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WISE J064336.71-022315.4:
A THICK DISK L8 GAIA DR2-DISCOVERED BROWN DWARF AT 13.9 PARSECS

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While spectroscopically characterizing nearby ultracool dwarfs discovered in the Gaia Second Data Release (GDR2 [Gaia Collaboration et al. 2018](#)) with the TripleSpec spectrograph on the Palomar 200" telescope, we encountered a particularly cool, nearby, new member of the solar neighborhood: Gaia DR2 3106548406384807680 = WISE J064336.71-022315.4 = 2MASS J06433670-0223130 (hereafter W0643).

Astrometry: [Gaia Collaboration et al. \(2018\)](#) reports an epoch 2015.5 ICRS position for W0643 of $\alpha, \delta = 100^{\circ}90303036652$ (± 1.3 mas), $-2^{\circ}38793881136$ (± 1.2 mas) and proper motion $\mu_{\alpha}, \mu_{\delta} = 28.3 \pm 2.3, -221.2 \pm 2.5$ mas yr $^{-1}$. The [Gaia Collaboration et al. \(2018\)](#) parallax $\varpi = 71.9 \pm 1.4$ mas corresponds to a distance of 13.9 ± 0.3 pc. Combined, these yield a tangential velocity $V_{tan} = 14.7 \pm 0.4$ km s $^{-1}$.

Photometry: W0643 has 2MASS photometry ([Skrutskie et al. 2006](#)) of $J = 15.48 \pm 0.05, H = 14.38 \pm 0.05, K_s = 13.62 \pm 0.05$ ($J - K_s = 1.86 \pm 0.07$), and AllWISE photometry ([Wright et al. 2010](#)) of $W1 = 12.85 \pm 0.03, W2 = 12.50 \pm 0.03, W3 = 11.54 \pm 0.26$, and $W4 < 8.74$. Gaia DR2 reports $G = 20.680 \pm 0.014$. Pan-STARRS PS1 ([Chambers et al. 2016](#)) reports $i = 21.071 \pm 0.007, z = 18.505 \pm 0.013$, and $y = 17.474 \pm 0.013$. Combined with the Gaia DR2 parallax, we estimate absolute magnitudes $M_G = 19.96 \pm 0.04$, and $M_{K_s} = 12.91 \pm 0.06$. The colors and magnitudes are typical for late-L dwarfs ([Wang et al. 2018](#)).

Spectroscopy: W0643 was observed 12:47 UT 17 October 2018 with TripleSpec on the Palomar 200" ([Herter et al. 2008](#)), with a $1'' \times 30''$ slit, and the spectrum covering $1.0\text{--}2.4$ μm at resolution $R \simeq 2600$. W0643 was observed at airmass 1.26 and conditions were clear with $\sim 1''.5$ seeing. We obtained 8 frames of 240 s each in an ABBA nodding pattern with the slit aligned with the parallactic angle. The A0V star HD 54601 was observed afterwards to provide telluric absorption correction and flux calibration ([Vacca et al. 2003](#)). Data were reduced with a modified version of SpeXtool ([Cushing et al. 2004](#)).

Analysis: In Fig. 1, we compare W0643's TripleSpec spectrum to SpeX Prism Spectral Library standards using SPLAT ([Burgasser 2014; Burgasser & Splat Development Team 2017](#)). We classify W0643 as L8, with a "plateau-shaped" H -band spectrum typical for field Ls ([Allers & Liu 2013](#)). We measured a heliocentric radial velocity of 142 ± 12 km s $^{-1}$. When combined with *Gaia* astrometry, we determine a Galactic velocity (heliocentric; U towards Galactic center) of $U, V, W = -109, -91, -12$ ($\pm 10, 5, 3$) km s $^{-1}$. We estimate that W0643 passed within ~ 1.4 pc away from the Sun $\sim 100,000$ years ago. Using the kinematic criteria of [Bensby et al. \(2003\)](#), we estimate a 96% probability that W0643 is a thick disk star, which implies an age of 9-13 Gyr ([Haywood et al. 2018](#)).

Using the VOSA SED analyzer ([Bayo et al. 2008](#))¹ with the Pan-STARRS/2MASS/WISE photometry, we find a best fit BT-Settl CIFIST spectrum with $T_{\text{eff}} = 1400$ K, $\log(g) = 4.5$, with solar metallicity, with luminosity $\log(L/L_{\odot}) = -4.61 \pm 0.02$ dex. Combining these values, the age constraint, and the *Sonora 2018* evolutionary models ([Marley et al. 2018](#)), we predict W0643's mass to be $\sim 0.070 M_{\odot}$ (i.e. a brown dwarf).

Part of this research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with NASA. This work has made use of data from the European Space Agency (ESA) Gaia mission (<https://www.cosmos.esa.int/gaia>), processed by the Gaia Data Processing and Analysis Consortium (DPAC, <https://www.cosmos.esa.int/web/gaia/dpac/consortium>). This research has benefitted from the SpeX Prism Spectral Libraries, maintained by Adam Burgasser at <http://pono.ucsd.edu/~adam/browndwarfs/spexprism>.

Facilities: Gaia, Hale, WISE, 2MASS, PS1, IRTF

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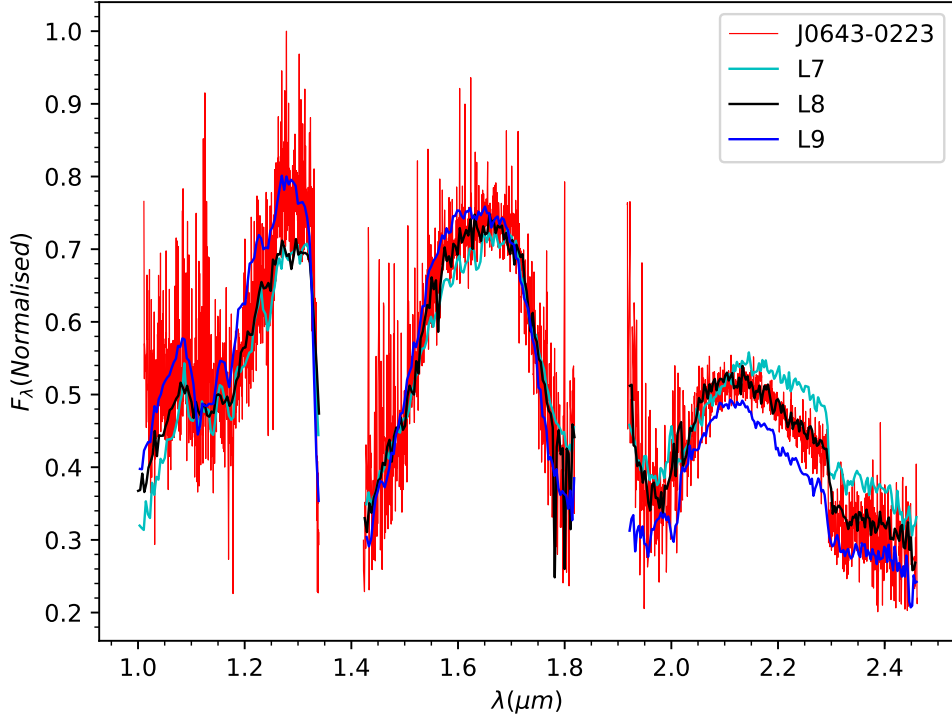


Figure 1. TripleSpec *JHK*-band spectrum of WISE J064336.71-022315.4 (red line) compared to those of the L dwarf standards 2MASS J0103+1935 (L7, in teal; Cruz et al. 2004), 2MASS J1632+1904 (L8, in black; Burgasser 2007) and DENIS J0255-4700 (L9, in blue; Burgasser et al. 2006).

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