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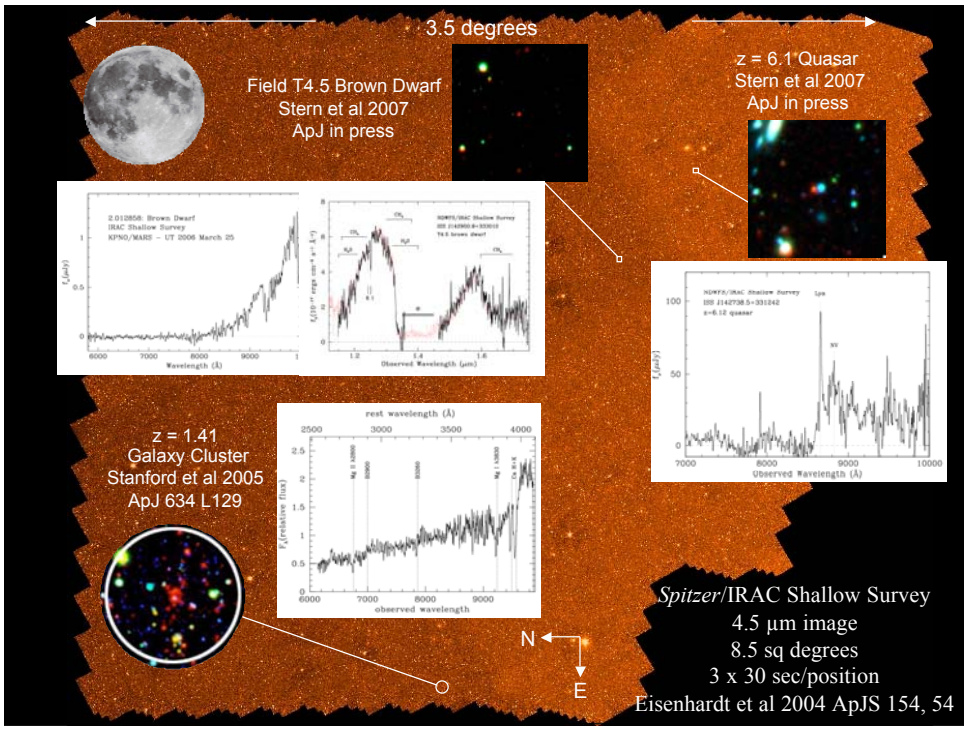
The Porcupine Survey: Spitzer Warm Mission Followup of WISE Brown Dwarf Candidates

WISE Science Team
June 4, 2007



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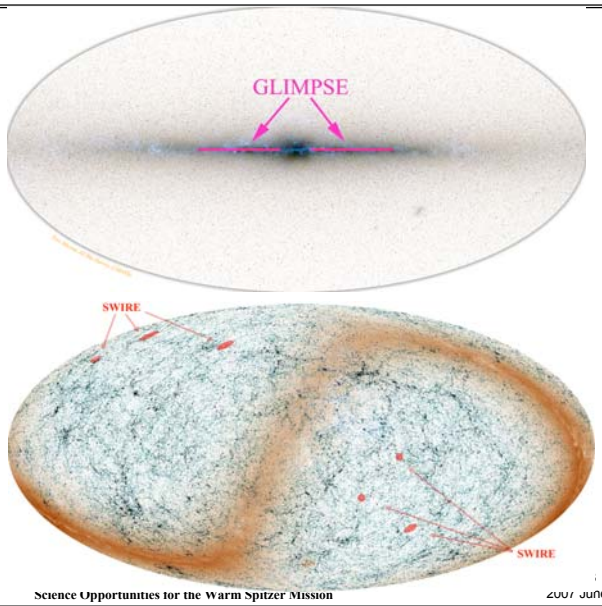
WISE and Spitzer: Complementary Missions

- WISE will survey 170x GLIMPSE and 800x SWIRE area
- Detailed information available for Spitzer sources will define characteristics of the most interesting WISE sources
- Spitzer Warm Misison and JWST will followup interesting WISE sources



Porcupine Survey: Wide-field **I**nfrared **S**urvey **E**xplorer Followup

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Project Overview

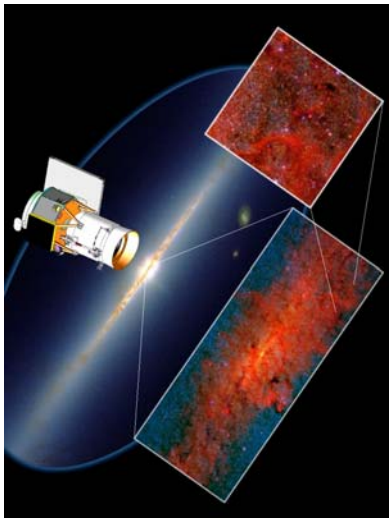
Science

- *Sensitive all sky survey with 8X redundancy*
  - *Find the most luminous galaxies in the universe*
  - *Find the closest stars to the sun*
  - *Provide an important catalog for JWST*
  - *Provide lasting research legacy*

Salient Features

- *4 imaging channels covering 3 - 25 microns wavelength*
- *40 cm telescope operating at <17K*
- *Two stage solid hydrogen cryostat*
- *Delta launch from WTR in November, 2009*
- *Sun-synchronous 6am/6pm 500km orbit*
- *Scan mirror provides efficient mapping*
- *Operational life: 7 months (130% margin)*
- *4 TDRSS tracks per day*
- *Preliminary Catalog 6 mos. after end of survey*
- *Final Catalog 17 mos. after end of survey*

Wide-field Infrared Survey Explorer



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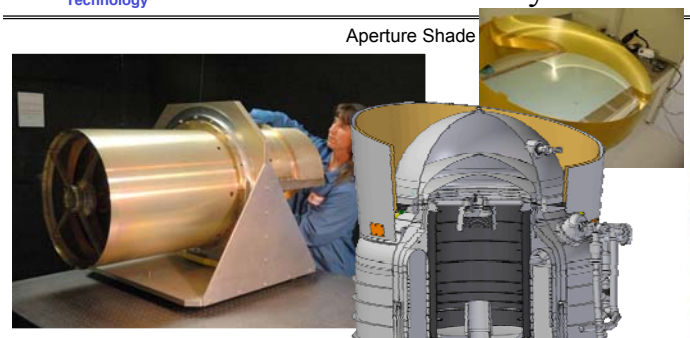
Work is Progressing on all Subsystems

Aperture Shade



Primary\Secondary Tank Assembly

Telescope Assembly

MEB Electronics

Beam Splitter Assembly

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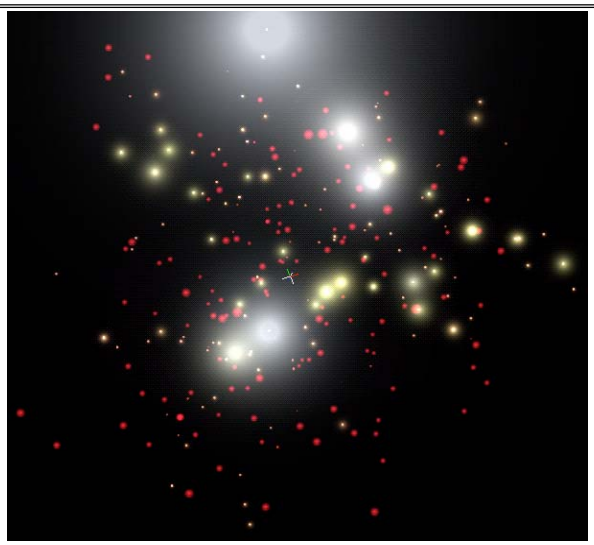
WISE Will Find the Nearest Stars



WISE stars within 25 lightyears

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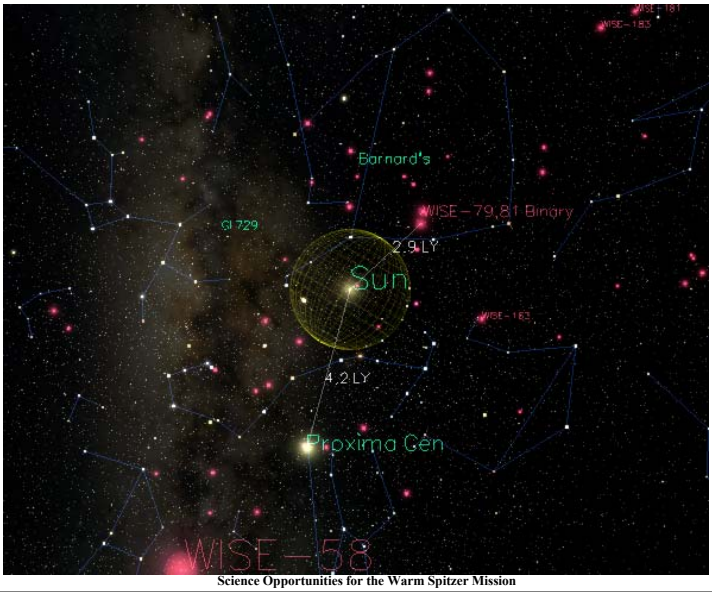
The closest stars…



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How many BDs will WISE see?

Mass Function	$T_{eff} < 300$	$T_{eff} < 500$	$T_{eff} < 750$	d < 1.3 pc
Chabrier etal log-normal	7	221	1340	0.88
Reid etal $M^{-0.7}$	5	121	671	0.53
Reid etal $M^{-1.0}$	11	197	921	0.93
Reid etal $M^{-1.3}$	22	330	1310	1.74

Assuming uniform star formation rate over the past 10 billion years and that WISE just meets its 4.6 μm sensitivity requirement.

At present, no Brown Dwarfs with T < 650 K have been found, even using Spitzer data.
WISE will find about one thousand such objects, including perhaps the nearest planetary system to our own.

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Porcupine Survey

- Y dwarfs will have very strong methane absorption:
  - [3.6] - [4.5] > 2
  - Largely invisible in [3.6] or WISE [3.3]
  - Primarily single band detections
  - Even with 8x or more redundancy, need confirmation from independent data
- Long time baseline provides proper motion and parallax
- Assume ~10^4 WISE Brown Dwarf Candidates
  - Typical 5 sigma WISE [4.7] flux 80 uJy (est. perf.) to 160 uJy (reqt.)
  - Distributed around sky

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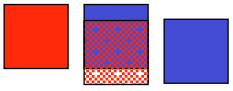
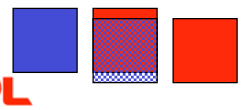
Porcupine Survey

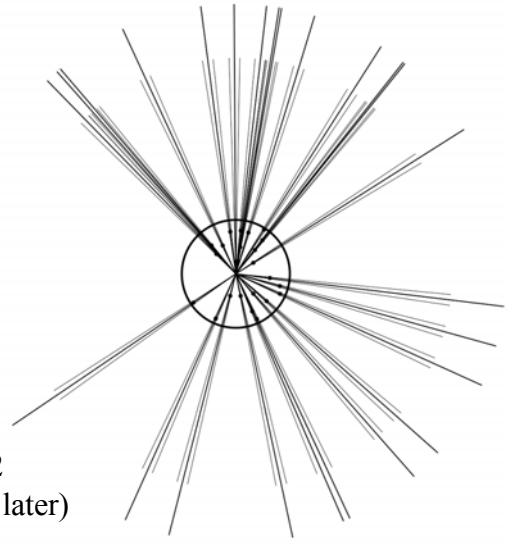
- Spitzer depth will be much greater than WISE (inner circle)
- Central field will be deeper than flanking fields



Epoch 1



Epoch 2
(6 mos. later)



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Porcupine Survey

- Followup Warm Mission survey on these fields
  - Assume 5 x 30s in both [3.6] and [4.5]
    - 3 uJy in [3.6], 6 uJy in [4.5] (5 sigma)
  - Repeat 6 mos. later
    - Parallax to < 0.1" (2 au baseline)
    - Proper motions to ~0.2"/yr
      - For 30 km/s, proper motion is 6/D arcsec/yr where D is distance in pc
- Closest brown dwarfs are best targets for additional followup with JWST and other facilities
  - Best angular scale
  - Biggest astrometric signatures for planets
  - Highest SNR spectroscopy
- Repeat 6 mos. later also provides two band coverage in flanking fields around each pointing
  - Covers ~ 200 sq deg
    - Similar volume to WISE survey
  - Takes ~ 3000 hr.

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Summary

- The Porcupine Survey proposed here will greatly enhance the value of the WISE survey
  - positively identify very nearby star systems
  - prime targets for follow-up with the JWST
- The combination of WISE, Spitzer warm, and JWST observations could very well lead to the discovery and verification of the closest star system to the Sun and the closest extrasolar planet.