Spectral Types and Properties of 51 Ultracool Dwarf Candidates

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Introduction

Ultracool dwarfs (often abbreviated as UCDs) straddle the stellar/sub-stellar boundary, and are crucial in our understanding of what separates stars from planets. These objects have spectral types later than M7[1], thus the term ultracool dwarf encompasses the lowest-mass stars, brown dwarfs and planetary mass objects (PMOs).

Although they were first theorised in 1963[2,3], the existence of ultracool dwarfs was only confirmed in the 1980s, so there is still much to be learned about their properties. By combining *Gaia* data with near-infrared surveys, ultracool dwarf candidates can be identified for observation so that we can characterise their properties (such as spectral types, temperatures, youth and binarity) and learn more about the nature of these objects.

The Data

The target list for the *Gaia* Ultracool Dwarf Sample (GUCDS) was created by cross-matching known L, T and Y-dwarfs with *Gaia* data[4]. Between 2018 and 2021, spectra of 69 objects were obtained using the ARCoIRIS instrument at the Blanco 4m telescope in Chile or the SpeX instrument at IRTF in Hawaii.

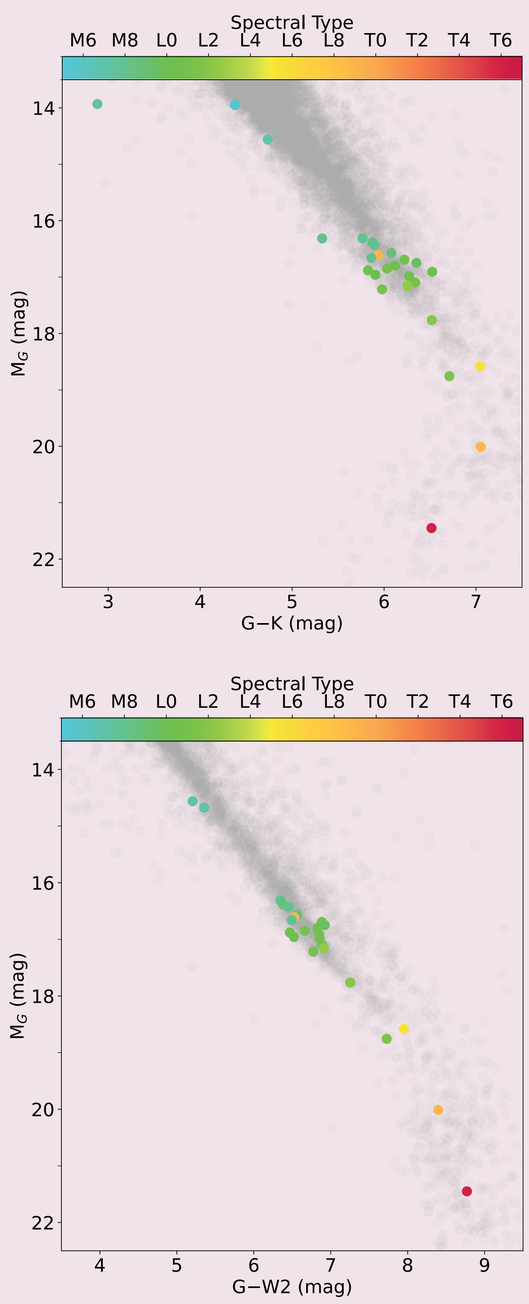
Spectral types were determined using the Python module `Splat`[5], resulting in 51 objects which can be deemed to be good UCD candidates. The spectral shapes were used to help verify the classifications, and also to identify any candidates with unusual spectral features or indications of youth. We also derived photometric spectral types for each of the candidates and compared our spectral types with published data to confirm the validity of the spectroscopic classifications.

Our Results

Our spectroscopic classification of the 51 UCD candidates resulted in a total of 26 M-type, 21 L-type and 2 T-type candidates, 35 of which are new UCD candidates. The other 16 candidates already have published spectral types, and comparisons of these with our spectroscopic classifications show that our spectral types are largely consistent with those published.

Colour-magnitude diagrams (see plots below) can be created to help identify any candidates which lie away from the main sequence, thus aiding in the identification of binaries, subdwarfs and PMOs. As can be seen, the candidates follow the expected trend of earlier spectral types being brighter and bluer than their cooler counterparts, with a handful being potential PMOs and binaries.

By combining the inspection of spectral features (see the plot to the right) with published parameters for each candidate, potential young, disc, halo and binary objects can be identified. Of the 51 UCD candidates in this sample, 8 show indicators of youth, 9 appear to be disc objects, 8 are potential binaries and none are halo objects.



Future Work

These UCD candidates can be used as valuable UCD references if we can derive more of their key properties, such as their temperatures and radial velocities. The next steps in working with these objects will be to calculate these values, in order to create a catalogue of the characteristics of our sample of UCD candidates.

The temperatures of the candidates can be calculated from the spectral energy distributions[6]. Once calculated, these values can be compared with those given by the *Gaia* Apsis module ESP-UCD, thus providing a valuable reference for the ESP-UCD team to validate their Apsis module.

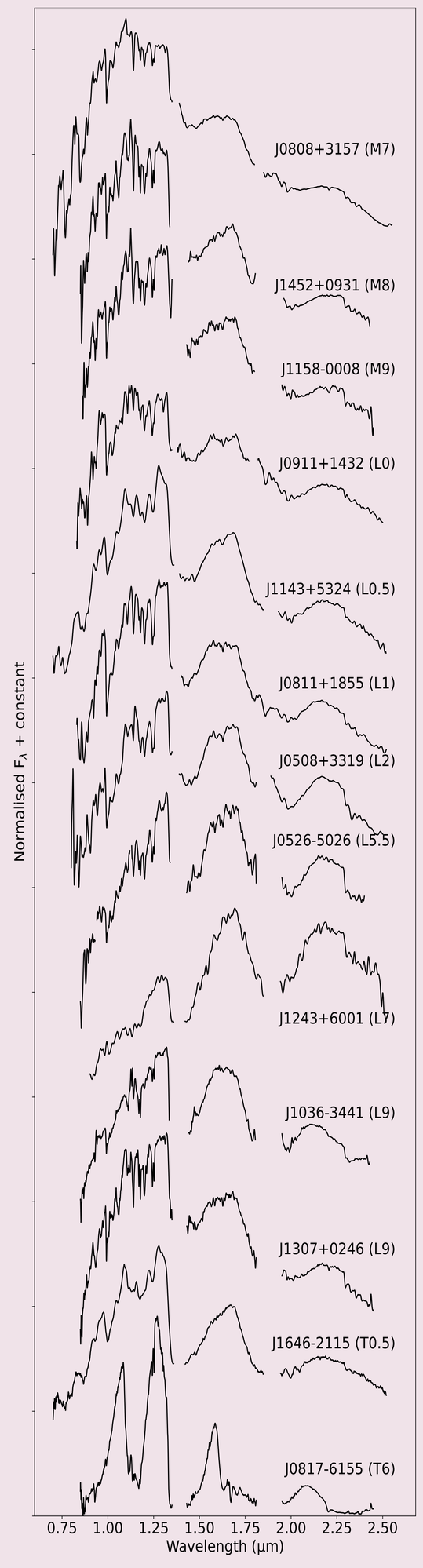
Radial velocities of the candidates can also be calculated using the spectra, namely by cross-correlating each object with our observed UCD templates[7].

Conclusion

In this work we present 51 UCD candidates, 35 of which are previously unclassified. Each candidate has been classified both spectroscopically and photometrically, in order to ensure consistency in the spectral types. We have also identified candidates which may be young, disc or binaries by combining spectral features with published parameters.

Of the 51 UCD candidates in our sample, we determined there to be 26 M-types, 21 L-types and 2 T-types. Of these candidates, 8 have properties expected of young objects, 9 have characteristics associated with disc objects and 8 can be considered to be potential binary objects.

In the future, we aim to derive further properties of the UCD candidates, such as their temperatures and radial velocities.



References: **1** Jones & Steele (2001) *Ultracool Dwarfs: New Spectral Types L and T*; **2** Kumar (1963) APJ 137, 1121; **3** Hayashi & Nakano (1963) PTP 30, 4, 460; **4** Smart et al. (2017) MNRAS 469, 1, 401; **5** Burgasser et al. (2017) *ASI Conference Series* 14, 7; **6** Marocco et al. (2010) A&A 524, A38, 11; **7** Burgasser et al. (2015) APJS 220, 1, 18, 44