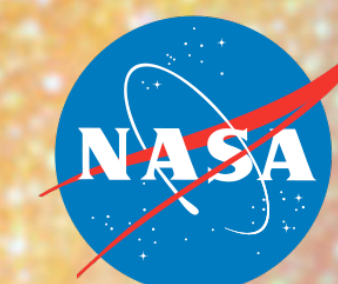# Science Validation of the Spitzer Source List

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http://irsa.ipac.caltech.edu/data/SPITZER/Enhanced/Imaging/announce.html

Abstract

The Spitzer Science Center and NASA Infrared Science Archive (IRSA) will produce and release a set of Enhanced Imaging Products from the Spitzer Heritage Archive. These will include enhanced mosaic images, combined data from multiple programs where appropriate, and a source list (SL) of photometry for compact sources. The primary requirement on the SL is very high reliability -- with areal coverage, completeness and limiting depth being secondary considerations. The enhanced imaging products will include data from the four channels of IRAC(3-8 microns) and the 24 micron channel of MIPS. The products will be generated for Spitzer observations of about 1500 square degrees and include around 30 million sources.

INTRO

- Source **List** for the Spitzer Heritage Archive: fluxes of high
- Science quality mosaics that will also be released
- Easily searchable, highly documented
- *Must minimize misuse*

- **Preliminary data release at the end of 2011, and a final data release in fall of 2012.**

COMING SOON
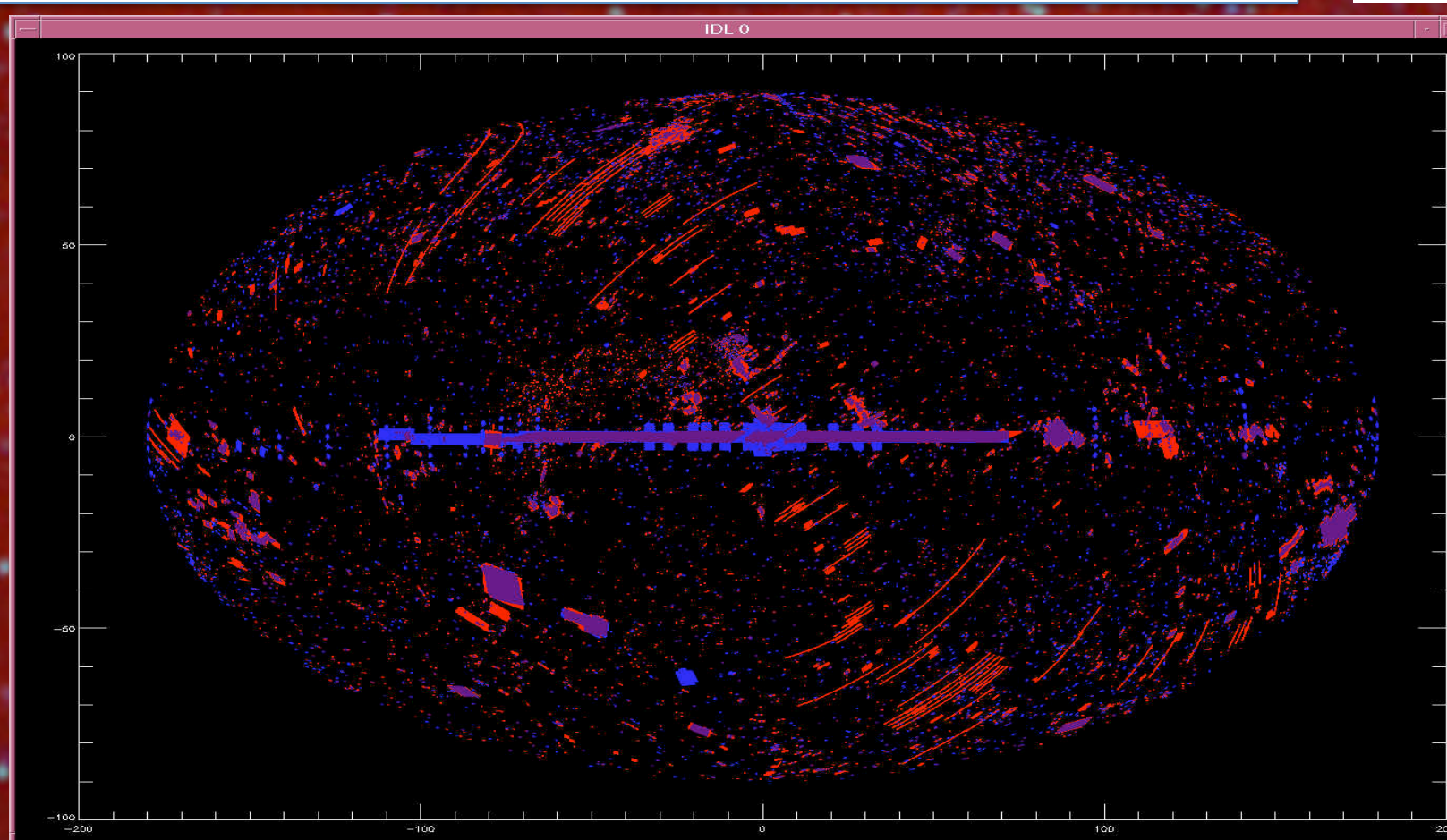
Distribution of Spitzer observations on the sky

IRAC only
MIPS only
Both

- IRAC+MIPS: 600 sq. degrees; 2/3 at |b|<20
- IRAC only: 350 sq. degrees; 2/3 at |b|<20
- MIPS only: 650 sq. degrees; 1/2 at |b|<20
- >= 30e6 galaxies in ch1
- >= 3e6 galaxies in ch4
- >= 1e6 galaxies in MIPS

Pipeline

Source List Inputs

Use-case specific namelists for mosaic and photometry (Programs sorted by proposal class)
- **IRAC**: Galactic low bg, Galactic high bg; xgal: shallow, medium, deep
- **MIPS**: Galactic and extragalactic

Masking

- SExtractor extended source mask for each field to exclude:
  - *Non-compact galaxies*
  - *Extended background structure*
  - *Defines 0.5sigma isophote*
- Mask regions around bright stars
  - *2MASS stars & Bright, red stars identified by pixel fluxes in BCDs*
  - *mask muxbleed spikes*

Products

- Mosaics
  - *IRAC data corrected by SSC pipeline*
  - *MIPS data additionally corrected for Latents, Jailbars and delta-flat*
  - *Will produce super-mosaics crossing observing programs*
    - *Average/Median images*
    - *Coverage maps; Uncertainty maps; IRAC color correction maps*
- Source list
  - *Will only include compact sources; not complete but highly robust*
  - *Extended sources masked to reduce artifacts and poor photometry due to confusion*
  - *Regions of extended emission have higher S/N cut*

Reject Spurious Sources

- Exclude sources that are too compact or too extended
  - *Cosmic rays are too compact; galaxies and false detections within extended emission are too extended*
  - *IRAC: Peak pixel flux divided by aperture flux*
  - *MIPS: Central flux (1 PSF) divided by extracted flux*
  - *Reject sources with FWHM inconsistent with point source (>2xPSF)*
- Reject source if peak pixel not within positional uncertainty (0.9") of centroid

Requirements

- Source *list*, not source *catalog* (data are too heterogeneous)
  - Need high reliability, but don't have to be complete
  - Mask significant area and when in doubt reject questionable sources
- Limit to common SNR threshold (10 sigma)
- Only point- and compact-sources (FWHM < 2 x PSF)
- No requirement on completeness
  - About 80% complete compared to Legacy surveys at 10σ
  - 50-70% compared to deeper, Legacy-survey full catalogs (e.g. c2d "class A+B" sources down to 5σ),
- Use only subset of the archive to make list feasible
  - Avoid extended sources (local galaxies, etc); very low galactic latitude
  - Minimum AOR requirements (e.g depth of coverage)
  - No 16,70,160 micron data
- Use-case specific namelists for mosaic and photometry

- Extragalactic
  - *SL shall meet reliability level achieved by Legacy teams*
  - *Maximum of 0.01% spurious sources*
- Galactic, without structured background
  - *SL shall meet reliability level achieved by Legacy teams*
  - *Maximum of 0.05% spurious sources when detected at 10 sigma in two bands*
- Galactic, with structure in the background
  - *Maximum of 0.2% spurious sources when detected at 10 sigma in two bands*
- MIPS-only fields (about half of MIPS data)
  - *Extragalactic: 0.05%*
  - *Galactic, low BG: 0.1% (appx, still under study)*
  - *Galactic, structured BG: 0.25% (appx, still under study)*
- Galactic with high crowding: *Under study*

Validation against "truth" data

Comparison to SWIRE
- Low coverage, xgal legacy survey (test area 0.2 sq. deg.)
- We can solve this case
  - spurious source rate is < 0.01% (area limited number)
  - Completeness is 80-90% relative to legacy catalog
- Small differences (phot. scatter, diff bg sub, SWIRE required ch1+ch2)

Comparison to c2d
- Typical galactic, legacy survey (test area 0.4 sq. deg. In Perseus)
- We can solve this case
  - spurious source rate is < 0.1% (area limited number)
  - Completeness is 80-90% w.r.t. to legacy catalog "class A"
- Some differences remain (photometry differs by ~15%; c2d used DOphot)

Validation with Original Science

Potential Uses for Galactic Science

- UKIDSS (JHK) goes 3 mag deeper than 2MASS at K
- Measure dust extinction law in high extinction areas from background stars
- Dark Cloud L673: IR extinction relative to K in high extinction areas is higher than diffuse ISM
- Agrees with results in large dense clouds
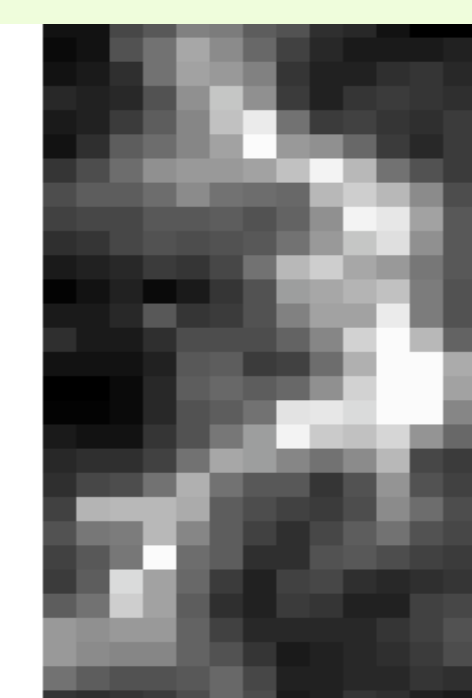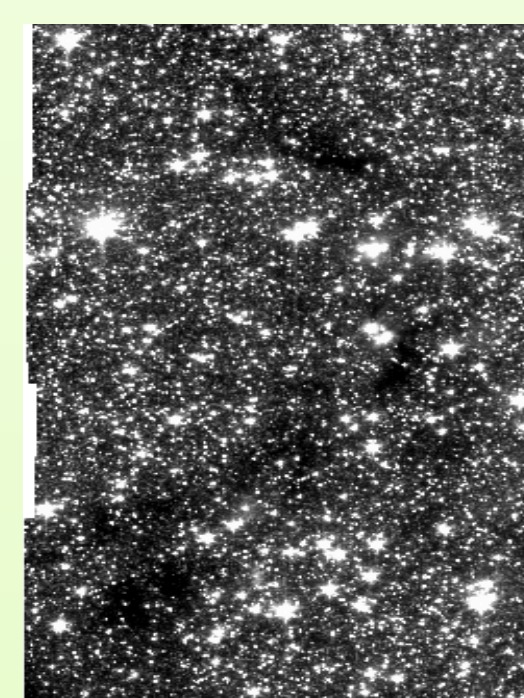
*Left*: IRAC 3.6 µm; *Right*: Median A(K) in magnitudes derived from UKIDSS in 1.5" bins (range 0.2-1.1)
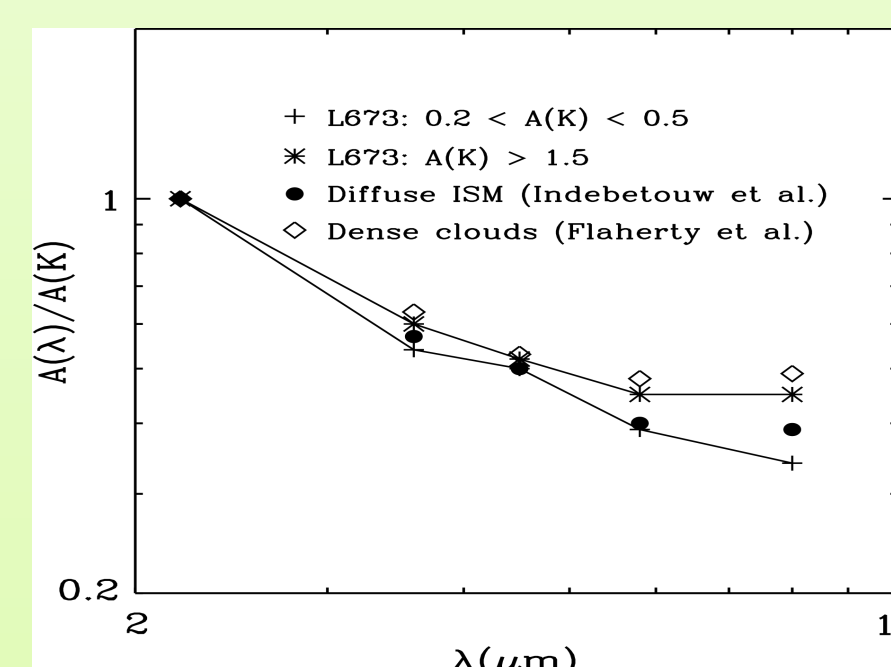
Cataclysmic Variables in the Infrared

- Study of mass transfer & accretion
- Spitzer targeted only ~2 dozen systems (out of 2500+)
- Source List, with comprehensive target list of known cataclysmic variables (CVs), will complete the census of MIR photometry: Ubiquity of dust in CVs? Origin/ formation mechanism for dust in CVs; Variability of IR SEDs on timescale of years
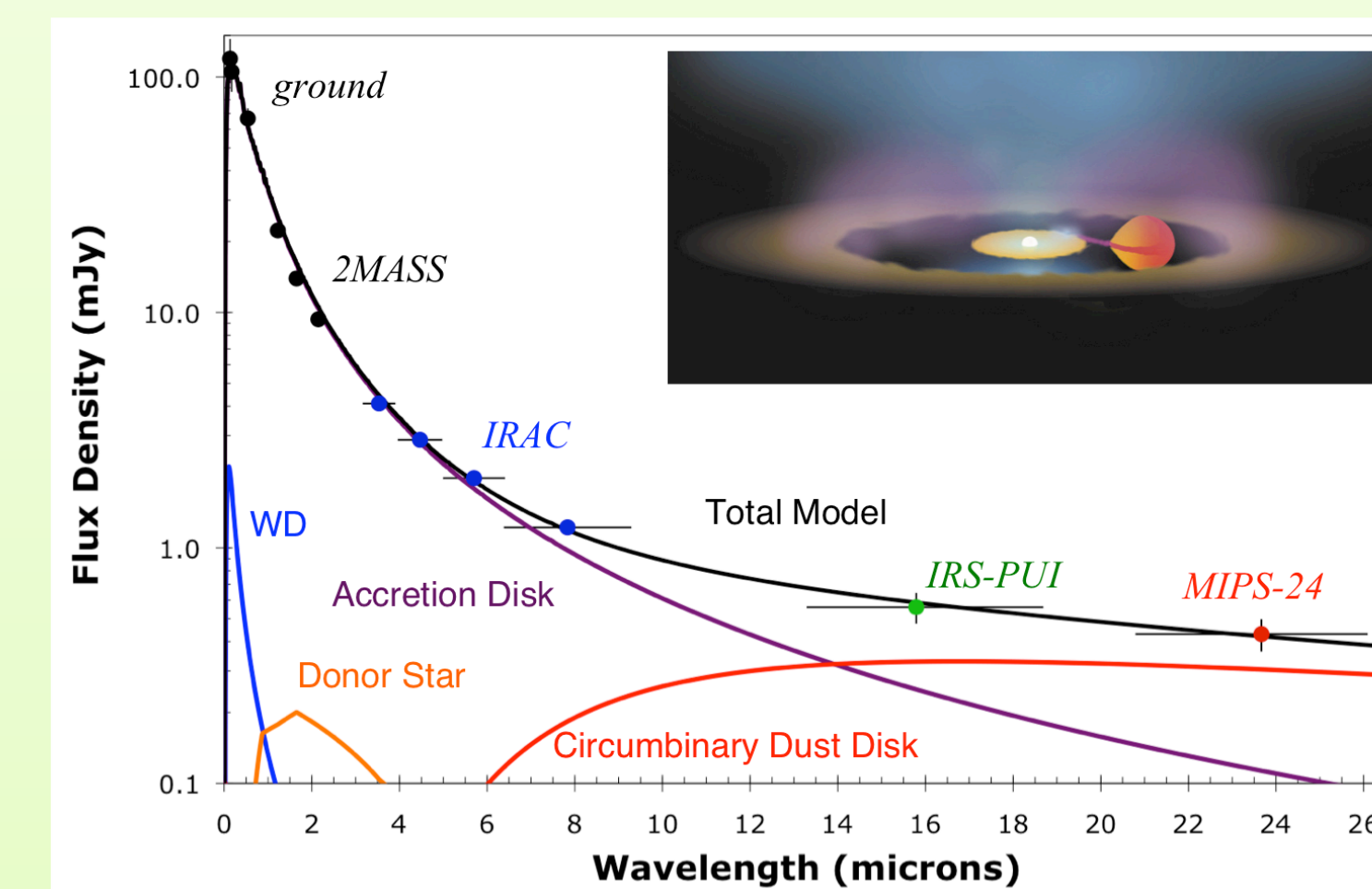
SED of the bright, nearly face-on cataclysmic variable V592 Cas, along with a multi-component model. Infrared data from pointed observations with the Spitzer Space Telescope were crucial to discovering the presence of a circumbinary dust disk that surrounds this close binary star (see artistic depiction in inset panel). For details, see Hoard et al. 2009, ApJ, 693, 236.

Gravitational Lens in RCS032727
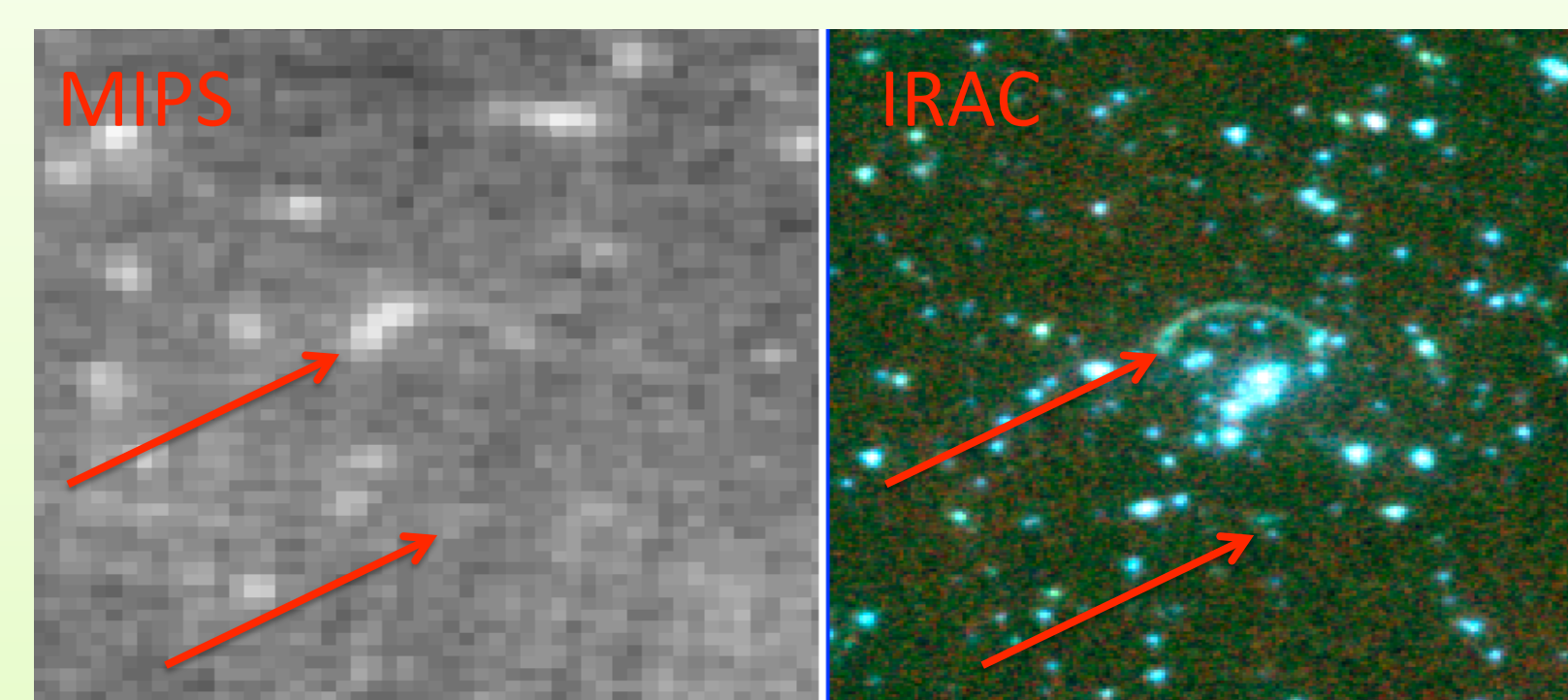
For this strongly lensed galaxy at z=1.7 (Wuyts et al. 2010; ApJ 724,1182), the arc, and counter-arc of the same galaxy are marked in red. The MIPS emission from the long arc is spatially resolved, while the counter-arc is not detected indicating the MIPS 24um emission is in a concentrated region of the galaxy. Our conclusions based on the Source-List photometry and mosaics quantitatively match those obtained by the PI.

Optically undetected sub-mm sources at z>3

–Aravena et al. 2010, ApJL, 719, 15
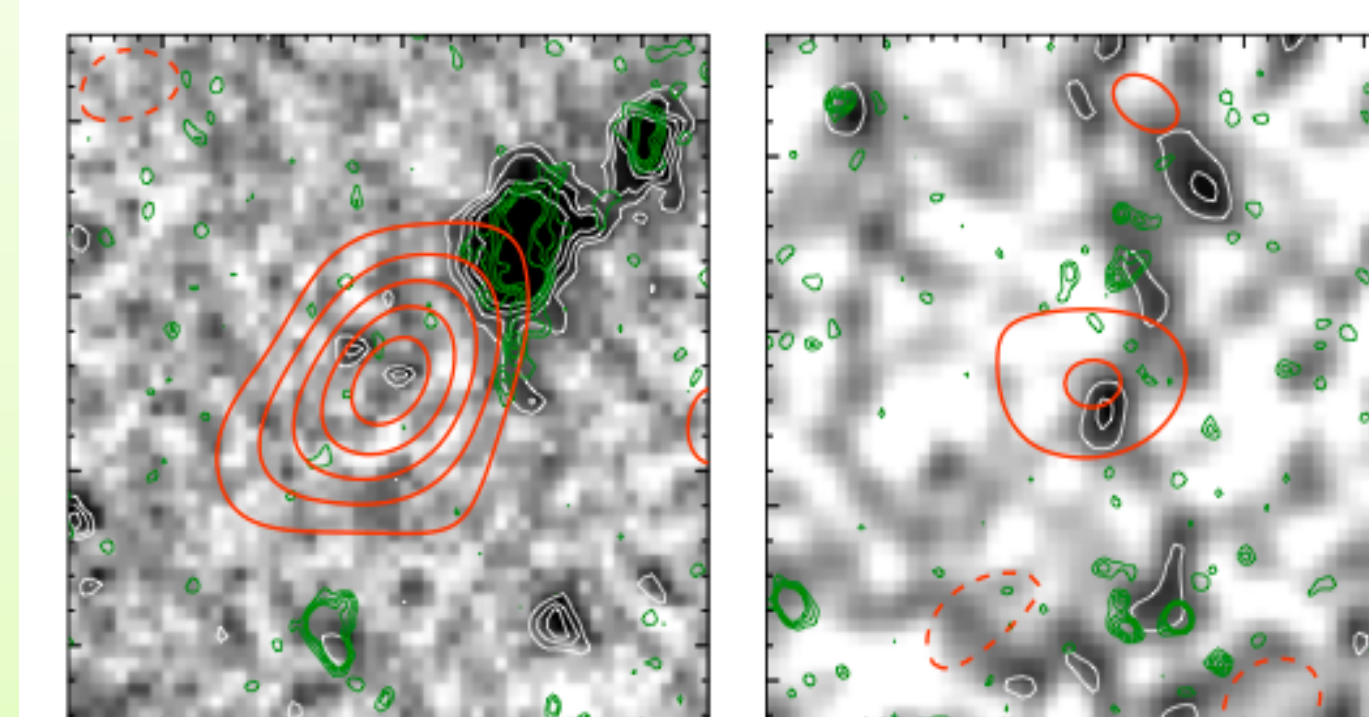
Two K-band dropout sub-mm sources in the COSMOS field with Sub-mm contours overlaid on K band images. Spitzer Photometry was measured using the SL Pipeline and Spitzer Warm Mission data.