Transient Identification and Classification with WISE

Doug Hoffman
R. Cutri & T. Jarrett

The Eventful Universe, 2010

The Wide-field Infrared Survey Explorer

Science

- *Sensitive all sky survey with 8X redundancy*
  - *Find the most luminous galaxies in the universe*
  - *Find the closest stars to the sun*
  - *Study darkest asteroids & comets*
  - *Provide an important catalog for JWST*

Salient Features

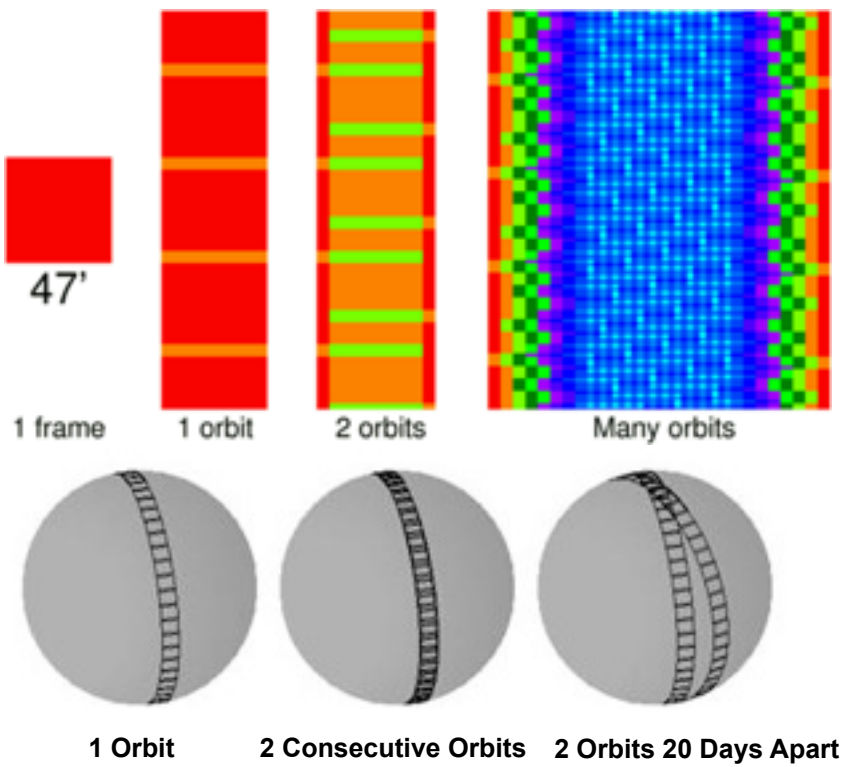
- *4 imaging channels simultaneously covering 3 - 25 microns wavelength*
- *40 cm telescope operating at <17K*
- *Two stage solid hydrogen cryostat*
- *Launched from WTR on December 14, 2009*
- *Sun-synchronous 6am/6pm 500km orbit*
- *Scan mirror provides efficient mapping*
- *Operational life: 10 months*
- *Principal Investigator: Ned Wright (UCLA)*

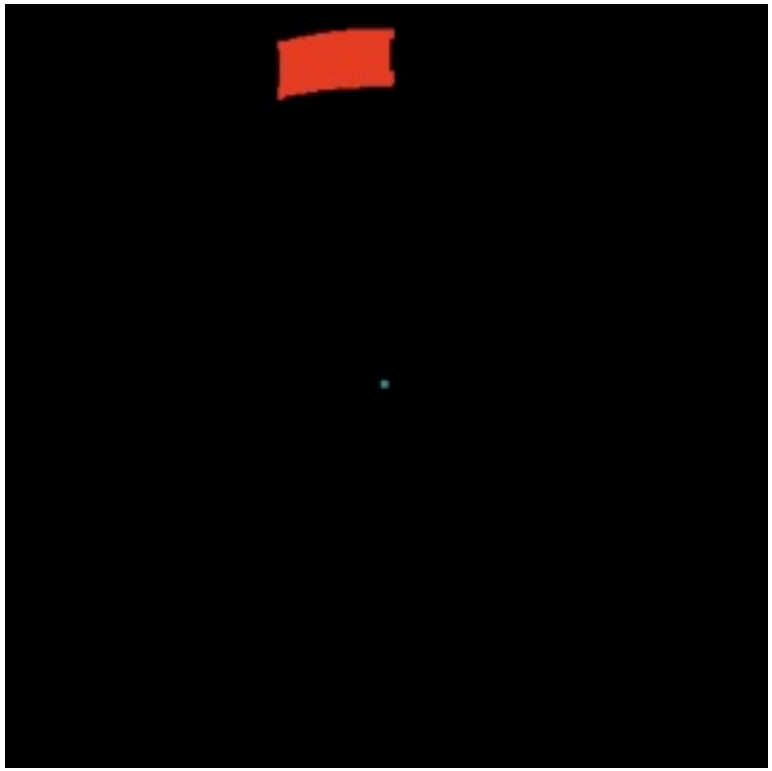
http://wise.astro.ucla.edu

WISE Survey Strategy

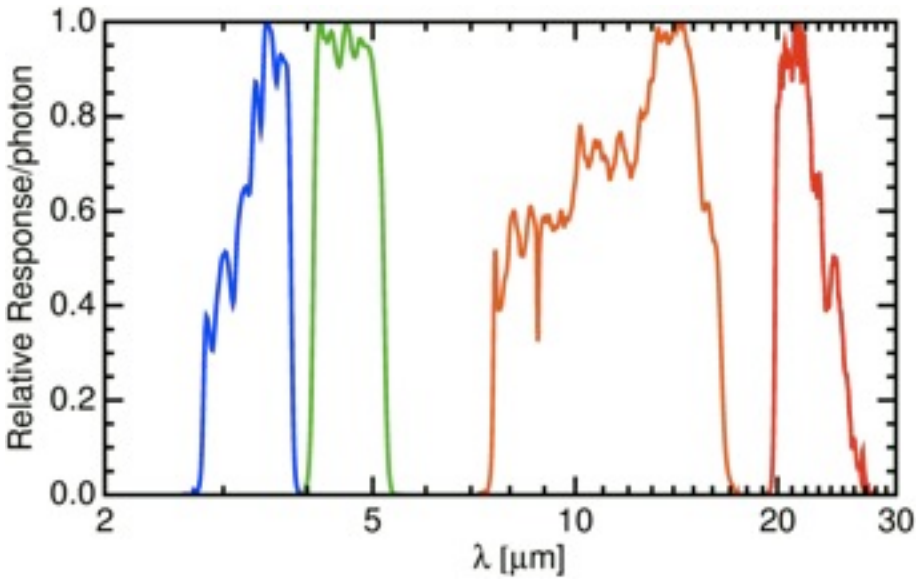
- Telescope scans continuously near zenith
- Scan mirror freezes the sky on the focal planes
  - 8.8-s exposure/11-s duty cycle
- 10% frame to frame overlap
- 90% orbit to orbit overlap (every other orbit)
- Orbital period of 95 min – each sky position observed each 190 minutes (on ecliptic)

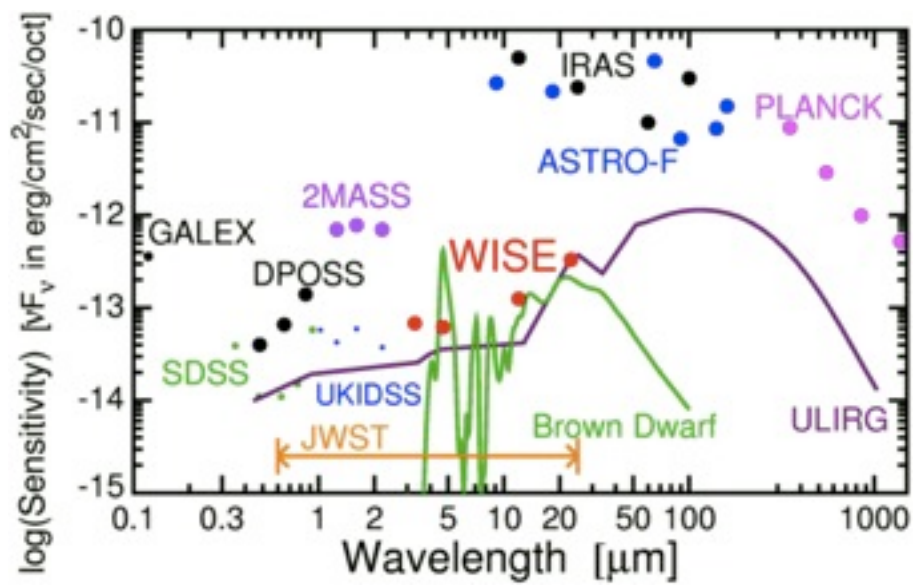
- Minimum 8, median 14 exposures/position after losses to Moon and SAA
- Sky covered in 6 month of observing
- **34%** of the sky observed so far!





Bandpasses and Sensitivity





3.4, 4.6, 12, and 22 micron bands selected to sample the emission of cool and obscured objects in the Universe

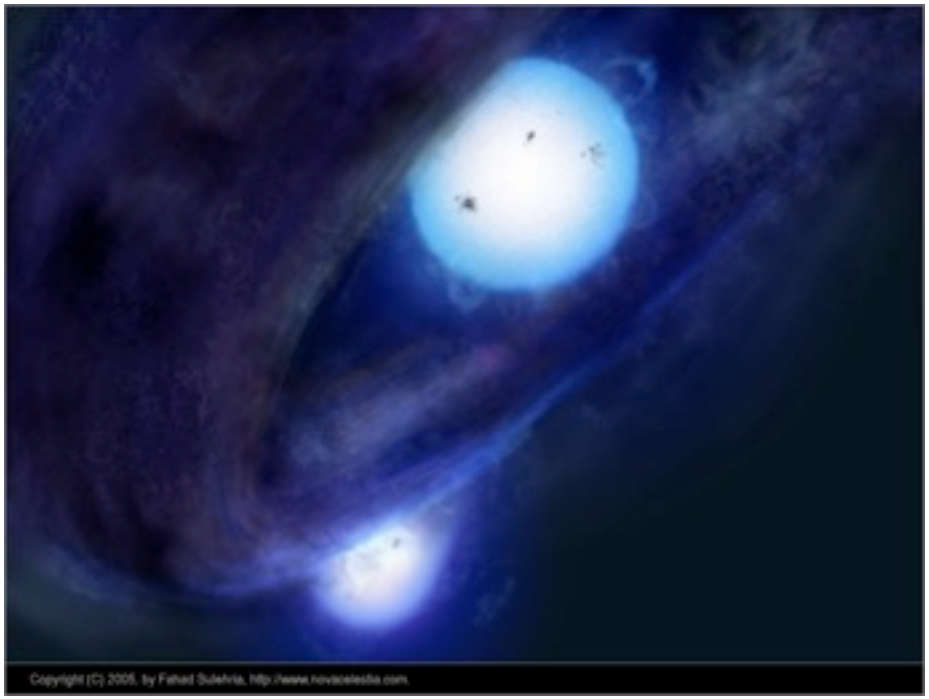
5sigma sensitivity limits (on ecliptic)

120/160/850/4000 microJy (W1/W2/W3/W4) 8 repeats

295/423/2220/11030 microJy (W1/W2/W3/W4) 1 repeat

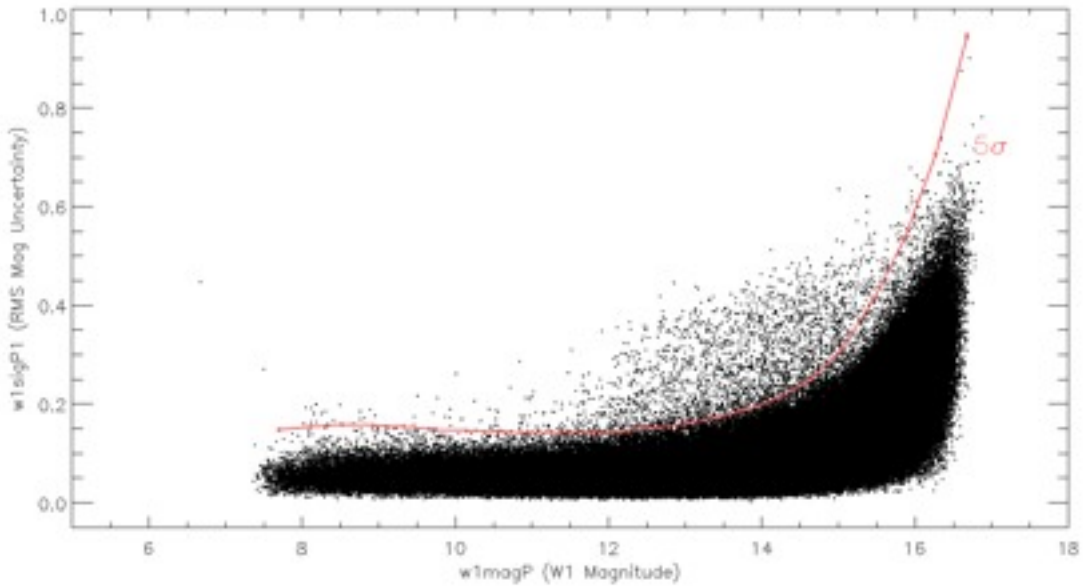
Variable and Transient Identification

- Challenges associated with different number of observations for different regions in the sky
  - About 8 observations per object near the ecliptic
  - Up to about 2000 observations for objects near the ecliptic pole
  - Time baseline from hours to months
- Types of variability:
  - Physical, periodic variables (e.g, RR Lyr, Cepheids, Miras)
  - Geometric variables (e.g., eclipsing binaries, microlensing, rotating stars)
  - Explosive (e.g., novae, supernovae)
  - Accretion (e.g., cataclysmic variables, AGN)

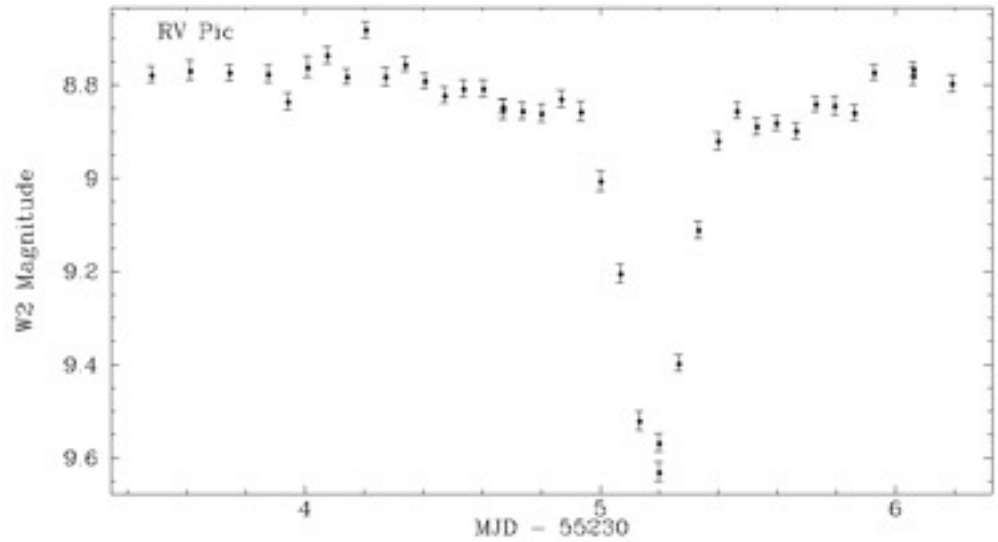


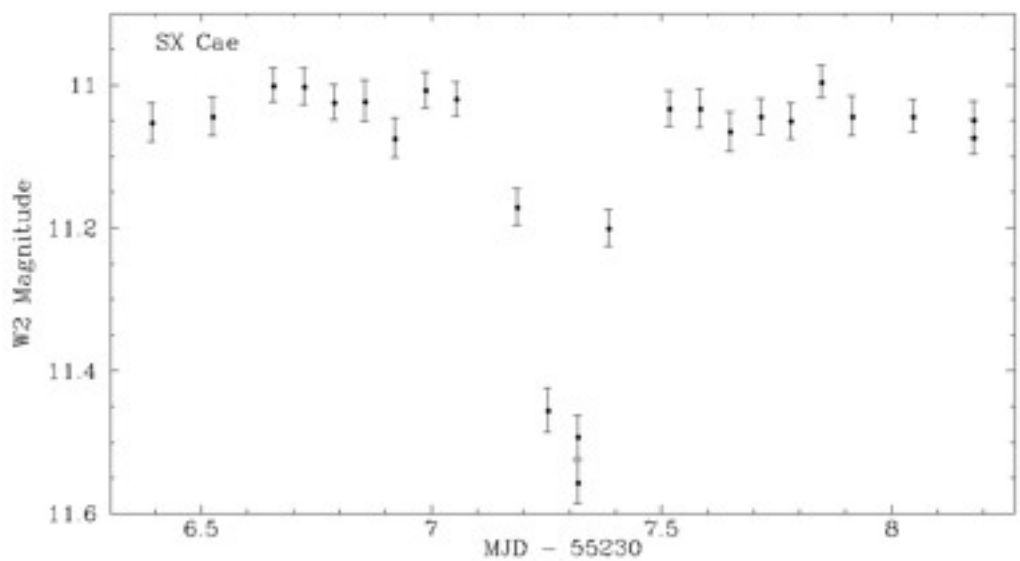
Identification Method

- Select candidates from RMS threshold vs. magnitude
- Threshold must be met in at least two bands
- Use a box-fitting algorithm to identify transients/eclipses (Kovacs, et al, 2002)
- Fit a linear slope to the data to identify variables
- Attempt to phase light curve for objects near the poles

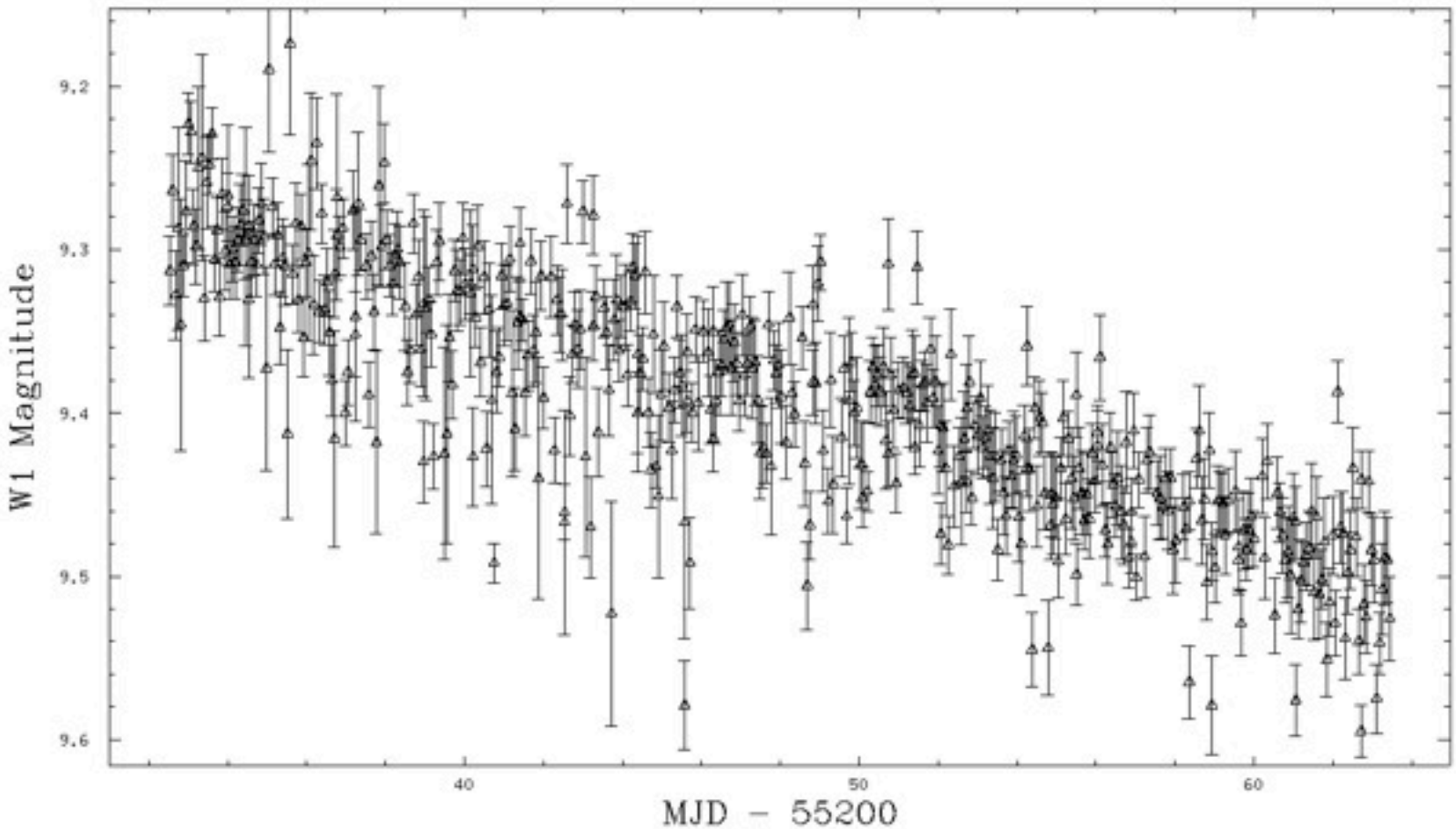


Known Eclipsing Binaries



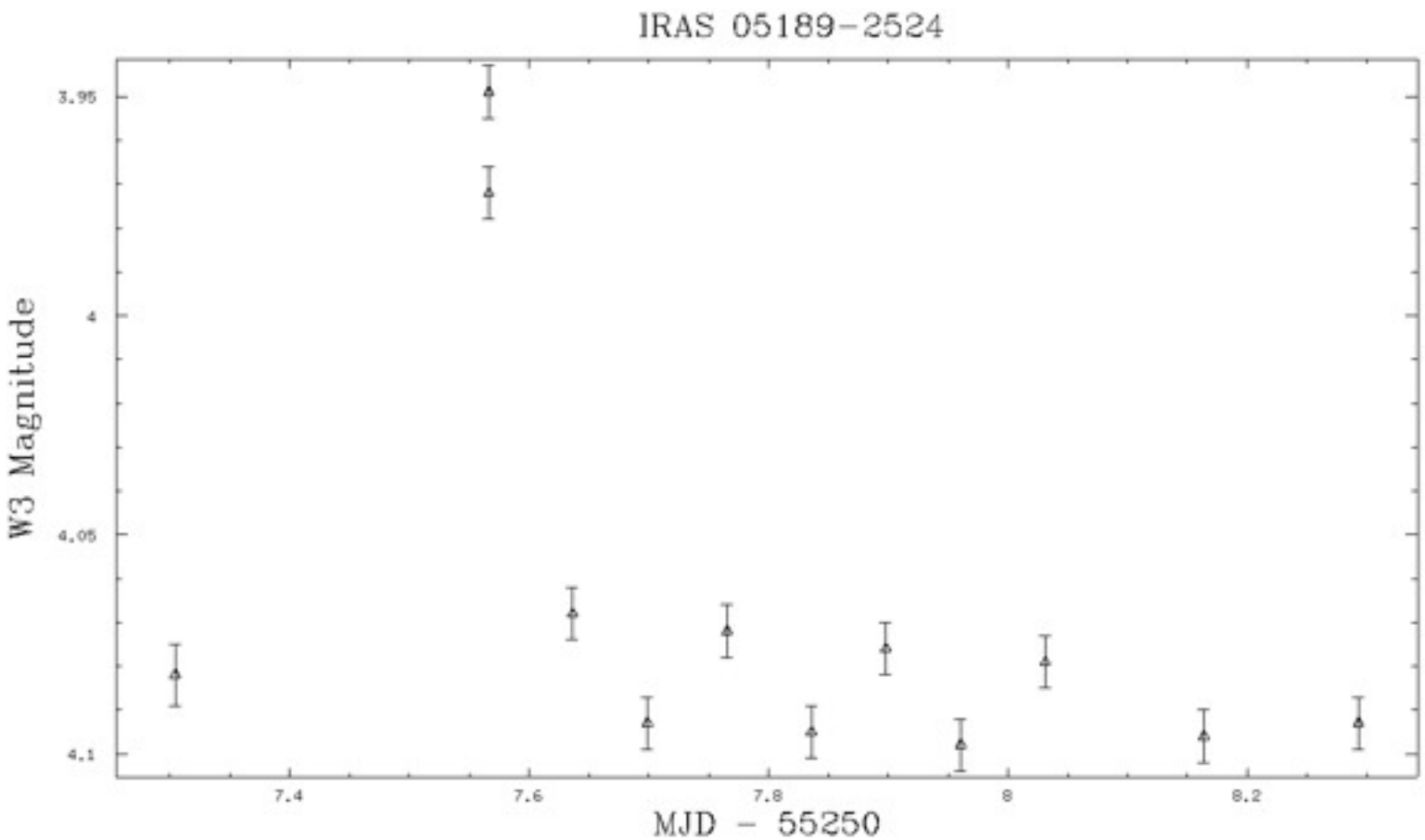


WISE's First New Variable Candidate



W1-W2 = 0.8 W2-W3 = 1.1

Possible Red Outburst in a Sy-1 ULIRG



Object Classification

- Use WISE + 2MASS colors for rough classification
- AGN/stars distinguished from color
- For objects with many observations near the ecliptic poles and are periodic, apply Fourier decomposition for stellar classification

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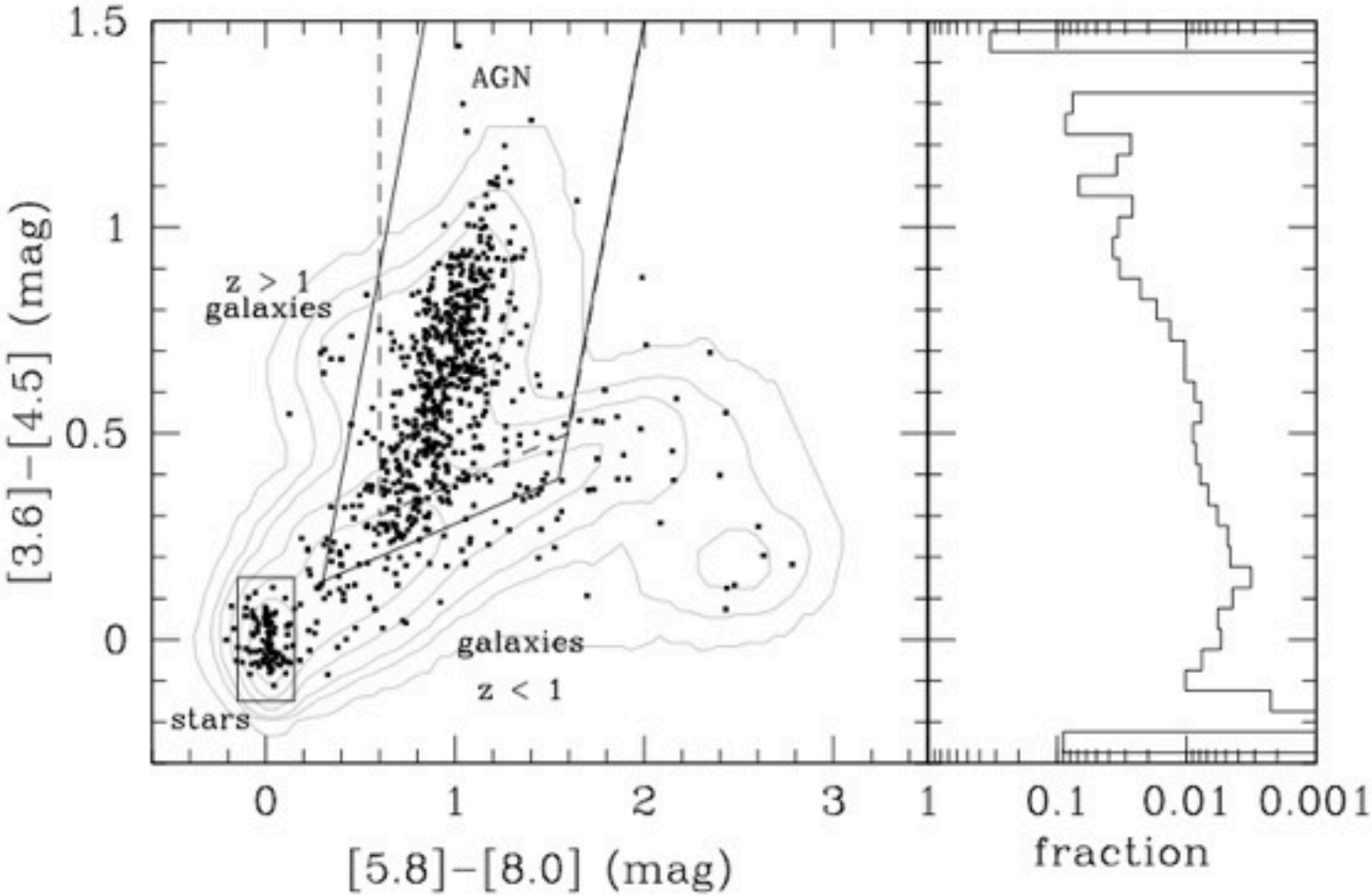

Kozlowski et al, 2010

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Fourier Decomposition