SN2024uj: molecule formation in a Ca-strong transient

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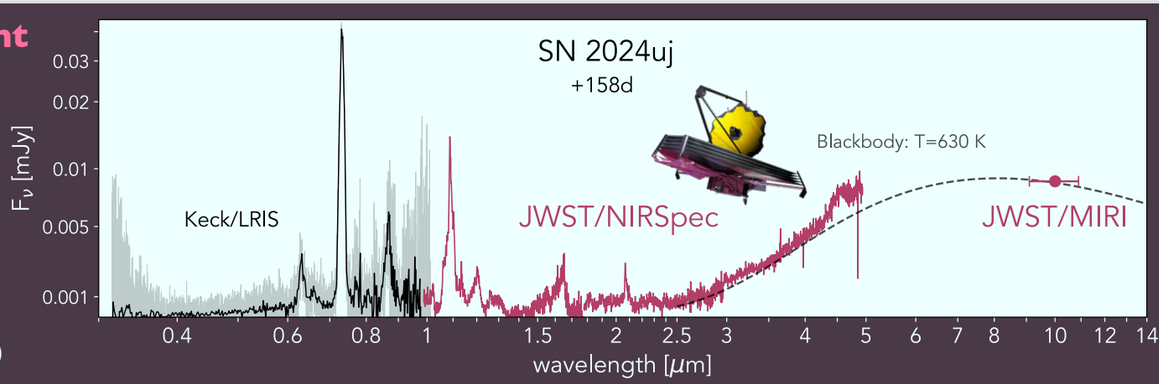
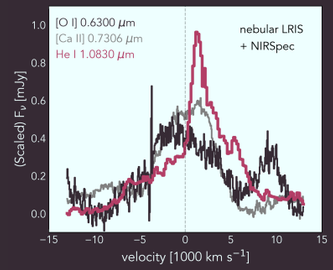
First-ever Ca-strong Transient Observed with JWST

- Ca-strong transients: rare subclass of supernovae (SNe) w/ debated progenitor systems
- Nebular spectrum (+100d post-explosion) → insight on SN structure and composition
- JWST data: program DD 6591 (PI: L. A. Kwok)

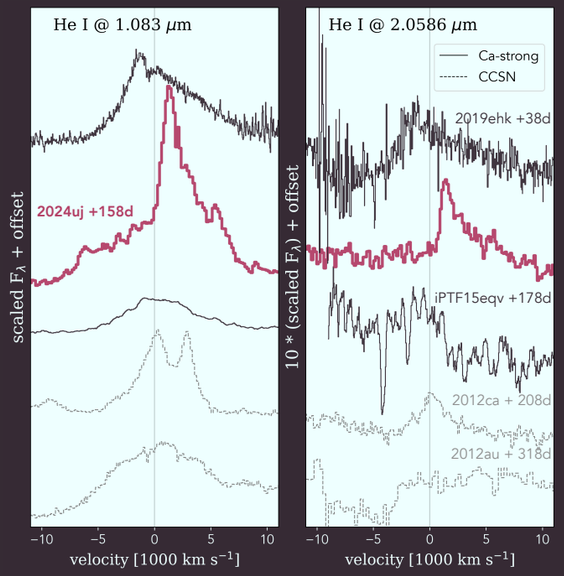




Prominent profiles hint at complex structure

- Helium likely originates from different region than oxygen and calcium

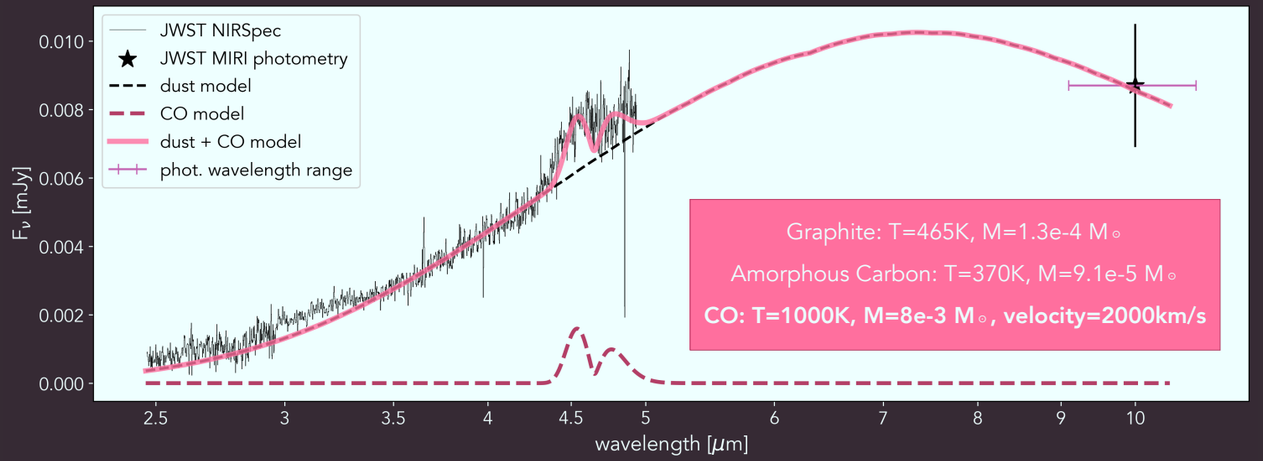
Clear Helium in NIR



- Unambiguous detection of He at 1 & 2 microns

Dust and Freshly Formed Carbon Monoxide

- Modeling dust as amorphous carbon (AmC) and graphite; models from Joel Johansson
- Modeling carbon monoxide fundamental band (at 4.5 - 5 microns); referencing [1], [2], [3]



Progenitor scenarios

Core-collapse	Thermonuclear
✓ Helium emission ✓ Dust and molecule formation ✓Optical and NIR spectra resemble SN Ib (massive star explosion)	✓ Located far from star formation (WD explosion) ✓ Helium could be explained by Helium novae (e.g. [4])
✗ Isolated location, far from star formation	✗ Helium emission

References

[1] S. H. Park et al., "Near-Infrared Spectroscopy and Detection of Carbon Monoxide in the Type II Supernova SN 2023ixf," Jul. 16, 2025, arXiv: arXiv:2507.11877. doi: 10.48550/arXiv.2507.11877.
[2] J. Cami, R. van Malderen, and A. J. Markwick, "SpectraFactory.net: A Database of Molecular Model Spectra," The Astrophysical Journal Supplement Series, vol. 187, pp. 409–415, Apr. 2010, doi: 10.1088/0067-0049/187/2/409.
[3] D. Goorvitch, "Infrared CO Line List for the X 1 Sigma + State," The Astrophysical Journal Supplement Series, vol. 95, p. 535, Dec. 1994, doi: 10.1086/192110.
[4] C.-G. Touchard-Paxton et al., "SN 2023xwi: forbidden line emission in the peak spectrum of a Ca-strong transient," Monthly Notices of the Royal Astronomical Society, vol. 537, pp. 1015–1027, Feb. 2025, doi: 10.1093/mnras/staf069.

Acknowledgments

S. H. thanks the LSST-DA Data Science Fellowship Program, which is funded by LSST-DA, the Brinson Foundation, the WoodNext Foundation, and the Research Corporation for Science Advancement Foundation; her participation in the program has benefited this work.