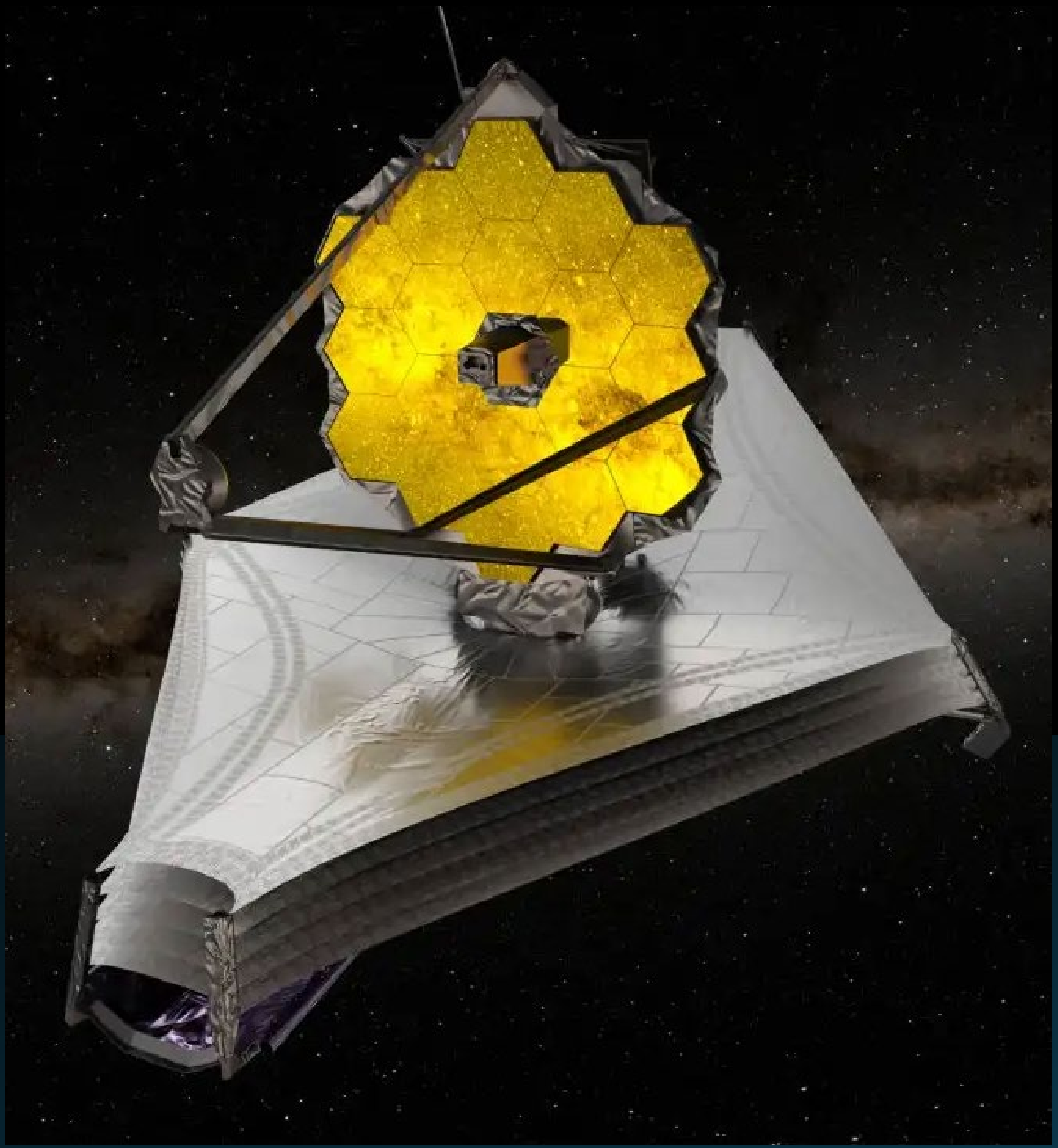
The CIA Mystery: Collision-Induced Absorption in Ultracool White Dwarfs



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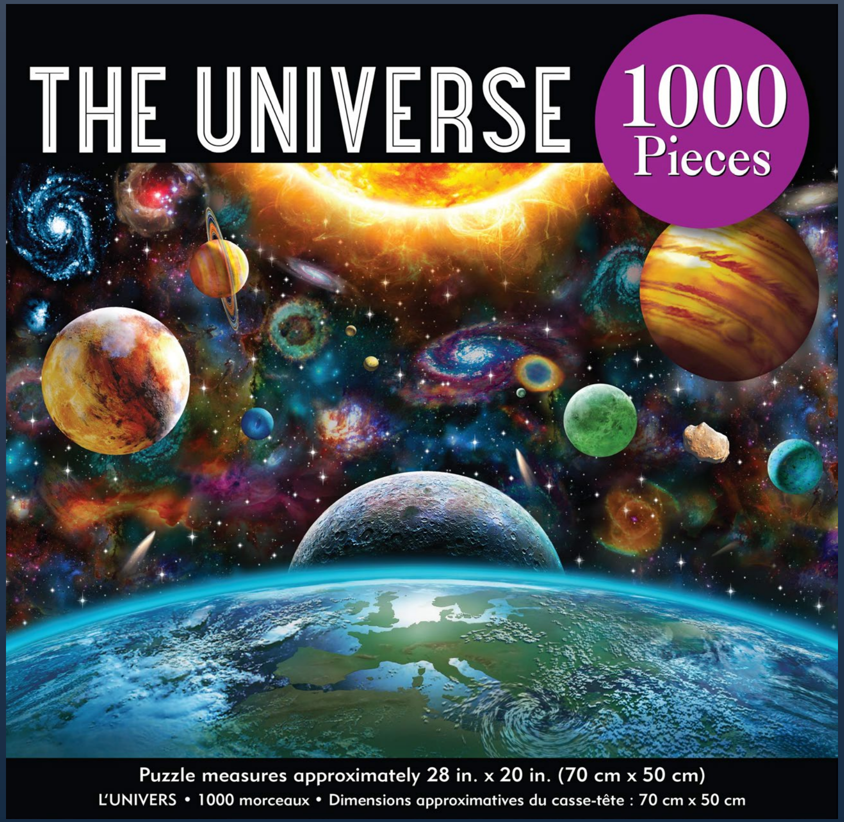
White Dwarf Age Dating

- Many applications require accurate WD model atmospheres to reliably infer WD ages:
  - Determining the ages of individual stellar populations[6, 7]
  - Reconstituting the formation history of our Galaxy[4]
  - Calibrating models for M, L, and T dwarf companions[10]
  - Tracing back the chemical evolution of our Galaxy[9]



Current Issues

- 10% (400 K) uncertainty on T_{eff} implies 1 Gyr error on cooling age
- Recent analyses differ by more than 1000 K[1, 3]
- Poor agreement between models and observations
- Atmospheric compositions can only be inferred from a detailed fit to their SEDs
- Difference in cooling time between He-dominated and H-dominated atmosphere is of the order 2 Gyr

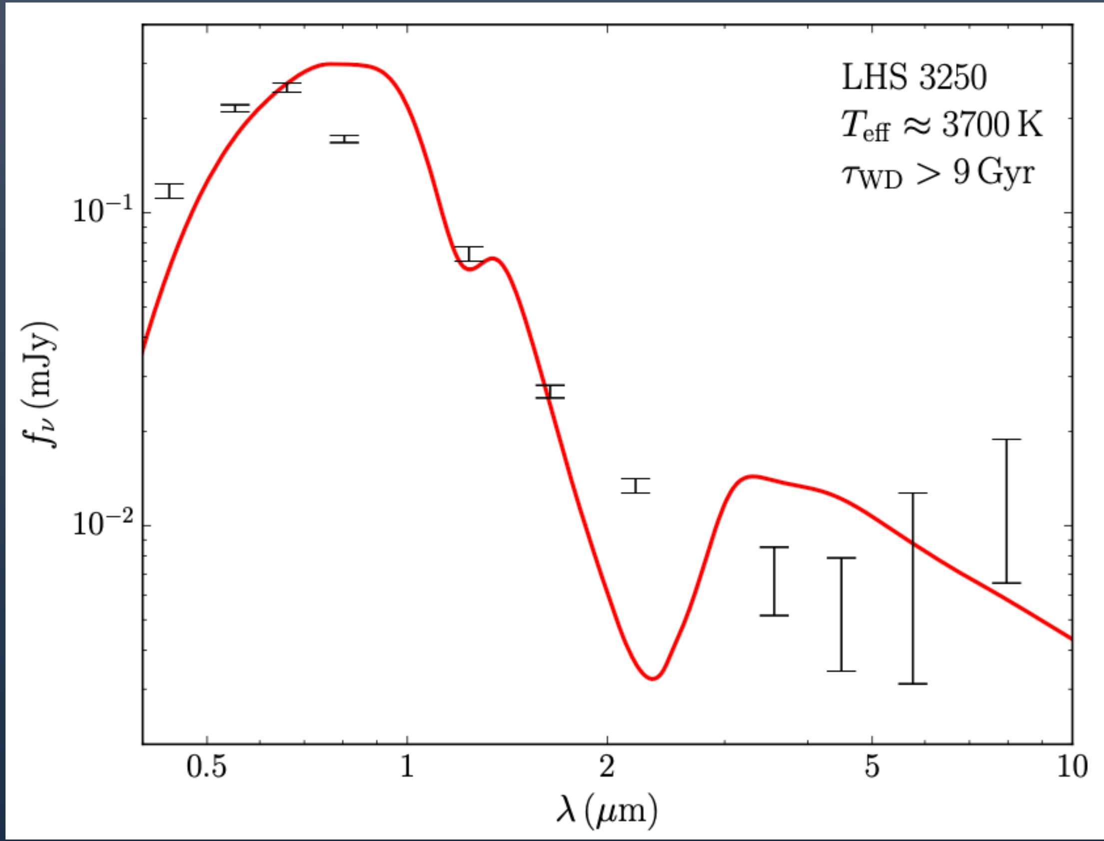


Figure 2: Best fit (in red) to the SED of LHS 3250, a typical ultracool WD and one of the three targets. The error bars show the BVRIJHK and Spitzer 3.6 – 8 µm photometry.

Not so cool after all...

- Ultracool WDs might be in the T_{eff} = 4000 – 5000 K range[1] instead of T_{eff} = 3000 – 4000 K range[5]
  - Updated physics of models[2]
  - Explored effect of changing collision-induced absorption (CIA) opacities
- Found much better fits using older CIA calculations[8]
- Predictions of the locations of the H_2 absorption features differ greatly

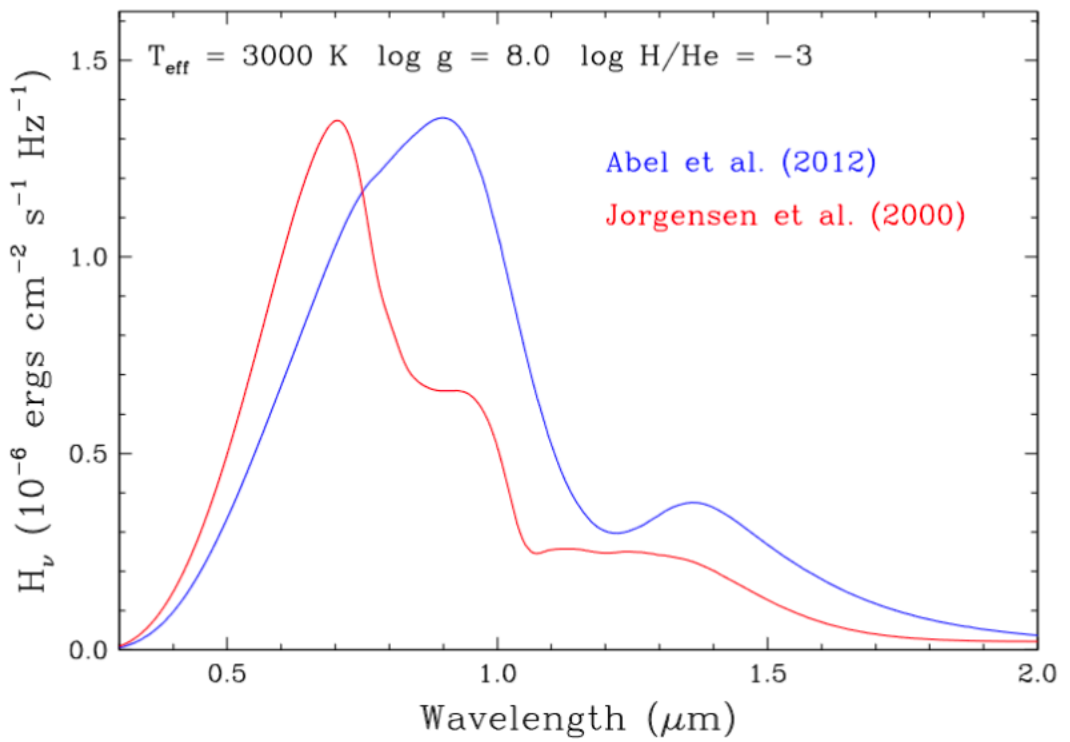


Figure 3: Model SEDs of ultracool WDs for two different choices of CIA opacities. (Bergeron et al. 2022)

Goals

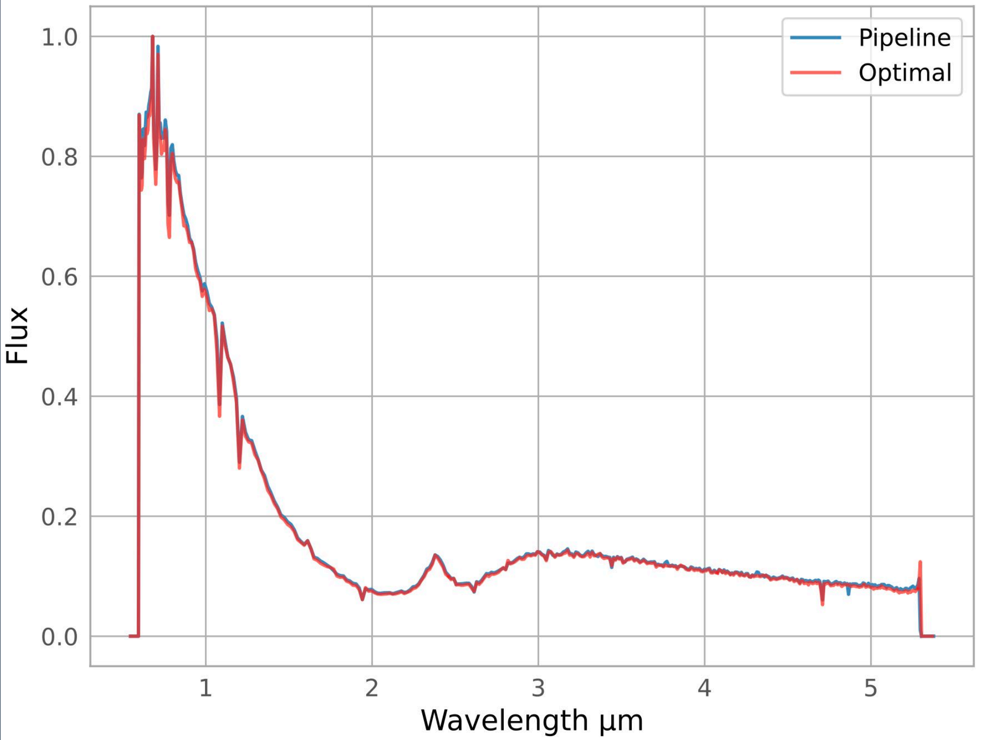
Obtain first IR spectra of ultracool WDs using NIRSpec and MIRI

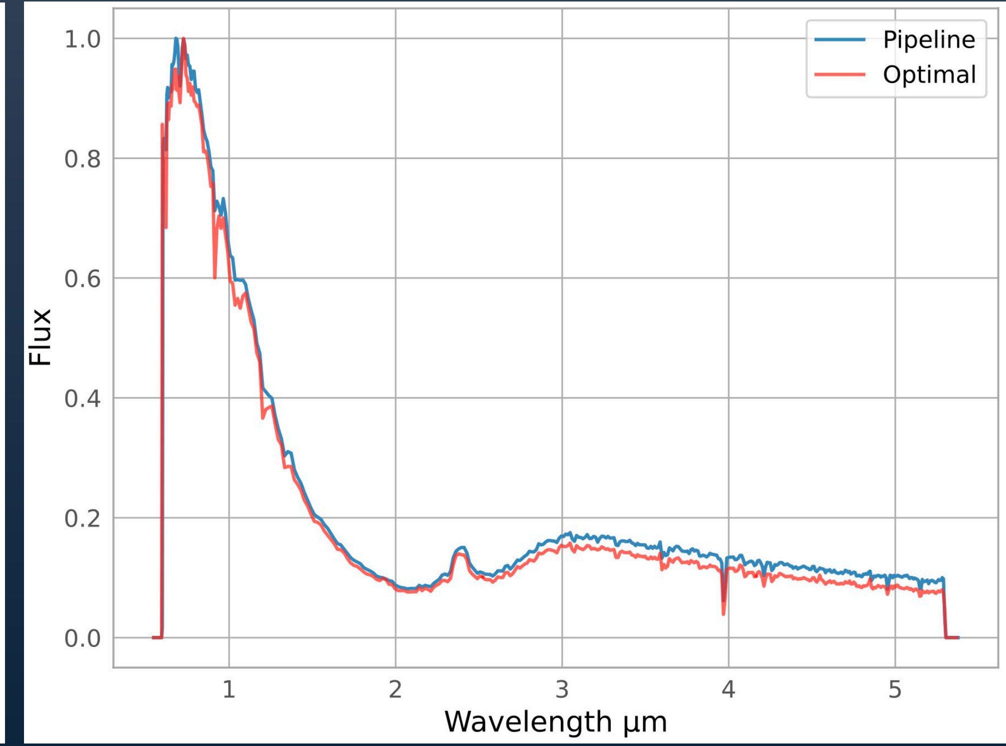
Utilize IR spectra to unveil & resolve CIA features

Settle the debate on the very nature of ultracool WDs

What has been done so far?

- Obtained JWST spectroscopy of three ultracool WDs
- Used JWST Pipeline to obtain optimally extracted spectrum of J1922 and LHS 3250





Figures 3 (left) and 4 (right): Optimally extracted spectrum of the two dithers for the J1922 target (red) compared with the x1d pipeline product (blue). Note the emission feature near 2.4 μm.

References

[1] Bergeron et al. 2022, ApJ, 934, 36

[2] Blouin et al. 2018, ApJ, 863, 184

[3] Elms et al. 2022, MNRAS, 517, 4557

[4] Fantin et al. 2019, ApJ, 887, 148

[5] Gianninas et al. 2015, MNRAS, 449, 3966

[6] Hansen et al. 2007, ApJ, 671, 380

[7] Hansen et al. 2013, Nature, 500, 51

[8] Jorgensen et al. 2000, A&A, 361, 283

[9] Kaiser et al. 2021, Science, 371, 6525

[10] Meisner et al. 2020, ApJ, 889, 123