A new type of supernova from an exploding carbon-oxygen star

Main points:

- Some of the most massive stars in our galaxy blow dense winds of carbon and oxygen from their outer surface (Wolf-Rayet stars)
- These were predicted to explode as supernovae, but no such explosions were known
- We discovered a new type of supernova explosions that originate from such stars

Thanks to the WIS team and all the co-authors of Gal-Yam et al. 2022

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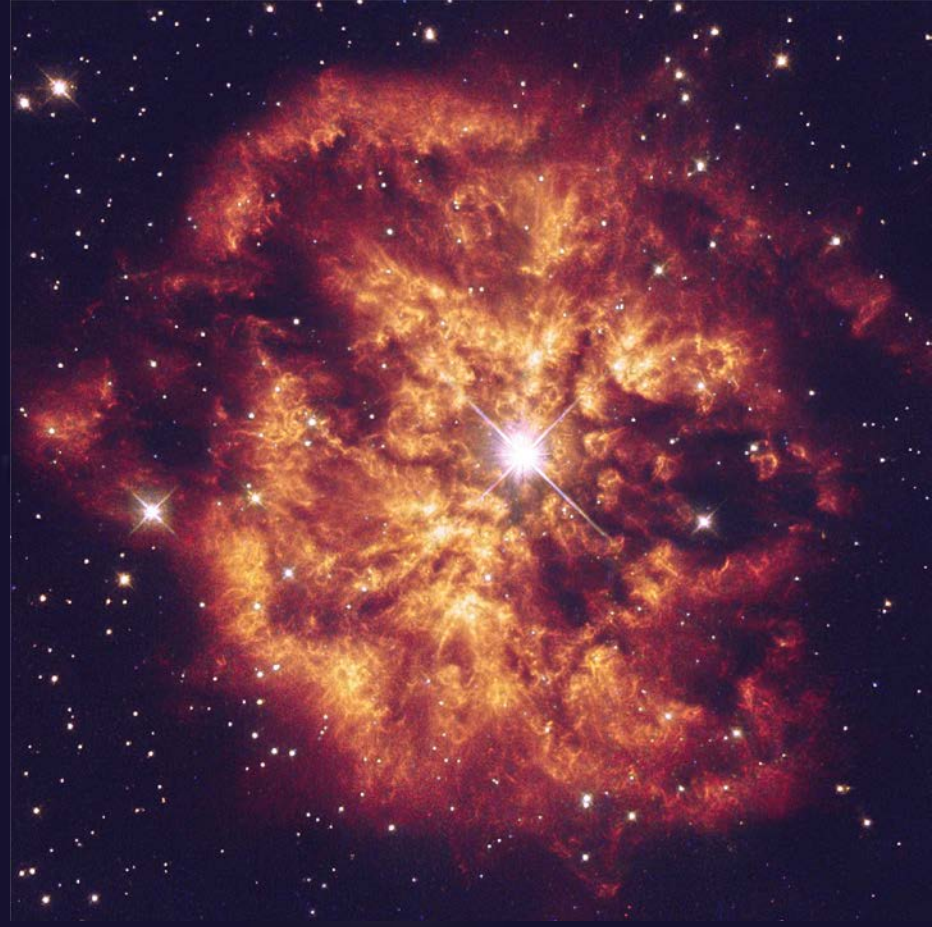
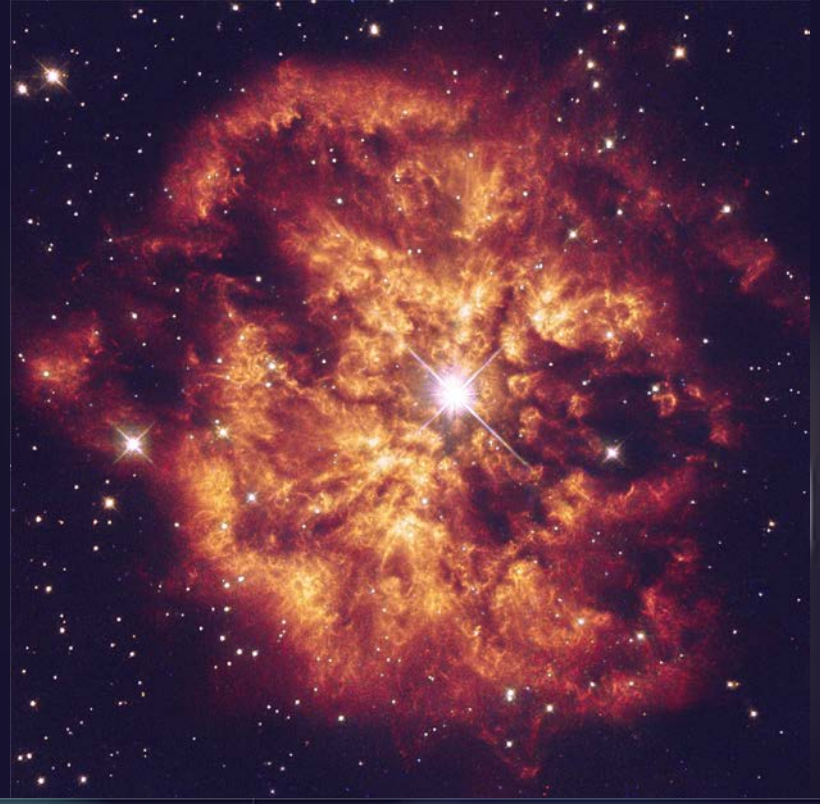
Wolf-Rayet Stars

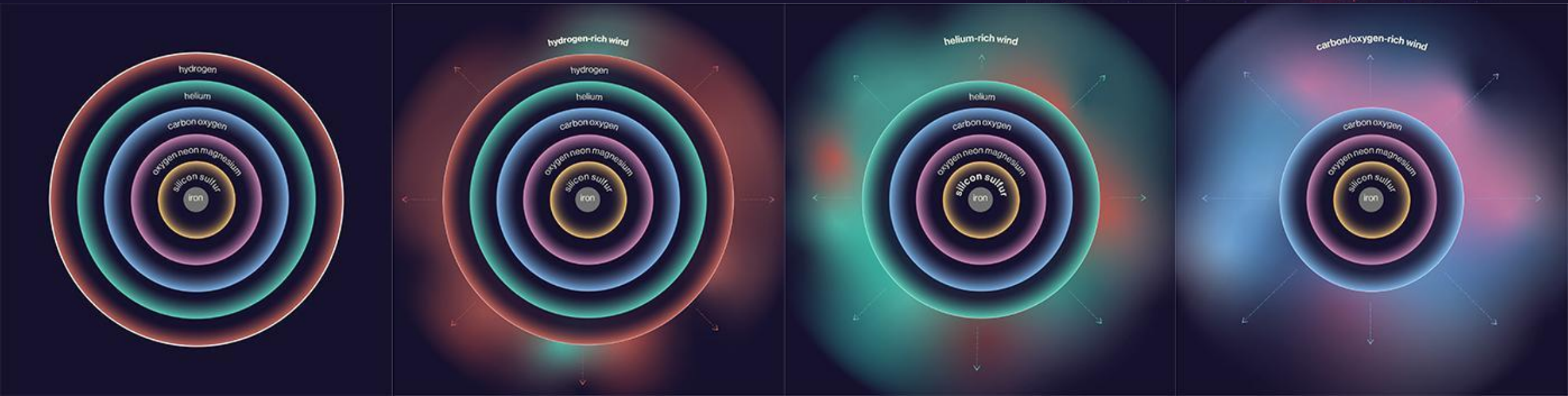
- Some of the most massive stars in our galaxy are surrounded by dense winds, blown from their outer surfaces; these are called Wolf-Rayet (WR) stars
- These winds are rich in elements heavier than the ubiquitous hydrogen: some stars show helium and nitrogen (“WN”), and others are dominated by carbon and oxygen (“WC”)
- Such massive stars are expected to explode as supernovae; the failure to locate such events led some to speculate that WR stars collapse silently to black holes



Wolf-Rayet Stars

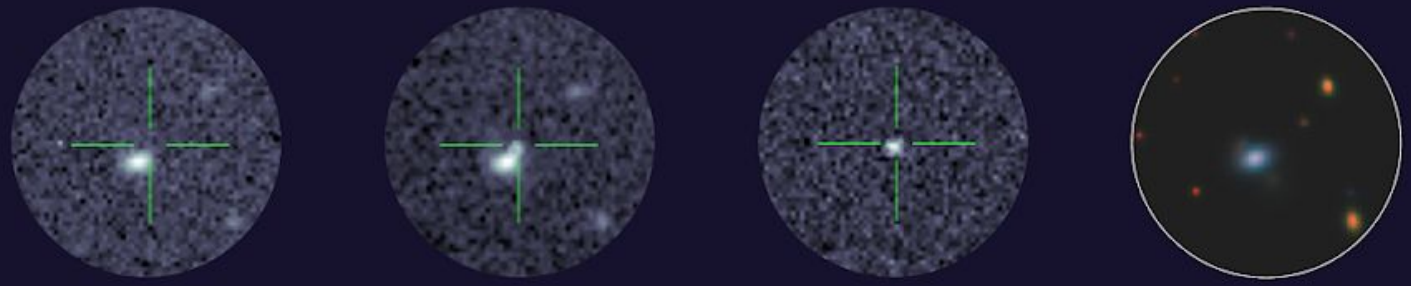
- Due to continuous nuclear fusion in their cores, all massive stars are composed of layers of elements: light on the outside and heavier as we go in.
- Continuous removal of the external layers exposes the inner layers that lie below





SN 2019hgp

On June 8th 2019, the Supernova was discovered by the **Zwicky Transient Facility survey** (ZTF), one day after explosion, at the outskirts of a galaxy almost 1 billion light years away.

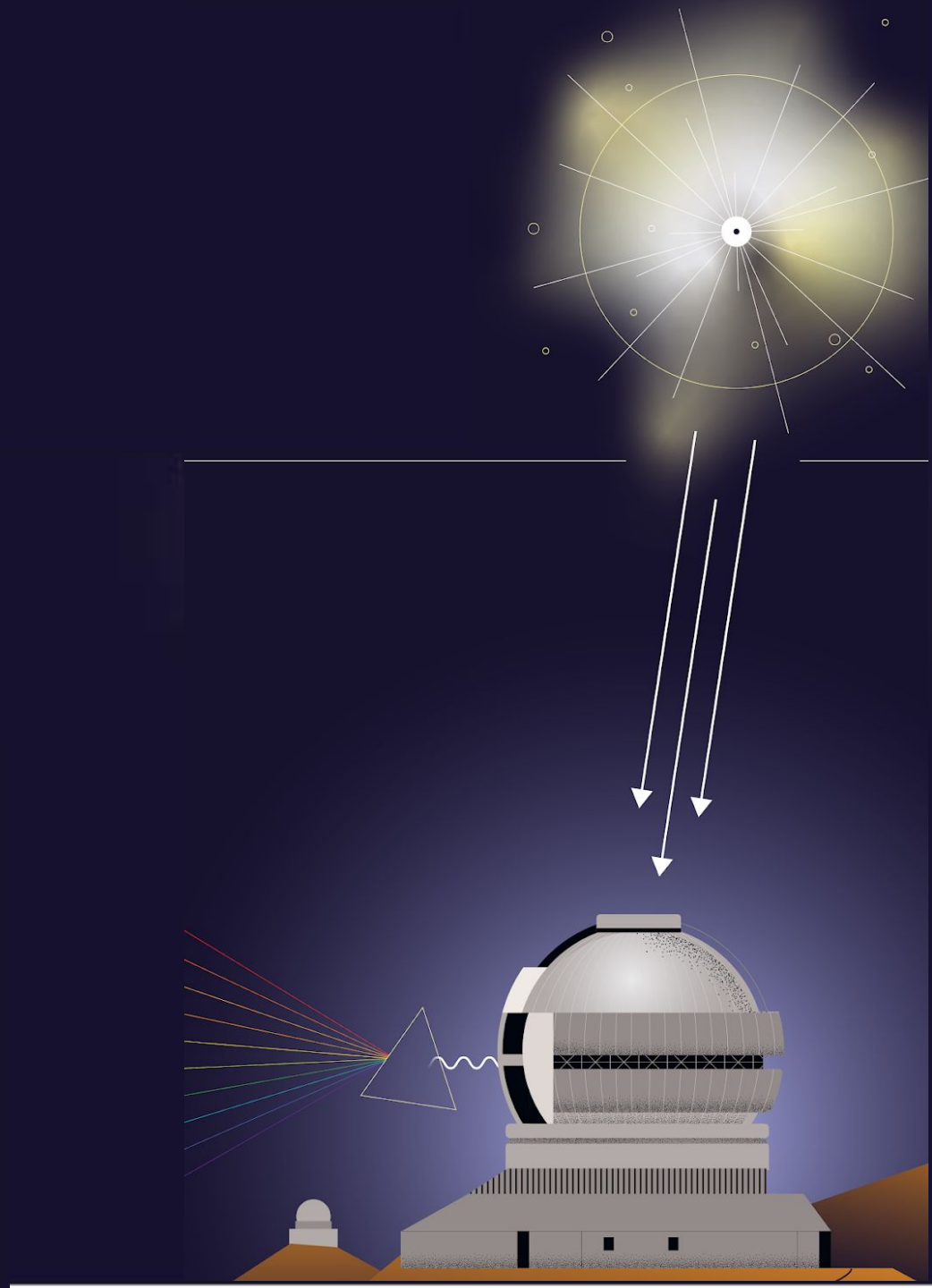


Pre-explosion reference

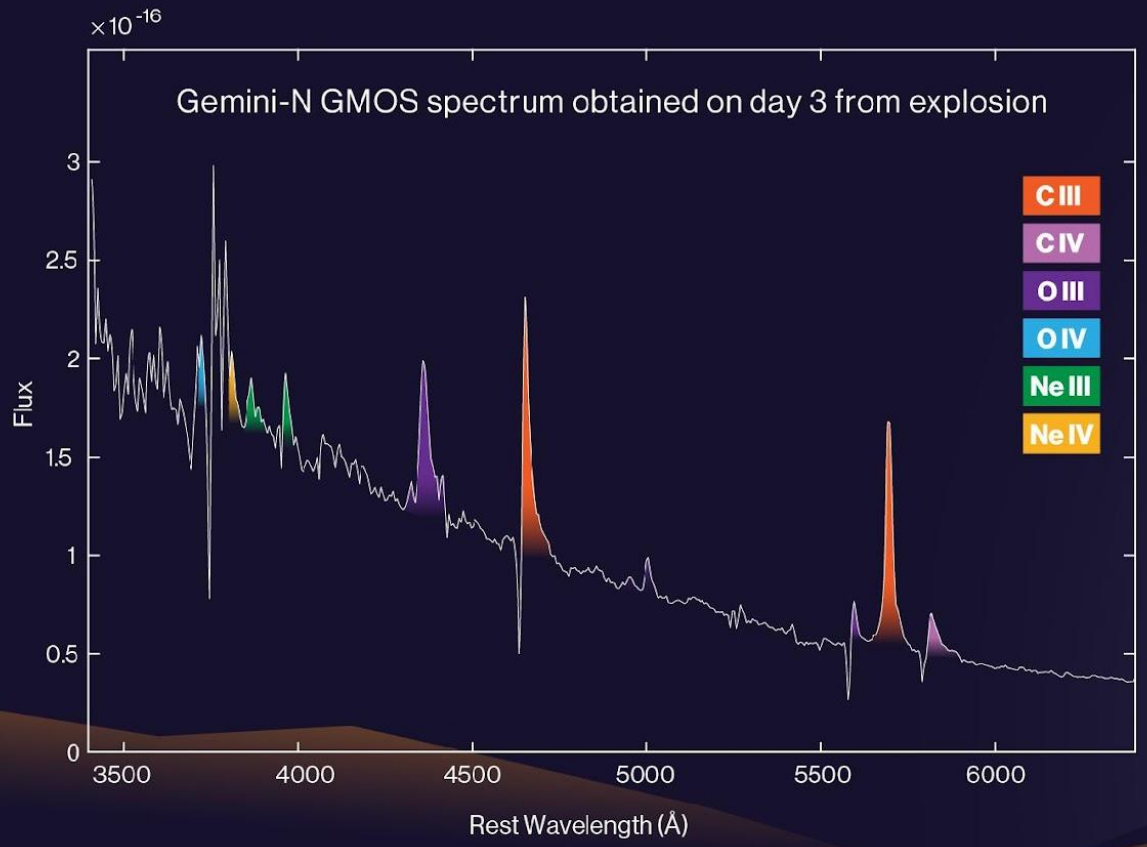
New image

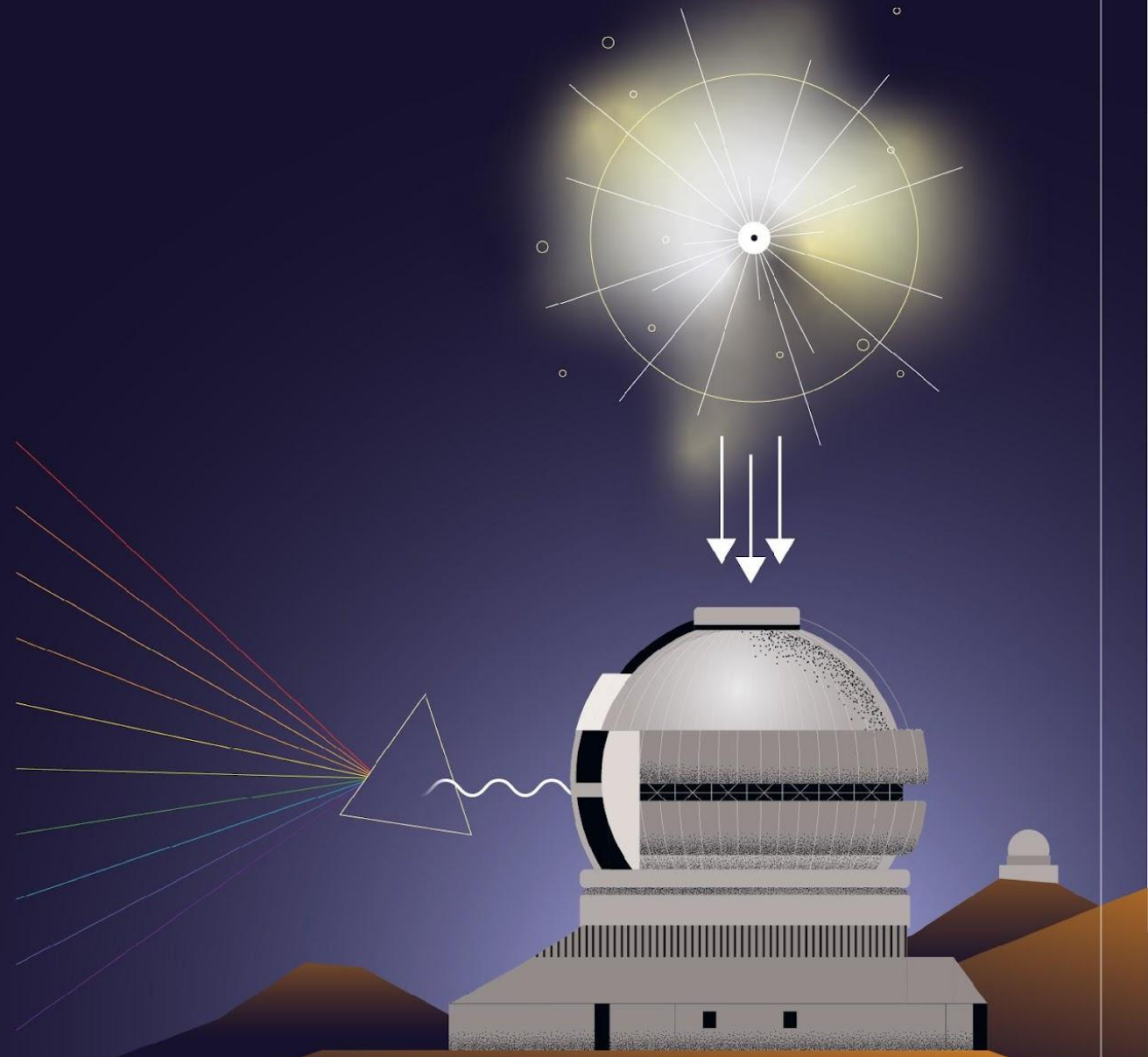
Difference image

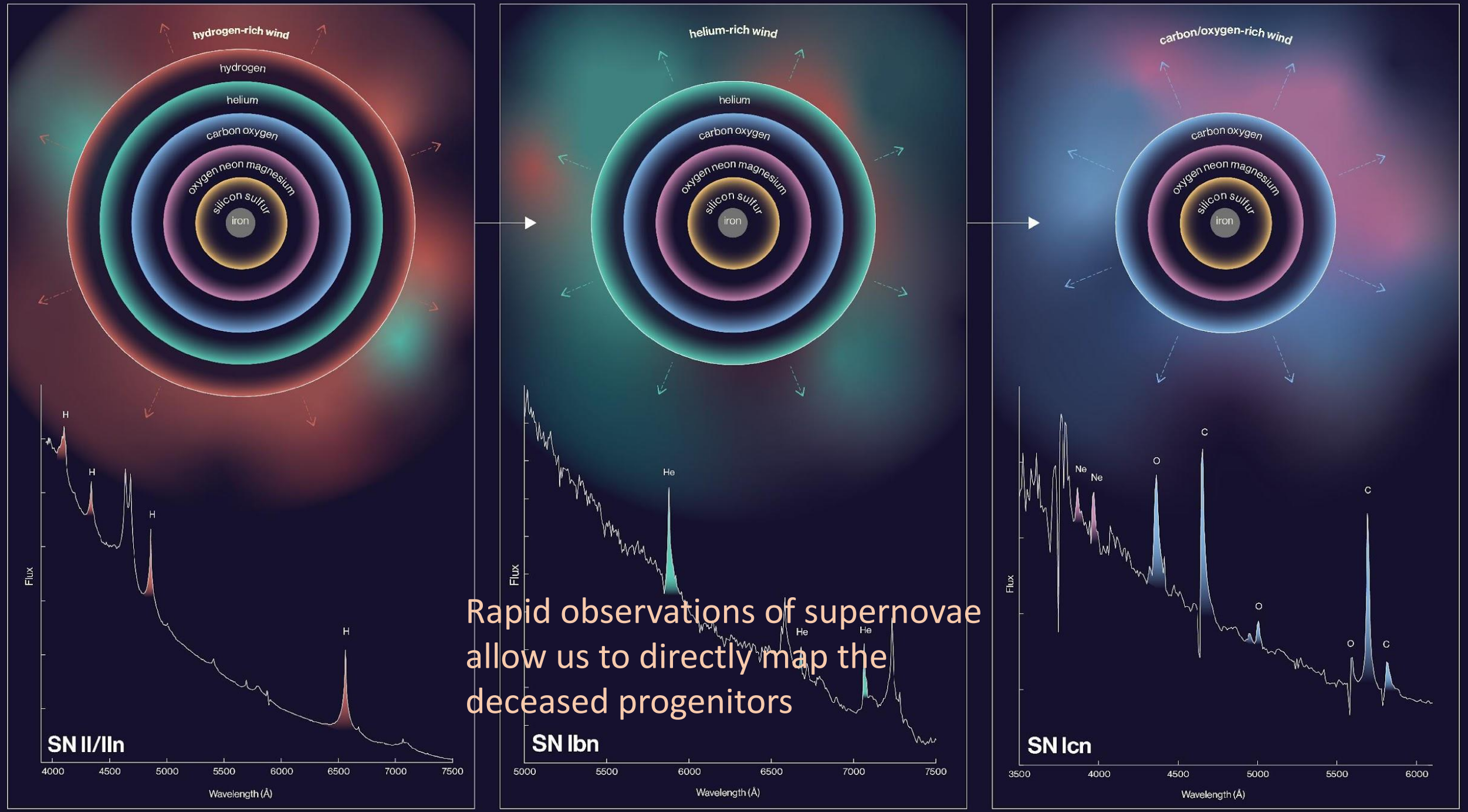
Legacy Survey image of the field



Early spectra are dominated by emission lines of highly ionized carbon, oxygen and neon, with no obvious trace of hydrogen or helium, and indicate that the Supernova exploded within a circum-stellar nebula similar to those of Wolf-Rayet stars of the WC family.





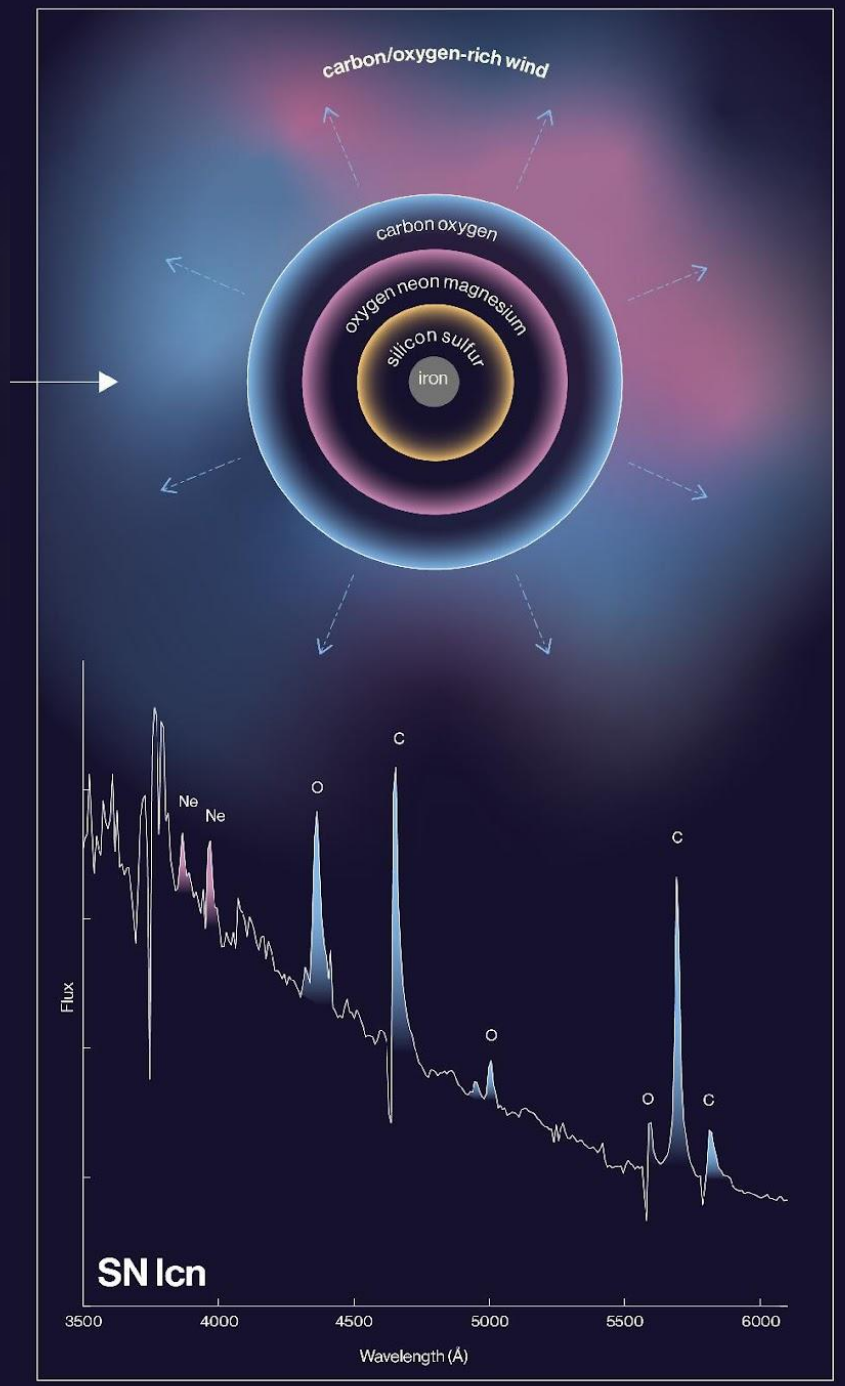


Rapid observations of supernovae allow us to directly map the deceased progenitors

A new type of supernova from an exploding carbon-oxygen star

Our study shows that:

- Some Wolf-Rayet stars explode
- These explosions manifest as a new type of supernova explosion
- Comparison of the ejected mass in the explosion to the estimated mass of the progenitor WC star, suggest the explosion may have resulted in a black hole



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