

Spectroscopic Identification of a Metal-Poor Brown Dwarf Candidate

with JWST/COSMOS-3D slitless spectroscopy

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TAKE-HOME RESULT

ID 639188 is identified as a cool metal-poor brown dwarf in COSMOS-3D using a centered JWST/WFSS trace, F444W-consistent custom extraction, and atmosphere-model fitting.

$T_{\text{eff}} \sim 700 \text{ K}$

$\log g \sim 4.0 - 4.5$

$[M/H] \sim -1.1 \text{ to } -0.85$

Photometry $\chi^2 = 0.37$
Spectroscopy $\chi^2 = 1.16$

SUPPLEMENTARY SLIDES



TARGET DETAILS

COSMOS2025 ID: 639188
(RA, Dec):
(150.0634341, +2.3552216)

NIRCam photometry:
F115W = 24.216 ± 0.011 mag
F150W = 24.895 ± 0.011 mag
F277W = 25.509 ± 0.019 mag
F444W = 22.160 ± 0.003 mag

Very red color:
F277W – F444W = 3.35 mag

SUMMARY

A centered 2D trace, red JWST photometry, and custom-extracted WFSS spectrum consistently favor a cool brown dwarf atmosphere.

Independent atmosphere model checks support $T_{\text{eff}} \sim 600 - 700 \text{ K}$. The subsolar metallicity is consistent with an old, metal-poor brown-dwarf atmosphere.

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1- Why brown dwarfs?

Brown dwarfs bridge stars and planets: too low-mass for stable hydrogen fusion, but warm enough to show molecular atmospheres [1]. Metal-poor brown dwarfs trace old populations and test low-metallicity atmosphere models.

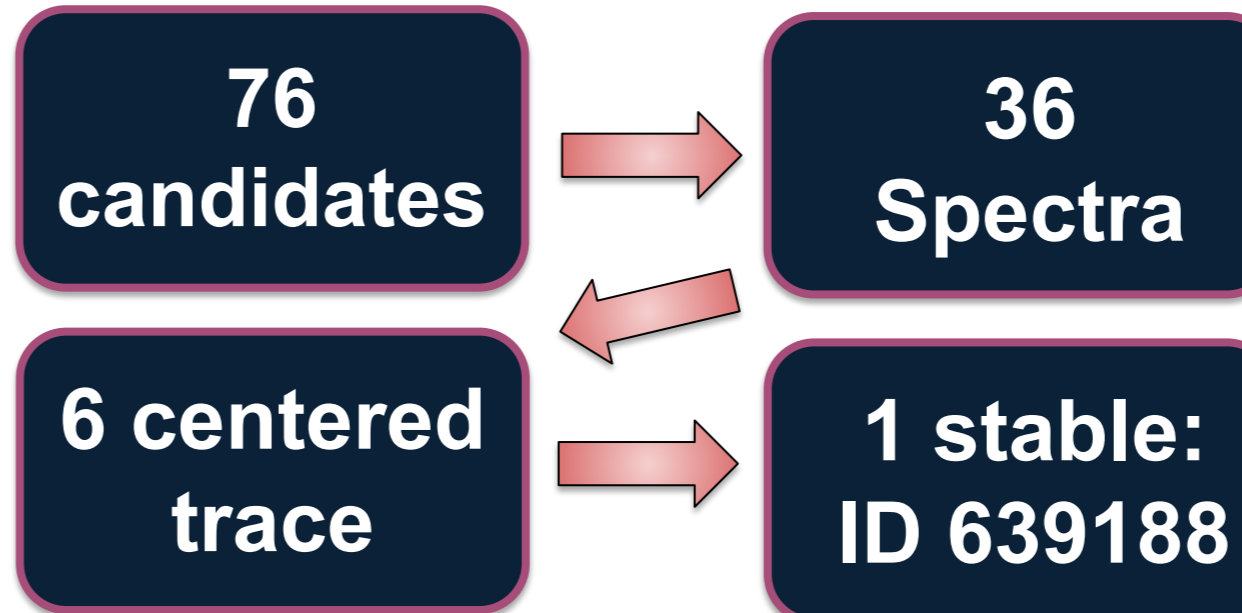
2- Pre-selected candidates

Applying $S/N(F444W) > 9$, catalog quality flags, point-source morphology, red V-shaped SED colors, visual inspection, and initial atmosphere-model checks yielded **76 brown-dwarf candidates** [3].

3- Data

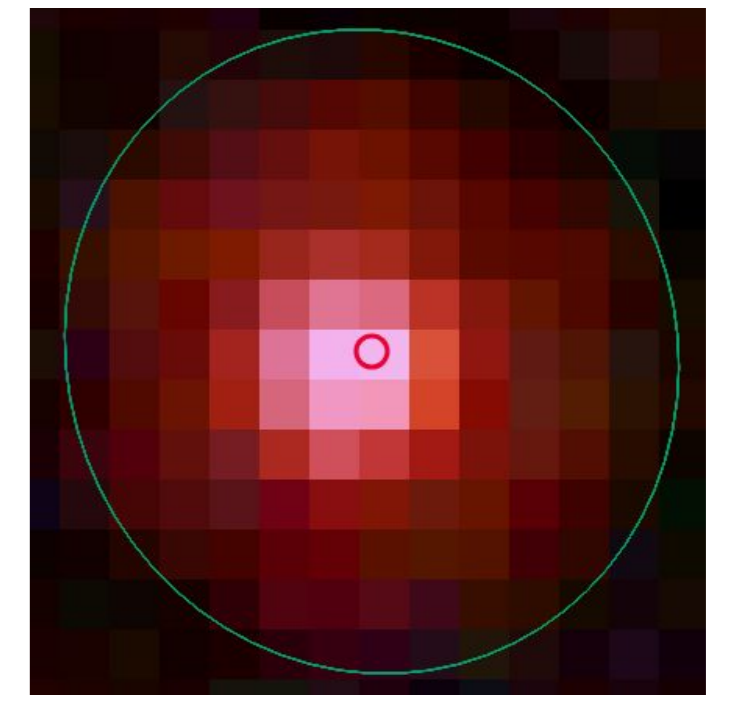
We use COSMOS-3D [2], a JWST Cycle 3 Large Programme with NIRCam/WFSS F444W spectroscopy over $\sim 0.33 \text{ deg}^2$, to test whether faint red COSMOS-Web point sources can be spectroscopically confirmed as cool brown dwarfs.

JWST makes faint, distant cool brown dwarfs detectable at kpc scales.



4- Final Target: ID 639188

ID 639188 was selected from the COSMOS-3D coverage for its **centered trace, low contamination, red SED, and stable atmosphere model solution.**



COSMOS-Web NIRCam Image Cutout
(Ra, Dec): (150.0634341, 2.35522156)

5- Trace validation: why 639188 is credible

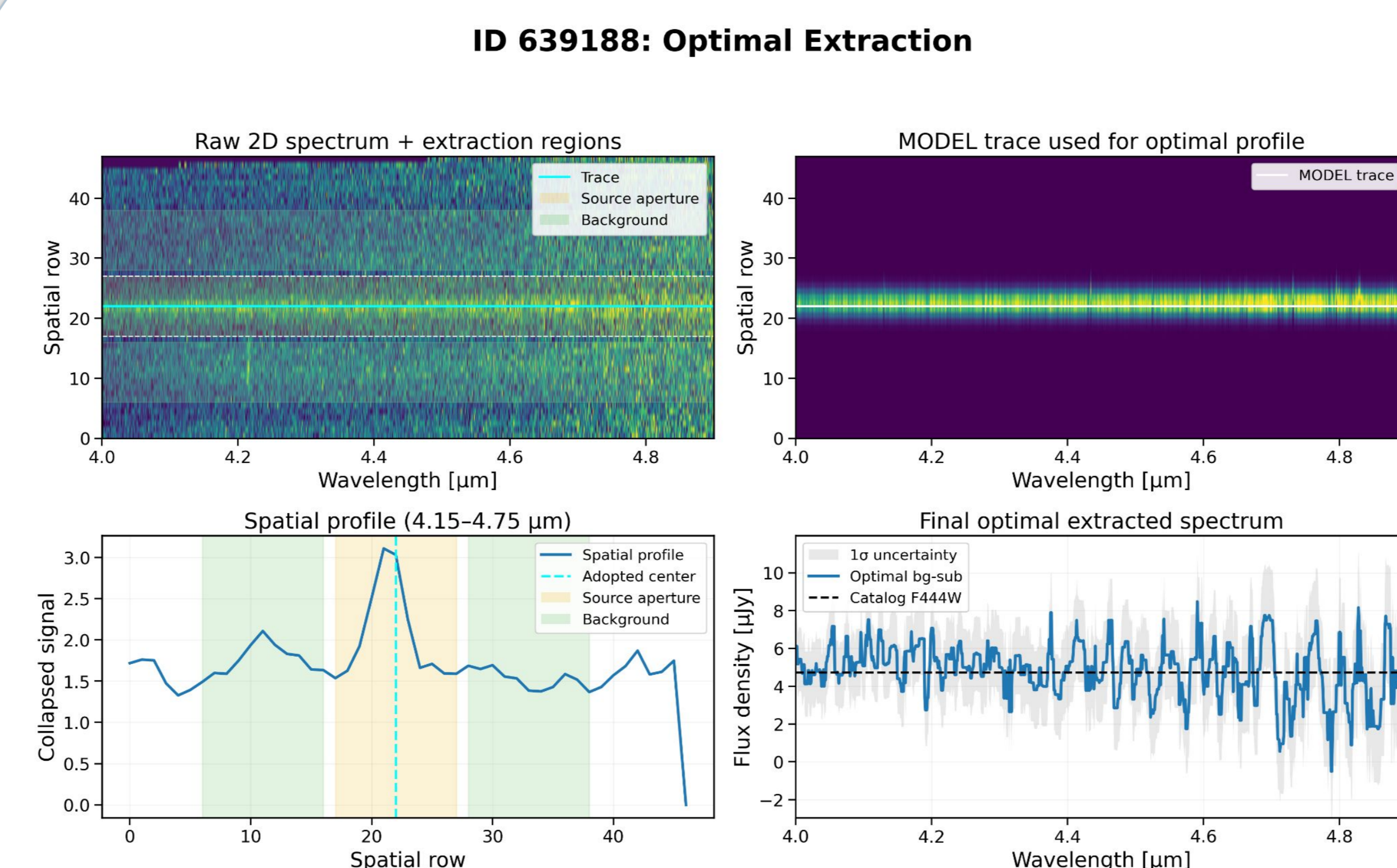


Fig. 1: Centered 2D trace; optimal extraction uses the model profile and local background regions.

8- Main result: ID 639188

SAND best fit: $T_{\text{eff}} \sim 700 \text{ K} \mid \log g \sim 4.5 \mid [M/H] \sim -0.85 \mid [\alpha/Fe] \sim 0.10$

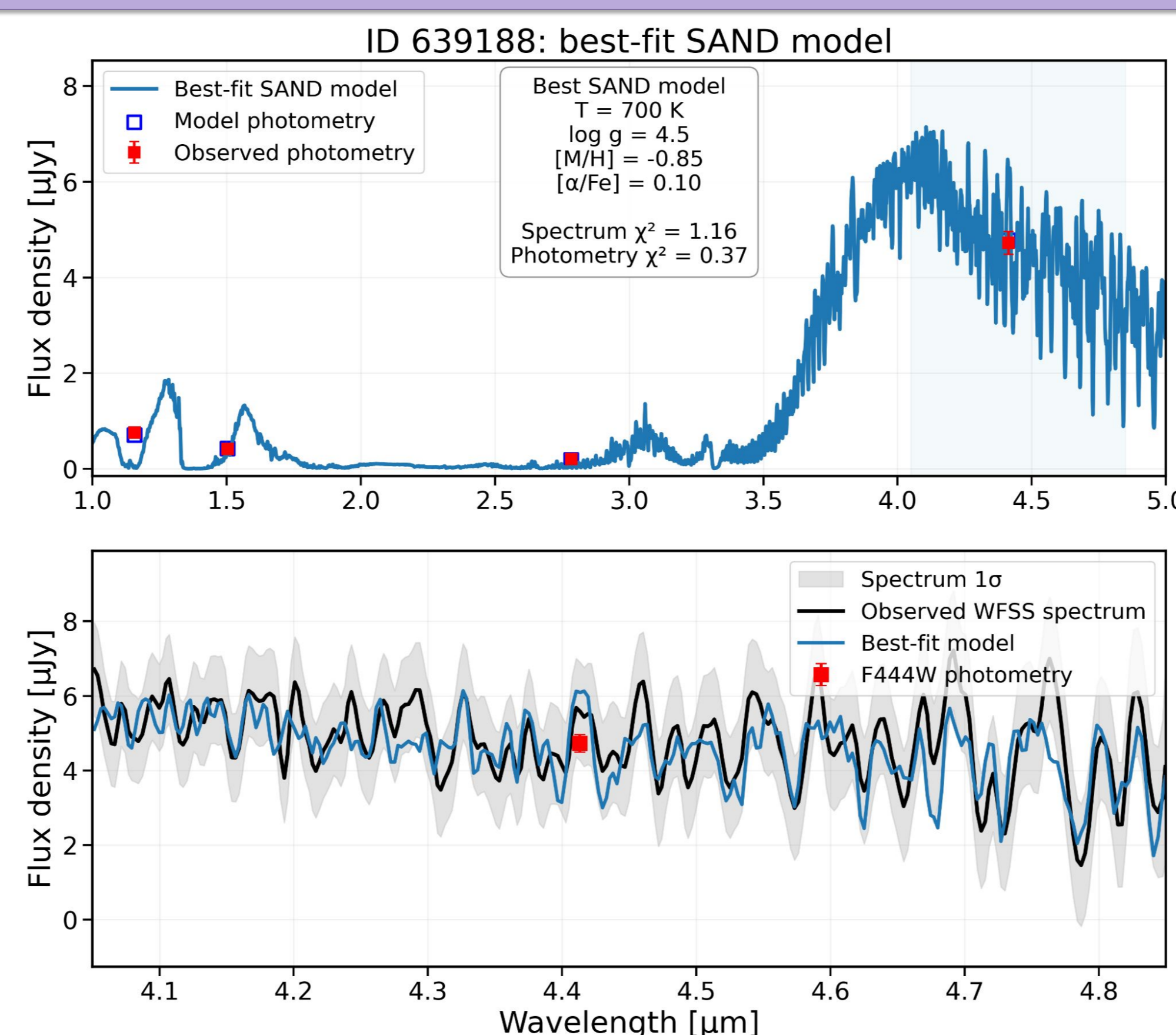


Fig. 2: Photometry and spectrum are broadly matched by a cool SAND model.

Residual check: observed - model

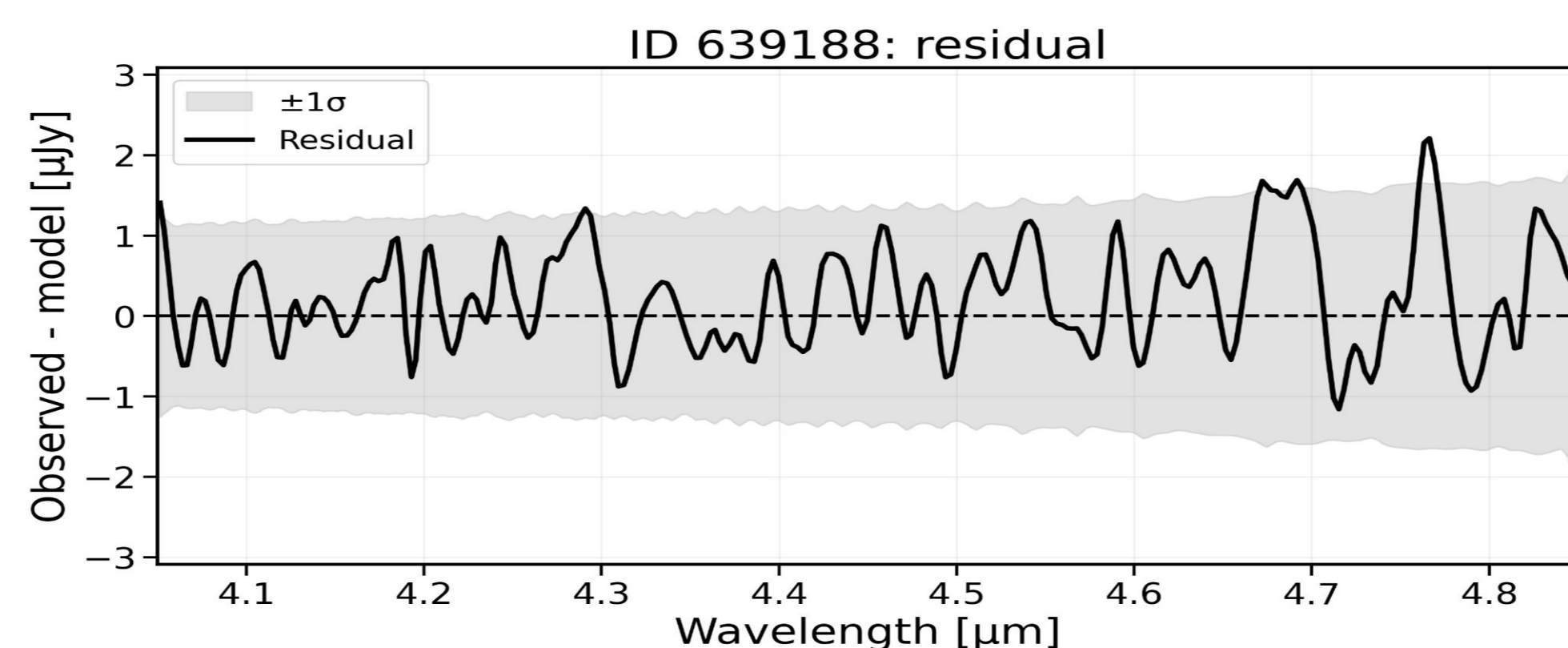


Fig. 3: Residuals are mostly consistent with the 1σ uncertainty.

Robustness: SAND, ATMO 2020, and Sonora Elf Owl all favor $T_{\text{eff}} \sim 600 - 700 \text{ K}$.

6- Why SAND models?

- The Spectral ANalog of Dwarfs (SAND) is a brown dwarf atmosphere grid.
- It spans T_{eff} , $\log g$, metallicity, and $[\alpha/Fe]$ [4].
- Useful for testing old / metal-poor candidates, not only solar-metallicity field dwarfs.

7- Fitting Logic

- 1 Photometry
F115W, F150W, F277W, F444W
- 2 Extracted 1D spectrum
4.05-4.85 μm
- 3 Joint fit with SAND

9- Physical interpretation

- Cool atmosphere: broad SED favors a very cool brown-dwarf solution.
- Low metallicity is consistent with an old substellar atmosphere.
- Residuals are mostly comparable to the 1σ envelope, but small-scale structure remains noisy.

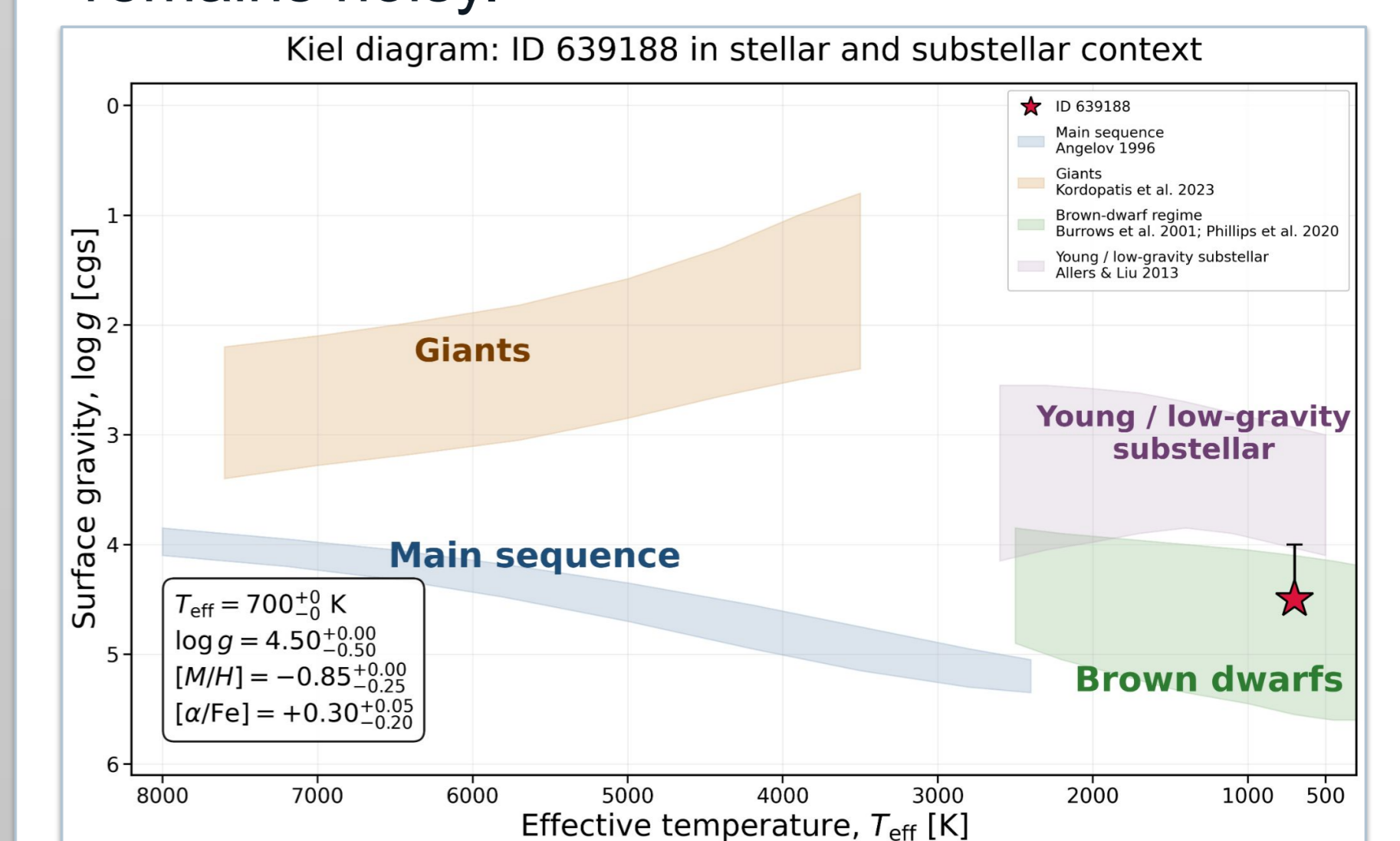


Fig. 4: ID 639188 lies in the cool, high-gravity brown-dwarf regime. Shaded regions are approximated schematic.

10- Conclusion

- ID 639188 is a newly identified cool, metal-poor brown dwarf.
- It is the coolest source in our spectroscopically analyzed COSMOS-3D sample, with $T_{\text{eff}} \sim 600-700 \text{ K}$.
- SAND, ATMO 2020, and Sonora Elf Owl give consistent solutions.

ID 639188
A newly identified
cool metal-poor brown dwarf

References

[1] Cushing et al. 2008, ApJ, 678, 1372
[3] Festin et al. 2026, PASP, under revision

[2] Kakiichi et al. 2024, JWST Proposal, 5893
[4] Alvarado et al. 2024, RNAAS, 8, 134