Knowing Our Neighbors:
Fundamental Properties of Nearby Stars

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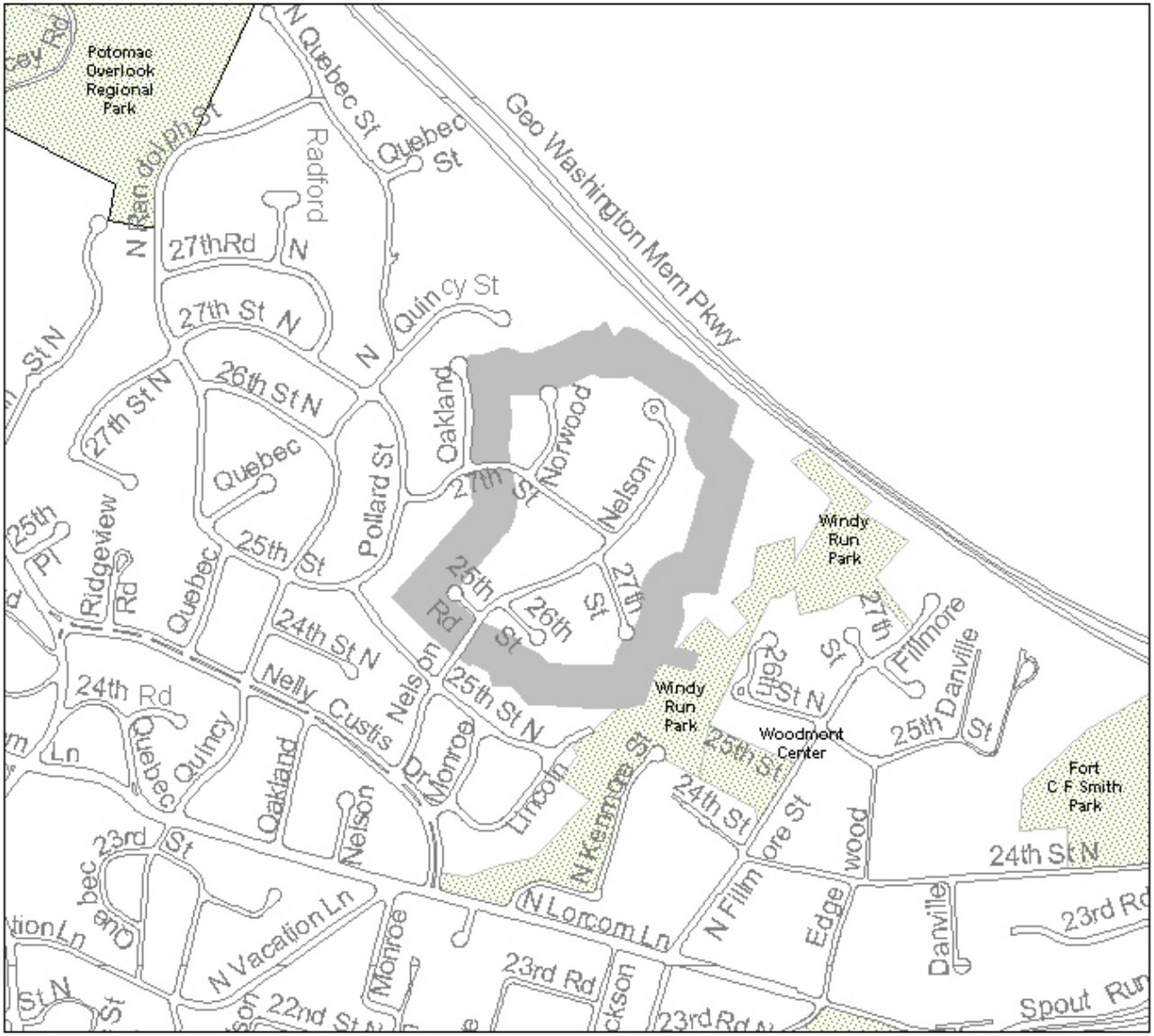
with P. Ianna, M. Begam, & RECONS
November 28, 2006

Riverwood Civic Association



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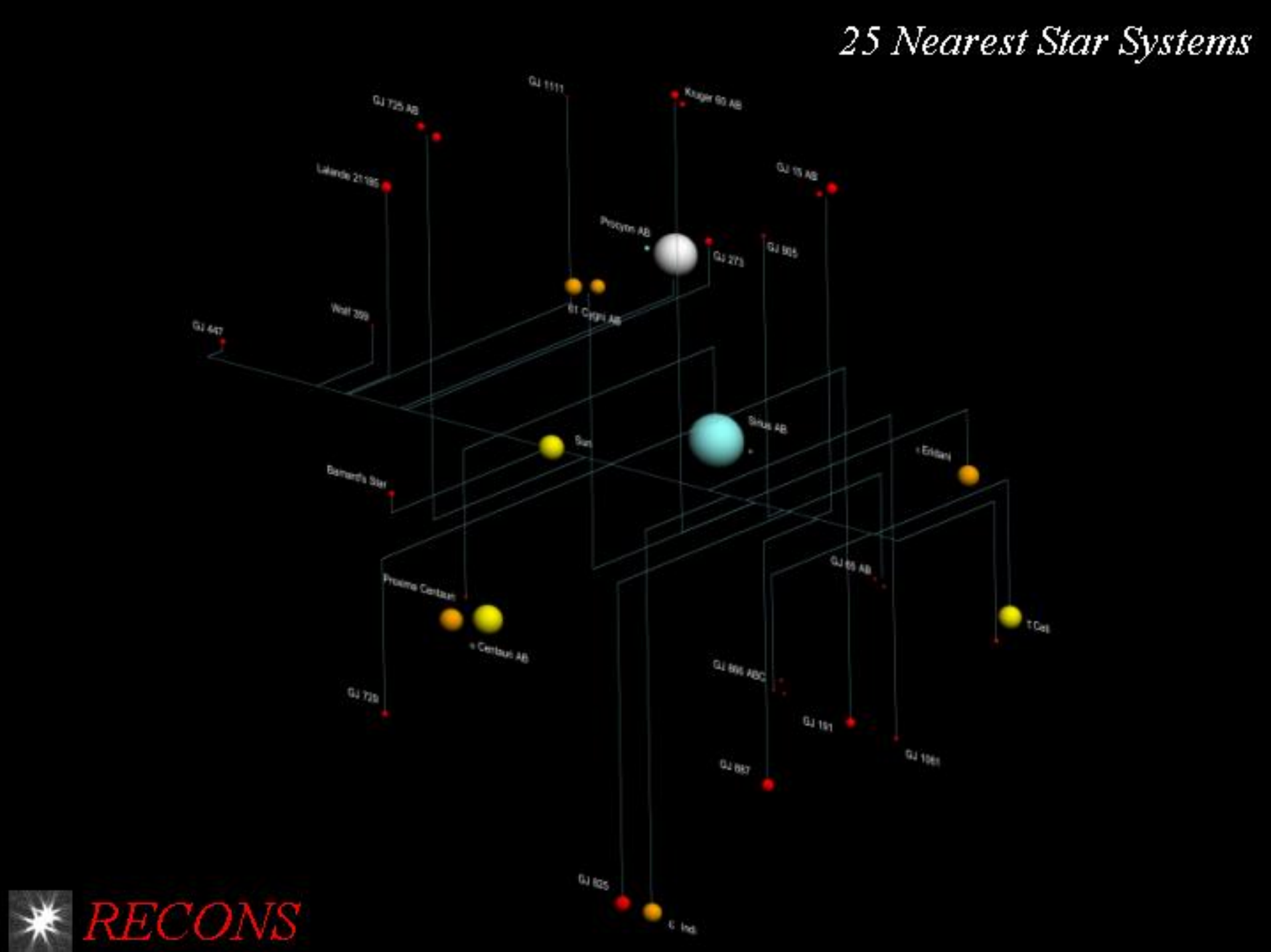
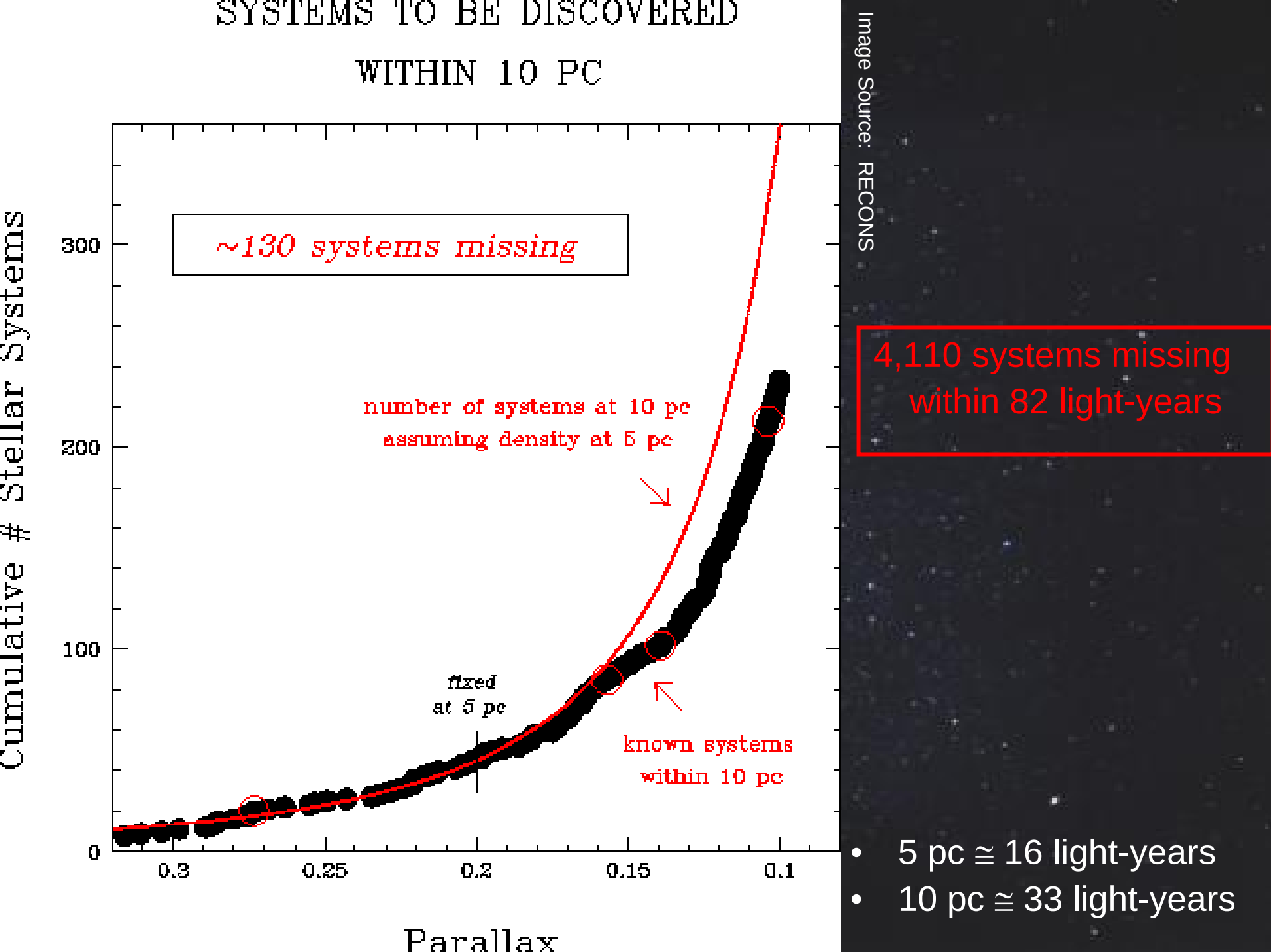
C:\MapInfo\Newbase\civic\web\riwood\riwwdct.wor 703-228-3717 DPW-Planning

25 Nearest Star Systems



RECONS


SYSTEMS TO BE DISCOVERED
WITHIN 10 PC
~130 systems missing
number of systems at 10 pc
assuming density at 5 pc
fixed
at 5 pc
known systems
within 10 pc
Cumulative # Stellar Systems
300
200
100
0
0.3
0.25
0.2
0.15
0.1
Parallax
Image Source: RECONS
4,110 systems missing
within 82 light-years
• 5 pc ≅ 16 light-years
• 10 pc ≅ 33 light-years

Parallax → Distance

$\pi = 0.''552 \pm 0.007$

$d = 1/\pi$

d=1.81 pc (5.90 light-years)

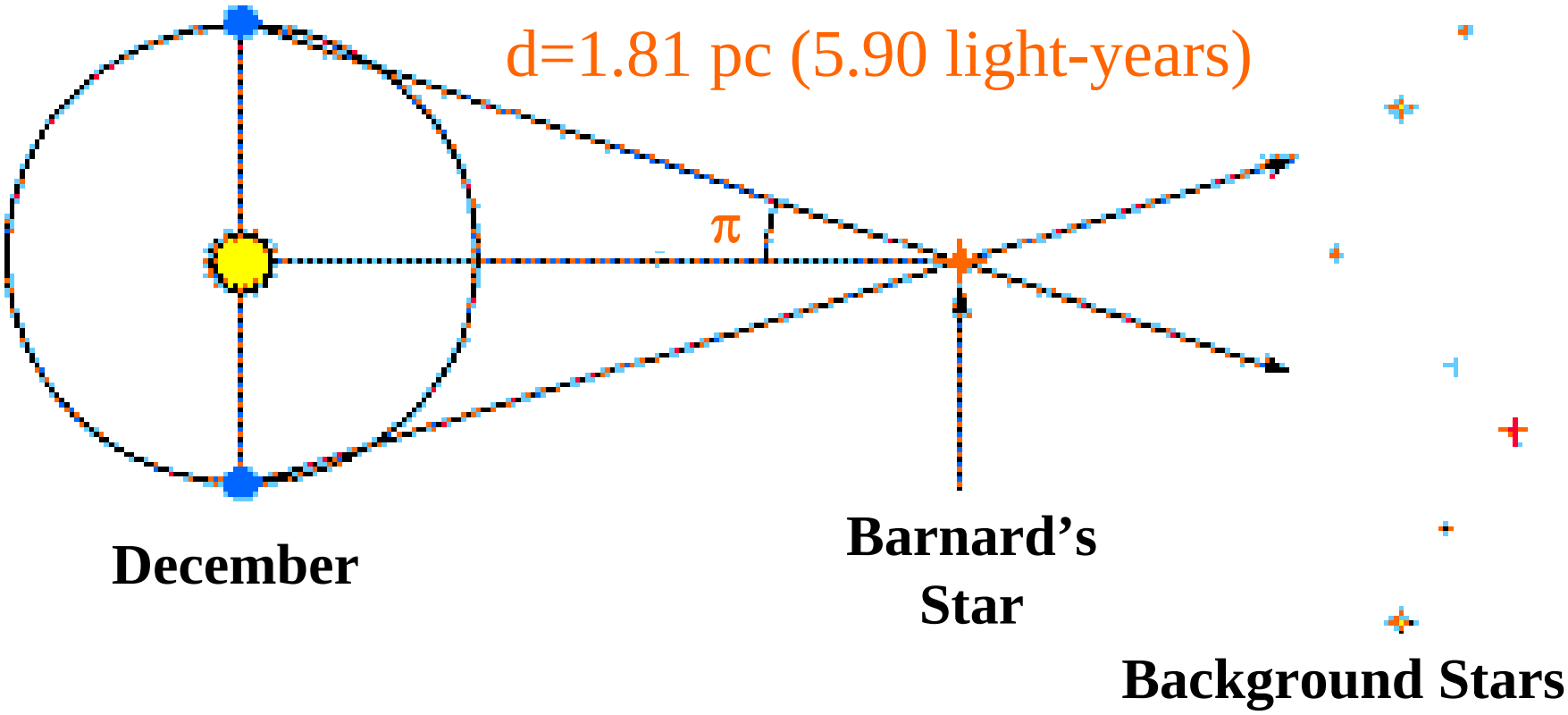


Image Source: Pogge

Barnard's Star Moves

1950

1997

μ = 10".354 ± 0.006 per year in 355.85 ± 0.06°

Image Source: POSS and Schmidling.

Parallax and Proper Motion

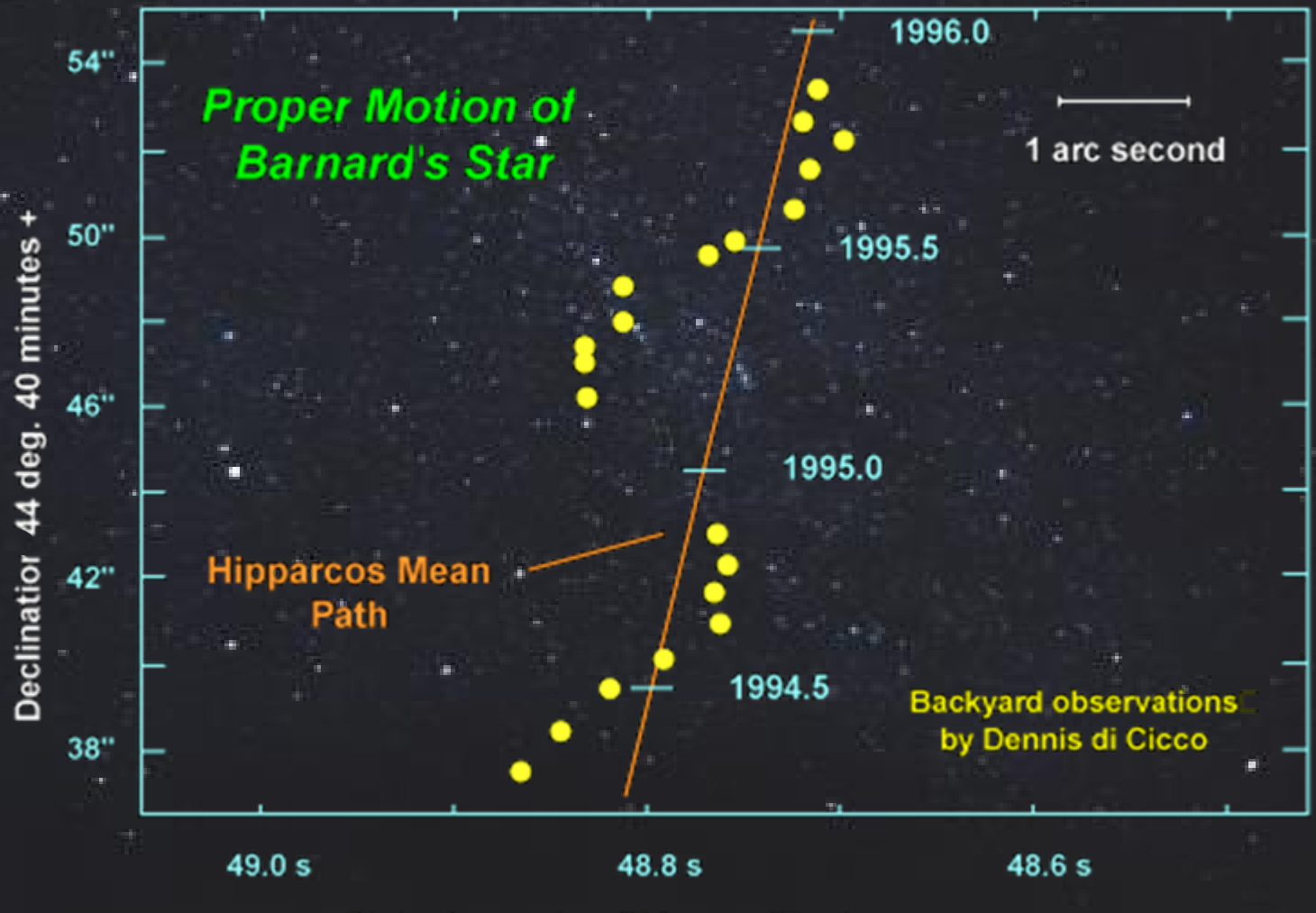


Image Source: Univ. TN

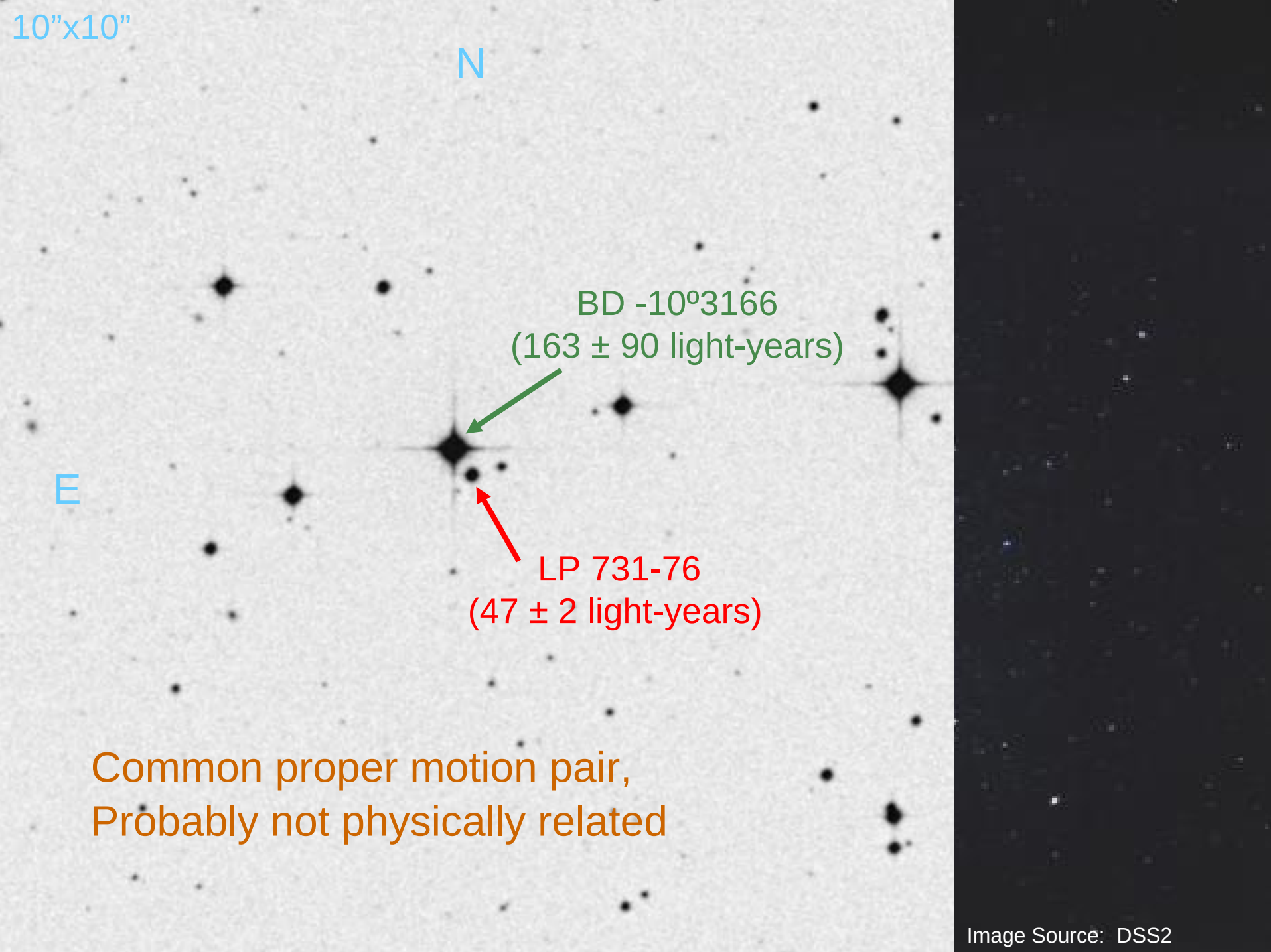
Image Source: Frogel

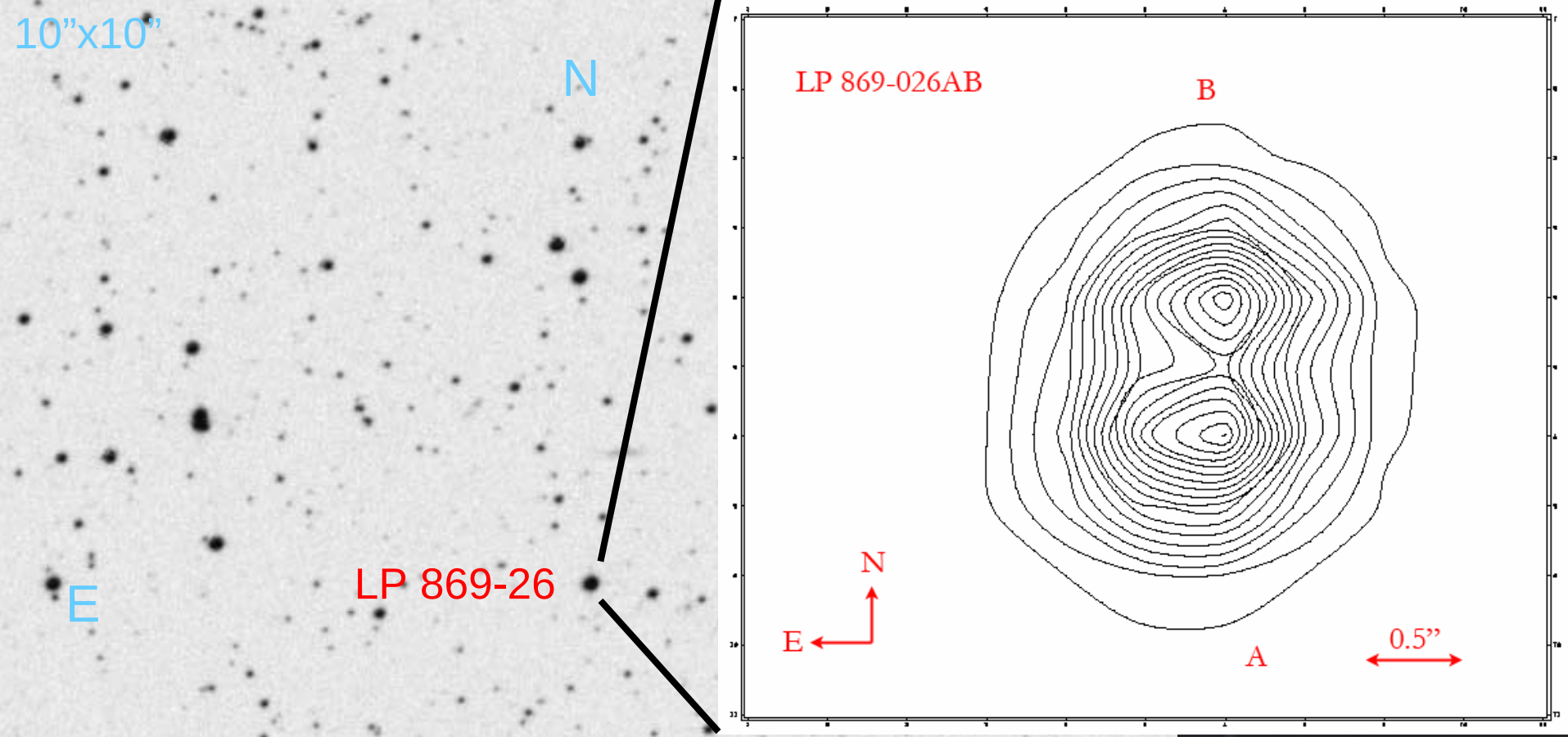
Preliminary CTIOPI Results

- 43 possible nearby stars
  - ✓New stars within 33 light-years
    - ✸LP 876-10 at 24.2 light-years
    - ✸LP 991-84 at 28.2 light-years
    - ✸LHS 6167 at 29.7 light-years
  - ✓25 stars between 33—82 light-years
  - ✓3 stars on border of Solar Neighborhood
  - ✓12 awaiting further measurements

CTIOPI Double Stars

- 43 possible nearby stars
  - ✓Previously known binaries
    - 3 close binaries, not resolved at CTIO
    - 4 common proper motion pairs, need parallaxes (distances)
  - ✓New binary possibilities
    - 11 stars appear brighter than their distances indicate
    - 1 close binary, newly resolved

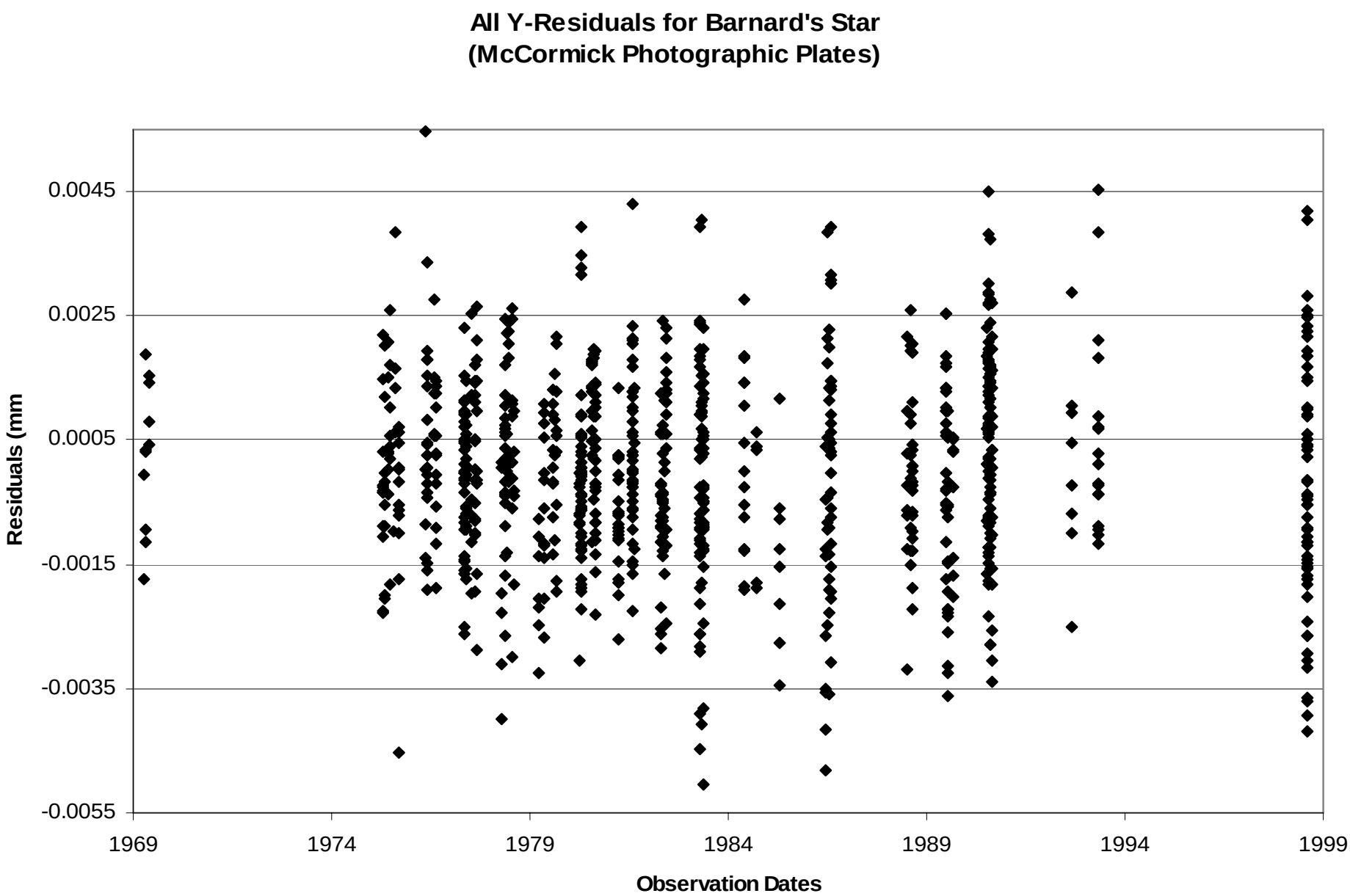

10”x10”
N
BD -10º3166
(163 ± 90 light-years)
E
LP 731-76
(47 ± 2 light-years)
Common proper motion pair,
Probably not physically related
Image Source: DSS2



Single star recently resolved as pair

Need distances or motions to confirm as binary

Image Sources: DSS2 & CTIOP


All Y-Residuals for Barnard's Star
(McCormick Photographic Plates)
0.0045
0.0025
0.0005
-0.0015
-0.0035
-0.0055
Residuals (mm
1969
1974
1979
1984
1989
1994
1999
Observation Dates

Planets?

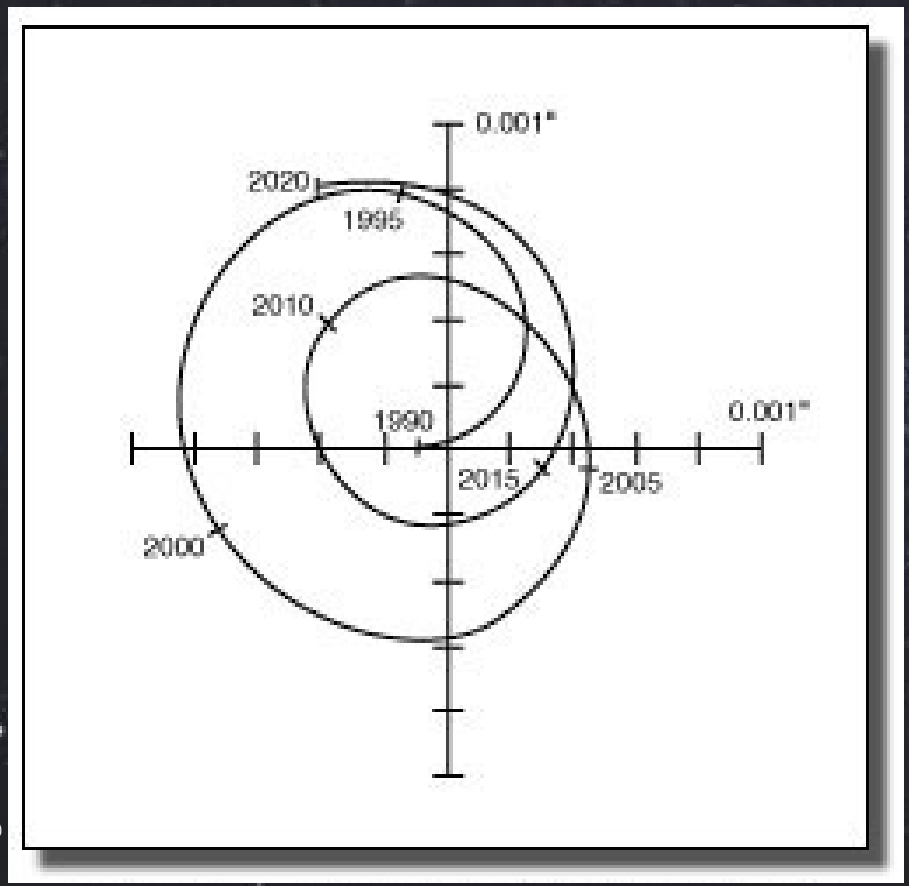


Image Source: NASA/JPL

Displacement of Sun due to Jupiter as observed from 33 light-years away

Barnard's Star Planets?

Piet van de Kamp 1901 - 1995

Image Source: Schrimer and Majewski

- Barnard's Star
  - 2nd closest system to Sun
  - Highest known proper motion
  - Hosts planets?
- 1963, van de Kamp announces detection of 1st extrasolar planet system
- To date, no one has confirmed these planets

Leander McCormick Observatory

Image Source: Schrimer and Majewski

- 26.25” refractor
  - Built by Alvan Clark & Sons
  - Dedicated April 1886
- 2nd largest collection of Barnard’s Star images
  - ✓919 photographic plates
  - ✓1969 through 1998

Barnard's Star

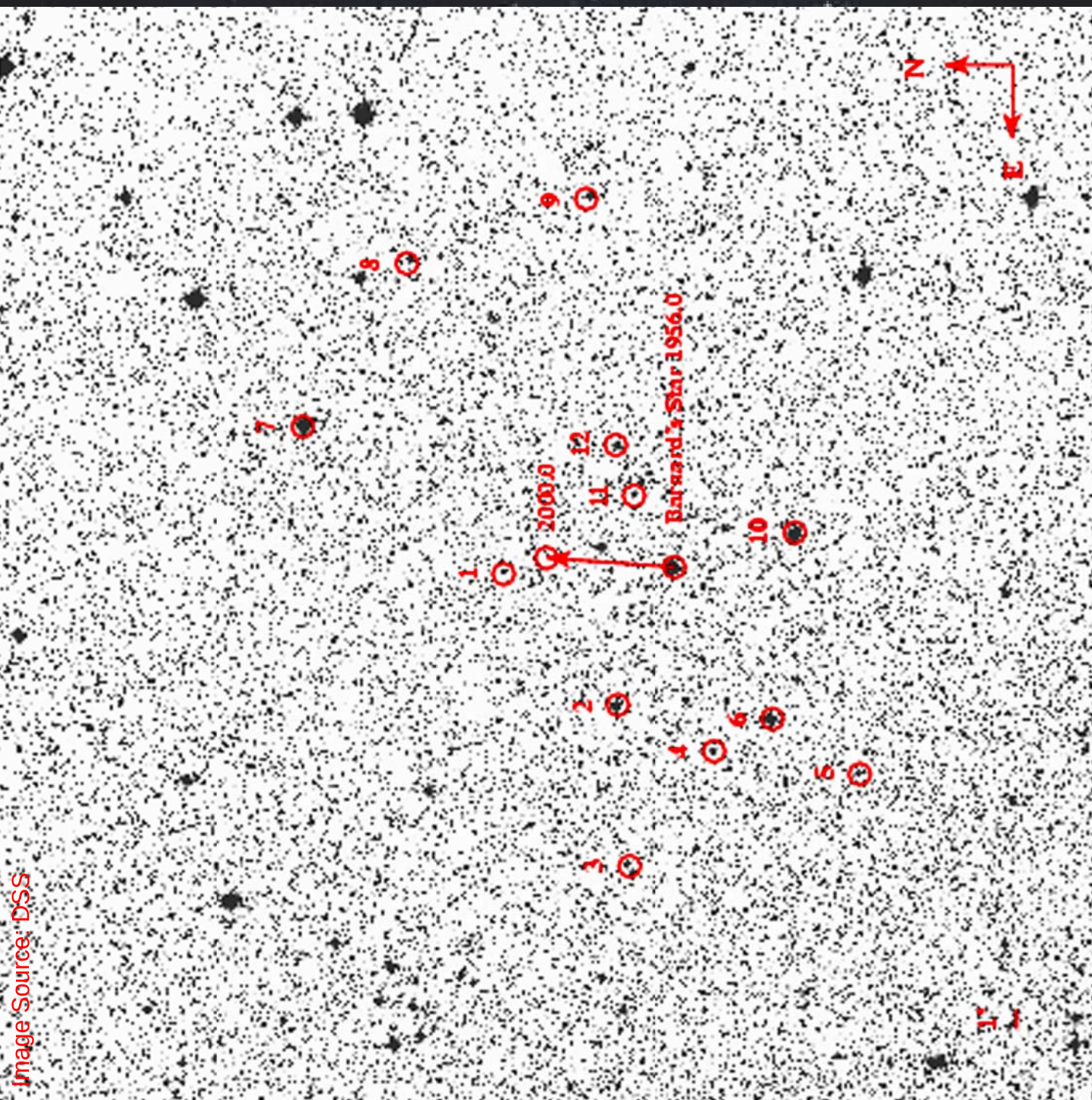
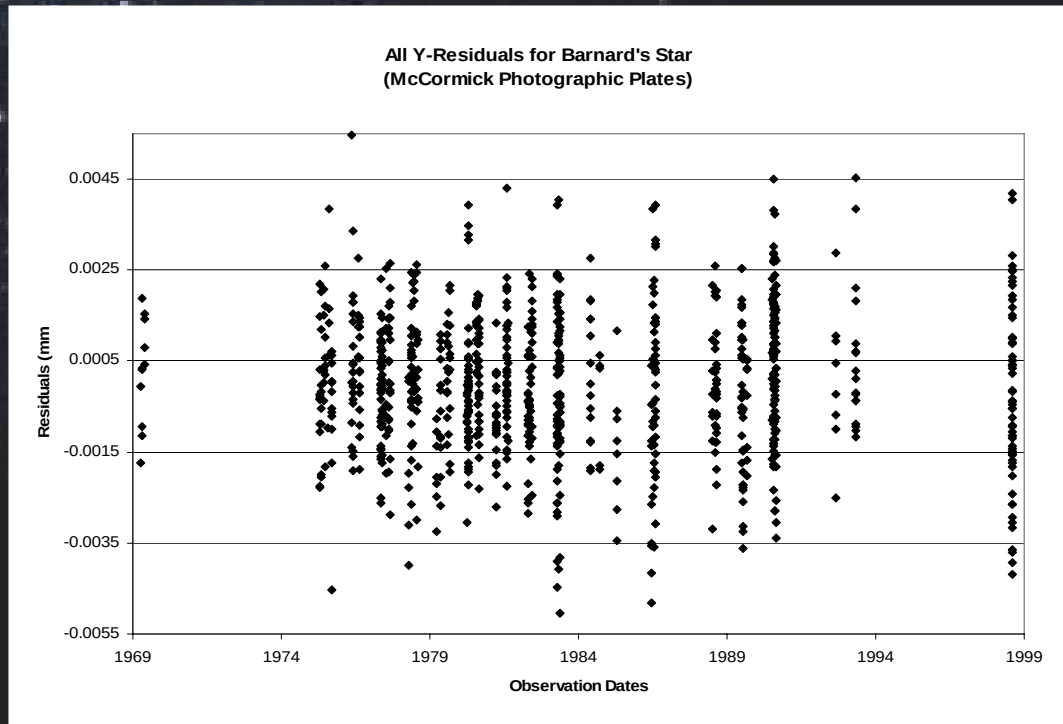


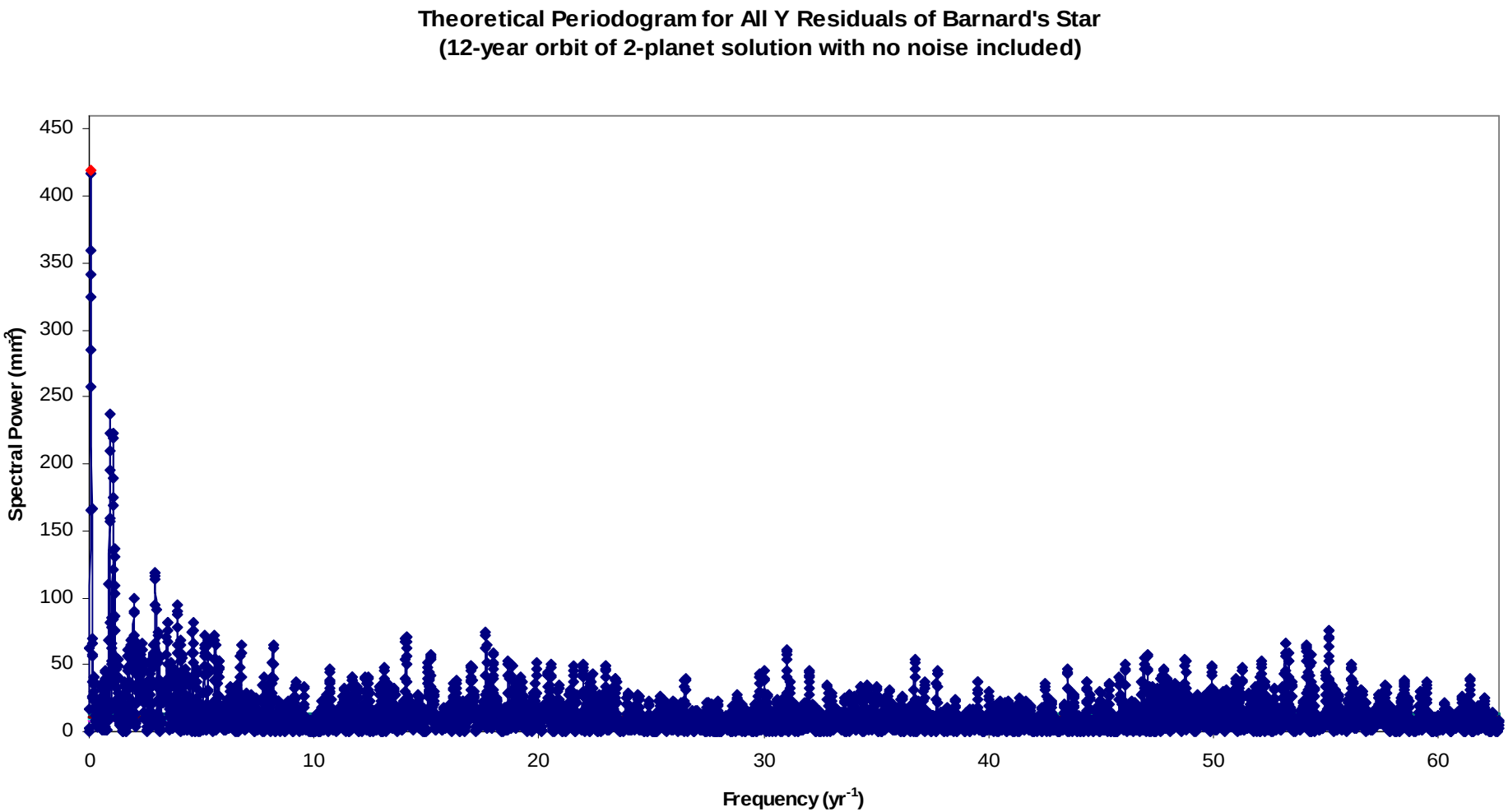
Image Source: DSS

Barnard's Star Motion

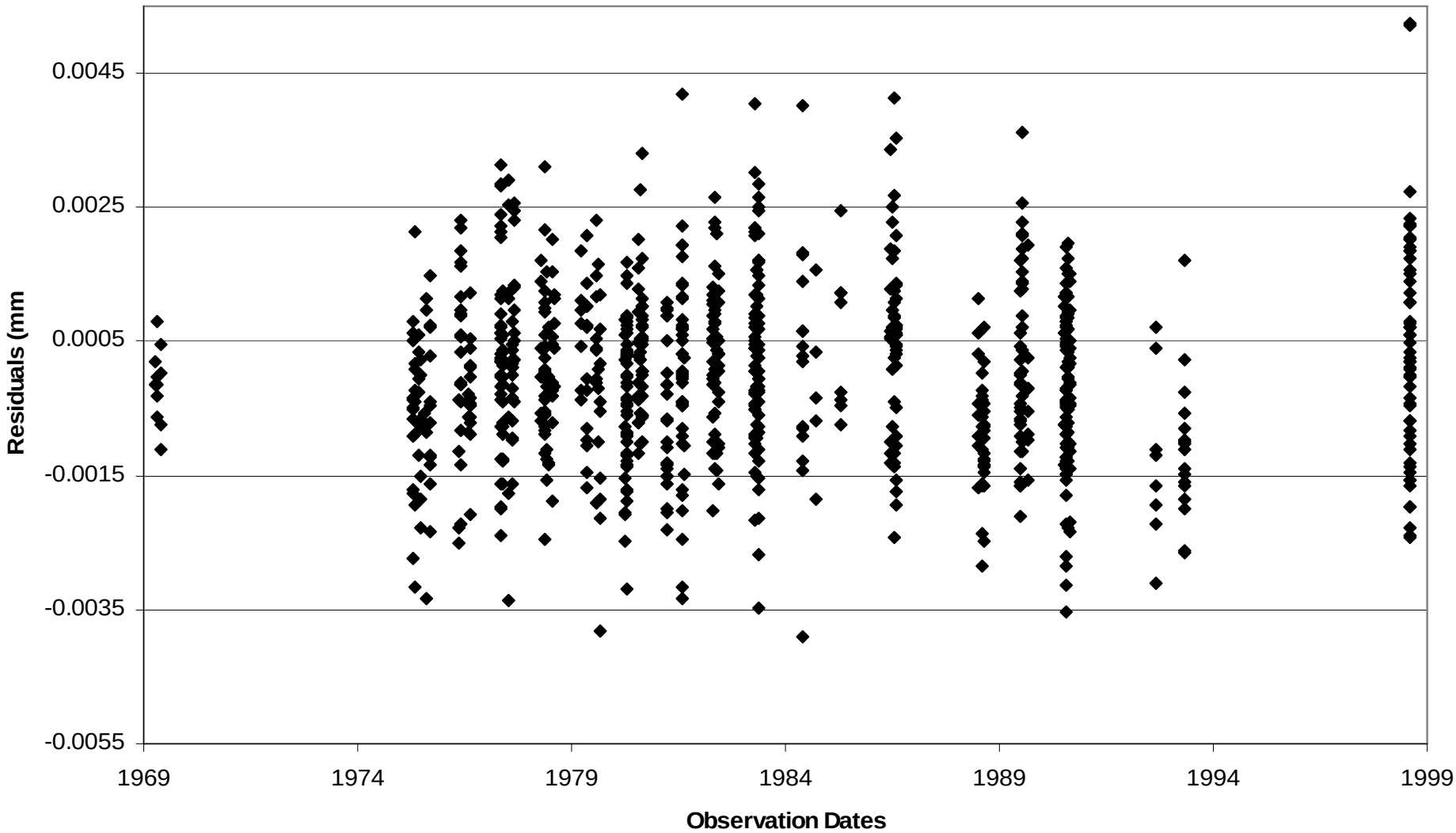
- Leander McCormick Observatory
  - Parallax 0.552 ± 7"→ 5.90 ± 0.07 light-years
  - Proper Motion 10.354 ± 0.006"/yr → 89 ± 1 km/s
  - Secular acceleration 0.00125 ± 0.00004"/yr^2



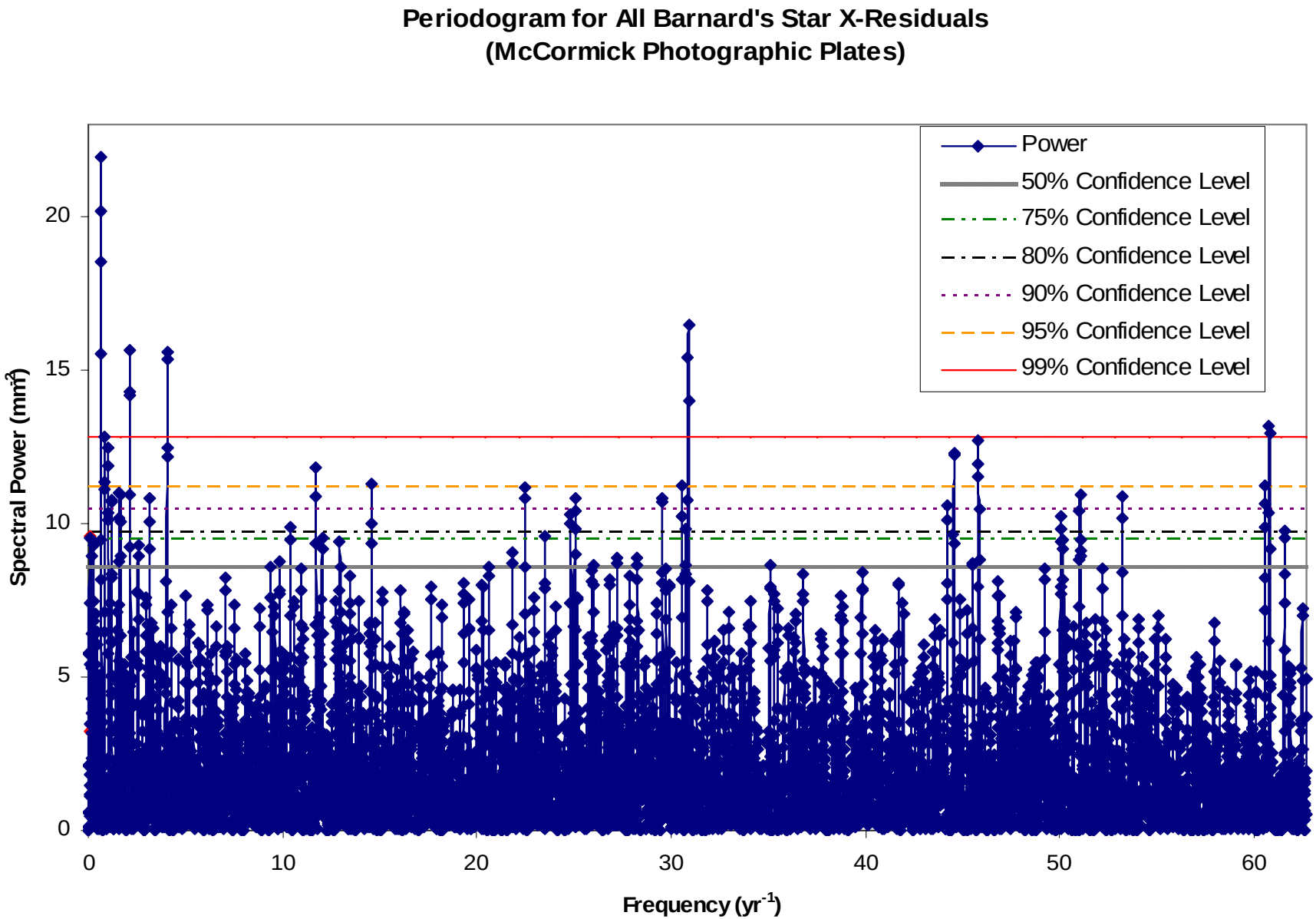
If There Were a Planet …



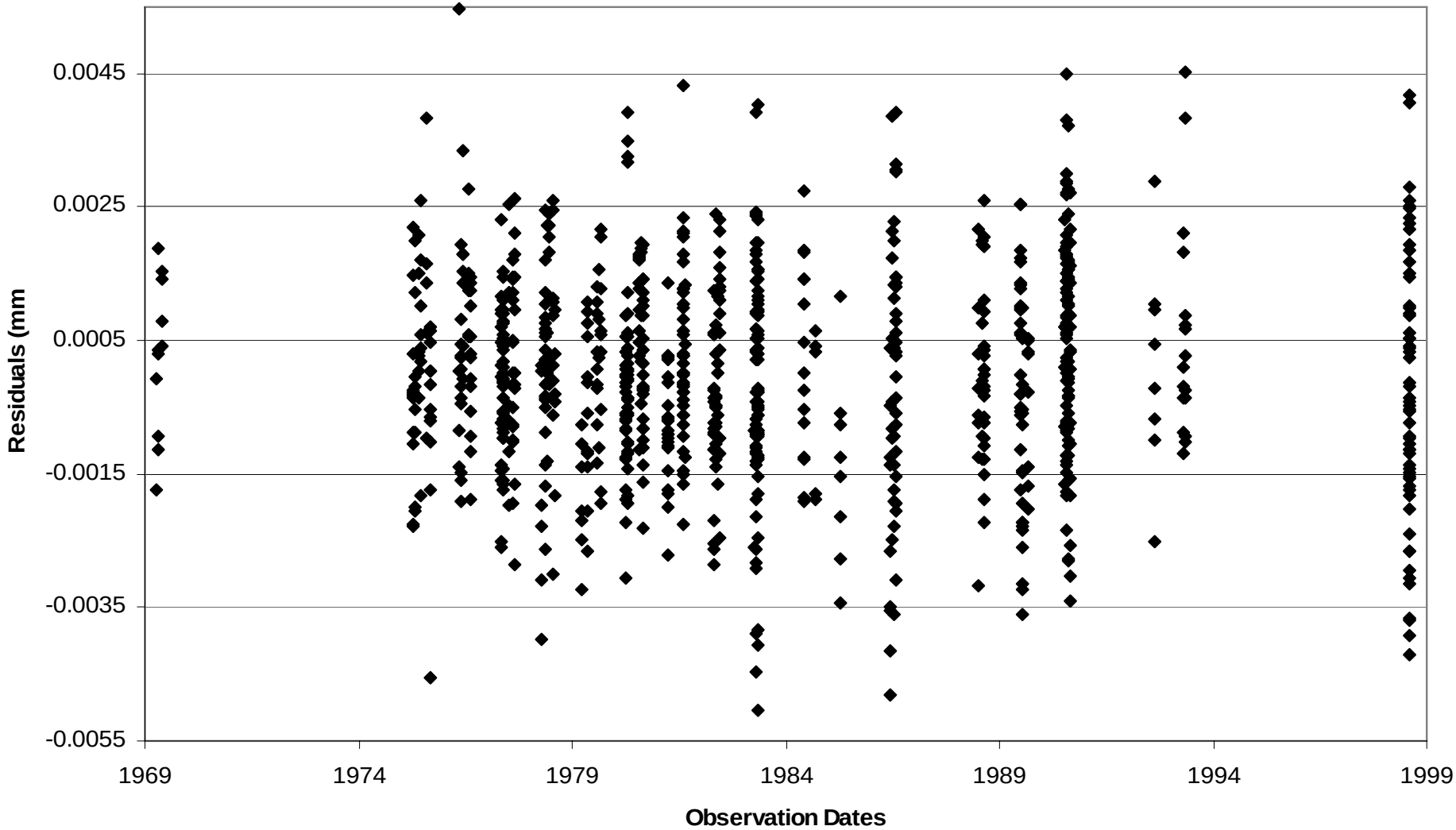
X-Coordinate for Barnard's Star



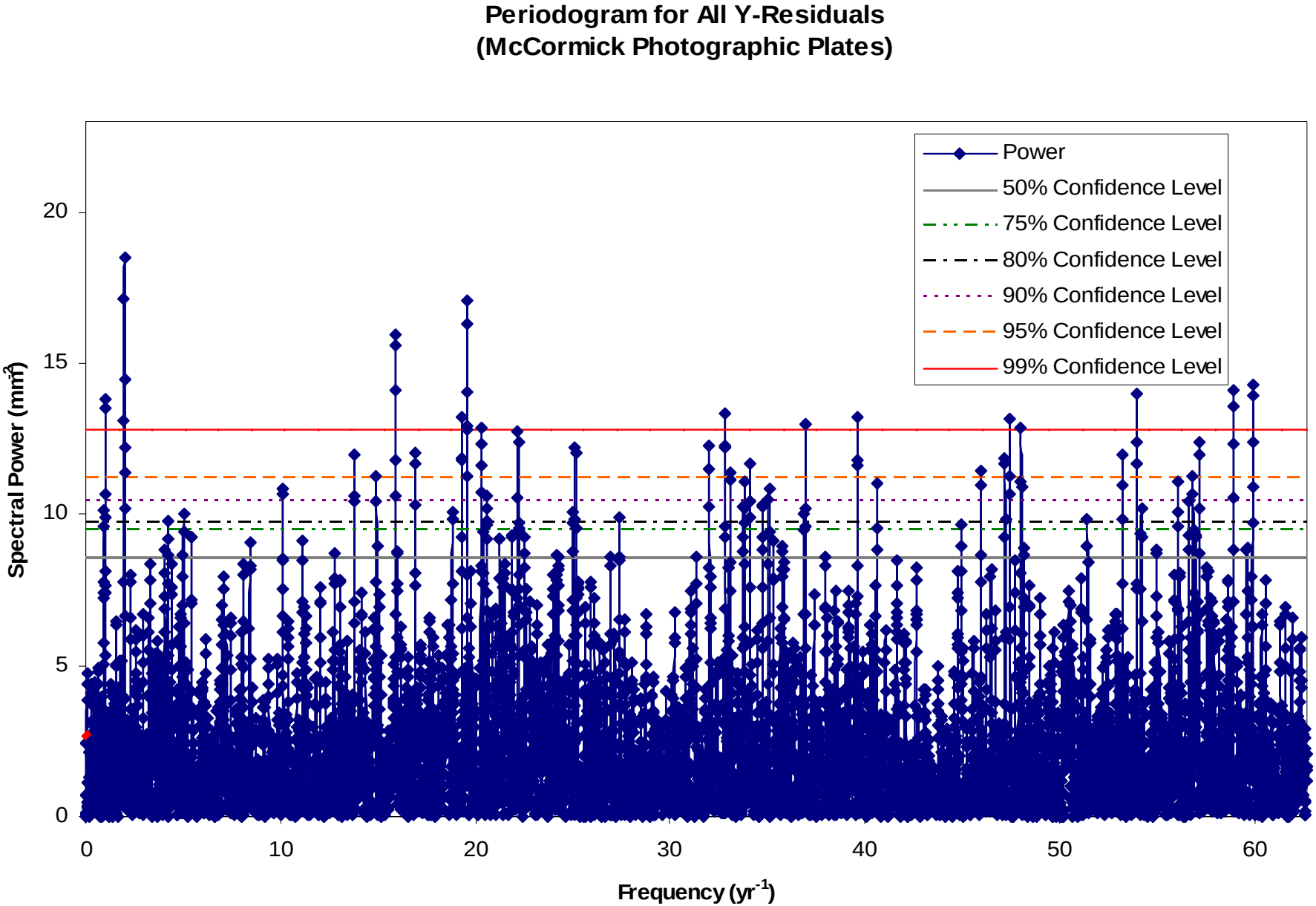
X-Coordinate for Barnard's Star



Y-Coordinate for Barnard's Star



Y-Coordinate for Barnard's Star



Southern Parallax Program

- Siding Spring Observatory, Australia
- 40” telescope
- Observed 1987-2002
- Parallaxes and proper motions for 90 possible nearby stars

Image Source: Sebo

Possible Hosts

- 13 stars with best parallax and proper motion results for further analysis
- 12 stars without detectable planets, for example
  - LHS 337 nothing $\geq$ 6.3 $M_{\oplus}$
  - LHS 1565 nothing $\geq$ 1.7 $M_{\oplus}$

- Nearby
  0.213 ± 0.002” → 15.3 ± 0.1 light-years
- High proper motion
  1.6420 ± 0.006”/yr → 36.5 ± 0.3 km/s
- Moderately dim
  V = 13.97 ± 0.05 mag.

LHS 288

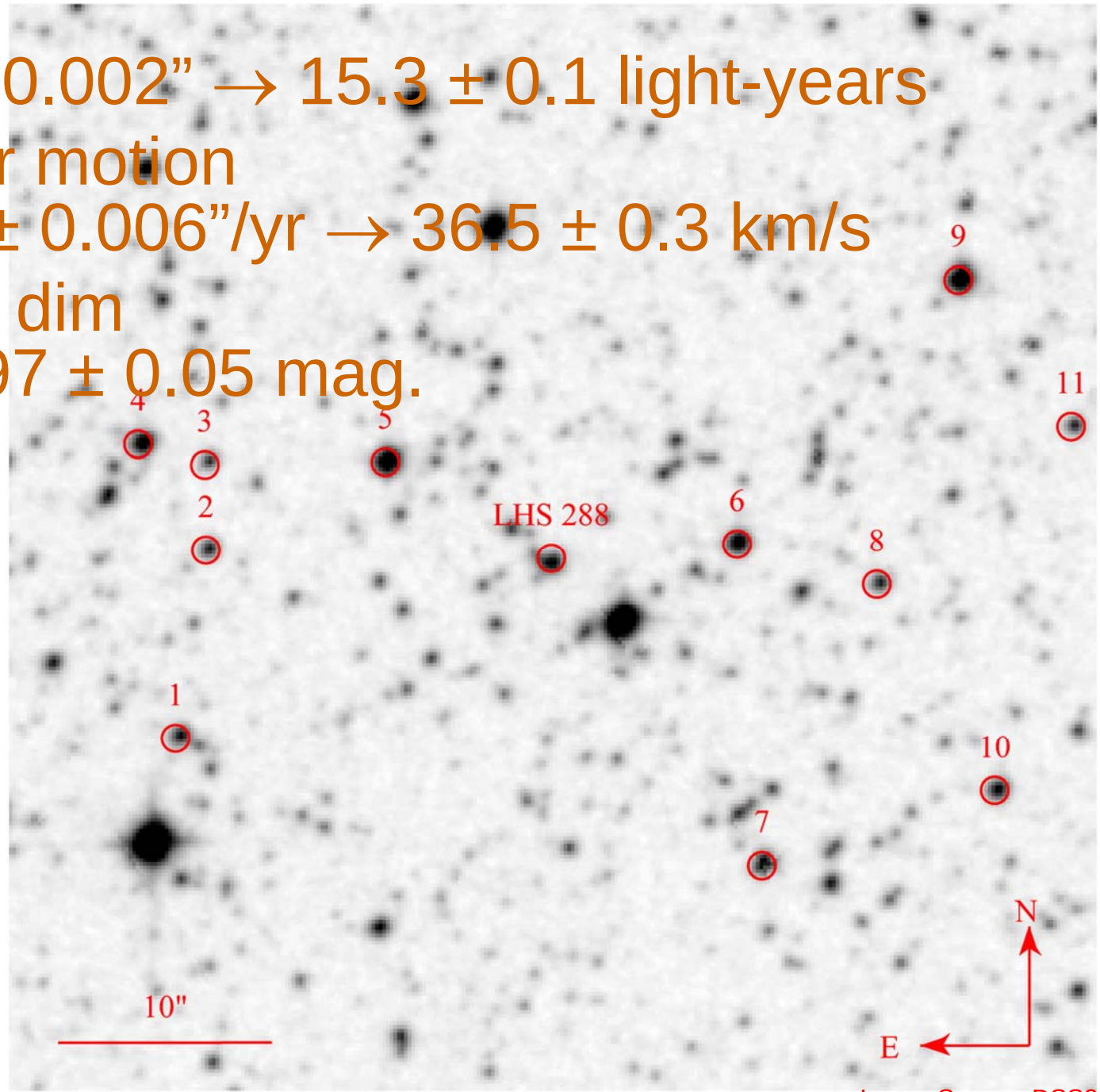
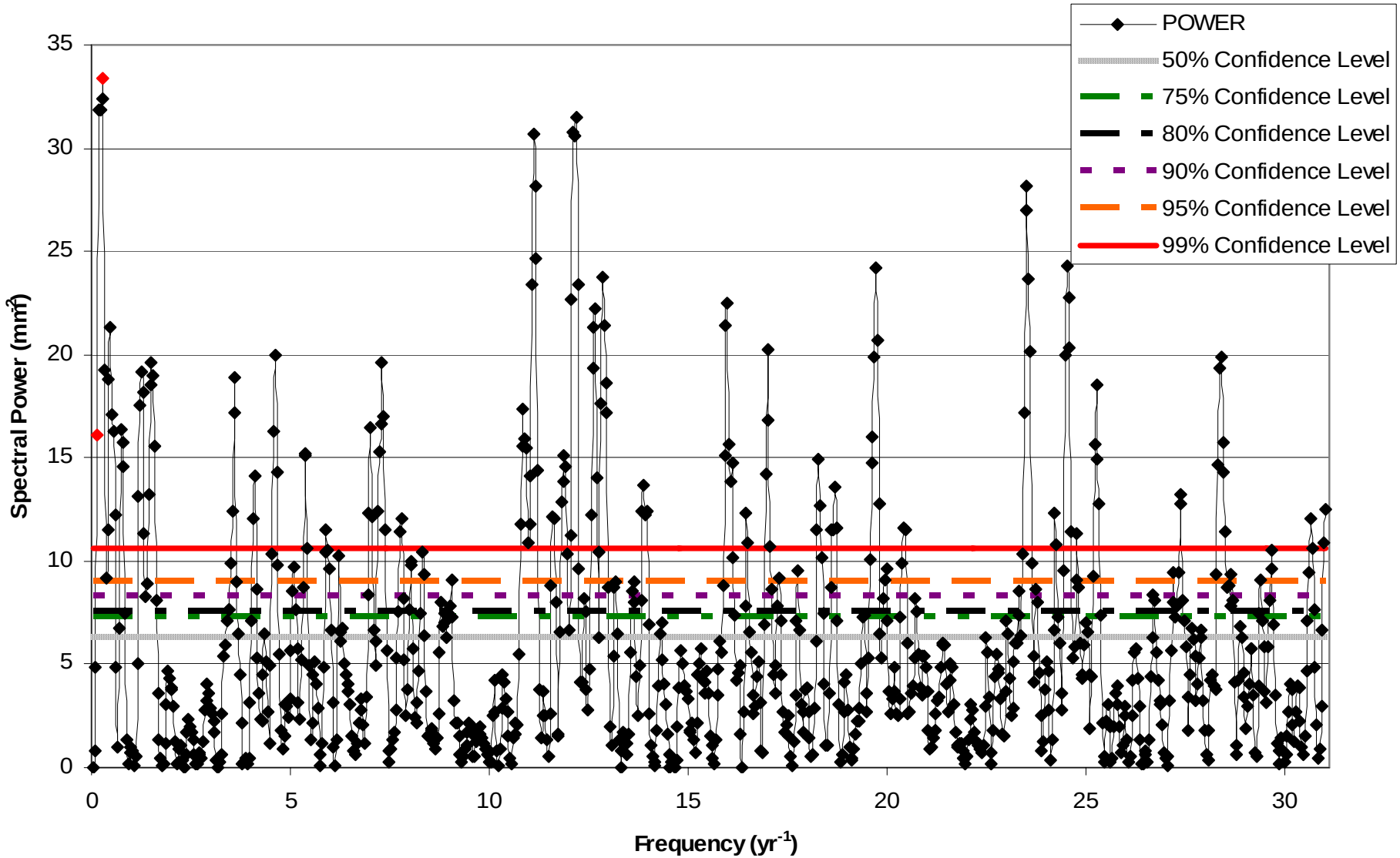


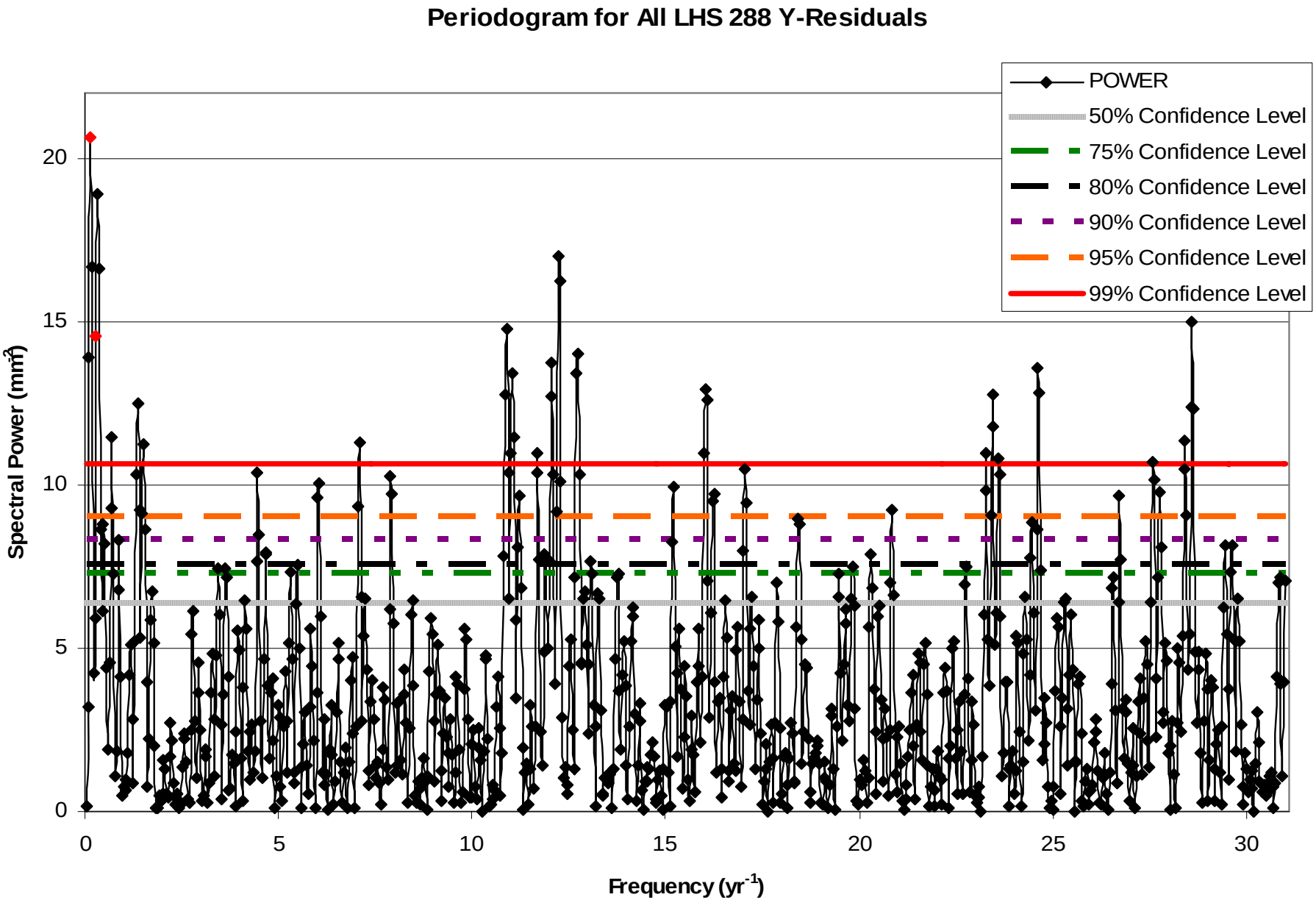
Image Source: DSS2

LHS 288?

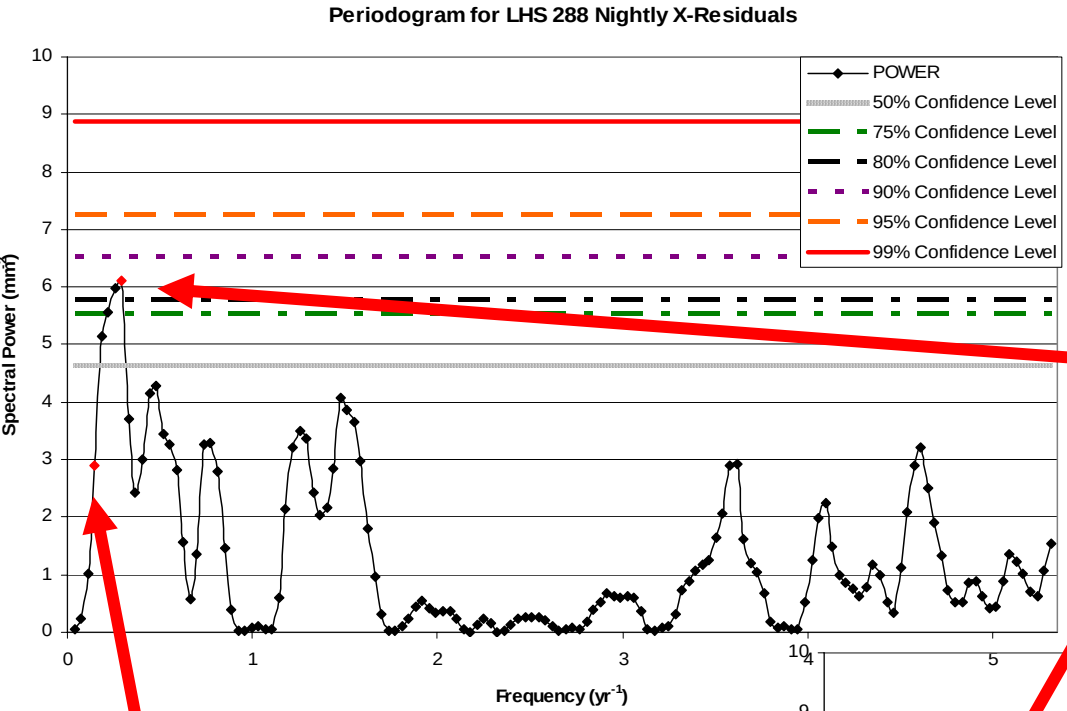
Periodogram for All LHS 288 X-Residuals



LHS 288?

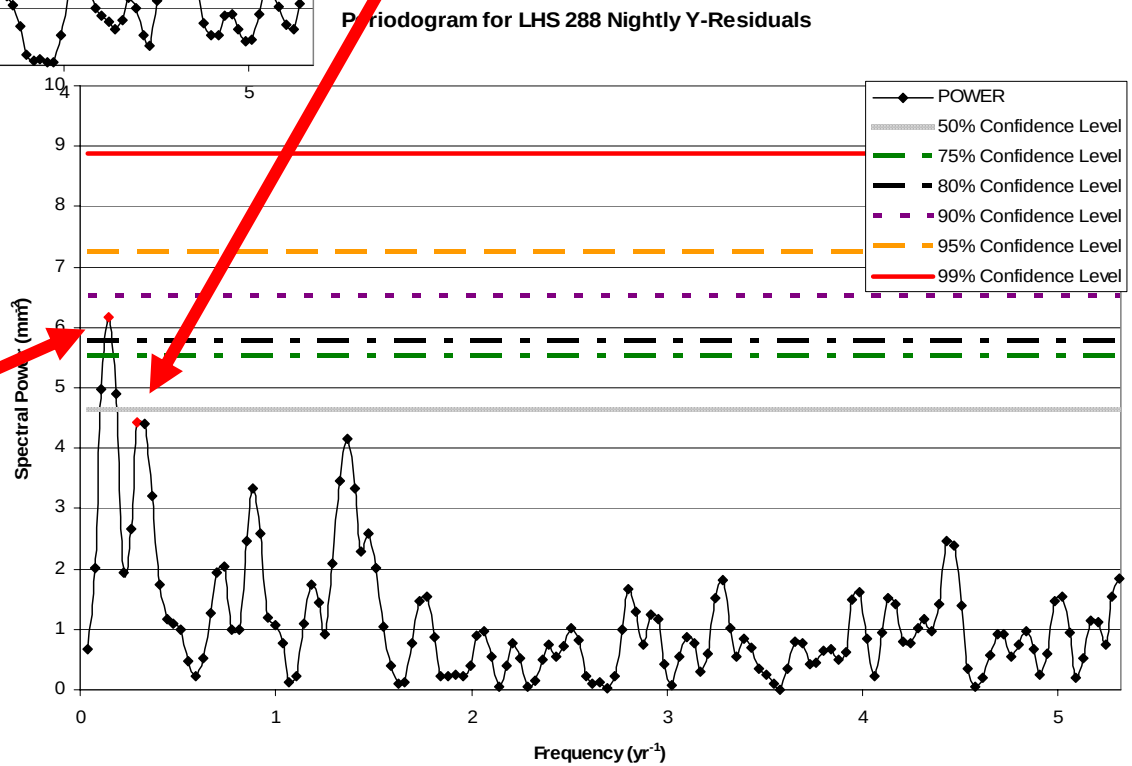

Periodogram for All LHS 288 Y-Residuals
POWER
50% Confidence Level
75% Confidence Level
80% Confidence Level
90% Confidence Level
95% Confidence Level
99% Confidence Level
Spectral Power (mm²)
Frequency (yr⁻¹)
0
5
10
15
20
25
30

LHS 288 Smoothed



3.4-year period?

6.8-year period?



Contributions to Census

- Parallaxes
  - ✓43 possible nearby stars under investigation
  - ✓28 stars confirmed in solar neighborhood
  - ✓1 possible new binary resolved
- Planet Search Limits
  - ✓Barnard's Star nothing $\geq 2.2\ M_{\odot}$
  - ✓12 Southern Parallax Program stars with nothing detectable
  - ✓LHS 288, possible low mass companion $\geq 2.4\ M_{\odot}$

Fan Mountain Infrared Parallax Program

- Astrometric Precision of Single Frame (mean error of unit weight)
  - Siding Springs (optical) ± 0.4 μm
  - USNO IR program ± 1.3 μm
  - Fan Mountain IR camera ± 1.3 μm
  - McCormick Photographic plates ± 1.5 μm

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- CTIOPI. CTIOPI was a NOAO Survey Program and continues as part of the SMARTS Consortium.
- DSS2. This research made use of DSS2 images (McLean et al. 2000) that were obtained by AAO with UK Schmidt Telescope. STScI digitized and compressed images under US Govt. grant NAG W-2166. AAO Board retains copyright. UK Schmidt Telescope was operated by ROE with funding from UK SERC/PPARC, until 1988 June, and thereafter by AAO. In addition, I acknowledge using NASA's SkyView (McGlynn, Scollick, & White 1996) facility located at NASA Goddard Space Flight Center.
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he telleth the number of the stars;
he calleth them all by their names.
great is our lord, and of great power:
his understanding is infinite.

psalm 147:4-5, kjv