A Search for New High Proper Motion Objects in the UKIDSS Galactic Plane Survey

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The UKIDSS Galactic Plane Survey (GPS) began in 2005, as a 7 year effort to survey approximately 1800 deg^2 of the northern Galactic plane in the J, H, and K passbands. The survey also included a second epoch of K band data with a baseline typically > 2 years for the purpose of investigating variability, this also allows for the measurement of stellar proper motions. We have calculated and visually verified proper motions for 617 high proper motion (> 200 mas yr^{-1}) sources from some 900 deg^2 of sky, 162 of which are new detections. Among these we have a new spectroscopically confirmed T5 dwarf and a further T6 dwarf awaiting confirmation, 14 new L dwarf candidates, and several new common proper motion systems containing ultracool dwarf candidates. The high source density in the Galactic plane leads to a high rate of mismatches. Spurious high proper motion detections are common and visual verification is essential as a result. The rate of false positives increases dramatically towards lower Galactic longitudes, though the reliability of detections improves at lower proper motions, and hence these data are potentially useful for identifying members of clusters within a few hundred pc. Gaia will vastly improve the accuracy and completeness of proper motion searches in the Galactic plane, though searches in current NIR surveys maintain their usefulness by probing deeper for brown dwarfs and identifying low mass benchmark companions to Gaia's discoveries.

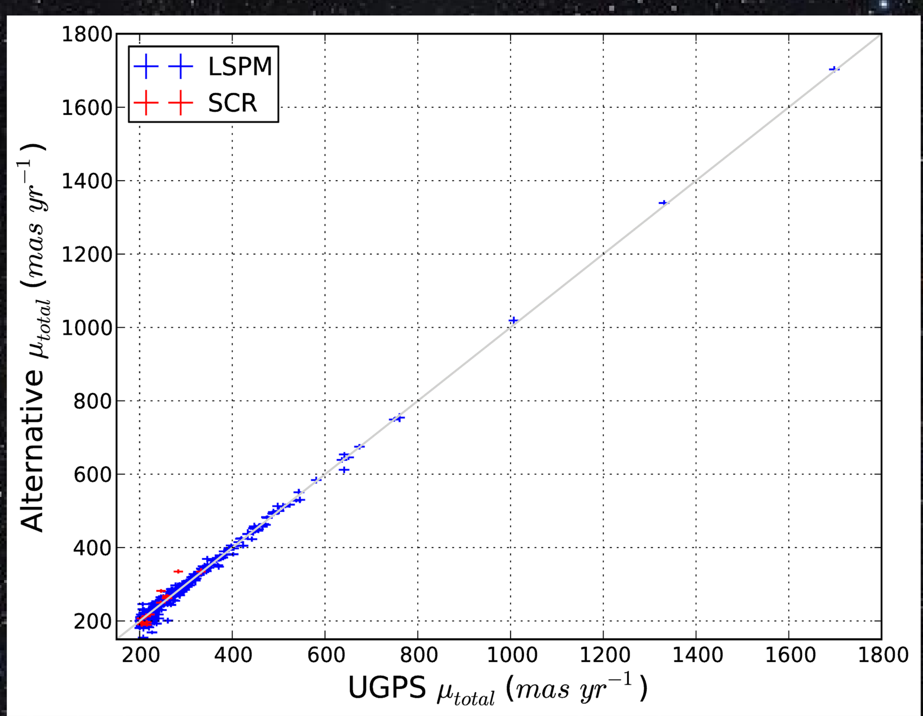

Fig. 1: A comparison between proper motions of the LSPM catalogue (Lépine & Shara, 2005), the SCR proper motion search of Boyd et al. (2011), and our own measurements.

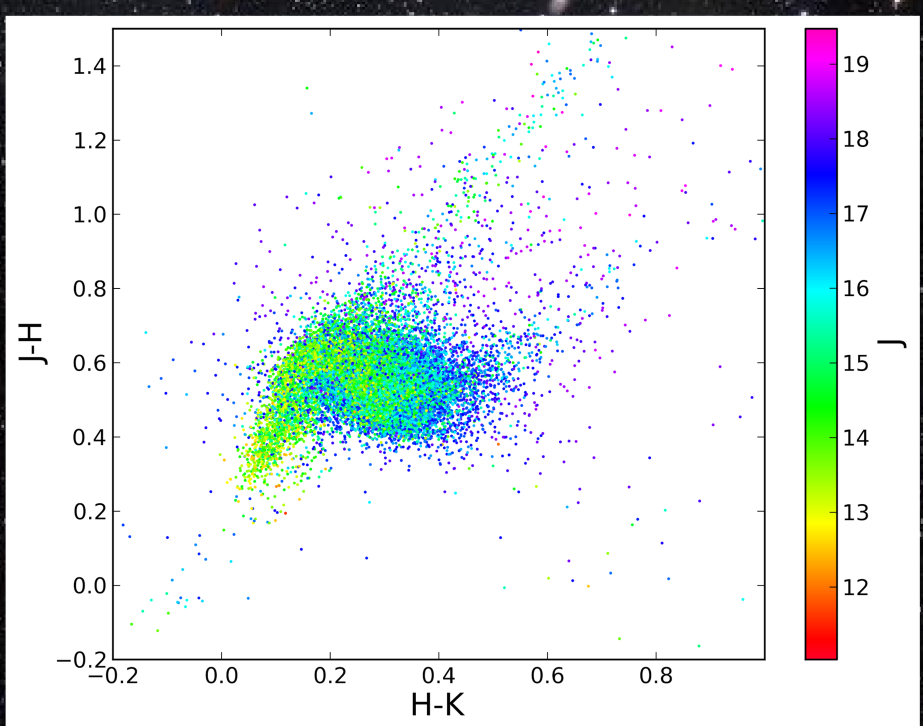

Fig. 6: A 25,729 source UKIDSS DR8 only sample which survive some common sense quality control cuts; have low proper motion (μ_{tot} < 200 mas yr^{-1}); have motion between the epochs > 200 mas; and DR8 coverage in J, H, and K.

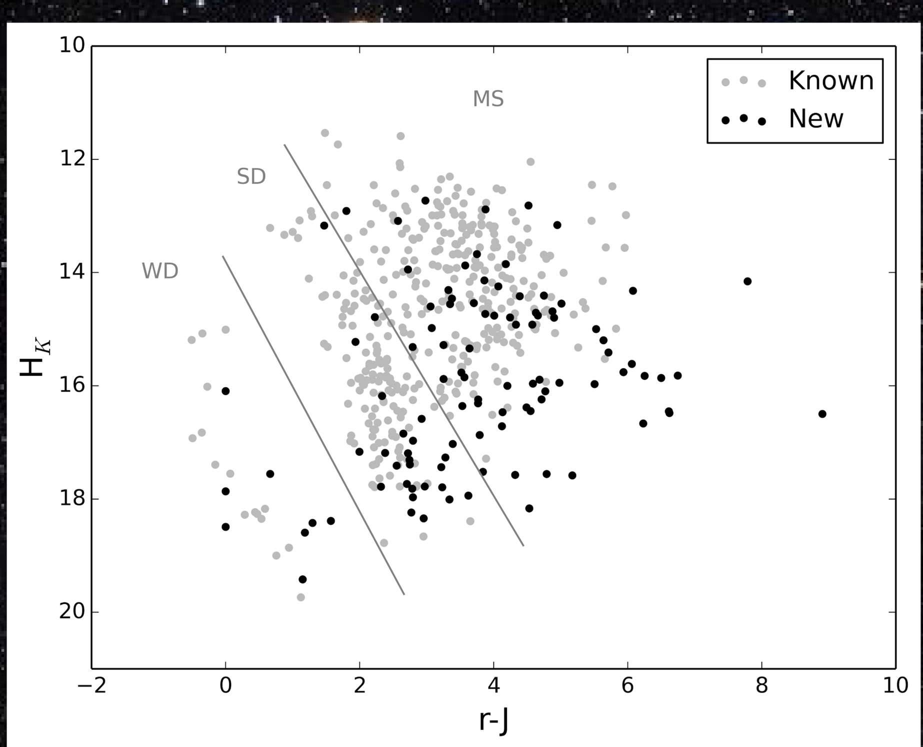

Fig. 7: An r-J vs. K band reduced proper motion plot of the 104 new and 391 previously identified high proper motion sources for which we have r and J photometry. White dwarf, subdwarf, and main sequence populations are nicely separated, labelled.

We paired UKIDSS GPS K band FITS file catalogues with epoch differences > 1.8 years and l > 60 and matched their contents using a 24" radius and a K band difference tolerance of 0.3 magnitudes. We selected high quality reference sources and used them to create a unique local 2nd order polynomial coordinate transform for every source. These transformations map the second epoch array coordinates onto the first epoch array coordinate frames and produces a more accurate motion measurement than transformation of each frame as a whole (Smith et al., 2014).

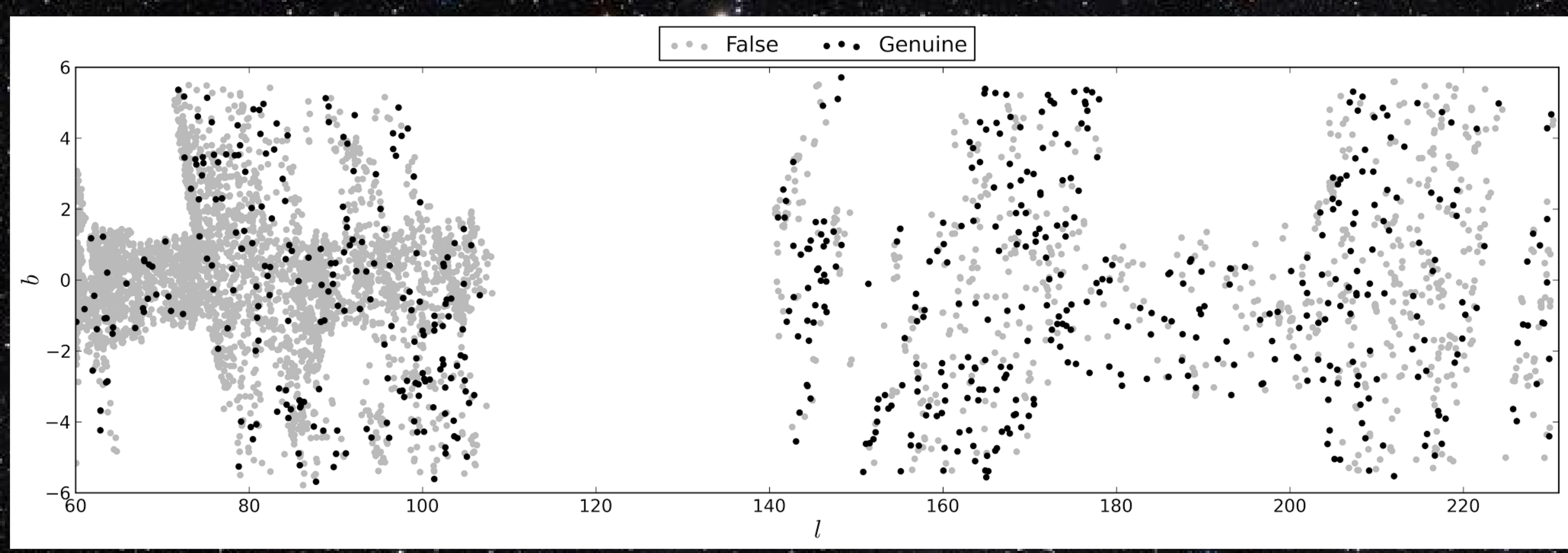

Fig. 2: The distribution of high proper motion candidates in Galactic coordinates. The fraction of false positives increases with source density at lower galactic latitudes. High proper motion sources are relatively nearby and we expect them to be at a fairly constant density across the sky, which appears to be the case here. This suggests the higher source density is not inhibiting our sensitivity to high proper motion sources to any great degree, at least at l > 60.

From the 155 million source results table we selected 5600 good quality high proper motion (> 200 mas yr^{-1}) candidates for visual verification (Fig. 2). The high source density in the Galactic plane produced many mismatches, which were the dominant cause of false detections and make visual verification essential for a trustworthy high proper motion source identification.

We identified 617 genuine high proper motion sources, 162 of which were previously unidentified (Fig. 3) and will be published in Smith et al. (2014b, in prep). Among these we find at least 14 new candidate L dwarfs, one of which is a companion to an early M dwarf; and two T dwarfs within 25 pc, a T6 dwarf and a T5 dwarf with possible low gravity/high metallicity spectral features (Fig. 4).

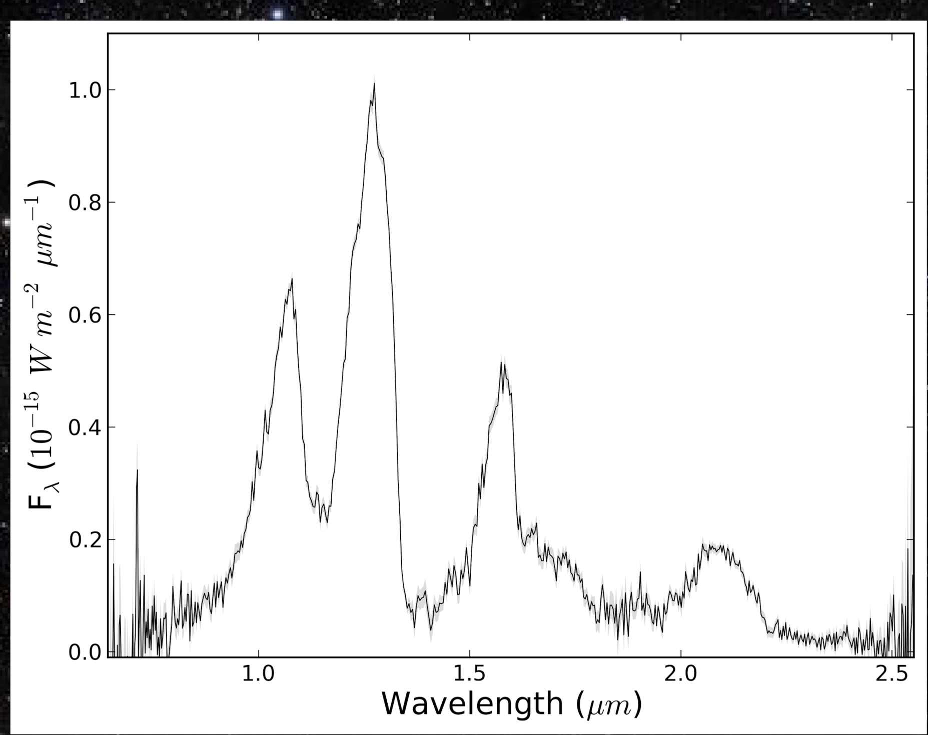

Fig. 4: An IRTF SpeX spectrum of the previously unidentified T5 dwarf UGPS 2048.

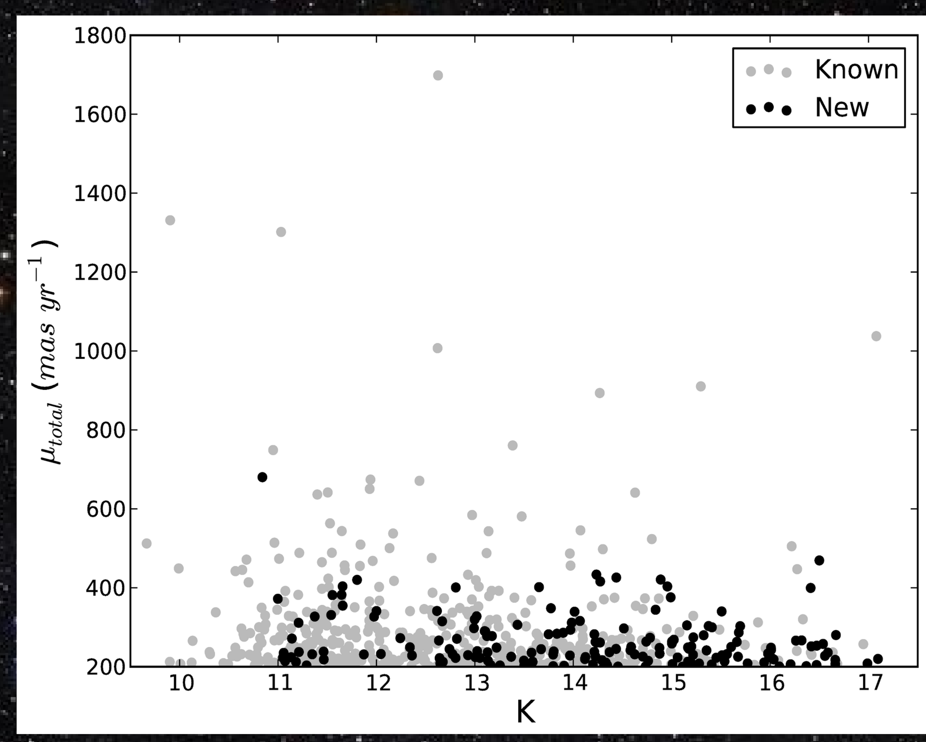

Fig. 3: The distribution in K band magnitude and total proper motion space of the 617 total high proper motion sources identified. The 162 previously unidentified sources are shown in black.

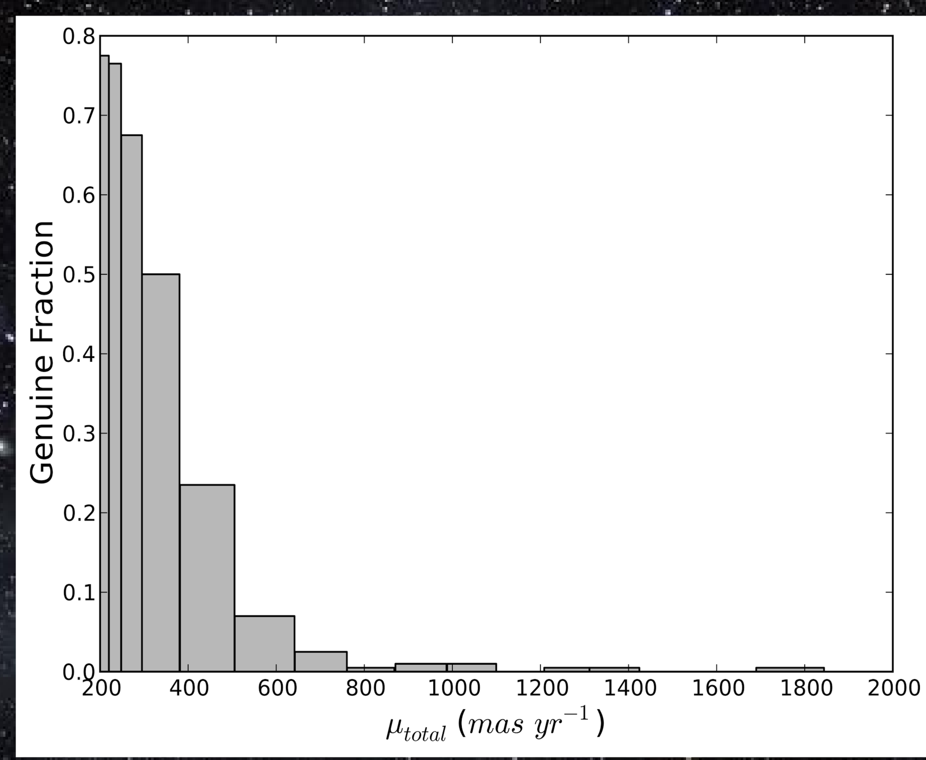

Fig. 5: The decrease in the fraction of genuine high proper motion detections with apparent proper motion. This may mean visual confirmation of high quality low proper motion candidates is not necessary, and could be used for eg. identification of new members of nearby clusters.

The fraction of false positive high proper motion detections decreases with apparent proper motion as expected (Fig. 5). This suggests that the lower proper motion results, of which there are too many to feasibly inspect, might be useful without visual verification. Figure 6 shows a two colour magnitude (J, J-H, H-K) diagram of 25,729 high quality sources with UKIDSS DR8 JHK detections, proper motion less than 200 mas yr^{-1}, and motion between the epochs greater than 200 mas. This selection is a fairly clean sample of nearby sources with minimal contamination by more distant reddened stars which may be either false proper motion detections or in fact genuine genuine distant Galactic sources. We are likely to find many more previously unidentified brown dwarfs, subdwarfs and white dwarfs within this sample (Fig. 7). The low proper motion selection may also prove useful for identification of new members of nearby clusters, low mass companions to known proper motion stars, and new members of nearby young moving groups.

In the context of Gaia, proper motion catalogues such as these allow us to search for low mass companions to the brighter main sequence stars and white dwarfs that Gaia will find. These can then be used as benchmarks to test theories of brown dwarf formation and evolution.

Blink some candidates?

http://goo.gl/zCkHK3

References:
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