

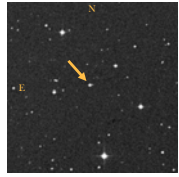


# Knowing Our Neighbors: Two In and One Out

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## Solar Neighborhood Census

Obtaining a well-understood, volume-limited (and ultimately volume-complete) sample of nearby stars is necessary for determining a host of interesting astrophysical quantities, including the stellar luminosity and mass functions, the distribution of stellar velocities, and the stellar multiplicity fraction. Furthermore, such a sample provides insight into the local star formation history. Towards that end, the Research Consortium on Nearby Stars (RECONS) team measures trigonometric parallaxes to establish which systems truly lie within the Solar Neighborhood, emphasizing those within 25 pc. Less accurate photometric and spectroscopic estimates previously suggested LHS 2880, LHS 6167AB, and LP 991-84 as possible members of the 10-pc sample, which made them desirable candidates.



LHS 2880  
( $1^{\text{h}}13^{\text{m}}04.86^{\text{s}} -12^{\circ}01'26.8''$ )

### X Not Solar Neighborhood Member: LHS 2880 (Unresolved binary? Young system?)

#### Astrometry

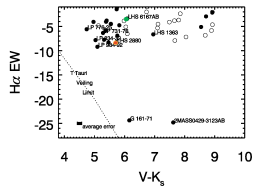
- $\pi = 31 \pm 1$  pc
- > NOT within 25 pcs, 3x farther than previous photometric estimate of  $9.8 \pm 0.7$  pc (Reid, Kilkenny, & Cruz 2002)
- > No indication of perturbation in residuals; unresolved CTIOPI frames
- $\mu = 0.7113'' \pm 0.00047''/\text{yr}$  in  $237.0' \pm 0.2'$
- > moving at more than  $0.5''/\text{yr}$  consistent with  $0.758''/\text{yr}$  in  $237.1'$  (LHS)
- $v_{\text{tan}} = 104.3$  km/s
- > moving faster than median speed of previous RECONS Solar Neighborhood members
- > not associated with any moving group or association, even in young-star mode, according to LACEwING

#### Photometry

- V =  $13.89 \pm 0.02$  mag
- R =  $12.52 \pm 0.03$  mag
- I =  $10.79 \pm 0.02$  mag
- R variability  $\approx 0.014$  mag
- > detectable but insignificant variability

#### Spectroscopy

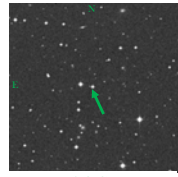
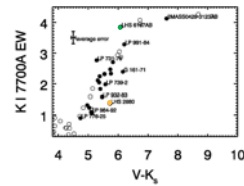
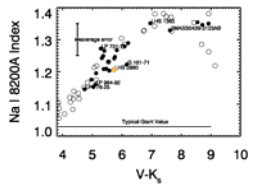
- Spectral type: M 4.5 V ( $\pm 0.5$ )
- H $\alpha$  EW:  $-8.3 \pm 0.2$  Å
- Na I index:  $1.21 \pm 0.05$
- K I EW:  $1.4 \pm 0.2$  Å
- > H $\alpha$ , Na I, & K I suggest an age < 120 Myr



Plots of H $\alpha$  EW, Na I index, and K I EW vs V-K<sub>s</sub> color for systems with new CTIOPI parallaxes and spectroscopy (filled circles). For comparison, the open circles are field systems from Riedel et al. (2014); these systems appear to be similar in age to the Pleiades or older.

On the left, all of the systems plotted have H $\alpha$  emission less than the T Tauri veiling limit (White & Basri 2003).

On the lower left, all of the systems plotted have Na I indices greater than the "Typical Giant Value" below which all CTIOPI spectra of known giants lie (Riedel et al. 2014).



LHS 6167AB  
( $09^{\text{h}}15^{\text{m}}36.40^{\text{s}} -10^{\circ}35'47.2''$ )

### ✓ New 10-pc Sample Member: LHS 6167AB (New Solar Neighborhood Binary)

#### Astrometry

- $\pi = 9.68 \pm 0.09$  pc
- > within 10 pcs, slightly more distant than previous photometric estimate of  $6.7 \pm 0.5$  pc (Reid, Kilkenny, & Cruz 2002)
- $\mu = 0.4394'' \pm 0.00047''/\text{yr}$  in  $244.60' \pm 0.07'$
- > moving at more than  $0.2''/\text{yr}$  consistent but less than  $0.459''/\text{yr}$  in  $244.3'$  (LHS)
- $v_{\text{tan}} = 20.2$  km/s
- > moving slower than median speed of previous RECONS Solar Neighborhood members
- > 38.13% likelihood of membership in Her-Lyr Moving Group (field-star mode)

#### Photometry

- V =  $13.82 \pm 0.01$  mag
- R =  $12.32 \pm 0.02$  mag
- I =  $10.42 \pm 0.02$  mag
- V variability  $\approx 0.032$  mag
- > significant variability including a 2012 flare

#### Spectroscopy (Joint)

- Spectral type: M 4.5 V ( $\pm 0.5$ )
- H $\alpha$  EW:  $-3.4 \pm 0.2$  Å
- Na I index:  $1.28 \pm 0.05$
- K I EW:  $3.8 \pm 0.2$  Å

## Astrometry

Each astrometric parameter reported herein was measured with the Cerro Tololo Inter-American Observatory (CTIO) 0.9-m as part of the on-going CTIO Parallax Investigation (CTIOPI). The reduction of LHS 6167AB included frames taken with both the "old" and "new" V filter while that of LP 991-84 used only "old."

## Photometry

Each photometric measurement reported herein is based on at least 3 nights of observations with the CTIO 0.9-m. All V-band photometry was obtained using the discontinued "new" filter. CTIOPI VRI photometry is supplemented by 2MASS KS, where necessary.

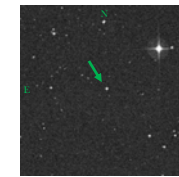
Photometric variability was assessed using the astrometric frames. The detection threshold for this method is  $\sim 0.007$  mag, but systems with variability measures < 0.020 mag are not considered significantly variable.

## Spectroscopy

The spectral types and indices reported herein are from CTIO 1.5-m spectra covering 6,000–9,500 Å with a resolution of 8.6 Å. Computation of EWs and indices used 11-Å windows centered on the max/min of the H $\alpha$  line (6563 Å) and K I doublet (7699 Å) while full 24-Å bins were used for the Na I doublet (8200 Å).

## Moving Groups

LACEwING calculates proper motion, distance, position, and radial velocity (if available) metrics for each of 14 moving groups:  $\epsilon$  Cha,  $\eta$  Cha, TW Hya,  $\beta$  Pic, Oct, Tuc-Hor, Col. Arg, AB Dor, Pleiades, Her-Lyr, Com, UMa, and Hyades. LACEwING combines the metrics and transforms them into membership probabilities using pre-computed membership probability functions, derived from a simulation of the Solar Neighborhood. LACEwING has two sets of such functions: assuming general-field systems and assuming known young systems. For each group, LACEwING combines the metrics into a goodness-of-fit match. Based on a large simulation of the solar neighborhood, LACEwING knows the percentage of simulated stars at the same goodness-of-fit value that are actual members of the group and reports this value as the membership likelihood.



LP 991-84  
( $01^{\text{h}}39^{\text{m}}21.72^{\text{s}} -39^{\circ}36'09.1''$ )

### ✓ New 10-pc Sample Member: LP 991-84 (New Solar Neighborhood Member)

#### Astrometry

- $\pi = 8.6 \pm 0.1$  pc
- > within 10 pcs, identical within the errors to previous photometric estimate of  $8 \pm 1$  pc (Reid et al. 2003)
- $\mu = 0.2589'' \pm 0.00047''/\text{yr}$  in  $146.7' \pm 0.2'$
- > moving at more than  $0.2''/\text{yr}$  consistent with NLTT
- $v_{\text{tan}} = 10.6$  km/s
- > moving slower than median speed of previous RECONS Solar Neighborhood members
- > not associated with any moving group or association, even in young-star mode

#### Photometry

- V =  $14.480 \pm 0.008$  mag
- R =  $12.97 \pm 0.01$  mag
- I =  $11.06 \pm 0.02$  mag
- V variability  $\approx 0.014$  mag
- > detectable but insignificant variability

#### Spectroscopy

- Spectral type: M 4.5 V ( $\pm 0.5$ )
- H $\alpha$  EW:  $0.249 \pm 0.2$  Å
- > lack of H $\alpha$  emission implies age  $\geq 1$  Gyr
- Na I index:  $1.29 \pm 0.05$
- K I EW:  $3.3 \pm 0.2$  Å

## References

Bartlett, J. L. et al. 2016, in prep.  
 Bonnard, F. et al. 2000, *A&AS*, 143, 33 (Aladin)  
 Luyten, W. J. 1979, *LDS Catalogue: A Catalogue of Stars with Proper Motions Exceeding 0.5" Annually*, (Minneapolis: Univ. Minnesota) (LHS)  
 Luyten, W. J. 1980, *New Luyten Two-Tenths Catalogue* (Minneapolis: Univ. Minnesota) (NLTT)  
 McGlynn, T., Sozlöck, K., & White, N., 1996 in *IAU Symp. 179, New Horizons from Multi-Wavelength Sky Surveys*, ed. B.J. McLean et al. (Boston: Kluwer Academic Publishers), 463 (SkyView)  
 Odenwiler, F., Bauer, F., & Marconi, J., 2000, *A&AS*, 143, 221 (VizieR)  
 Reid, L. et al. 2003, *AJ*, 126, 3007  
 Reid, L., Kilkenny, D., & Cruz, K. 2002, *AJ*, 123, 2822  
 Riedel et al. 2014, *AJ*, 147, 85  
 Riedel, A. et al. 2016, in prep. LACEwING  
 Skrutskie, M. F. et al. 2006, *AJ*, 131, 1163 (2MASS)  
 White, R. J. & Basri, G. 2003, *ApJ*, 582, 1109

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## Finding Charts (Image Credits)

The 8.5"x8.5" finding charts use 1st epoch DSS images that were obtained by the AAO with the UK Schmidt Telescope. The STScI digitized & compressed images under US Gov't grant NAG-W-2166. The UK SERC/PPARC & the Anglo-Australian Telescope Board jointly hold the copyright to the DSS images. The UK Schmidt Telescope was operated by ROE with funding from the UK SERC/PPARC until 1988 June & thereafter, by the AAO. NASA's SkyView facility located at GSCF provided DSS-access.

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