



# A USNO Search for Astrometric Companions to Brown Dwarfs



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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> )
00303013-1450333	L7	37.42 ± 4.50	246.6 ± 3.6	96.56 ± 0.42	31.20 ± 3.80
02431371-2453298	T6	93.62 ± 3.63	354.8 ± 4.1	234.20 ± 0.33	18.00 ± 0.70
03284265+2302051	L8	33.13 ± 4.20	61.0 ± 4.9	168.08 ± 2.30	8.70 ± 1.30
04151954-0935066	T8/T9	174.34 ± 2.76	2255.3 ± 3.2	76.48 ± 0.04	61.40 ± 1.00
05160945-0445499	T5.5	1	..	...	..
05325346+8246465	sdL7	2	..	...	..
05591914-1404488	T5	85.53 ± 1.44	655.2 ± 2.8	121.10 ± 0.12	32.50 ± 0.50
07271824+1710012	T7	110.14 ± 2.34	1296.5 ± 4.5	126.25 ± 0.10	55.80 ± 1.20
07554795+2212169	T5	1	..	...	..
08251968+2115521	L7.5	95.64 ± 1.84	584.5 ± 4.0	239.45 ± 0.20	29.00 ± 0.60

REFERENCES: Unless otherwise noted values are from Vrba *et al.* 2004; (1) Burgasser *et al.* 2006; (2) Burgasser, Cruz, & Kirkpatrick 2007

### Parallaxes and Proper Motions

- Preliminary results
  - baselines ≤ 2.20 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)

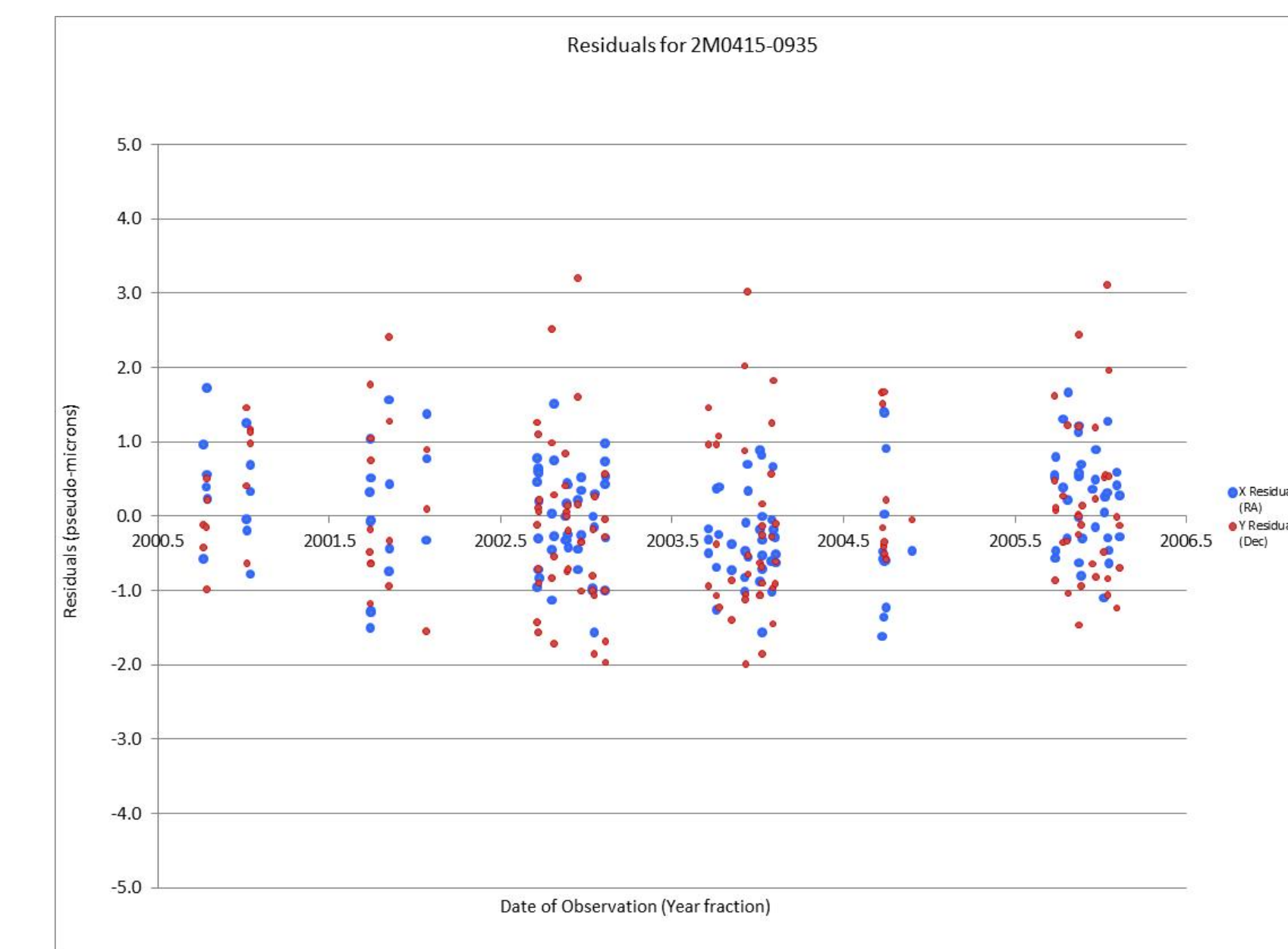


Figure 2. Residuals for 2MASS J04151954-0935066

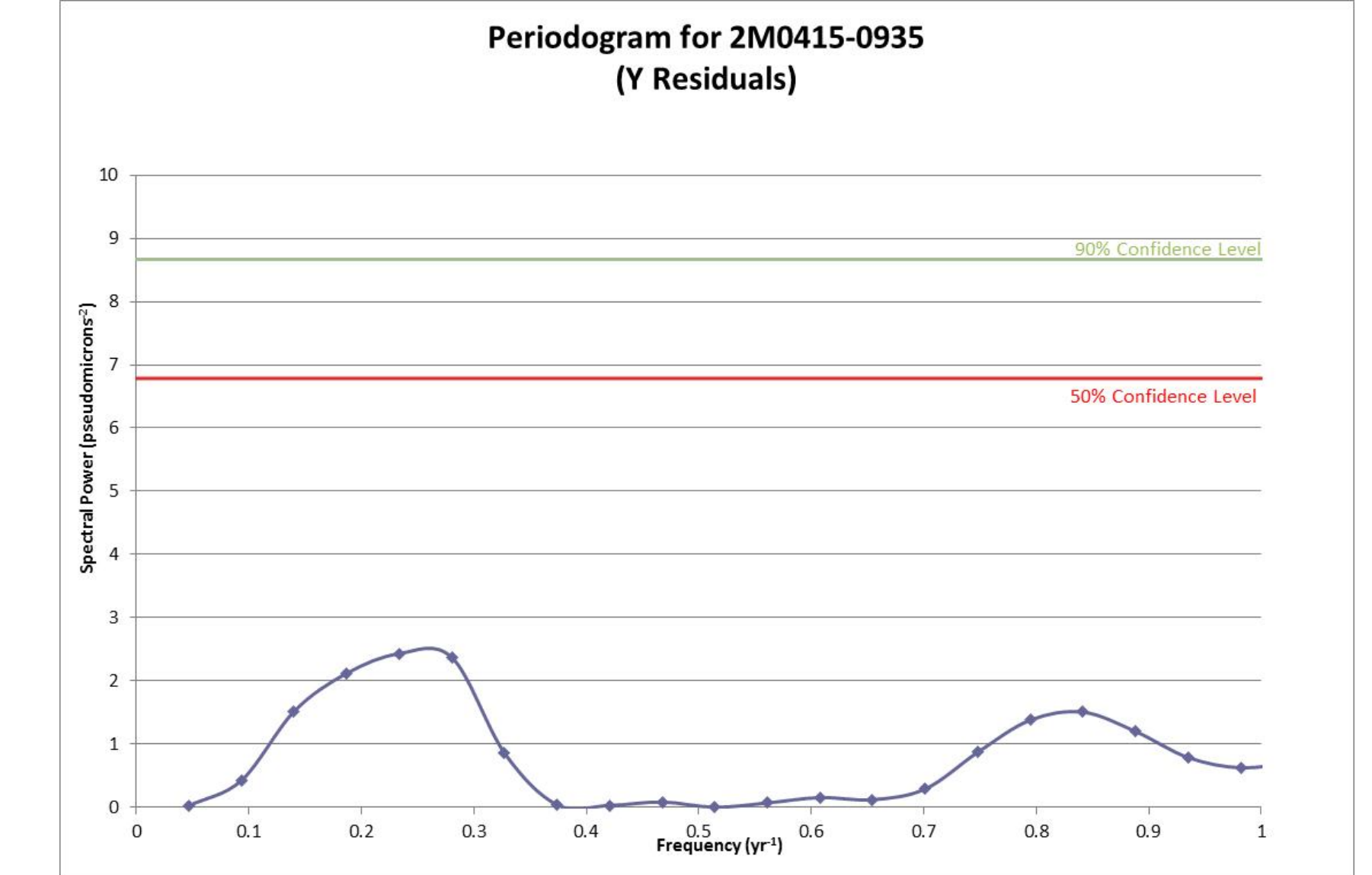
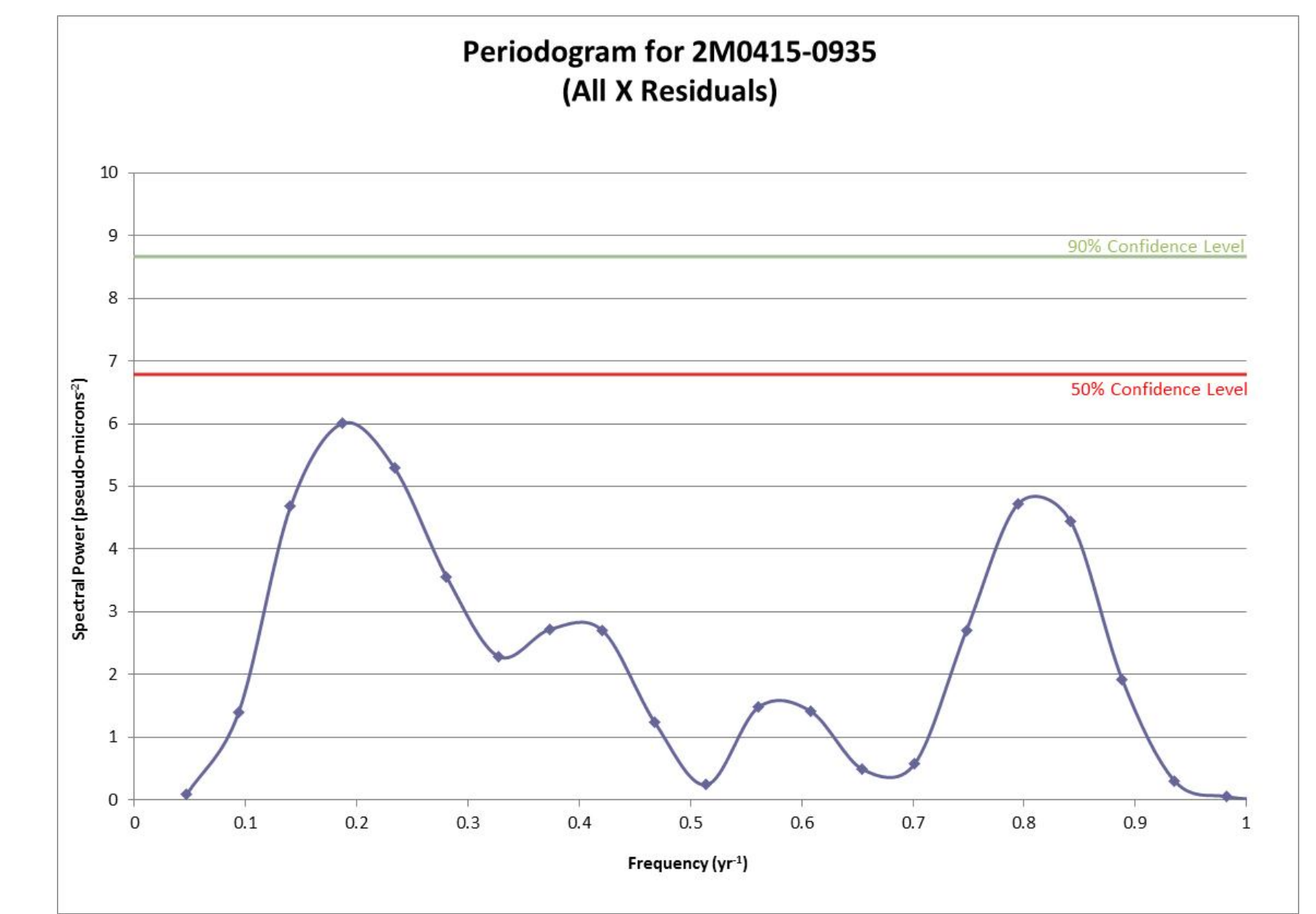


Figure 3. Periodograms for 2MASS J04151954-0935066

TABLE III. OBSERVATIONS OF SELECTED BROWN DWARFS

Brown Dwarf (2MASS J)	Observations Begin	End	Baseline (yr)	Plates	Nights	Filter
00303013-1450333	SEP 2000	DEC 2005	5.27	180	141	H
02431371-2453298	SEP 2000	JAN 2006	5.35	176	142	J
03284265+2302051	SEP 2000	JAN 2006	5.35	141	106	H
04151954-0935066	OCT 2000	FEB 2006	5.35	153	143	J
05160945-0445499	FEB 2003	FEB 2006	3.00	114	92	J
05325346+8246465	FEB 2003	FEB 2006	3.01	91	62	H
05591914-1404488	OCT 2000	FEB 2006	5.35	269	179	J
07271824+1710012	NOV 2000	MAR 2006	5.33	255	190	J
07554795+2212169	NOV 2002	MAR 2006	3.33	157	118	J
08251968+2115521	JAN 2001	APR 2006	5.25	142	78	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 39 additional brown dwarfs planned



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'

### REFERENCES

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- For More Information  
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### 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

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### 2MASS JJ05325346+8246465—Not much happening

- Late L subdwarf
- 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 (assuming distance of 25 pc): ~23 M<sub>Jup</sub> in 1.5-yr orbit or ~15 M<sub>Jup</sub> in 3-yr orbit

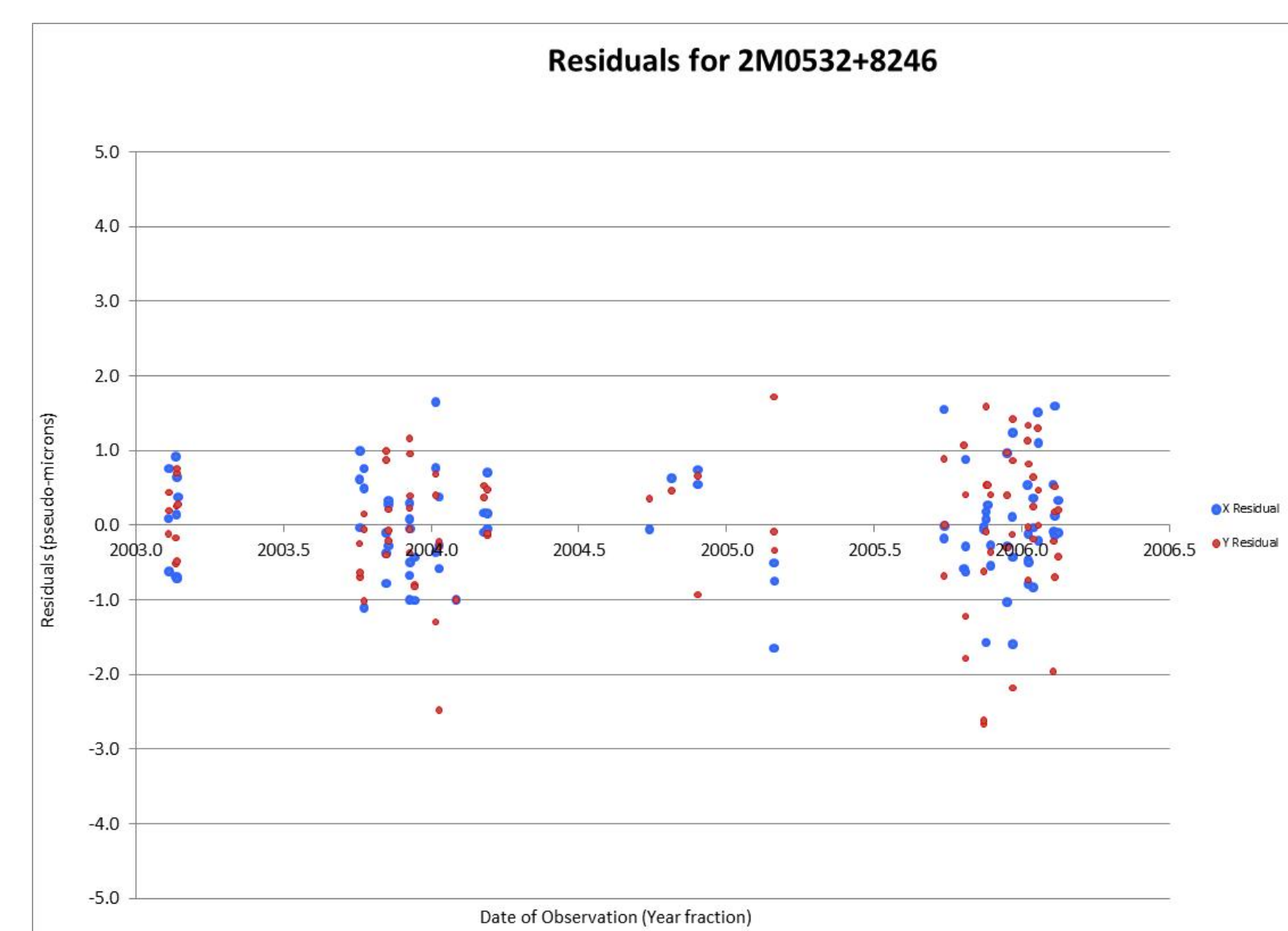


Figure 5. Residuals for 2MASS J05325346+8246465

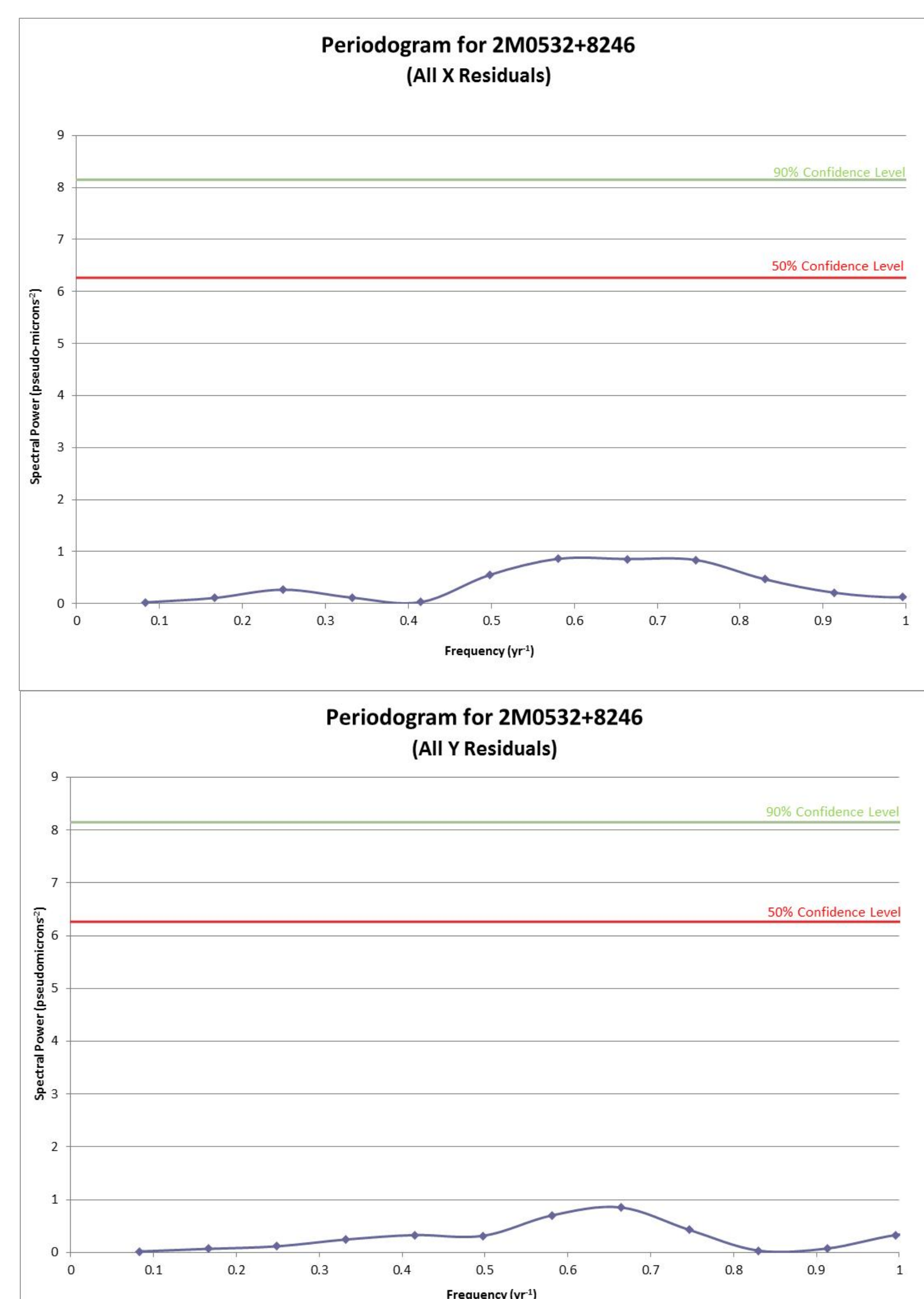


Figure 4. Periodograms for 2MASS J05325346+8246465

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> )
00303013-1450333	L7	37.42	11	.06	5.27	16
02431371-2453298	T6	93.62	11	.04	5.35	5
03284265+2302051	L8	33.13	12	.05	5.35	19
04151954-0935066	T8/T9	174.34	9	.03	5.35	2
05160945-0445499	T5.5	...	8	.04	3.00	14
05325346+8246465	sdL7	...	6	.06	3.01	15
05591914-1404488	T5	85.53	6	.05	5.35	3
07271824+1710012	T7	110.14	8	.04	5.33	3
07554795+2212169	T5	...	9	.05	3.33	14
08251968+2115521	L7.5	95.64	6	.06	5.25	3

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