PHL 293B: The Possible Disappearance of a Massive Star

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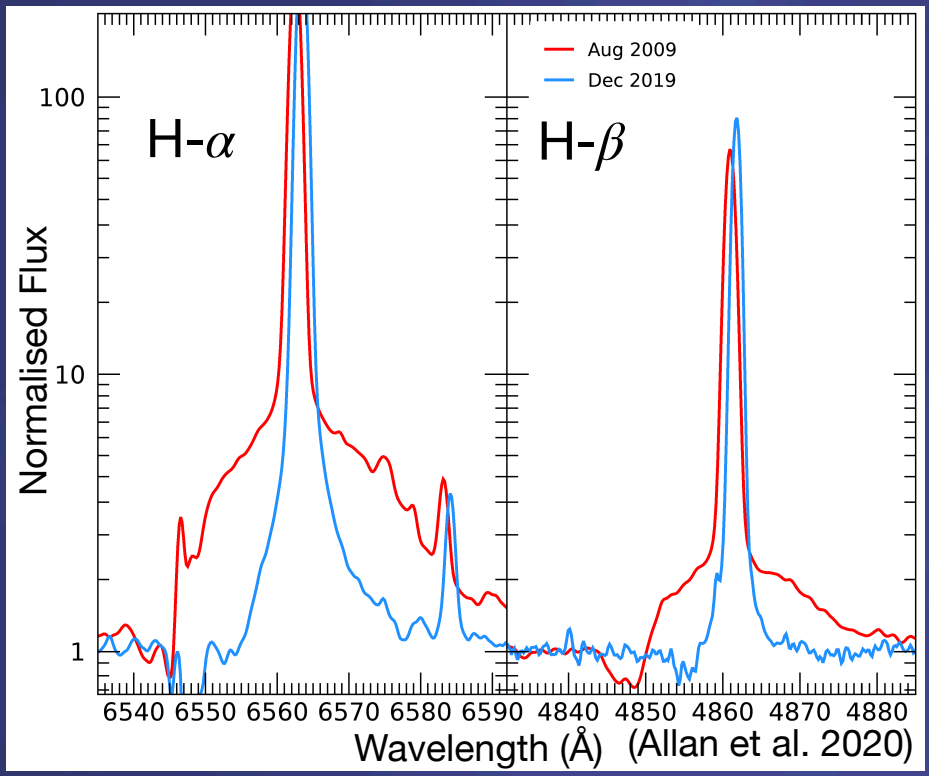
- PHL 293B is a Blue Compact Dwarf (BCD), low metallicity (0.1Z⊙) Galaxy located at 23.1 Mpc in which we predict the surprising disappearance of its most extreme, massive star
- Consistently broad, strong emission in the H-α & H-β lines in past observations of PHL 293B have suggested the presence of a massive Luminous Blue Variable (LBV)* star towards the galactic centre
- **This suspected stars signature is absent in our 2019 observations taken with the ESPRESSO and X-Shooter instruments of ESO's VLT!**

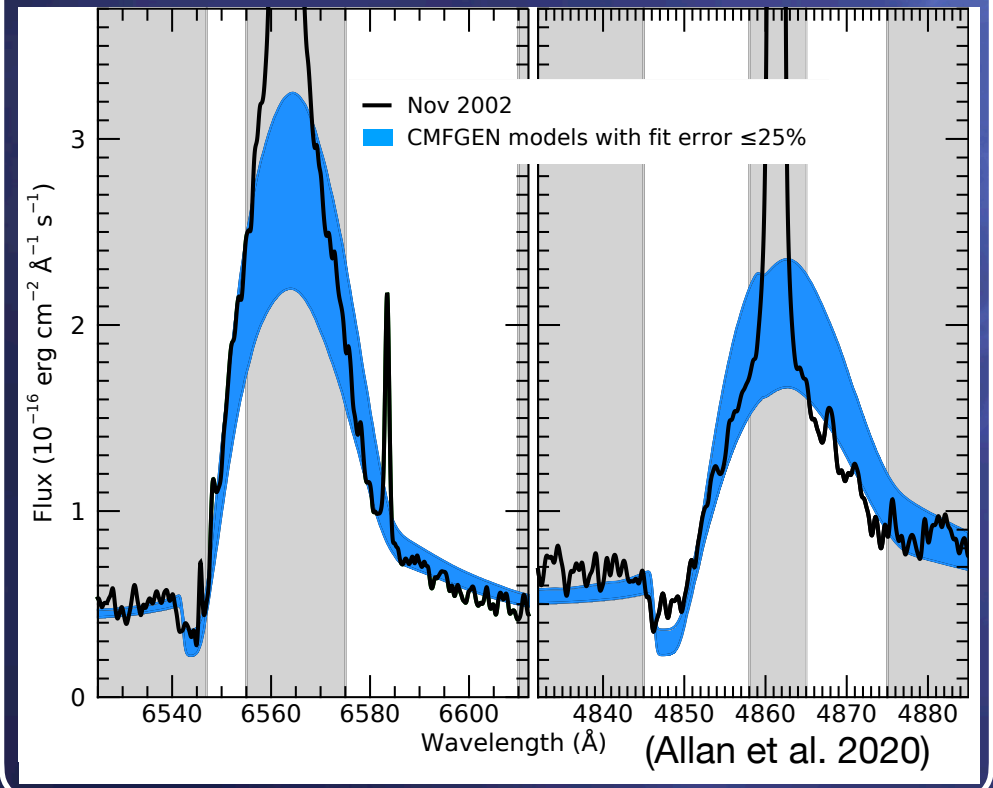


*Luminous Blue Variable (LBV): A late phase in the evolution of massive stars in which reoccurring eruptions generate considerable mass loss

Predicting the Properties of the Star

CMFGEN (Hillier & miller 1998):
Models the transport of light through a star to create a synthetic spectrum

We compare synthetic spectra from our models to a spectrum of PHL 293B taken pre-disappearance in 2002



(Allan et al. 2020)

- Our best-fit models predict:
  mass loss rate $\dot{M} = 0.005 - 0.020\ M_\odot\ \mathrm{yr}^{-1}$
  Luminosity $L_* = 2.5 - 3.5 \times 10^6\ L_\odot$
  wind velocity $v_* = 1000\ \mathrm{km\ s}^{-1}$

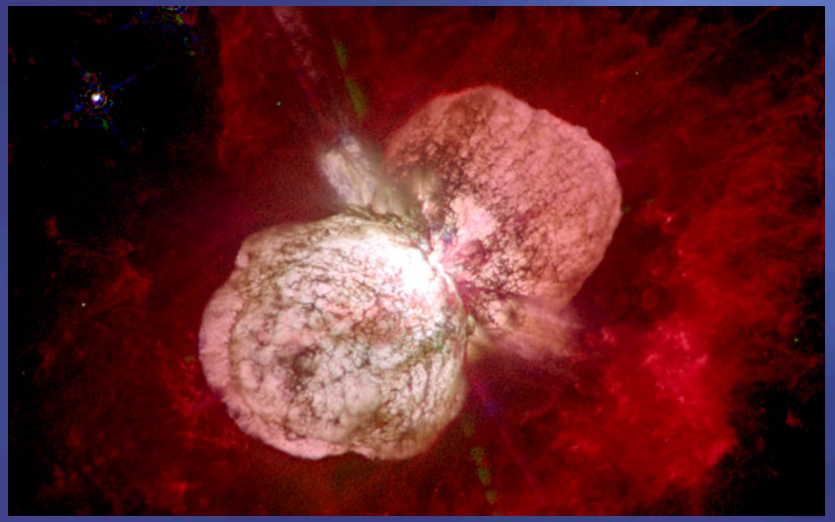
- These suggest that the LBV was in an eruptive state before disappearing

Background image credit: ESO press release on this work

Explaining the Disappearance

1. Surviving star

- The eruption coming to an end and obscuration by dust could hide a surviving star
- Dust could form from material ejected by the stars strong eruption which lasted >8.5 yrs
- Near-infrared 2019 observations rule out hot (>1500 K) dust



Eta-Carinae: Partially dust obscured stellar system
credit: universetoday.com

2. Collapse to Black-hole

- Eruption signals the end of LBV's life
- Evolutionary models (Georgy et al. 2013; Groh et al. 2019b) predict initial stellar mass: 85–120 $M_{\odot}$ and the black-hole could acquire 40-90 $M_{\odot}$
- Collapse to a black-hole without a bright supernova has been observed only once before for a 25 $M_{\odot}$ RSG in N6946-BH1 (Adams et al. 2017)

3. Undetected Supernova

- A type-IIn supernovae event may have occurred between 1995-1998 (no photometry taken during this period)
- Inferred stars signature present in earlier observations instead due to supernova ejecta crashing into dense circumstellar material (CSM)
- Requires that a potentially prolonged SN interaction went undetected
- Non detections set upper limits for both the X-ray and Radio luminosities below that expected for Type II supernova

New Observations with the Hubble Space Telescope (HST)

Image credit: esa.int

- Our team will get the chance to re-observe PHL293b using HST in the next year
- Photometric observations were taken before the disappearance in various filters
- Our models predict significant variation in apparent magnitude in the HST filters due to the stars disappearance
- Our future HST observation should hopefully both confirm and help explain the stars disappearance

Our research paper: https://arxiv.org/pdf/2003.02242

ESO press release: https://www.eso.org/public/news/eso2010/

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