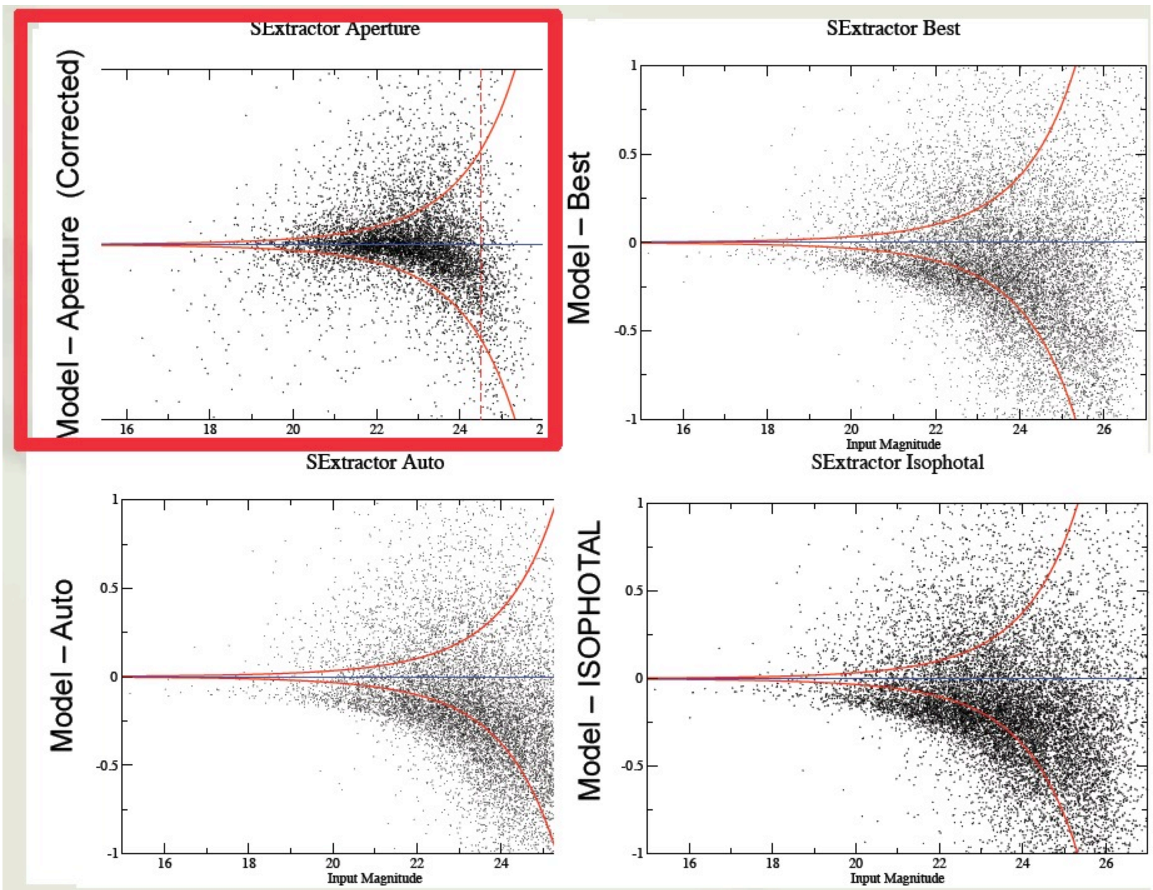


Figure 4.3 Comparison between different SExtractor magnitude types. A fixed aperture magnitude corrected to a total magnitude provides the best match to simulated model magnitudes.

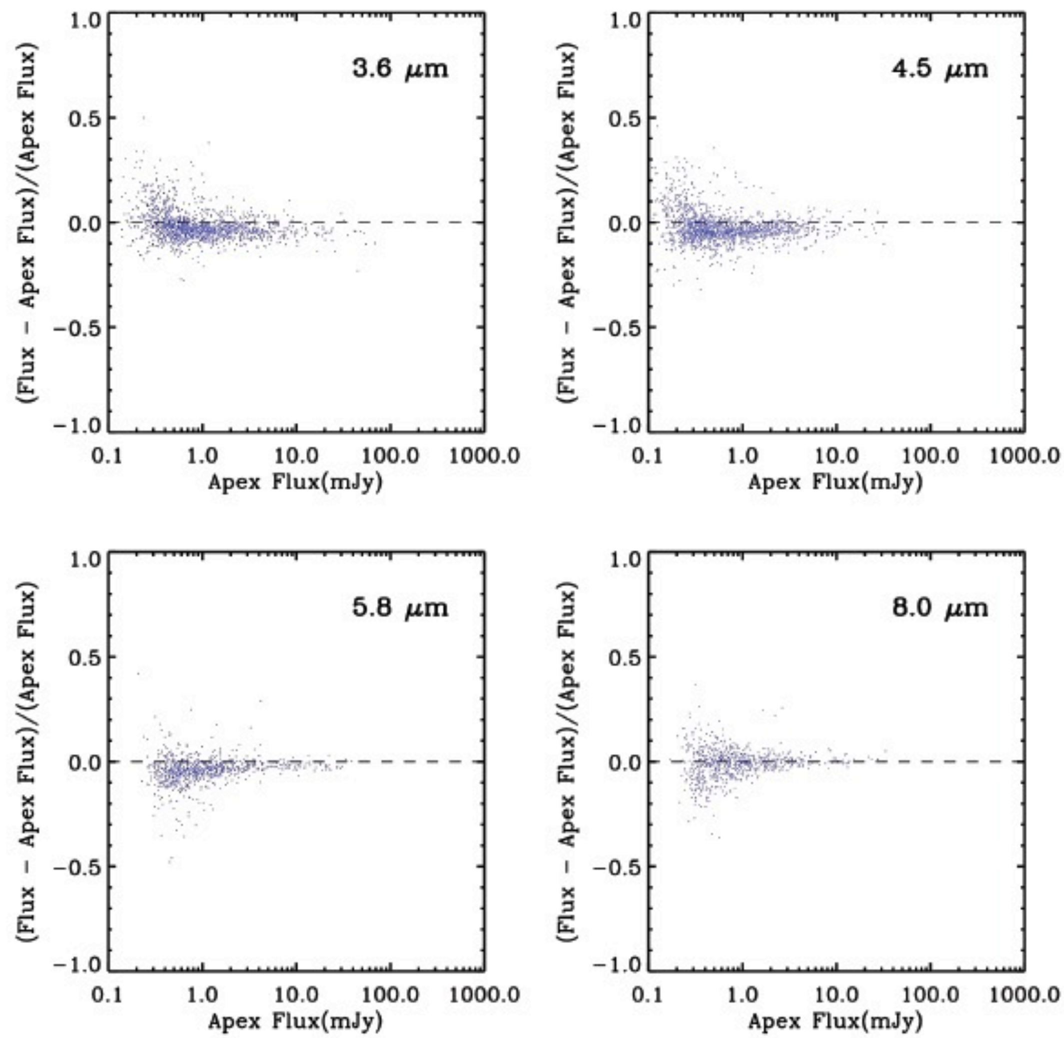


Figure 4.4 A comparison between Source List SExtractor corrected aperture fluxes and APEX PRF fluxes in a crowded Galactic field. Source List aperture photometry agrees with verified APEX PRF fluxes to 5%. The offset is a background estimation effect, due to the difficulty in estimating backgrounds in crowded fields.

4.5 Zero points for computing magnitudes

The zeropoints for computing magnitudes are provided in Table Table 4.3, where magnitudes = -2.5 * log10(f/zeropoint). Please see the IRAC Instrument Handbook and the MIPS Instrument Handbook for details on these zeropoints. The zeropoints on both the AB and Vega system are recorded in the image headers.

Table 4.3 Zeropoints for computing magnitudes.

Wavelength (micron)	zeropoint (Jy)	zeropoint error (Jy)
IRAC 3.6	280.9	4.1
IRAC 4.5	179.7	2.6
IRAC 5.8	115.0	1.7
IRAC 8.0	64.9	0.9
MIPS 24	7.17	0.11

4.6 Flux Uncertainties

Measuring noise on mosaics is very tricky because re-sampling correlates noise and leads to an underestimate of the true error. Also, gain changes with coverage and exposure time, so can vary across a mosaic.

APEX properly calculates the noise for Spitzer images, taking into account coverage, gain, and the noise map. However, the default behavior of SExtractor is to estimate noise on the input image and assume a gain that varies as the ratio of the measured noise to the noise map. This method significantly underestimates the noise for resampled images. We have tuned SExtractor to estimate the true noise by using absolute uncertainty maps, no gain scaling, and a gain calculation based on the exposure time and mean coverage in the mosaics. As a result, Spitzer Source List errors will typically be larger than those produced by Legacy Teams, especially at bright fluxes. The mean gain used is recorded in the image headers.

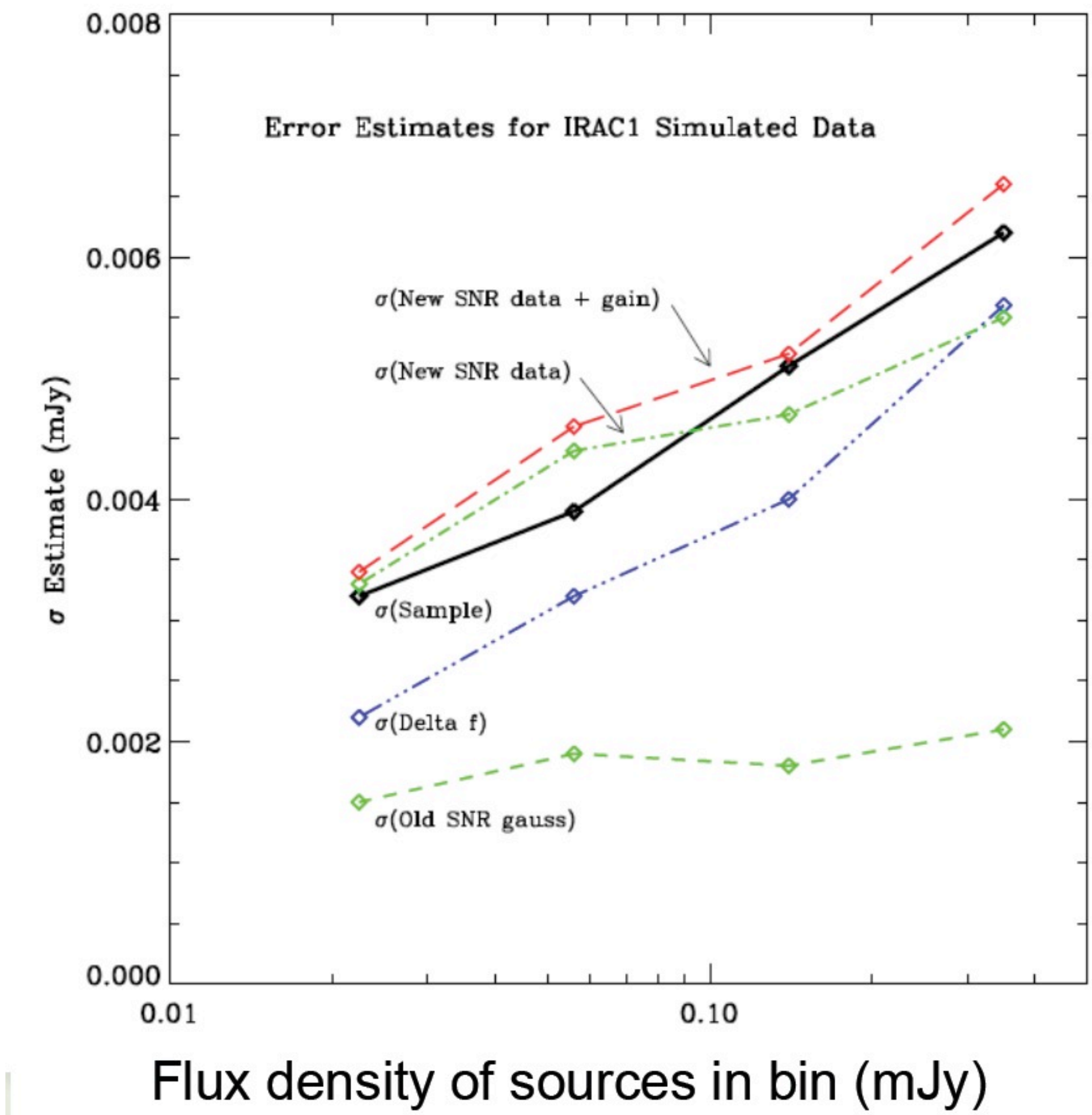


Figure 4.5 Flux density noise estimates from IRAC Channel 1 (3.6 micron) simulated data. The true noise is shown as a black solid line. Additional estimates available within MOPEX are also shown: 1) old SNR with Gaussian background noise (green, short dash); 2) Delta flux (blue, dot-dot-dot-dash); 3) new SNR with Gaussian noise, but no gain-corrected source photon noise (blue, long dash); 4) new SNR with Gaussian noise, with gain-corrected source photon noise (green, dot-dash); and 5) new SNR with data uncertainties (red, long dash). See the MOPEX documentation for details. Because of IRAC undersampling, some error estimates can underestimate the true noise. The method adopted for the Source List uses the top estimate to provide a conservative estimate when MOPEX is used, and uses proper noise maps and gain factors when SExtractor is used.

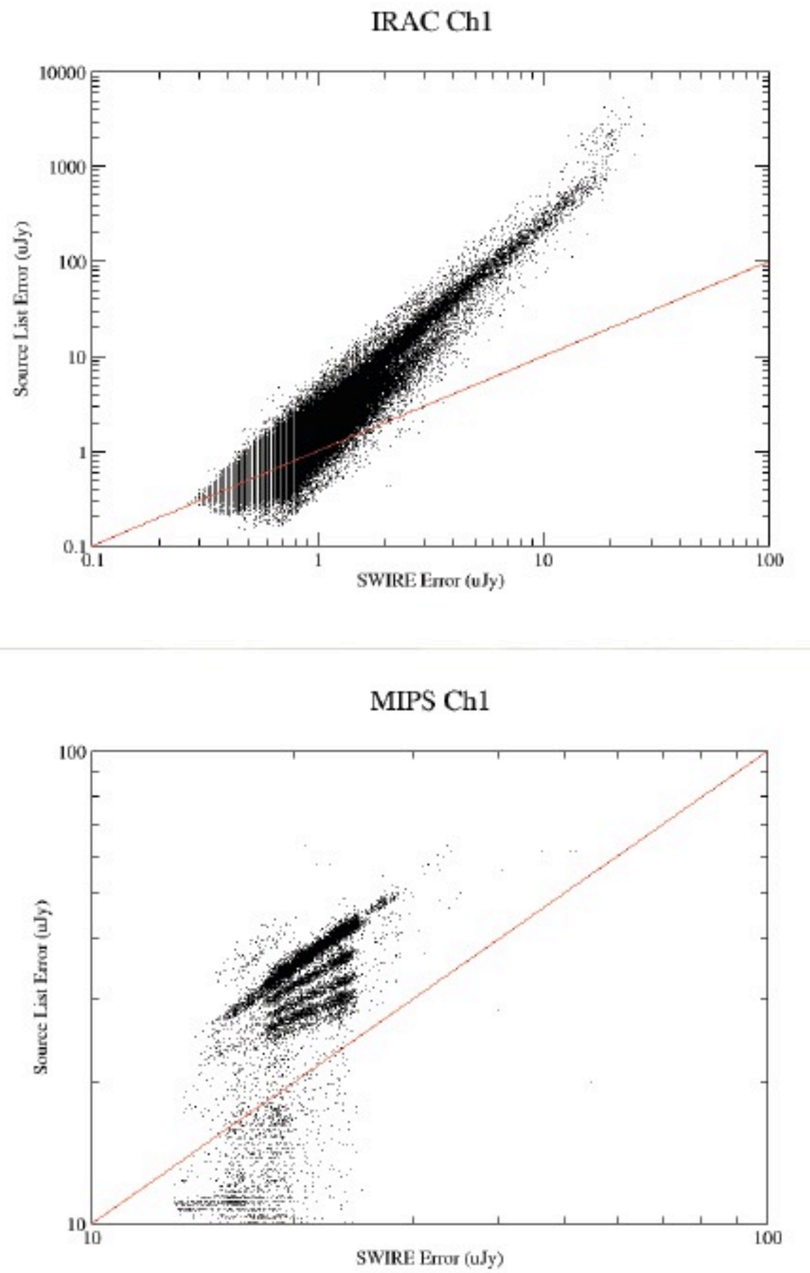


Figure 4.6 A comparison of the errors estimated for the Spitzer Source List and those generated by the SWIRE Legacy Survey Team. Source List errors tend to be significantly higher due to the proper use of noise maps and gain in SExtractor.

4.7 Astrometry

The astrometry of the Source List was checked against both the 2MASS and UCAC3 catalogs using 5000 point sources that are well-detected in all bands of the Spitzer Enhanced Imaging Mosaics of the Taurus Molecular Cloud. These sources were matched to the 2MASS and UCAC3 catalogs using a 1 arcsec matching radius.The median positional offsets between the Source List and the 2MASS and UCAC3 catalogs are very small, approximately a tenth of the IRAC beamsize of 2 arcsec. See Table 4.4 and Figure 4.8. Note that the IRAC astrometry with respect to 2MASS has systematics at the 0.3 arcsec level after superborersight refinement. The SL astrometry is well within this systematic uncertainty.

Table 4.4 Astrometric comparison between SL, 2MASS, and UCAC3.

	Mean (arcsec)	**Median (arcsec)**	**standard deviation (arcsec)**
RA(SL) - RA(2MASS)	0.071	0.082	0.177
DEC(SL) - DEC(2MASS)	-0.044	-0.034	0.157
RA(SL) - RA(UCAC3)	0.153	0.1098	0.293
DEC(SL) - DEC(UCAC3)	-0.063	0.000	0.279

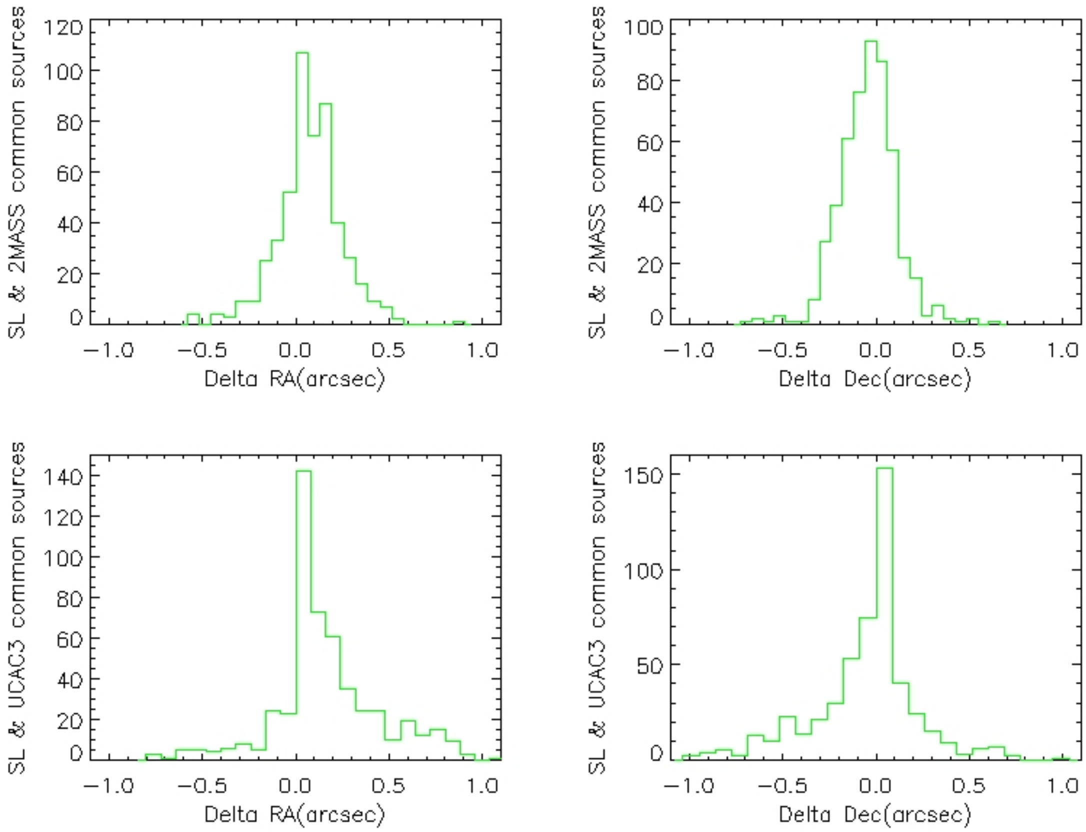


Figure 4.7 Comparison between Source List and 2MASS positions (top) and between Source List and UCAC3 positions (bottom).

4.8 Comparison with WISE

Starting with a sample of approximately 5000 well-detected sources from the Taurus Legacy Survey, about 4000 were found in both the SL and WISE, with about 400 sources found in the SL that were not found in WISE. The differences in the number of identified sources partially arise from different sensitivity limits, angular resolution, and coverage of the Taurus Molecular Cloud in the WISE Preliminary Release. The sensitivity limits of the Legacy catalog are, for instance, 0.038 and 2.4 mJy at 3.6 and 24 micron, respectively. In comparison the sensitivity limits of WISE are 0.08 and 6.0 mJy at 3.4 and 22 microns, respectively. The Spitzer Space Telescope angular resolution is approximately three times that of WISE at shorter wavelengths (2 arcsec at 3.6 micron versus 6 arcsec at 3.5 micron), and twice at longer wavelengths (6 arcsec at 24 micron versus 12 arcsec at 22 micron). Figure 4.8 shows a color magnitude diagram created from both SL and WISE photometry. Astronomically, one sees the same trends in both SL and WISE colors, even without applying any color corrections.

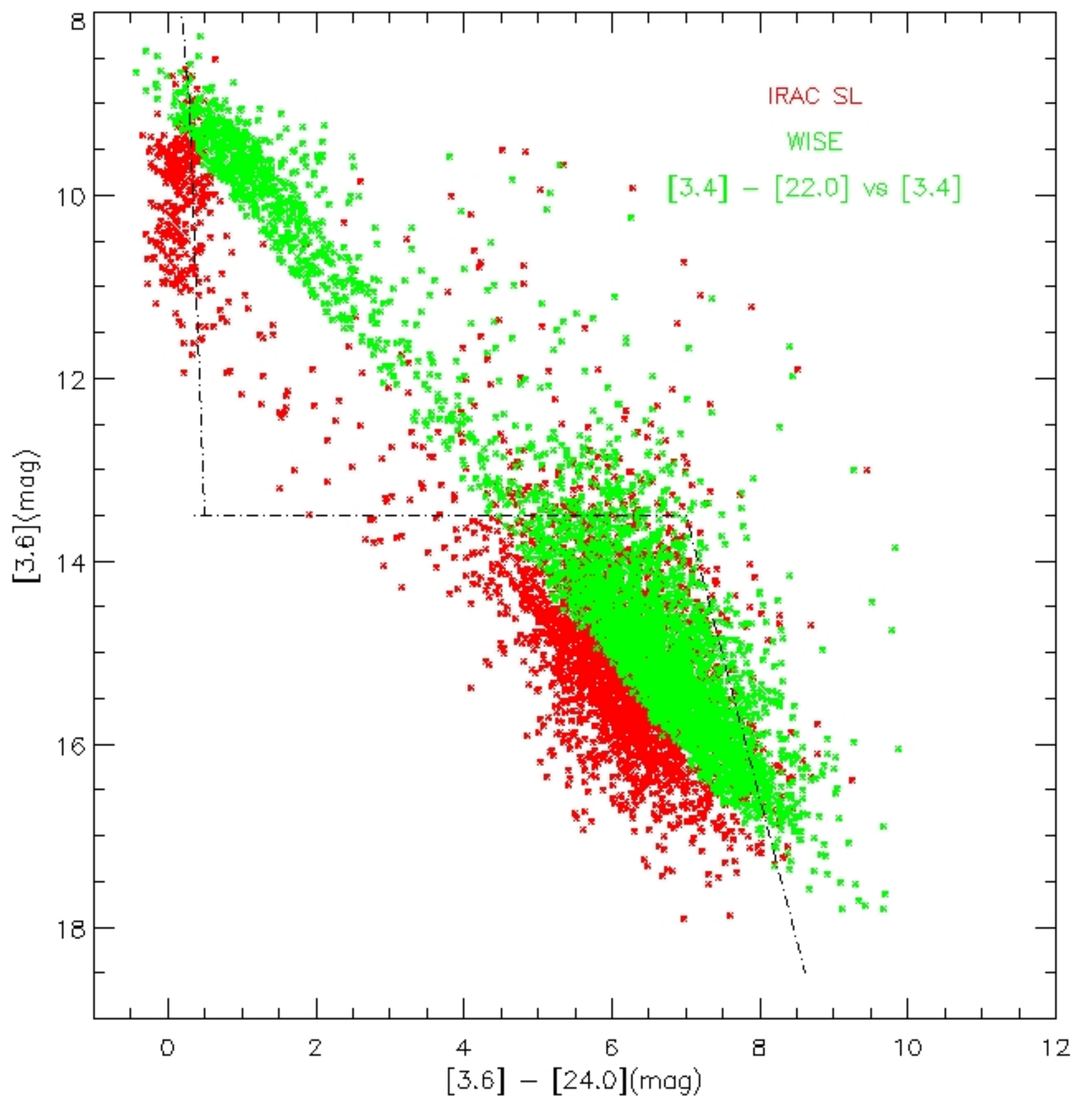


Figure 4.8 Comparison between IRAC SL (red) and WISE (green) photometry for approximately 4000 sources in the Taurus Molecular Cloud. No color corrections have been applied. Objects to the left of the dot-dashed line tend to be extragalactic. Objects to the right include Young Stellar Objects.

4.9 Content of Source List

The Table below describes all of the columns available in the Source List. For all quantities, the null values are the string "null".

Table 4.5 Description of columns in Source List.

Column Name	Format	Units	Description
ObjID	string	none	Object Identification Number. Sexagesimal, equatorial position-based source name in the form: **hhmmss.ss±ddmmss.s**. The full naming convention for the Spitzer Source List Cryogenic Release sources has the form "**SSTSLP Jhhmmss.ss±ddmmss.s**". **CAUTION:** The ObjID should not be used as an astrometric reference. It is not a substitute for the source position information in the ra and dec columns.
ra	float	deg	Right Ascension (J2000) of the shortest wavelength ten-sigma Spitzer detection.
dec	float	deg	Declination (J2000) of the shortest wavelength ten-sigma Spitzer detection.
l	float	deg	Galactic Longitude
b	float	deg	Galactic Latitude
NMatches	int	none	Number of possible matches
NReject	int	none	Number of possible matches rejected
NBands	int	none	The number of Spitzer bands that have ten-sigma detections (Ap1 for IRAC, PSF flux density for MIPS 24), plus one if there is a 2MASS association.
I1_FluxType	int	none	I1_FluxType indicates which type of measured flux density is available for IRAC channel 1. If I1_FluxType = 0, then there is no IRAC channel 1 imaging data available and no flux densities are available. If I1_FluxType=1, then a ten-sigma source was detected in IRAC channel 1, and measured flux densities can be found in the columns I1_F_Ap1 and I1_F_Ap2. If I1_FluxType=2, then there was not a ten-sigma source detected in channel 1, but a >3-sigma Bandfill flux density was measured at ra, dec and can be found in I1_F_Ap1_BF and I1_F_Ap2_BF. If I1_FluxType=3, then three-sigma upper limits are recorded in the columns I1_F_Ap1_3siglim and I1_F_Ap2_3siglim. If I1_FluxType=4, then the source is bright and detected in multiple bands, but fails to meet the size criteria; this source is real, but its flux density cannot be measured accurately, so it is not reported.
I2_FluxType	int	none	Same as for I1_FluxType, but for IRAC channel 2.
I3_FluxType	int	none	Same as for I1_FluxType, but for IRAC channel 3.
I4_FluxType	int	none	Same as for I1_FluxType, but for IRAC channel 4.

M1_FluxType	int	none	M1_FluxType indicates which type of measured flux density is available for MIPS channel 1. If FluxType = 0, then there is no MIPS channel 1 imaging data available and no flux densities are available. If M1_FluxType=1, then a ten-sigma source was detected in MIPS channel 1, and measured flux densities can be found in the columns M1_F_Ap and M1_F_PSF. If M1_FluxType=2, then there was not a ten-sigma source detected in channel 1, but a >3-sigma Bandfill flux density was measured at ra, dec and can be found in M1_F_Ap_BF and M1_F_PSF_BF. If FluxType=3, then three-sigma upper limits are recorded in the columns M1_F_Ap_3siglim and M1_F_PSF_3siglim.
I1_FluxFlag	int	none	This flag is set to 0 if the object lies in a normal region of the IRAC channel 1 Super Mosaic, 1 if the object lies in the vicinity of an extended source, and 2 if the object lies in the vicinity of a bright source. If the object lies in the vicinity of both a bright and an extended source, this flag is set to 2.
I2_FluxFlag	int	none	Same as I1_FluxFlag, except for IRAC channel 2.
I3_FluxFlag	int	none	Same as I1_FluxFlag, except for IRAC channel 3.
I4_FluxFlag	int	none	Same as I1_FluxFlag, except for IRAC channel 4.
M1_FluxFlag	int	none	Same as I1_FluxFlag, except for MIPS channel 1.
I1_SoftSatFlag	int	none	IRAC channel 1 (3.8 micron) soft saturation flag. This flag is nonzero if the source suffers from nonlinear pixels. See Section 1.1.1.
I2_SoftSatFlag	int	none	Same as I1_SoftSatFlag, except for IRAC channel 2 (4.5 micron).
I3_SoftSatFlag	int	none	Same as I1_SoftSatFlag, except for IRAC channel 3 (5.8 micron).
I4_SoftSatFlag	int	none	Same as I1_SoftSatFlag, except for IRAC channel 4 (8 micron).
I1_F_Ap1	float	uJy	IRAC channel 1 flux density measured within an aperture of diameter 3.8 arcsec and corrected to infinite radius. This column will have a non-null value only if the detection is at a significance greater than 10 sigma.
I1_dF_Ap1	float	uJy	Uncertainty in I1_F_Ap1.
I1_F_Ap2	float	uJy	IRAC channel 1 (3.6 micron) flux density measured within an aperture of diameter 5.8 arcsec and corrected to infinite radius. This column will have a non-null value only if the detection is at a significance greater than 10 sigma.
I1_dF_Ap2	float	uJy	Uncertainty in I1_F_Ap2.

I1_F_Ap1_BF	float	uJy	IRAC channel 1 (3.6 micron) bandfill flux density measured at the position ra, dec within an aperture of diameter 3.8 arcsec. This column will have a non-null value if the original detection was less significant than 10 sigma and the bandfill flux density is significant at a level greater than 3 sigma.
I1_dF_Ap1_BF	float	uJy	Uncertainty in I1_F_Ap1_BF.
I1_F_Ap2_BF	float	uJy	IRAC channel 1 (3.6 micron) bandfill flux density measured at the position ra, dec within an aperture of diameter 5.8 arcsec. This column will have a non-null value if the original detection was less significant than 10 sigma and the bandfill flux density is significant at a level greater than 3 sigma.
I1_dF_Ap2_BF	float	uJy	Uncertainty in I1_F_Ap2_BF.
I1_F_Ap1_3siglim	float	uJy	IRAC channel 1 (3.6 micron) three sigma upper limit on aperture flux density measured within an aperture of 3.8 arcsec and corrected to a total flux density. This column will have a non-null value only if there is no primary flux density and no bandfill flux density.
I1_F_Ap2_3siglim	float	uJy	Same as I1_F_Ap1_3siglim except within an aperture with diameter 5.8 arcsec.
I2_F_Ap1	float	uJy	Same as I1_F_Ap1 but for IRAC channel 2 (4.5 micron).
I2_dF_Ap1	float	uJy	Uncertainty in I2_F_Ap1.
I2_F_Ap2	float	uJy	Same as I2_F_Ap2, but for IRAC channel 2 (4.5 micron).
I2_dF_Ap2	float	uJy	Uncertainty in I2_F_Ap2.
I2_F_Ap1_BF	float	uJy	Same as I1_F_Ap1_BF but for IRAC channel 2 (4.5 micron).
I2_dF_Ap1_BF	float	uJy	Uncertainty in I2_F_Ap1_BF.
I2_F_Ap2_BF	float	uJy	Same as I1_F_Ap2_BF, but for IRAC channel 2 (4.5 micron).
I2_dF_Ap2_BF	float	uJy	Uncertainty in I2_F_Ap2_BF.
I2_F_Ap1_3siglim	float	uJy	Same as I1_F_Ap1_3siglim, but for IRAC channel 2 (4.5 micron).
I2_F_Ap2_3siglim	float	uJy	Same as I1_F_Ap2_3siglim, but for IRAC channel 2 (4.5 micron).
I3_F_Ap1	float	uJy	Same s I1_F_Ap1, but for IRAC channel 3 (5.8 micron).
I3_dF_Ap1	float	uJy	Uncertainty in I3_F_Ap1.
I3_F_Ap2	float	uJy	Same as I1_F_Ap2, but for IRAC channel 3 (5.8 micron).
I3_dF_Ap2	float	uJy	Uncertainty in I3_F_Ap2.
I3_F_Ap1_BF	float	uJy	Same as I3_F_Ap1_BF, but for IRAC channel 3 (5.8 micron).
I3_dF_Ap1_BF	float	uJy	Uncertainty in I3_F_Ap1_BF.

I3_F_Ap2_BF	float	uJy	Same as I1_F_Ap2_BF, but for IRAC channel 3 (5.8 micron).
I3_dF_Ap2_BF	float	uJy	Uncertainty in I1_F_Ap2_BF.
I3_F_Ap1_3siglim	float	uJy	Same as I1_F_Ap1_3siglim, but for IRAC channel 3 (5.8 micron).
I3_F_Ap2_3siglim	float	uJy	Same as I1_F_Ap2_3siglim, but for IRAC channel 3 (5.8 micron).
I4_F_Ap1	float	uJy	Same as I1_F_Ap1, but for IRAC channel 4 (8 micron).
I4_dF_Ap1	float	uJy	Uncertainty in I4_F_Ap1.
I4_F_Ap2	float	uJy	Same as I1_F_Ap2, but for IRAC channel 4 (8 micron).
I4_dF_Ap2	float	uJy	Uncertainty in I4_F_Ap2.
I4_F_Ap1_BF	float	uJy	Same as I1_F_Ap1_BF, but for IRAC channel 4 (8 micron).
I4_dF_Ap1_BF	float	uJy	Uncertainty in I4_F_Ap1_BF.
I4_F_Ap2_BF	float	uJy	Same as I1_F_Ap2_BF, but for IRAC channel 4 (8 micron).
I4_dF_Ap2_BF	float	uJy	Uncertainty in I4_F_Ap2_BF.
I4_F_Ap1_3siglim	float	uJy	Same as I1_F_Ap1_3siglim, but for IRAC channel 4 (8 micron).
I4_F_Ap2_3siglim	float	uJy	Same as I1_F_Ap2_3siglim, but for IRAC channel 4 (8 micron).
M1_F_PSF	float	uJy	MIPS channel 1 (24 micron) PSF-fit flux density. This column will have a non-null value only if the detection is at a signifigance greater than 10 sigma.
M1_dF_PSF	float	uJy	Uncertainty in M1_F_PSF. Formal uncertainty in the least-squares PSF fitting. This typically underestimates the true uncertainty. Users interested in more accurate uncertainties should use M1_F_PSF / M1_SNR.
M1_F_Ap	float	uJy	MIPS channel 1 (24 micron) flux density measured with an aperture of diameter 14.7 arcsec. The flux densities have not had an aperture correction applied. For stellar point sources, multiply by 1.488. This column will be non-null only if the PSF flux density detection is greater than 10 sigma.
M1_dF_Ap	float	uJy	Uncertainty in M1_F_Ap.
M1_F_PSF_BF	float	none	MIPS channel 1 (24 micron) PSF-fit bandfill flux density. If a source is detected at >3 sigma within a 6 arcsec diameter aperture, a PSF fit is attempted. However, if the best fit centroid changes by more than 2 pixels (5 arcsec), only aperture flux densities at the original position are reported. If a source is not detected at >3 sigma in a 6 arcsec diameter aperture, only upper limits are reported.

M1_dF_PSF_BF	float	uJy	Uncertainty in M1_F_PSF_BF. Formal uncertainty in the least-squares PSF fitting. This typically underestimates the true uncertainty. Users interested in more accurate uncertainties should use M1_F_PSF / M1_SNR.
M1_F_Ap_BF	float	uJy	MIPS channel 1 (24 micron) bandfill flux density measured at the position ra, dec within an aperture of diameter 14.7 arcsec. The flux densities have not had an aperture correction applied. For stellar point sources, multiply by 1.488. This column will have a non-null value if the original detection was less significant than 10 sigma and the bandfill flux density is significant at a level greater than 3 sigma.
M1_dF_Ap_BF	float	uJy	Uncertainty in M1_F_Ap_BF.
M1_F_PSF_3siglim	float	uJy	MIPS channel 1 (24 micron) three-sigma upper limit on the PSF-fit flux density. This limit is calculated within a 6 arcsec diameter aperture.
M1_F_Ap_3siglim	float	uJy	MIPS channel 1 (24 micron) three-sigma upper limit on the 14.7 arcsec diameter aperture flux density. No aperture correction has been applied.
I1_ExtFrac	float	none	The fraction of IRAC channel 1 (3.6 micron) pixels associated with the source that fall within the IRAC channel 1 extended source mask.
I2_ExtFrac	float	none	Same as I1_ExtFrac but for IRAC channel 2 (4.5 micron).
I3_ExtFrac	float	none	Same as I1_ExtFrac but for IRAC channel 3 (5.8 micron).
I4_ExtFrac	float	none	Same as I1_ExtFrac but for IRAC channel (8 micron).
M1_ExtFrac	float	none	Same as I1_ExtFrac but for MIPS channel 1 (24 micron).
I1_BrtFrac	float	none	The fraction of IRAC channel 1 (3.6 micron) pixels associated with the source that fall within the IRAC channel 1 bright source mask.
I2_BrtFrac	float	none	Same as I1_BrtFrac but for IRAC channel 2 (4.5 micron).
I3_BrtFrac	float	none	Same as I1_BrtFrac but for IRAC channel 3 (5.8 micron).
I4_BrtFrac	float	none	Same as I1_BrtFrac but for IRAC channel 4 (8 micron).
M1_BrtFrac	float	none	Same as I1_BrtFrac but for MIPS channel 1 (24 micron).
I1_SNR	float	none	Signal-to-noise ratio for I1_F_Ap1.
I2_SNR	float	none	Signal-to-noise ratio for I2_F_Ap1.
I3_SNR	float	none	Signal-to-noise ratio for I3_F_Ap1.
I4_SNR	float	none	Signal-to-noise ratio for I4_F_Ap1.
M1_SNR	float	none	Signal-to-noise ratio for M1_F_PSF.
I1_x	float	pix	IRAC channel 1 (3.6 micron) x pixel position.
I1_y	float	pix	IRAC channel 1 (3.6 micron) y pixel position.

I2_x	float	pix	IRAC channel 2 (4.5 micron) x pixel position.
I2_y	float	pix	IRAC channel 2 (4.5 micron) y pixel position.
I3_x	float	pix	IRAC channel 3 (5.8 micron) x pixel position.
I3_y	float	pix	IRAC channel 3 (5.8 micron) y pixel position.
I4_x	float	pix	IRAC channel 4 (8 micron) x pixel position.
I4_y	float	pix	IRAC channel 4 (8 micron) y pixel position.
M1_x	float	pix	MIPS channel 1 (24 micron) x pixel position.
M1_y	float	pix	MIPS channel 1 (24 micron) y pixel position.
I1_RA	double	deg	Right Ascension (J2000) of the detection in IRAC channel 1 (3.6 micron).
I1_DEC	double	deg	Declination (J2000) of the detection in IRAC channel 1 (3.6 micron).
I2_RA	double	deg	Right Ascension (J2000) of the detection in IRAC channel 2 (4.5 micron).
I2_DEC	double	deg	Declination (J2000) of the detection in IRAC channel 2 (4.5 micron).
I3_RA	double	deg	Right Ascension (J2000) of the detection in IRAC channel 3 (5.8 micron).
I3_DEC	double	deg	Declination (J2000) of the detection in IRAC channel 3 (5.8 micron).
I4_RA	double	deg	Right Ascension (J2000) of the detection in IRAC channel 4 (8 micron).
I4_DEC	double	deg	Declination (J2000) of the detection in IRAC channel 3 (8 micron).
M1_RA	double	deg	Right Ascension (J2000) of the detection in MIPS channel 1 (24 micron).
M1_DEC	double	deg	Declination (J2000) of the detection in MIPS channel 4 (8 micron).
I1_PeakFlux	float	uJy	IRAC channel 1 (3.6 micron) peak flux density.
I2_PeakFlux	float	uJy	IRAC channel 2 (4.5 micron) peak flux density.
I3_PeakFlux	float	uJy	IRAC channel 3 (5.8 micron) peak flux density.
I4_PeakFlux	float	uJy	IRAC channel 4 (8 micron) peak flux density.
I1_PeakDist	float	arcsec	IRAC channel 1 (3.6 micron) distance from peak to centroid.
I2_PeakDist	float	arcsec	IRAC channel 2 (4.5 micron) distance from peak to centroid.
I3_PeakDist	float	arcsec	IRAC channel 3 (5.8 micron) distance from peak to centroid.
I4_PeakDist	float	arcsec	IRAC channel 4 (8 micron) distance from peak to centroid.
I1_FWHM	float	arcsec	IRAC channel 1 (3.6 micron) full width at half maximum.
I2_FWHM	float	arcsec	IRAC channel 2 (4.5 micron) full width at half maximum.
I3_FWHM	float	arcsec	IRAC channel 3 (5.8 micron) full width at half maximum.
I4_FWHM	float	arcsec	IRAC channel 4 (8 micron) full width at half maximum.

M1_FWHM	float	arcsec	MIPS channel 1 (24 micron) full width at half maximum.
I1_A	float	arcsec	IRAC channel 1 (3.6 micron) semi-major axis.
I1_B	float	arcsec	IRAC channel 1 (3.6 micron) semi-minor axis.
I2_A	float	arcsec	IRAC channel 2 (4.5 micron) semi-major axis.
I2_B	float	arcsec	IRAC channel 2 (4.5 micron) semi-minor axis.
I3_A	float	arcsec	IRAC channel 3 (5.8 micron) semi-major axis.
I3_B	float	arcsec	IRAC channel 3 (5.8 micron) semi-minor axis.
I4_A	float	arcsec	IRAC channel 4 (8 micron) semi-major axis.
I4_B	float	arcsec	IRAC channel 4 (8 micron) semi-minor axis.
I1_SEFlags	int	none	IRAC channel 1 (3.6 micron) SExtractor flags.
I2_SEFlags	int	none	IRAC channel 2 (4.5 micron) SExtractor flags.
I3_SEFlags	int	none	IRAC channel 3 (5.8 micron) SExtractor flags.
I4_SEFlags	int	none	IRAC channel 4 (8 micron) SExtractor flags.
M1_DFlag	int	none	MIPS channel 1 (24 micron) deblending flag.
M1_SFlag	int	none	MIPS channel 1 (24 micron) APEX status flag.
M1_Bad_Pix	float	pix	MIPS channel 1 (24 micron) number of bad pixels in the PSF-fit region.
I1_Gain	float	e/count	IRAC channel 1 (3.6 micron)
I2_Gain	float	e/count	IRAC channel 2 (4.5 micron)
I3_Gain	float	e/count	IRAC channel 3 (5.8 micron)
I4_Gain	float	e/count	IRAC channel 4 (8 micron)
M1_Gain	float	e/count	MIPS channel 1 (24 micron)
I1_MeanNoise	float	uJy	IRAC channel 1 (3.6 micron) mean 1-sigma noise at ra, dec.
I2_MeanNoise	float	uJy	IRAC channel 2 (4.5 micron) mean 1-sigma noise at ra, dec.
I3_MeanNoise	float	uJy	IRAC channel 3 (5.8 micron) mean 1-sigma noise at ra, dec.
I4_MeanNoise	float	uJy	IRAC channel 4 (8 micron) mean 1-sigma noise at ra, dec.
SMID	long	none	Super Mosaic ID number. AORs that are in the same Observation Class and are spatially contiguous are grouped into a Super Mosaic labeled with a single identification number: SMID. The first digit of the SMID indicates the Observation Class: 2=zodiacal light, 3=Galactic plane, 4=Galactic, 5=extended sources, 6=extragalactic. If a Super Mosaic is divided into multiple Regions (see REGID) then its SMID will end in a 1. Otherwise, it will end in 0.

REGID	char	none	Region ID name. If a Super Mosaic is larger than 2 square degrees, it is broken up into 30x30 square arcminute Regions, with each Region overlapping its neighboring Regions by 2.6 arcminute on all sides. The REGID begins with the SMID followed by a "-" followed by a Tile Number. For example, a REGID of 40002981-108 has an SMID of 40002981 and a Tile Number of 108. Two sets of Regions per position are created for IRAC data taken in High Dynamic Range (HDR) mode. The short frames are assigned a REGID with a "-short" suffix. An example is 40002981-108-short.
IRAC_ObsType	int	none	IRAC Observation Type: 2= Zodiacal Background Observation; 3= Galactic Plane Observation; 4= Galactic Object Observation; 5= Extended Object; 6= Extragalactic Observation.
MIPS_ObsType	int	none	MIPS Observation Type, which is encoded in the same way as IRAC_ObsType.
I1_Coverage	float	images	IRAC channel 1 (3.6 micron) coverage.
I2_Coverage	float	images	IRAC channel 2 (4.5 micron) coverage.
I3_Coverage	float	images	IRAC channel 3 (5.8 micron) coverage.
I4_Coverage	float	images	IRAC channel 4 (8 micron) coverage.
M1_Coverage	float	images	MIPS channel 1 (24 micron) coverage.
TWOMASS_key	int	none	2MASS Unique ID key
TWOMASS_Assoc	int	none	2MASS association flag. If this is set to 0, there is no 2MASS point source within a 1 arcsec radius. If there is a 2MASS association, this flag is set to 1.
TWOMASS_RA	double	deg	Right Ascension (J2000) of the associated 2MASS point source, if any.
TWOMASS_DEC	double	deg	Declination (J2000) of the associated 2MASS point source, if any.
J	float	uJy	J-band flux density of the associated 2MASS point source, if any.
dJ	float	uJy	Uncertainty in J.
H	float	uJy	H-band flux density of the associated 2MASS point source, if any.
dH	float	uJy	Uncertainty in H.
K	float	uJy	K-band flux density of the associated 2MASS point source, if any.
dK	float	uJy	Uncertainty in K.
WISE_key	int	none	Unique identification number form the WISE Catalog
WISE_RA	double	deg	WISE J2000 right ascension with respect to the 2MASS PSC reference frame
WISE_DEC	double	deg	WISE J2000 declination with respect to the 2MASS PSC reference frame
WISE1	double	uJy	WISE W1 flux density or 95% upper limit if the W1 flux measurement has SNR<2
dWISE1	double	uJy	WISE W1 photometric measurement uncertainty in flux density units

WISE2	double	uJy	WISE W2 flux density or 95% upper limit if the W1 flux measurement has SNR<2
dWISE2	double	uJy	WISE W2 photometric measurement uncertainty in flux density units
WISE3	double	uJy	WISE W3 flux density or 95% upper limit if the W1 flux measurement has SNR<2
dWISE3	double	uJy	WISE W3 photometric measurement uncertainty in flux density units
WISE4	double	uJy	WISE W4 flux density or 95% upper limit if the W1 flux measurement has SNR<2
dWISE4	double	uJy	WISE W4 photometric measurement uncertainty in flux density units
WISE_cc_flags	char	none	WISE contamination and confusion flag (see the definition of cc_flags in the WISE Explanatory Supplement)
WISE_ext_flg	int	none	WISE extended source flag (see the definition of ext_flg in the WISE Explanatory Supplement)
WISE_var_flg	char	none	WISE variability flag (see the definition of var_flg in the WISE Explanatory Supplement)
WISE_ph_qual	char	none	WISE photometric quality flag (see the definition of ph_qual in the WISE Explanatory Supplement)
WISE_det_bit	int	none	WISE bit-encoded integer indicating bands in which a source has a detection (see the definition of det_bit in the WISE Explanatory Supplement)
WISE1rchi2	float	none	Reduced chi^2 of the WISE W1 profile fit photometry measurement
WISE1m	int	none	WISE W1 Integer frame coverage
WISE1nm	int	none	WISE W1 Integer frame detection count
WISE2rchi2	float	none	Reduced chi^2 of the WISE W2 profile fit photometry measurement
WISE2m	int	none	WISE W2 Integer frame coverage
WISE2nm	int	none	WISE W2 Integer frame detection count
WISE3rchi2	float	none	Reduced chi^2 of the WISE W3 profile fit photometry measurement
WISE3m	int	none	WISE W3 Integer frame coverage
WISE3nm	int	none	WISE W3 Integer frame detection count
WISE4rchi2	float	none	Reduced chi^2 of the WISE W4 profile fit photometry measurement
WISE4m	int	none	WISE W4 Integer frame coverage
WISE4nm	int	none	WISE W4 Integer frame detection count

4.10 Traceback Table

The Traceback Table translates between the Spitzer AOR number, the Spitzer Program ID (PID) number, and the Super Mosaic ID (SMID) number.

Table 4.9 Contents of Traceback Table.

Column Name	Description
SMID	Super Mosaic ID
REGID	Region ID
DCE	DCE number
AOR	AOR number
PID	Program ID
MJD	Modified Julian Date in days
exptime	Exposure time in seconds
ra	Right Ascension (J2000) in degrees
dec	Declination (J2000) in degrees
PA	Position Angle of the observation in degrees
ISM	Expected ISM background in MJy/sr
zody	Expected Zodiacal background in MJy/sr

4.11 Source List and Traceback Table Access

The Source List can be accessed through two separate IRSA services: The Catalog Search Tool (Gator) and the Spitzer Heritage Archive (SHA). Gator offers the easiest access to the full content of the Source List and Traceback tables, while the SHA offers the ability to overlay the Source List on Spitzer imaging.

4.11.1 Catalog Search Tool (Gator) access to the Source List and Traceback Table

A direct URL for accessing the SEIP Source List and Traceback tables via Gator is:

`irsa.ipac.caltech.edu/cgi-bin/nph-scan?irsa&submit=Select&projshort=SPITZER`

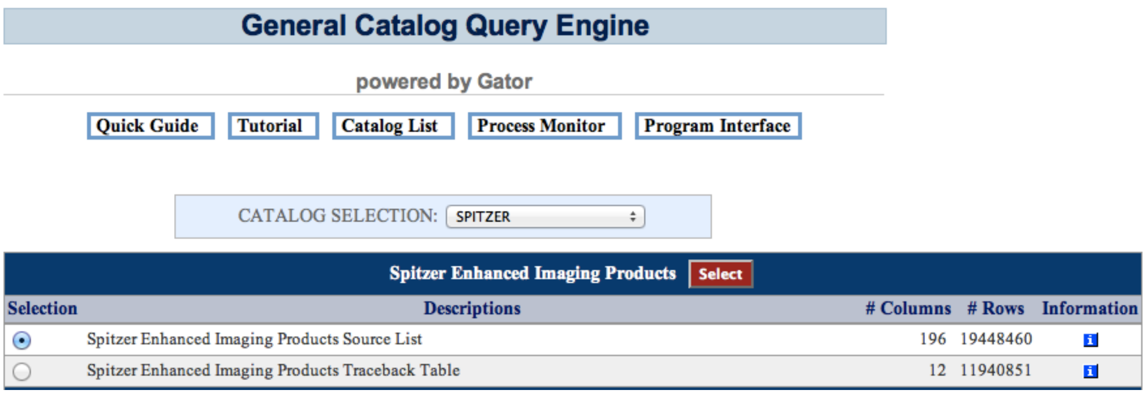


Figure 4.9 Screenshot of the SEIP section of IRSA's Catalog Search Tool (Gator). Both the Source List and the Traceback Table are available through this service.

Users who choose to search the Source List will be directed to a page that allows single object searches, multi-object searches, and all-sky searches. Users have the ability to select the Source List columns they want to download. They can choose from a "Standard" (abridged; default) set or a "Long" (complete) set, or they can choose to manually exclude some columns from either list.

4.11.2 Spitzer Heritage Archive (SHA) Access to the Source List

The Source List can be access through the SHA, but the Traceback Table cannot. The SHA can be found at the following URL:

`sha.ipac.caltech.edu/applications/Spitzer/SHA/`

The simplest way to search the Source List is by Position. Simply click on the box labeled "SSC Source List" under "Display search results in tabs for:"

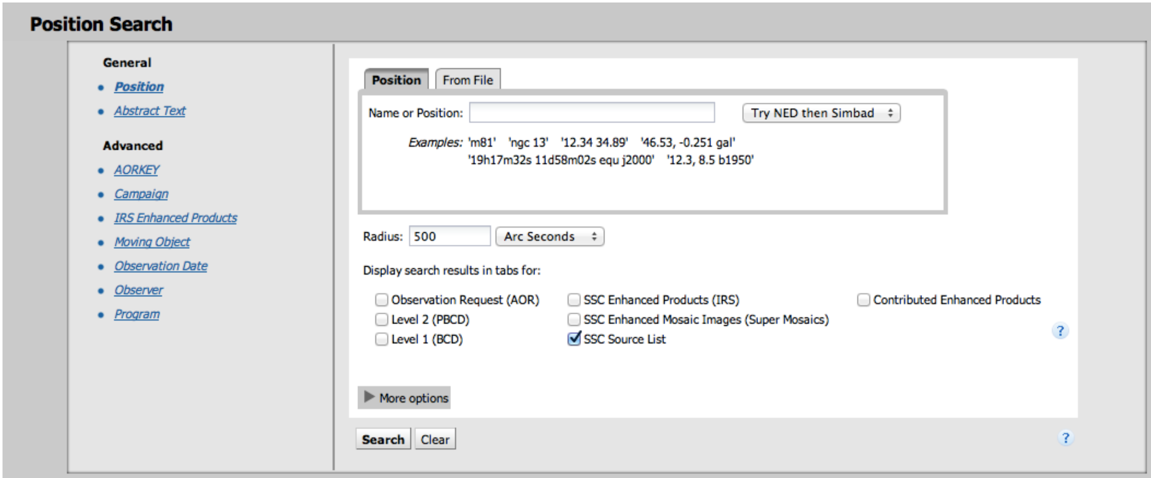


Figure 4.10 Screenshot of the Spitzer Heritage Archive (SHA) Position Search with the Source List selected.

Your results will be presented in a tab labeled "Source List". The columns listed are the same as the "Standard" list available through IRSA's Catalog Search Tool (Gator), so this is an abridged version of the full Source List, containing the columns most likely to be of interest to the most users. The results can be saved as an IPAC Table by clicking on "Save".

Users who access imaging data using the SHA also have the option to overplot the Source List on their search results. For example, if a user searches for super mosaics of Arp 220, the would encounter a results page that includes the following:

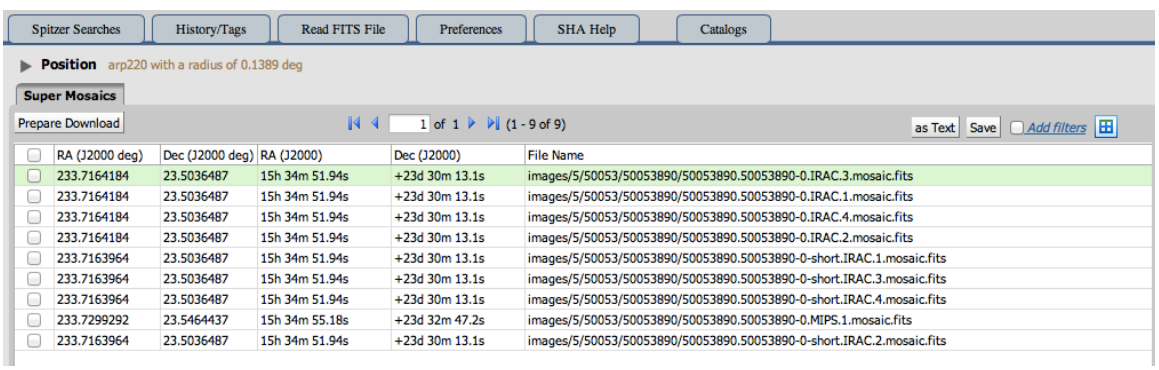


Figure 4.11 Partial screenshot of the Spitzer Heritage Archive Results page after searching for super mosaics of Arp 220. The Source List is accessible via the "Catalogs" tab near the upper right of the screen.

Clicking on the "Catalogs" tab near the upper right of the screen allows the user to choose between a number of catalogs included within IRSA's holdings. Among these is the Source List. The user can choose to access the "Short Form", which is an abridged set of columns, or the "Long Form", which is the complete set of columns. Simply click on "Set Column Restrictions".

After clicking on “Search”, the results will be presented in a tab labeled “SPITZER-slphotdr2”. Click on “Save” to download the results as an IPAC Table.

Chapter 5. Change Log

Cryogenic Release Version 2.0:

1. The Cryogenic Release contains data for different portions of the sky compared to the Preliminary Release. A detailed explanation is provided in Section 1.1. The most obvious omission is SMOG (adsabs.harvard.edu/abs/2008sptz.prop50398), which will be included in the next release.

2. Some MIPS Channel 1 mosaics had obvious processing issues. All mosaics are now visually inspected and badly processed mosaics have been removed and will be corrected in the next release.

3. This release replaces the old AOR-PID-SMID Table with a new Traceback Table.

4. This release does not include a Super Mosaic Table. This information is now in the image header. This includes information on the name lists used for the various processing steps, MJD of the observations, exposure times, gain, and coverage information.

5. This release does not include IRAC or MIPS Coverage Tables.

6. This release does not include the *dce.lst* with Atlas super mosaics. This information is now available in the Traceback Table.

7. WISE data are now being used in addition to Spitzer and 2MASS to determine the reality of sources. This prevents bright MIPS sources from being rejected from the Source List due to saturation in the IRAC bands. To prevent false WISE sources from being included in the catalog, a WISE source must meet the following criteria to be counted as a real association: ((w1snr>10 and w1m>4 and w1nm/w1m>0.5) and (w2snr>10 and w2m>4 and w2nm/w2m>0.5)) and (w3m>4 and w4m>4) and cc_flags='0000'.

8. The bright star mask has been modified so that it is based on WISE rather than 2MASS.

9. The Source List and super mosaics are now available from the Spitzer Heritage Archive (SHA).

Preliminary Release version 1.1 (PR1.1):

1. *_FluxType 4 has been added to denote sources that are bright and detected in multiple bands, but fail to meet the size criteria. These sources are real, but will have inaccurate flux densities, so no flux densities are reported.

2. Flagging parameters have been optimized to improve completeness.

3. The algorithm to detect extended backgrounds was changed. The new algorithm divides the image into a grid and calculates the mean of the lower-quartile of pixels in each grid square. A surface is then tessellated over these lower-quartile values, and SExtractor is used to segment regions of elevated emission into a mask.

4. The bright source mask for MIPS is now derived from the WISE catalog

5. A latent mask was added near very bright MIPS sources for scan map mode data.

6. WISE sources within 3 arcsec of a source list source are now reported. WISE detections currently do not add to the NBands value.

7. The SExtractor background subtraction and detection settings used for the IRAC photometry have been optimized.

8. The APEX background settings and aperture settings used for MIPS photometry have been optimized.

9. The MIPS PSF flux desnsities have been corrected for the PSF normalization used in APEX to better reflect accurate total flux densities.

10. The MIPS aperture flux densities have been corrected to total flux densities.

11. The MIPS bandfill fluxes are now calculated using a two pass method to avoid over-reporting the flux densities of faint sources next to bright sources. If a source is not detected at >3 sigma in a 6 arcsec diameter aperture, only upper limits are reported. If a source is detected at >3 sigma, a PSF fit is attempted. However, if the best fit centroid changes by more than 2 pixels (5 arcsec) only aperture flux densities at the original position are reported.

12. MIPS PSF flux density limits have been replaced by 6 arcsec diameter aperture limits to avoid nearby bright sources from biasing the limits.

13. Only the central bright source flux is now reported within MIPS bright source masks. This avoids false detections of artifacts on the airy ring.

14. Sources detected only in MIPS or MIPS+2MASS are no longer reported to reduce the artifact rate.

15. Ancillary structural and photometric information such as SNR, FWHM, mask bits, area, etc. are now reported along with bandfill flux densities. For IRAC, these values are calculated using a similar, but different, algorithm than SExtractor uses for the main detections, so they may not be exactly comparable. The MIPS structural parameters are calculated identically whether main flux densities or bandfill flux densities are reported.

16. The gain used to calculate photometric noise now reflects the mean exposure time used in each mosaic as well as the coverage.

17. Galactic Coordinates have been added to the Source List.

Chapter 6. Acronyms

AOR	Astronomical Observation Request
SEIP	Spitzer Enhanced Imaging Products
IER	Instrument Engineering Request – like an AOR, but for specific engineering tasks not able to be accomplished using an AOR.
IRAC	InfraRed Array Camera
IRSA	InfraRed Science Archive
MIPS	Multiband Imaging Photometer for Spitzer
PID	Program ID
SHA	Spitzer Heritage Archive
SSC	Spitzer Science Center
SL	Source List

Chapter 7. List of Tables

Chapter 8. List of Figures