



# A USNO Search for Astrometric Companions to Brown Dwarfs II



Jennifer Lynn Bartlett (USNO), Frederick J. Vrba (USNO), Jeffrey A. Munn (USNO), Christian B. Luginbuhl (USNO), Trudy Tilleman (USNO), & Arne A. Henden (AAVSO)

TABLE II. PRELIMINARY ASTROMETRY OF SELECTED BROWN DWARFS

Brown Dwarf (2MASS J)	Spectral Type	Absolute Parallax (mas)	Relative Proper Motion (mas yr <sup>-1</sup> )	Position Angle (deg)	Tangential Velocity (km s <sup>-1</sup> )
09373487+2931409	T6p	162.84 ± 3.88	1622.0 ± 7.1	143.14 ± 0.13	47.20 ± 1.10
09393548-2448279	T8	...	...	...	...
10475385+2124234	T6.5	94.73 ± 3.81	1728.4 ± 7.7	254.08 ± 0.13	86.50 ± 3.50
11145133-2618235	T7.5	...	...	...	...
12171110-0311131	T7.5	110.36 ± 5.88	1061.8 ± 10.2	274.95 ± 0.27	45.60 ± 2.50
12373919+6526148	T6.5e	96.07 ± 4.78	1131.4 ± 8.9	242.33 ± 0.23	55.80 ± 2.80
15031961+2525196	T5.0	...	...	...	...
15232263+3014562	L8	57.30 ± 3.27	221.4 ± 5.9	139.77 ± 0.76	18.30 ± 1.20
16322911+1904407	L8	63.58 ± 3.32	301.7 ± 5.1	101.37 ± 0.48	22.50 ± 1.20
18410861+3117279	L4p	23.57 ± 1.89	72.6 ± 3.7	55.00 ± 1.46	14.60 ± 1.40

REFERENCES: Unless otherwise noted values are from Vrba *et al.* 2004; (1) Burgasser *et al.* 2006

### Parallaxes and Proper Motions

- Preliminary results
- baselines ≤ 2.03 years
- X solution only for parallax
- limited reference frames
- Mean error of unit weight for dithered triplets
- 9 ± 3 mas in X (Right Ascension)
- 10 ± 3 mas in Y (Declination)

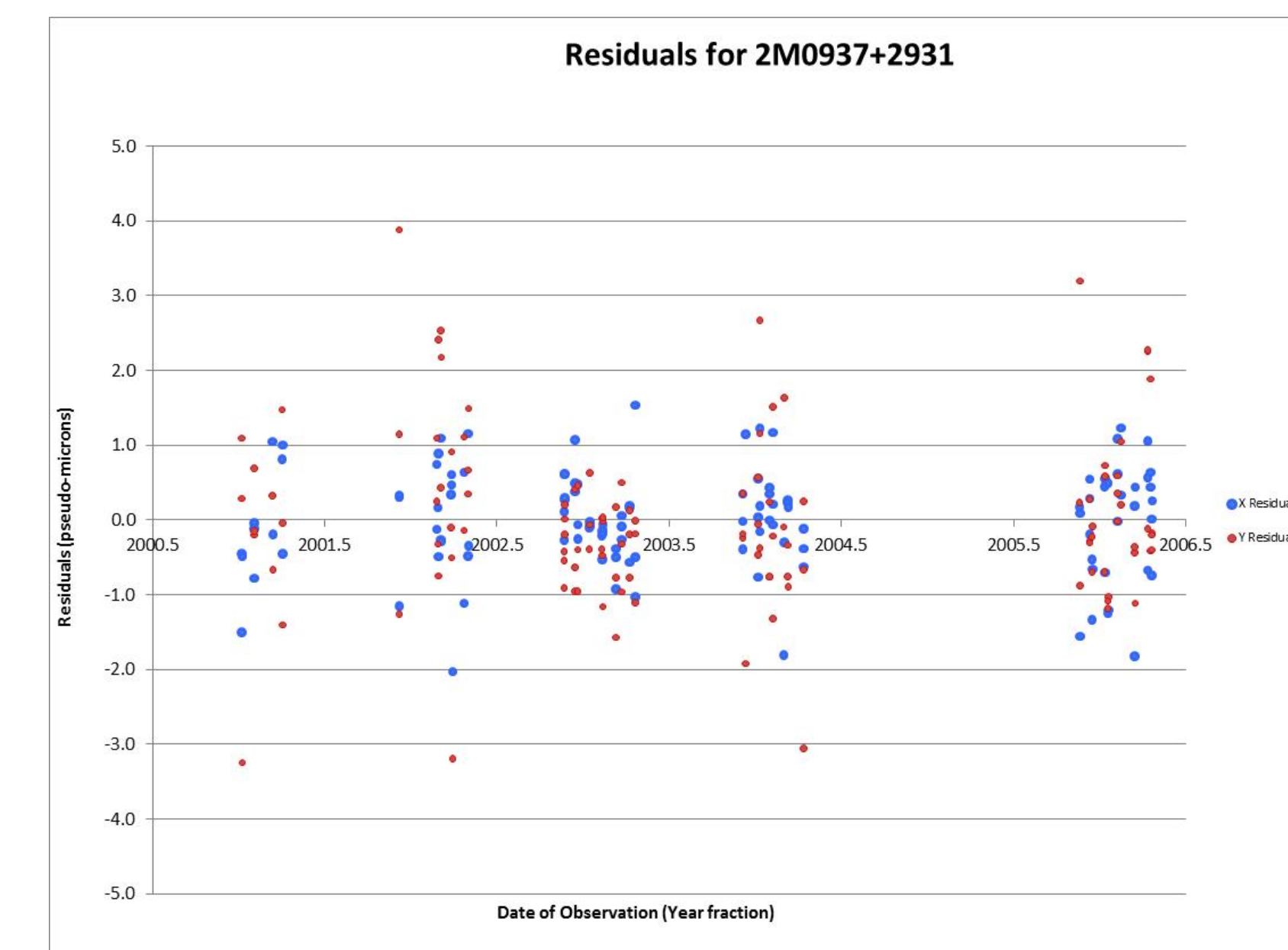


Figure 2. Residuals for 2MASS J0937347+293142

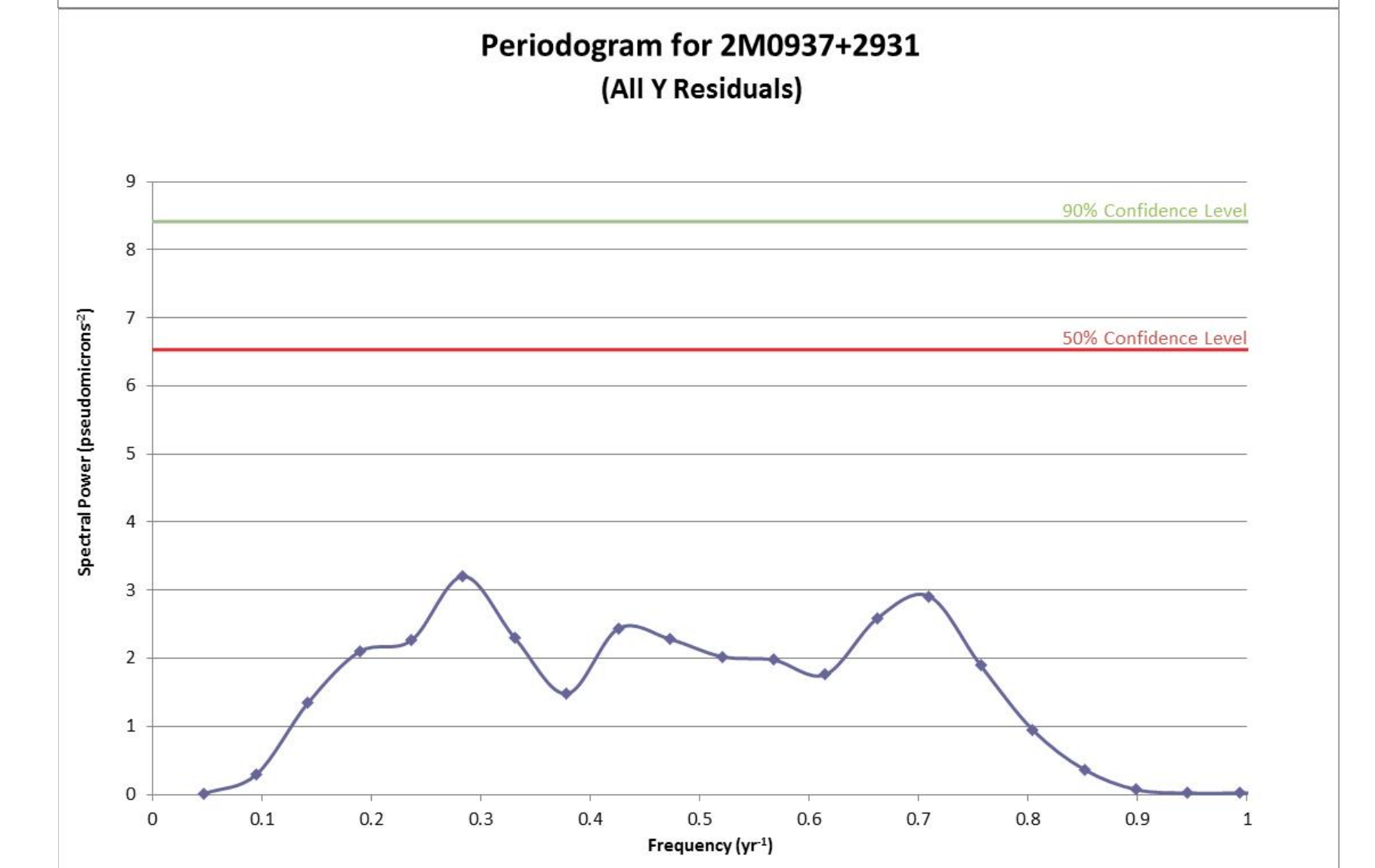
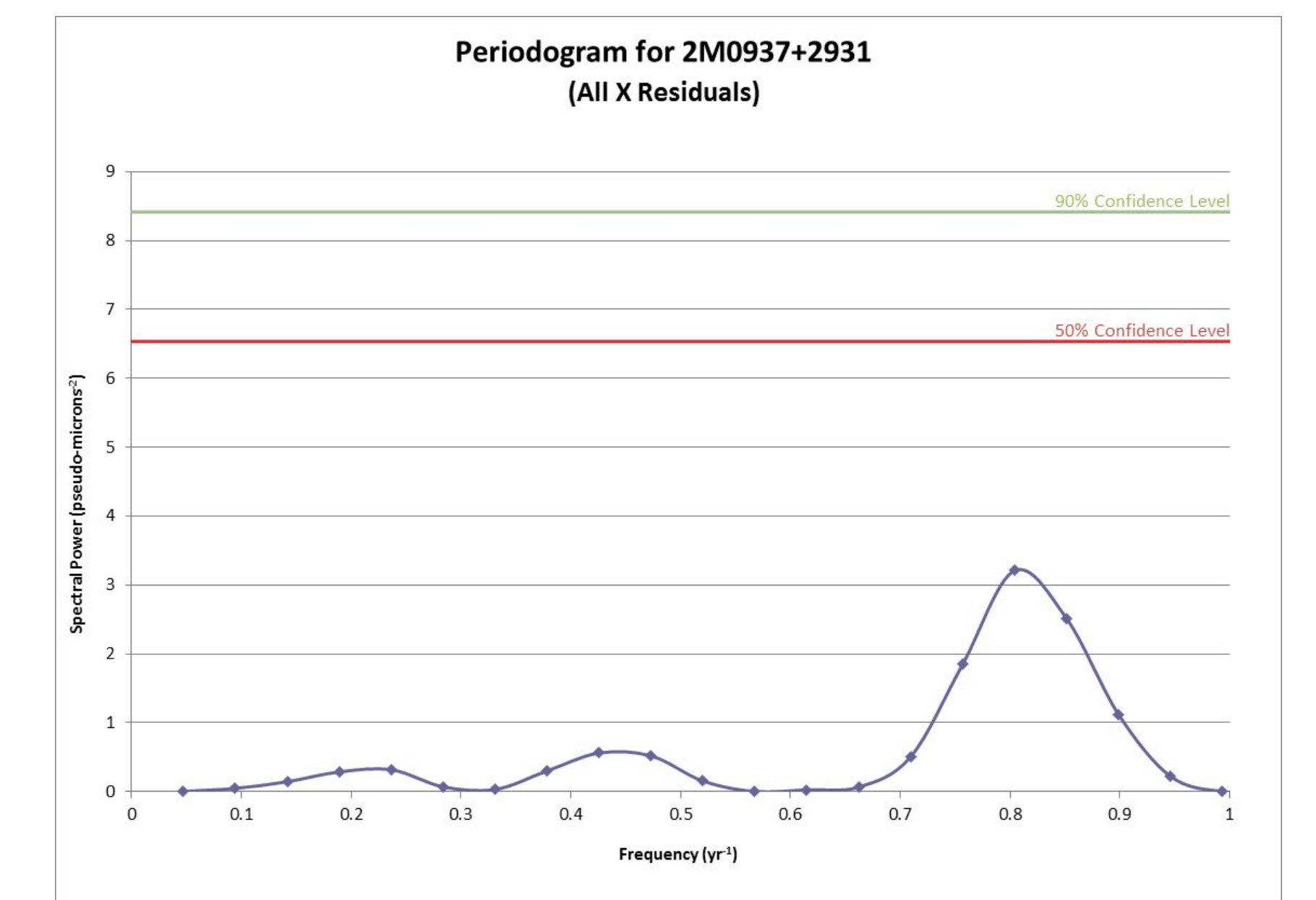


Figure 3. Periodograms for 2MASS J0937347+293142

TABLE III. OBSERVATIONS OF SELECTED BROWN DWARFS

Brown Dwarf (2MASS J)	Observations Begin	End	Baseline (yr)	Plates	Nights	Filter
09373487+2931409	JAN 2001	APR 2006	5.28	119	104	J
09393548-2448279	APR 2004	APR 2006	2.02	27	27	J
10475385+2124234	JAN 2001	APR 2006	5.29	180	154	J
11145133-2618235	APR 2004	APR 2006	2.02	29	29	J
12171110-0311131	FEB 2001	MAY 2006	5.29	157	130	J
12373919+6526148	JAN 2001	MAY 2006	5.33	147	108	J
15031961+2525196	FEB 2003	JUN 2006	3.31	135	105	J
15232263+3014562	FEB 2001	JUN 2006	5.32	219	153	H
16322911+1904407	MAR 2001	JUN 2006	5.25	165	105	H
18410861+3117279	SEP 2000	JUN 2006	5.76	260	202	H

NOTE: Broadband filters H (1.6 μm) and J (1.2 μm) per Elias *et al.* (1982)

### Results

10 brown dwarfs tested for possible astrometric perturbations due to low-mass companions

- Selection criteria
- Declination—north of -25°
- Spectral type—late L, mid- to late T
- Large parallax—half within 25 pc
- Not known to be binaries

None shows indication of companions, typical examples shown

Minimum detectable companions vary with brown dwarf mass and distance and with quality of observations, estimates in Table IV

Analysis of 29 additional brown dwarfs planned; 10 similar brown dwarfs reported earlier (Bartlett *et al.* 2012)

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For More Information jennifer.bartlett@usno.navy.mil



Figure 1. Kaj Strand Astrometric Reflector

TABLE I. REFLECTOR CHARACTERISTICS

Parameter	Description
Objective	1.55 meter (61 inches), f/9.8
Detector	ALADDIN 1024 <sup>2</sup> InSb array 27-μm pixels
Plate Scale	0.3654" pixel <sup>-1</sup> 13.55 mas μm <sup>-1</sup>
Broadband Filters	Z, J, H, K, K', K-long, & L'

### Method

USNO infrared parallax program

- Uses ASTROCAM infrared imager with 1.55-m Kaj Strand Astrometric Reflector at Flagstaff Station, Figure 1 and Table I
- Reduces observations using standard solution for parallax and proper motion, Table II (Vrba *et al.* 2004)

Selected brown dwarfs

- Observed 3–5 years, Table III
- L dwarfs in H band
- J dwarfs in J band
- Parallaxes and proper motions measured (Vrba *et al.* in prep.)
- Residuals to each observation analyzed
- x- and y- coordinates treated separately
- Time-series analysis per Lomb periodogram method (Press *et al.* 1992)
- Frequencies up to 4x Nyquist frequency searched
- Periodograms prepared using
  - Individual observations
  - Nightly averages

### ACKNOWLEDGEMENTS

This research made use of the NASA's Astrophysics Data System Bibliographic Services; the M, L, and T dwarf compendium housed at DwarfArchives.org, which is maintained by C. Gelino, J. Kirkpatrick, and A. Burgasser; the SIMBAD database, operated at CDS, Strasbourg, France; and the Very-Low-Mass Binaries Archive housed at www.vlmbinaries.org, which is maintained by N. Siegler, C. Gelino, and A. Burgasser.

### 2MASS J1217110-031113—Not much happening

- Late T dwarf within 10 pc
- No signal ≥ 50% possibility of being real for any frequency ≤ 1.0 yr<sup>-1</sup> (period ≥ 1 yr); similar when residuals averaged by night
- Minimum detectable companion: ~13 M<sub>Jup</sub> in 1.5-yr orbit or ~5 M<sub>Jup</sub> in 5-yr orbit

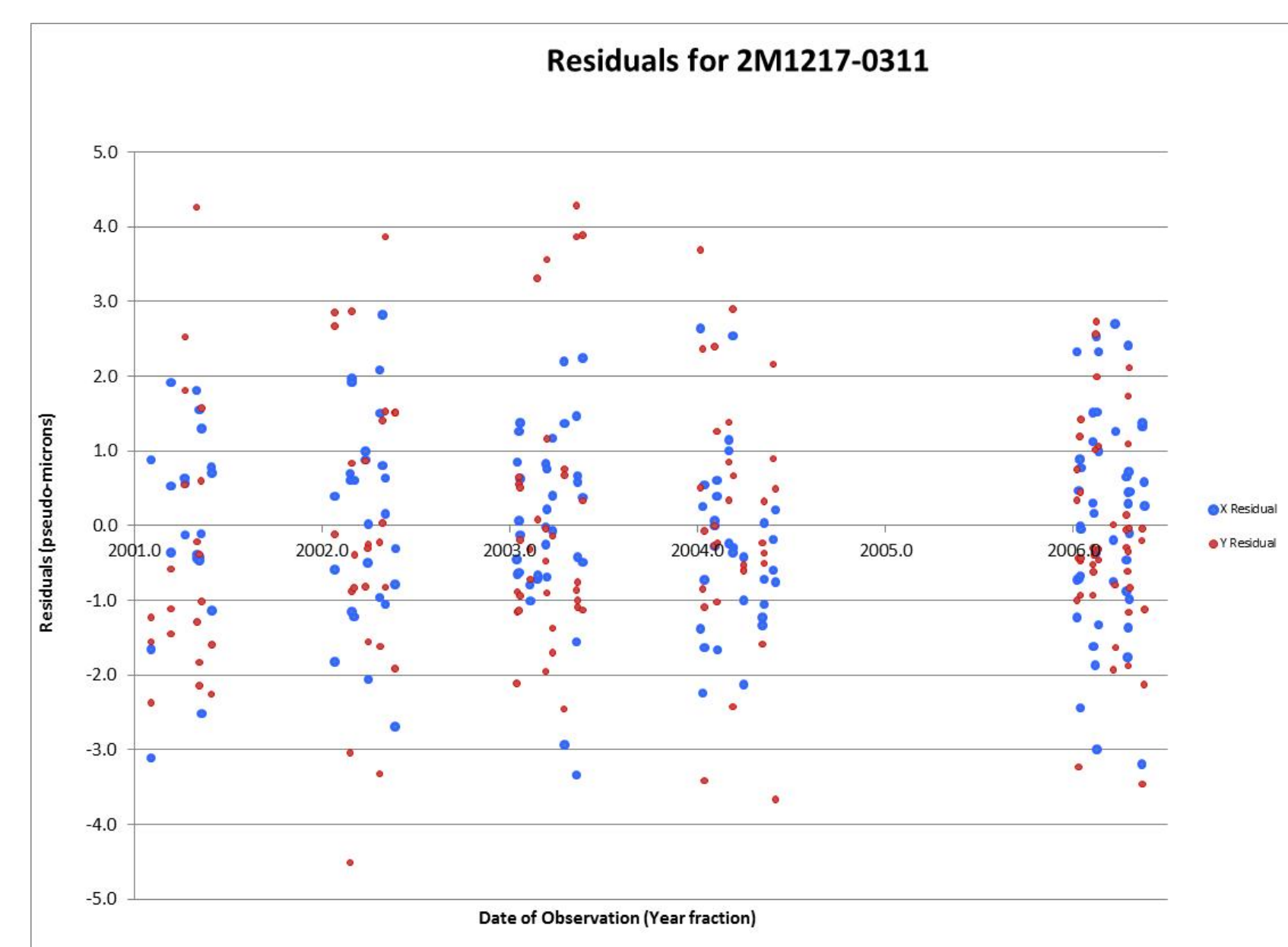


Figure 5. Residuals for 2MASS J1217110-031113

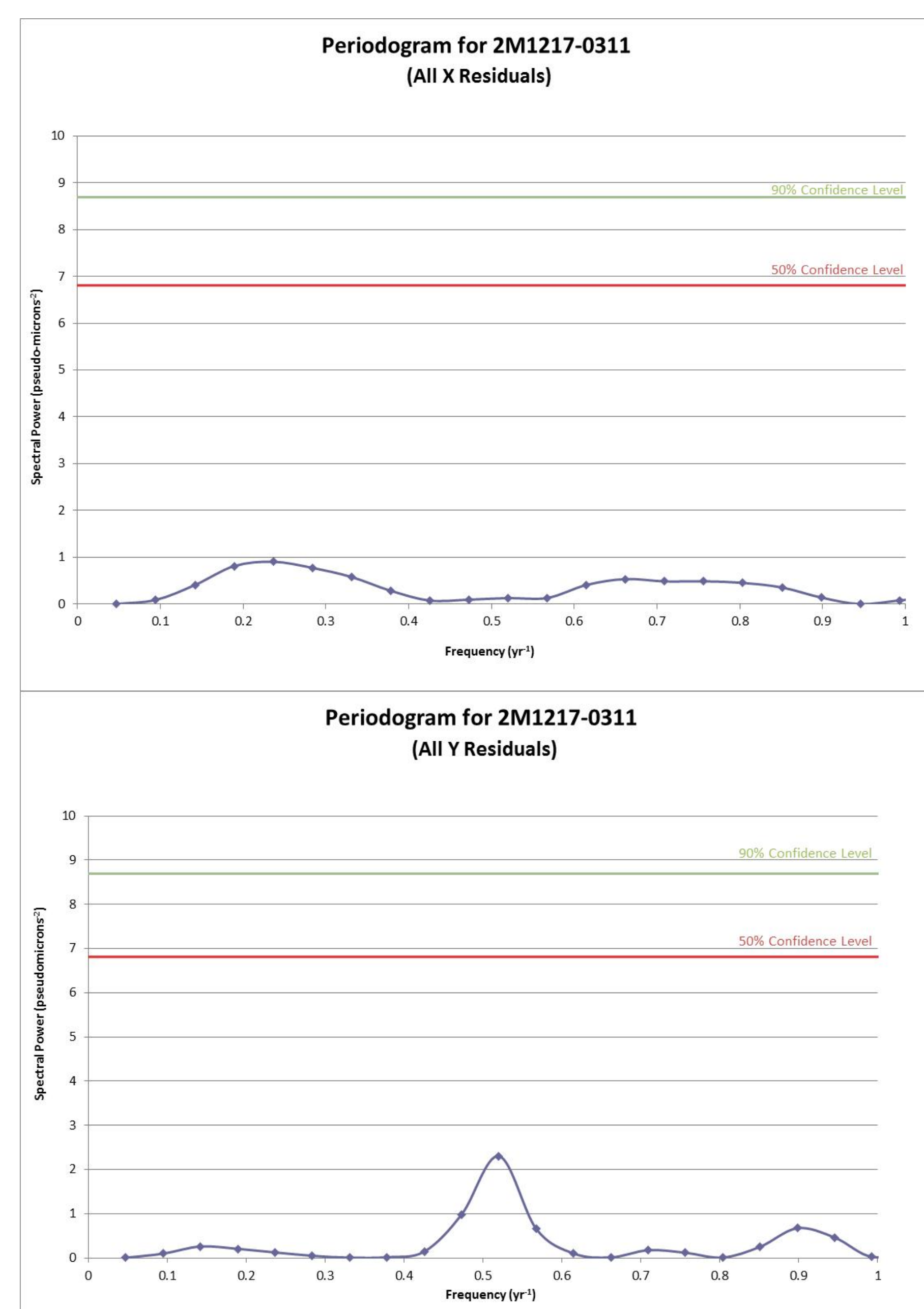


Figure 4. Periodograms for 2MASS J1217110-031113

TABLE IV. MINIMUM DETECTABLE COMPANIONS

Brown Dwarf (2MASS J)	Spectral Type	Absolute Parallax (mas)	Detectable Perturbation (mas)	Estimated Mass (M <sub>Sun</sub> )	Long Period (yr)	Companion Mass (M <sub>Jup</sub> )
09373487+2931409	T6p	162.84	8	0.04	5.29	2
09393548-2448279	T8	...	10	0.04	2.02	8
10475385+2124234	T6.5	94.73	10	0.04	5.29	5
11145133-2618235	T7.5	...	12	0.04	2.02	10
12171110-0311131	T7.5	110.36	15	0.04	5.29	5
12373919+6526148	T6.5e	96.07	10	0.04	5.33	4
15031961+2525196	T5.0	...	5	0.05	3.31	2
15232263+3014562	L8	57.30	9	0.06	5.32	8
16322911+1904407	L8	63.58	9	0.06	5.25	7
18410861+3117279	L4p	23.57	11	0.07	5.76	24

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