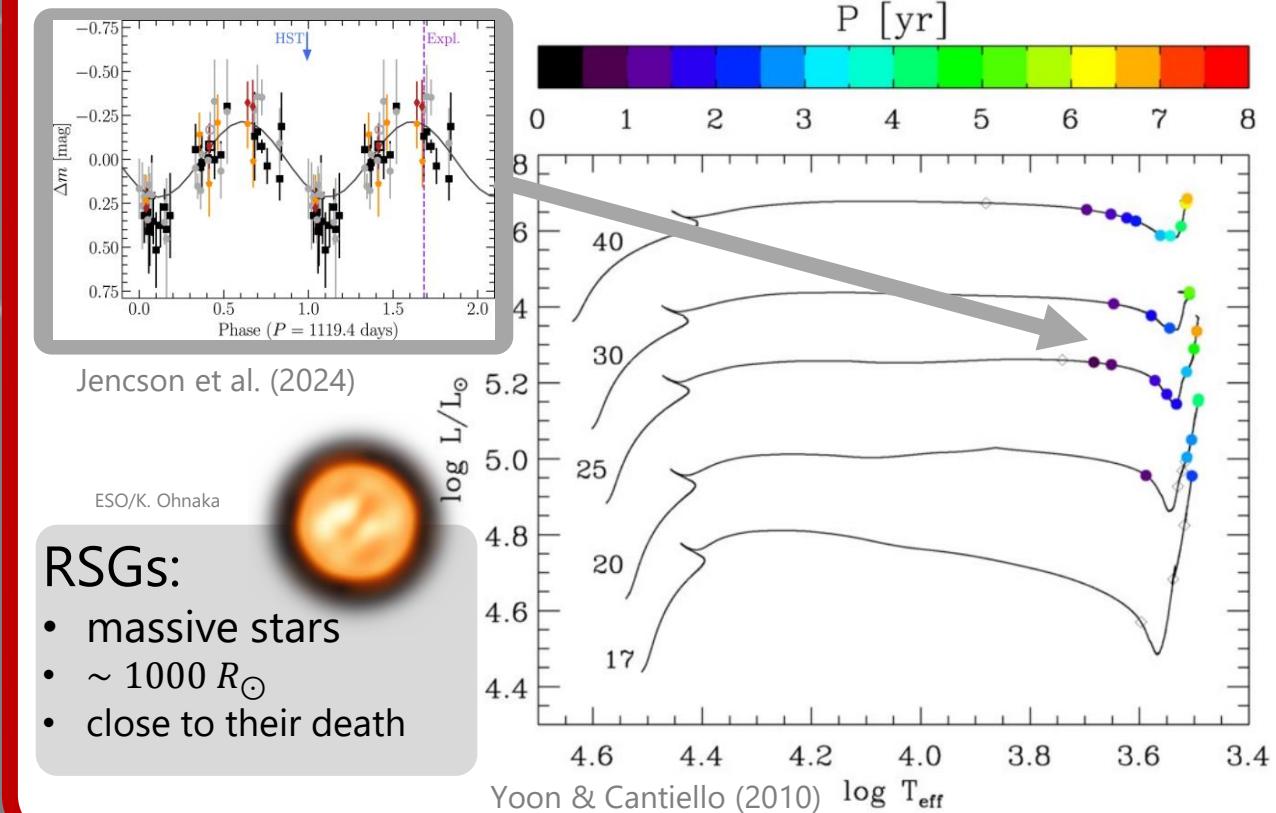


# Pulsating Red Supergiants: A New Perspective on Type II Supernova Light Curve Diversity

Vincent. A. Bronner, Eva Laplace, Fabian R. N. Schneider, Philipp Podsiadlowski

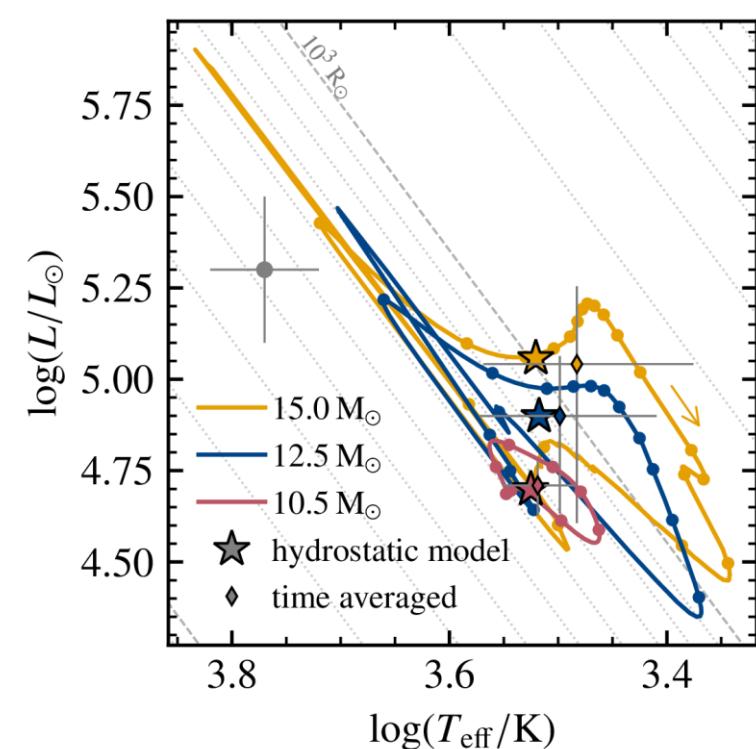


## Pulsating red supergiants (RSGs)



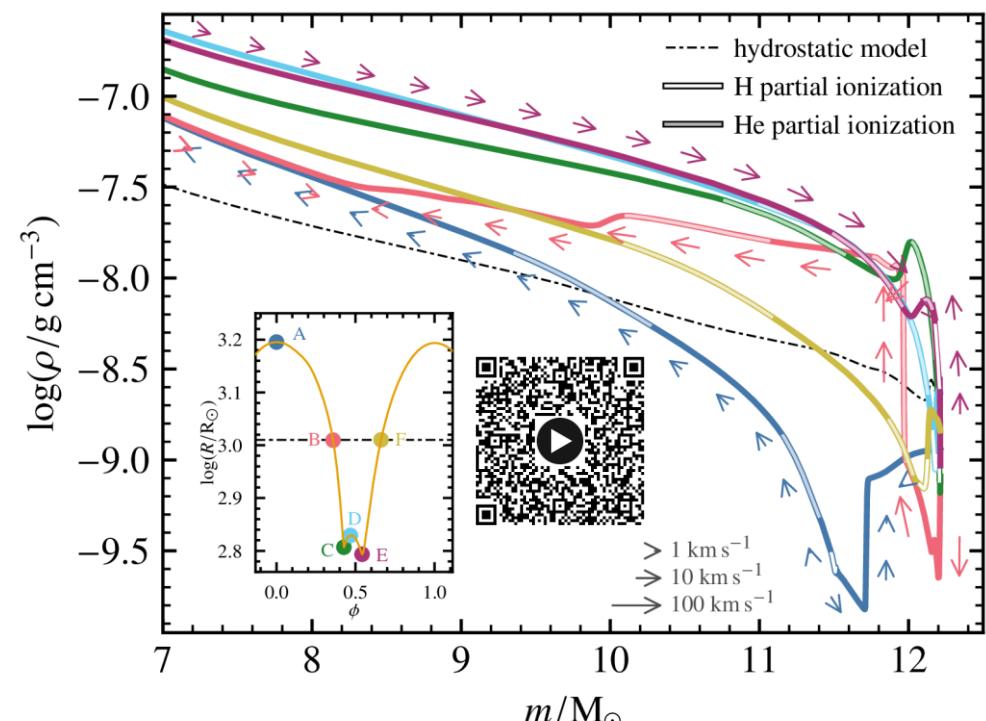
- RSGs: massive stars
- ~  $1000 R_\odot$
- close to their death

## Pulsations in Hertzsprung-Russell diagram



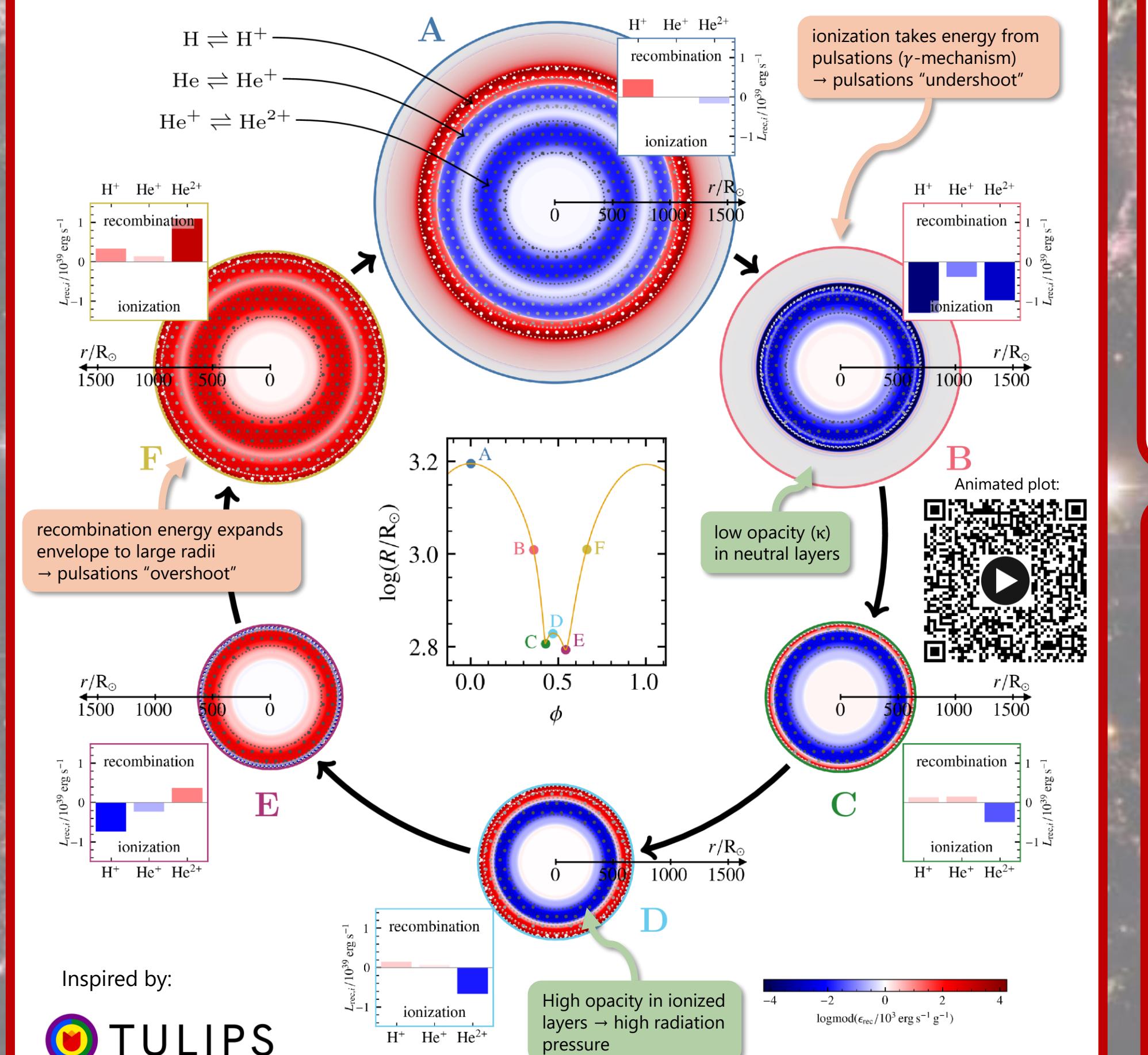
- pulsations just before core collapse
- up to **1.3 dex in luminosity**
- up to **5000 K in temperature**
- stronger pulsations for more massive RSGs
- uncertainties from pulsations similar to uncertainties from observed SN progenitors
- **difficult to connect SN progenitor observations to (hydrodynamic) stellar evolution models!**

## Density variations from pulsations



- large density variations in convective envelope
- **up to 2.5 dex**
- non-homologous variations
- density structure traces ionization zones** that cause pulsations
- distinct density structure compared to hydrostatic stellar model

## $\gamma$ -mechanism driving pulsations



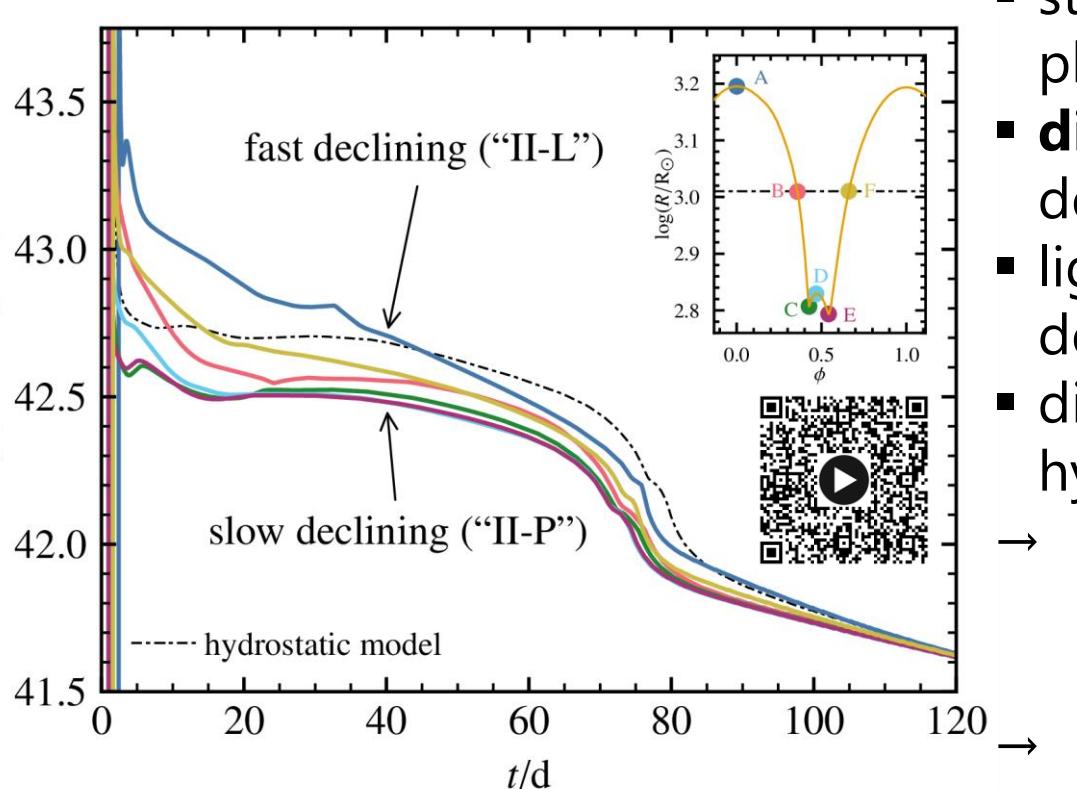
Inspired by:  
 TULIPS  
Tool for Understanding the Lives, Interiors, and Physics of Stars

## 2 new papers on arXiv this Monday

Bronner, Laplace et al. 2025 Laplace, Bronner et al. 2025

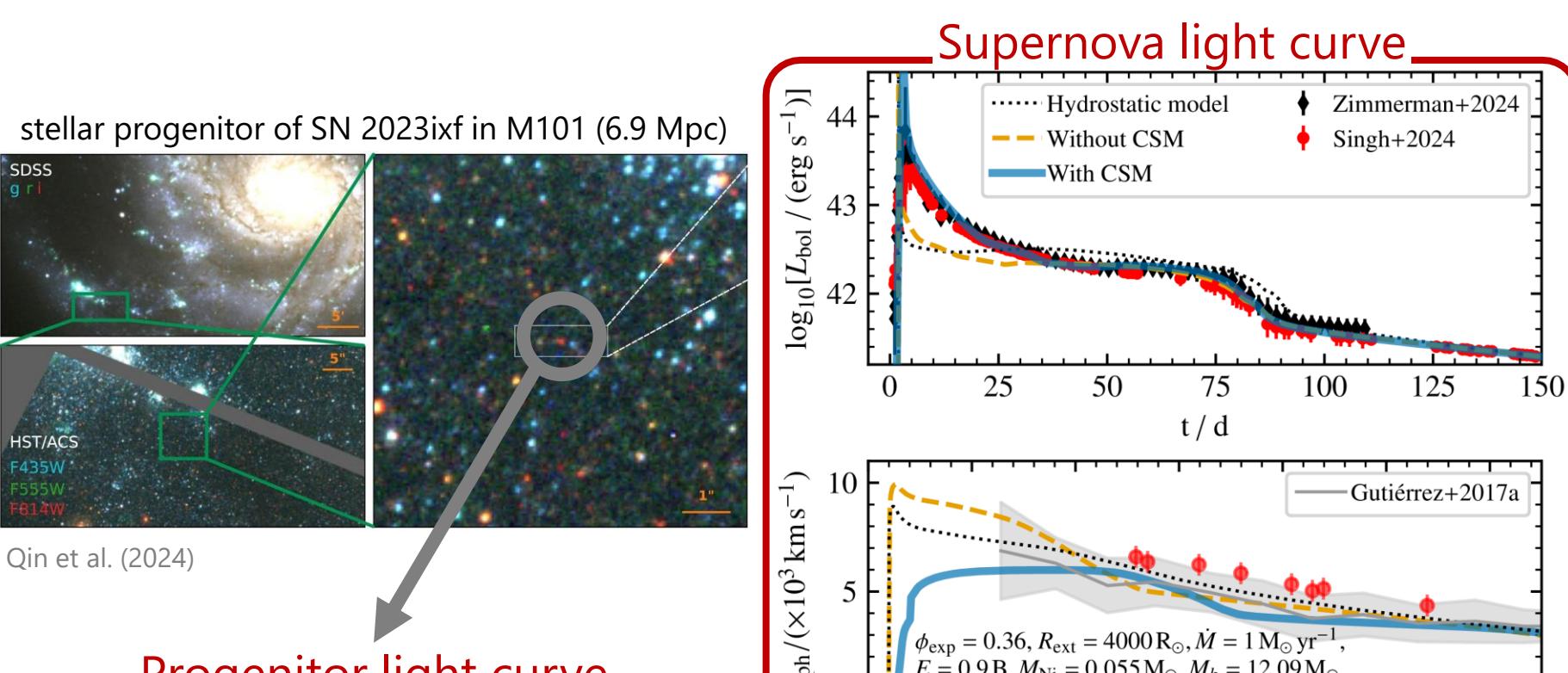


## Supernova light-curve diversity

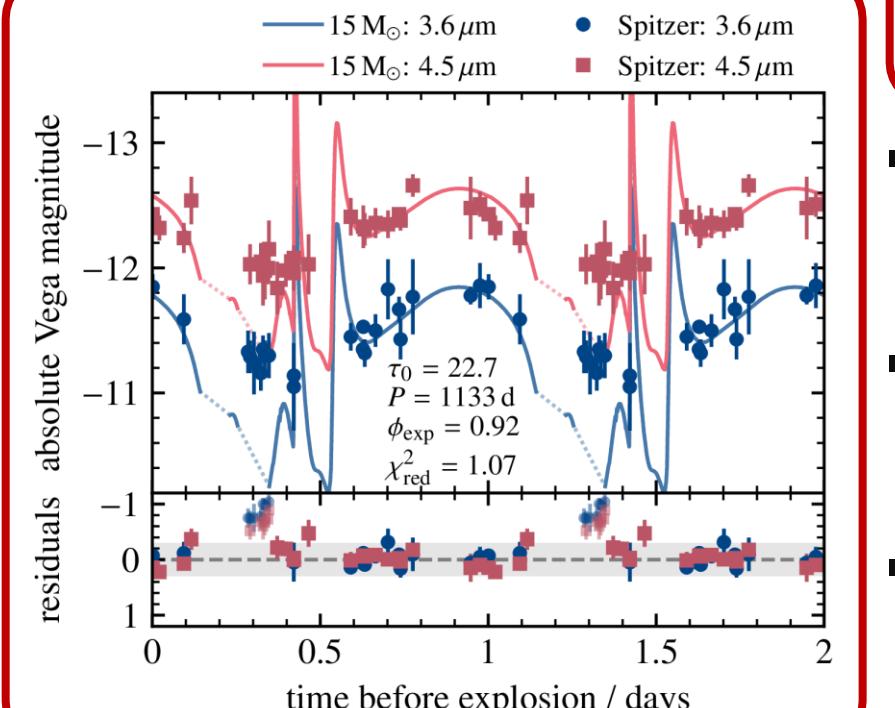


- star can explode in any pulsation phase
- different decline rates** depending on pulsation phase
- light-curve features linked to density/ionization structure
- distinct explosion compared to hydrostatic stellar progenitor
- **hydrodynamic modeling of stellar progenitor matters for SN light curves!**
- reproduces some of the observed supernova diversity

## Modeling SN 2023ixf with pulsating progenitor



## Progenitor light curve



- progenitor light curve **well reproduced by pulsating, dust-enshrouded RSG**
- supernova light curve well reproduced by pulsating RSG in **contracting phase**
- circumstellar material (CSM) needed to reproduce early-time light curve
- **CSM from pulsations**