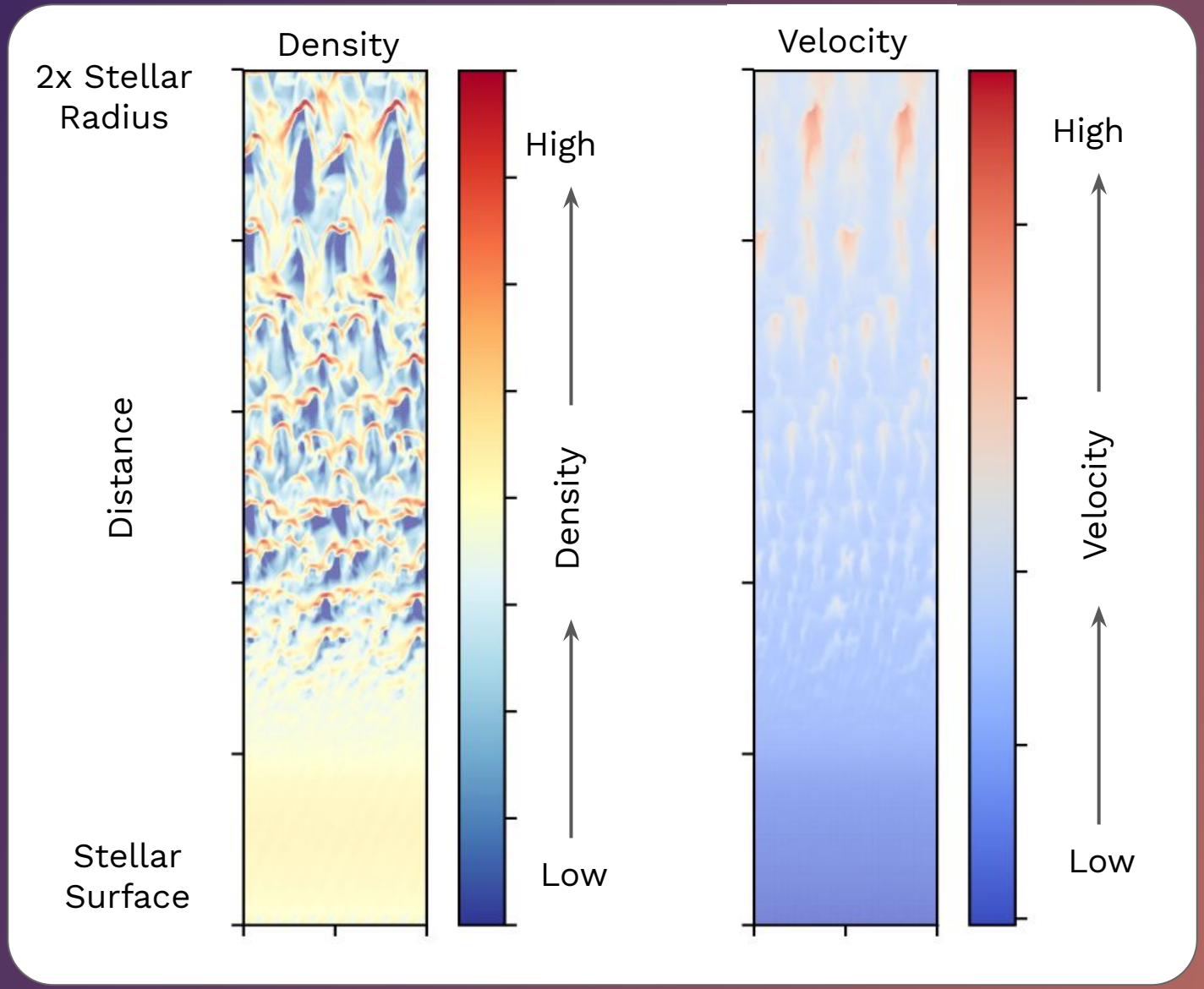
Context - Massive Stars Have Clumpy Winds

Simulations of the wind of a massive star, showing density and velocity against distance from the stellar surface.



Massive stars are rare have strong radiation-driven outflows called winds.

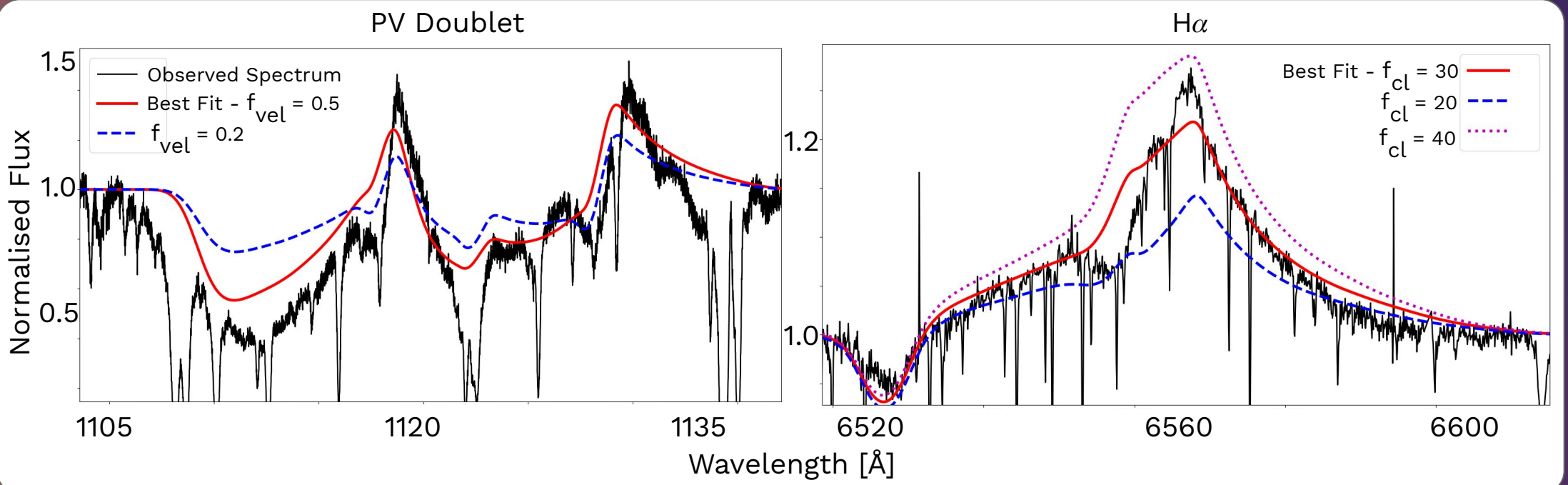
Winds are clumped and have a profound influence on the evolution of the star and its environment.

The most widely used stellar evolution calculations assume winds are smooth. State-of-the-art spectroscopic studies assume wind clumps are optically thin.

Radiation Driven Wind Instability Simulation computed by F, Driessen

Methods - Optically Thick Clumping & Mass Loss

This is the first study to use spectral models including optically thick clumping to measure mass loss rates in massive stars.

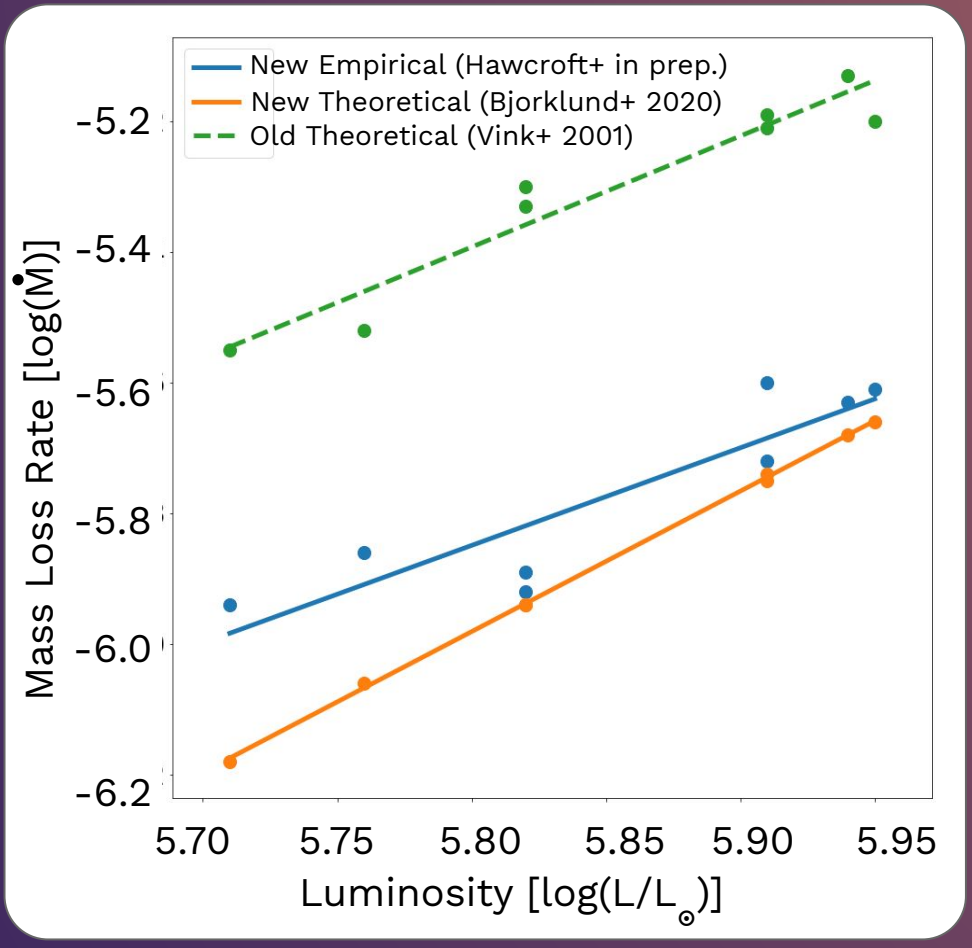


- Many UV lines are resonance driven processes sensitive to wind velocity filling factor - f_{vel}
- Hydrogen emission is recombination driven and highly sensitive to the clumping factor - f_{cl}
- **These wind clumping parameters not only affect the quality of fit but but also the mass loss rate!**

Spectra from J.-C, Bouret

Empirical Results

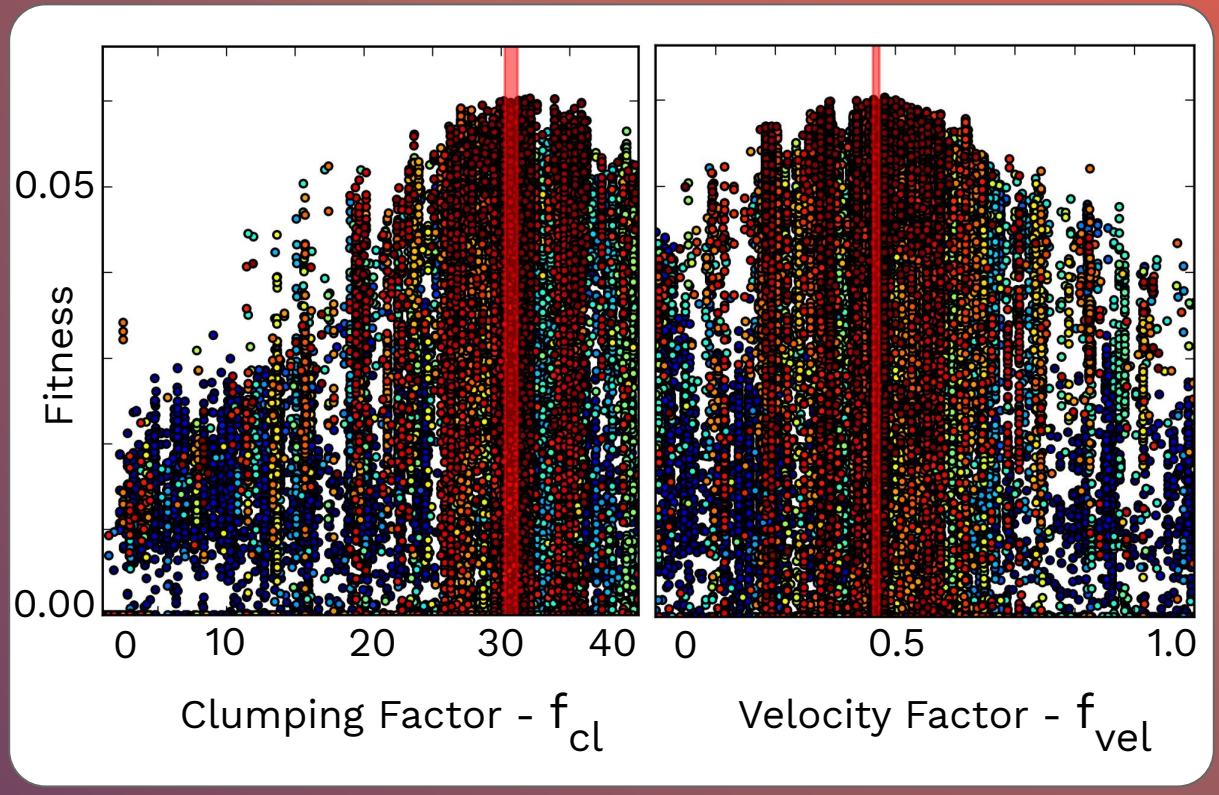
Mass Loss Rates



Reductions of 3x in mass loss rate!

Model predictions and observations are now much closer together!

Clumping Factors

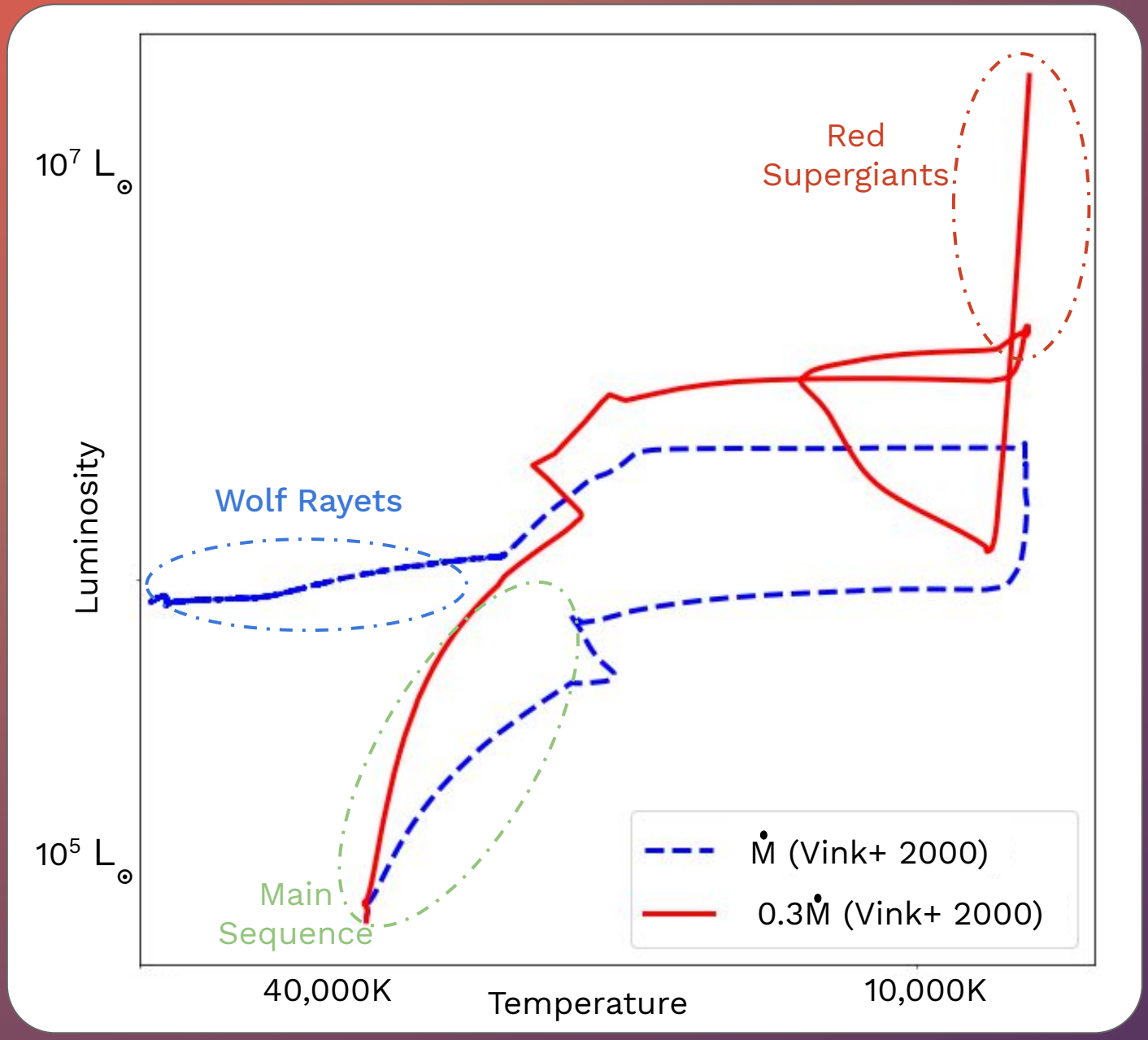


Distribution of models ranked by goodness of fit to observations.

Well defined fitness peaks to constrain clumping & velocity filling.

Implications

The end of the star's life is determined by mass loss!



Stellar evolution tracks computed by R, Bjorklund

The evolution of a 70 solar mass star from the onset of core Hydrogen burning to the onset of core Helium burning.

Blue - Mass loss rate predicted by Vink+ 2000.

Red - With reduced mass loss to one-third of the Vink+ 2000 prediction.

Poster by C, Hawcroft.
calum.hawcroft@kuleuven.be
@CalumHawcroft
Project collaborators: H, Sana. J.O, Sundqvist. L, Mahy. A, de Koter. L, Decin

KU LEUVEN