Exploring the Metallicity-Motion Relationship in M and L Dwarfs

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Background

- Older stars and brown dwarfs formed when the galaxy was less metal-enriched and should feature lower metallicities as a result
- Older objects are also thought to be kinematically hotter as a population, featuring greater galactic velocity
- As a galactic population, M dwarfs are believed to be older than L dwarfs

Aim

- To investigate the relationship between metallicity and galactic kinematics for M and L dwarfs
  - Do older, higher metallicity objects feature increased galactic motion?
  - Can we find kinematic evidence that M dwarfs are older than L dwarfs?

Data

- 42 M and L dwarfs, SpT mid-M to mid-L
- IR and optical spectra observed Aug. 2015-June 2017 with FIRE and MagE (R=3000) on the Magellan telescopes at Las Campanas Observatory in Chile
- Spectra reduced with Firehose and MASE pipelines *[1,2]*
- Incorporating 18 MagE optical spectra and their radial velocity values from *Burgasser et al. 2015*
- Parallax and proper motions from *GAIA [3]*
- Fundamental properties being determined from BT-Settl Atmospheric Models *(Allard, F. 2014)* in a parallel effort *(Dieterich et al. 2021, in prep)*

Data Reduction

- Flux calibration of spectra using J, H, and K 2MASS magnitudes
- Combining optical and IR spectra
- Gaussian smoothing of BT-Settl models (factor of 50) to resemble resolution of our spectra

Radial Velocity

Radial Velocity Calculation:

Done:
- located *McLean et al. 2007* strong K I lines in BT-Settl models with *[Fe/H]=0*, surface gravity *log(g) = 5*, and T_{eff} similar to our sample

Doing:
- Locating centroid of these lines
  - designing method of choosing range for centroid calculation
  - choosing other lines of interest

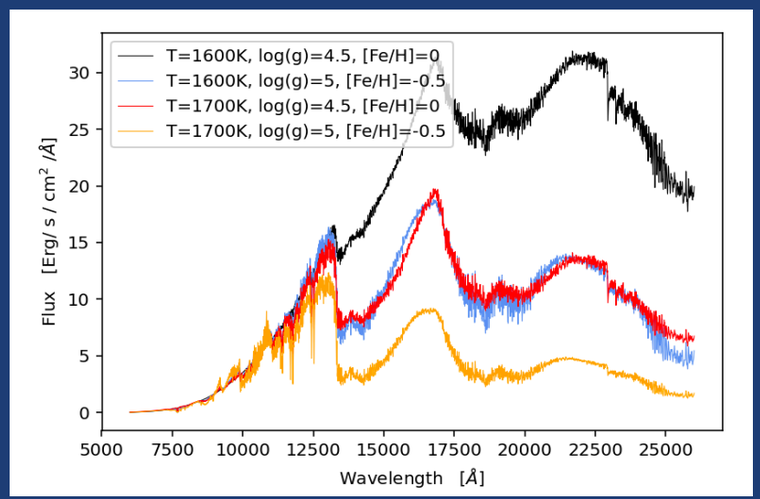
To-Do:
- Calculate difference in centroid location between BT Settl model and our spectrum
- Average all centroid differences for a dwarf to estimate shift in RV

Galactic Motion Calculation:

- Will use eq. 1 of *Johnson & Soderblom 1987*, following *Burgasser et al. 2015*, to calculate U, V, and W from RA, Dec, parallax, radial velocity, and RA and Dec proper motions
- Use galactic motions to establish memberships in thin disk, thick disk, or young moving groups

Metallicity

- Most recent methods of calculating [Fe/H] for M dwarfs do not extend to L dwarfs *(Rojas-Ayala et al. 2012, Newton et al. 2014, Mann et al. 2014)*
- We are trying to create a method of calculating [Fe/H] for both M and L Dwarfs through comparison to the BT-Settl models in both the optical and IR range
  - Biggest issue: accounting for degeneracies in the models *(T_{eff}, surface gravity, metallicity)*
  - Once we have it, we can test the validity of our method by comparing our mid M dwarf [Fe/H] values to those calculated through previous methods *(e.g. Rojas-Ayala et al. 2012, Newton et al. 2014, Mann et al. 2014)*



4 BT-Settl models, normalized from 6500-10,000 Å. Note the degeneracy (in red and blue) created by varying temperature, surface gravity, and metallicity. As more models are added to the plot, more degeneracies are seen in various wavelength ranges. We are currently trying to account for these degeneracies.

How do RV and [Fe/H] relate?
…to be determined!

References

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