How Much Hydrogen is in Type Ib and IIb SN Progenitors?

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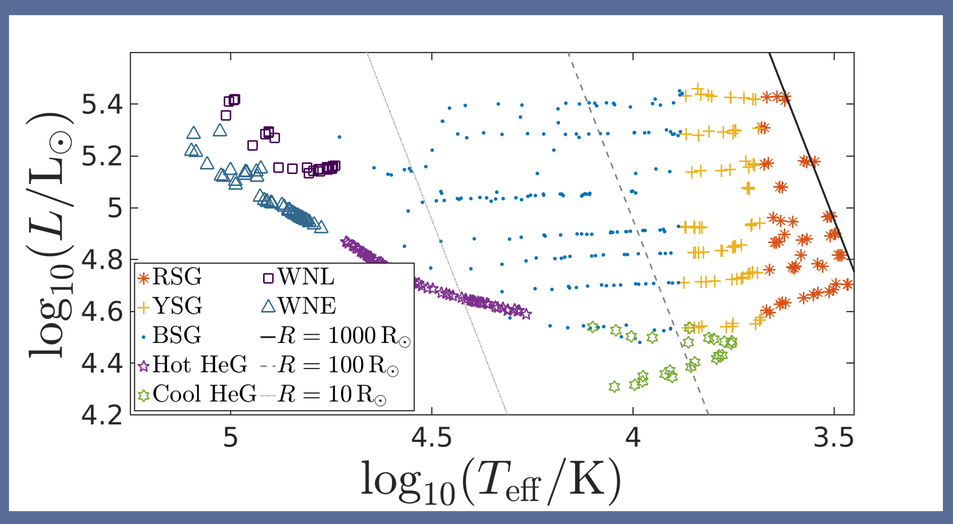
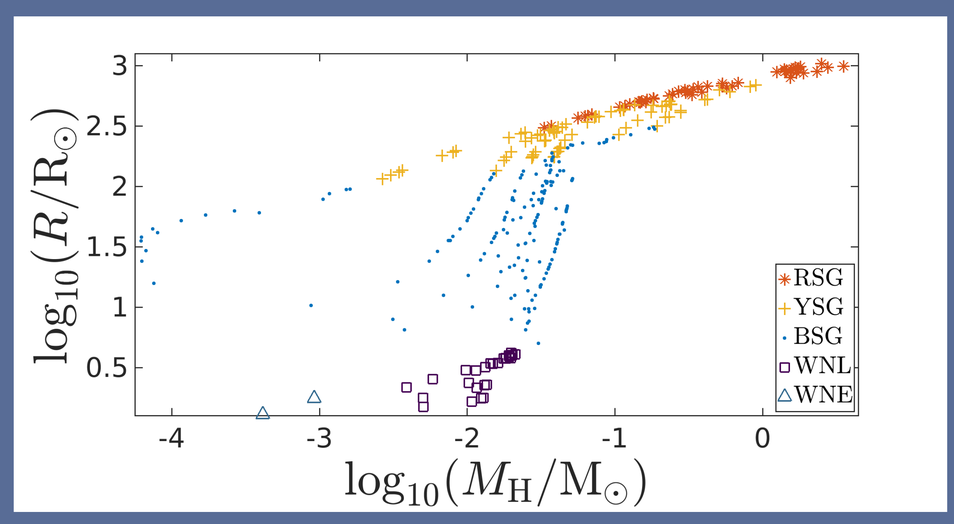
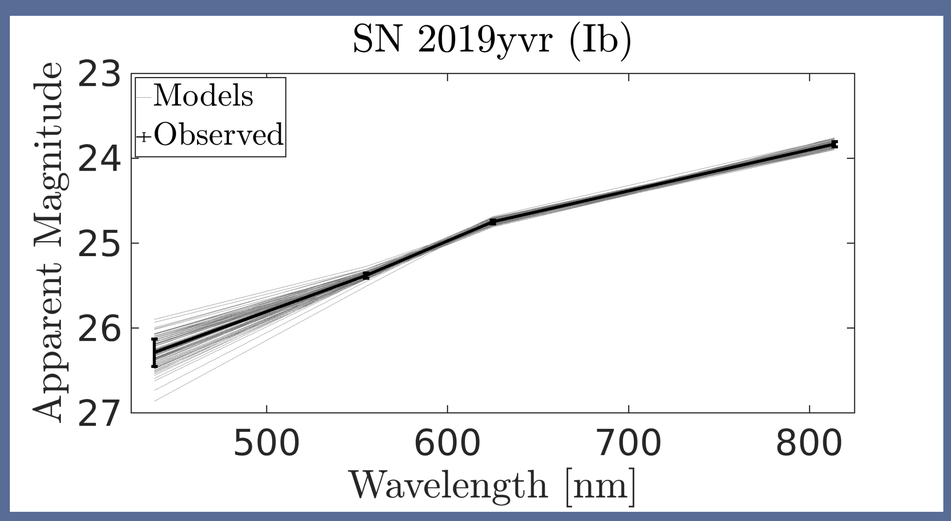
Abstract: *We compare* ***pre-supernova observations*** *with synthetic photometry from stellar evolution models to infer the* ***progenitor properties*** *of the seven known progenitors of Type Ib and IIb supernovae. Our results are roughly consistent with a hydrogen mass threshold of $\approx 0.033 M_{\odot}$ for a Type II appearance. We estimate the apparent magnitude of a surviving companion to the recent progenitor candidate for the Type Ib SN 2019yvr.*

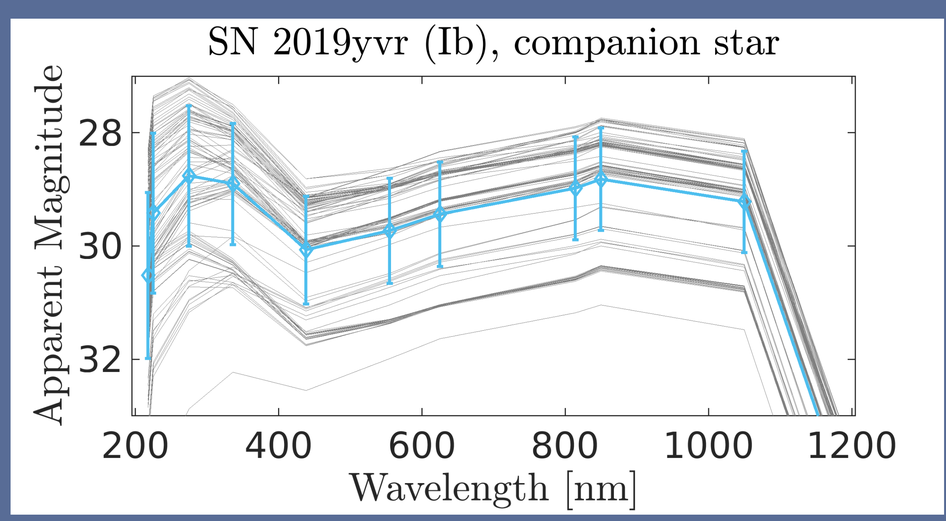
Step 1: evolve massive binary models until core carbon depletion.



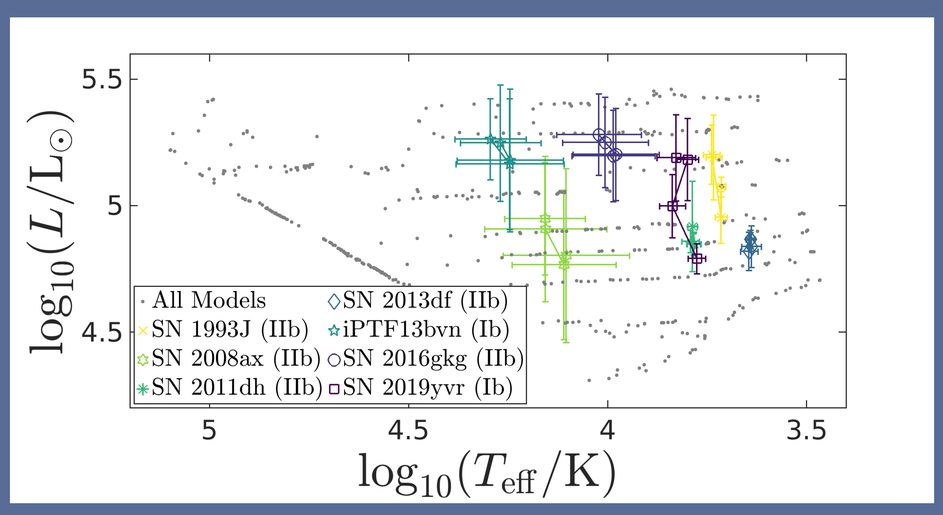


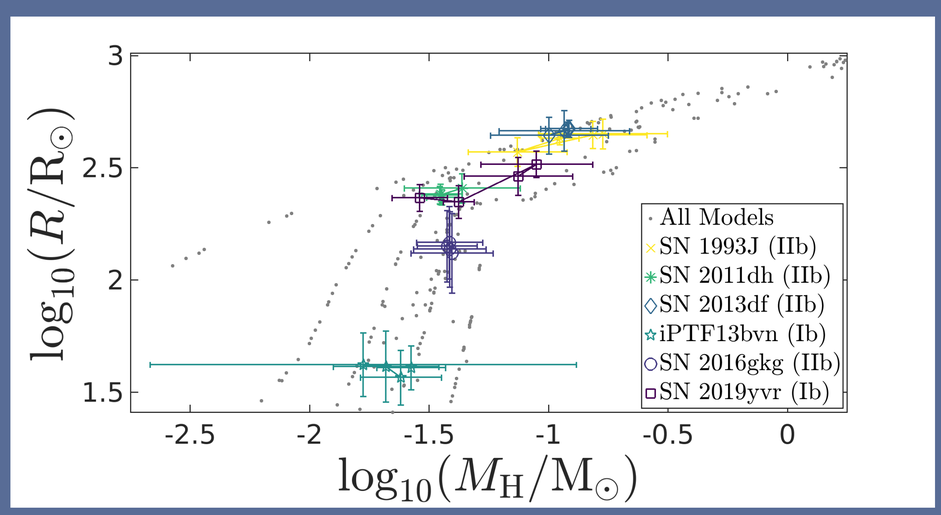
Step 2: generate Monte Carlo realizations of the pre-SN observations and find the best-fitting models.





Step 3: derive progenitor properties from distributions of best-fitting models.





Numerical method and setup

- Stellar evolution:
  - ✓ 494 binary models with MESA (**Paxton+11**) version 10398
  - ✓ Primary masses of 11, 12, 13, 14, 16, 19, 22, 25
  - ✓ Mass ratios between 0.35 and 0.96
  - ✓ Periods between 5 and 2223 days
- Physical assumptions:
  - ✓ The mass transfer efficiency follows **Gilkis+19** and is recomputed each time step to limit the accretion on to the companion by its thermal timescale.
  - ✓ Two wind mass loss recipes are used for the hydrogen-deficient phase – **Nugis+Lamers (00)** and **Vink (17)** – resulting in endpoints with different properties. Helium giants arise only from the **Nugis+Lamers** prescription.
- Synthetic photometry:
  - ✓ Spectral libraries
    - ✓ **Pickles (98)** empirical spectra for T<15kK
    - ✓ TLUSTY models (**Lanz+Hubeny 03,07**) for 15kK<T<55kK
    - ✓ PoWR models (**Todt+15**) for T>55kK
  - Four different assumptions for dust extinction
    - ✓ R_V and E(B-V) fixed
    - ✓ R_V fixed and E(B-V) variable (within observational limits)
    - ✓ R_V variable and E(B-V) fixed
    - ✓ Both R_V and E(B-V) variable

References

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