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3D MODELS OF COOL GIANTS

Properties of a AGB star model grid

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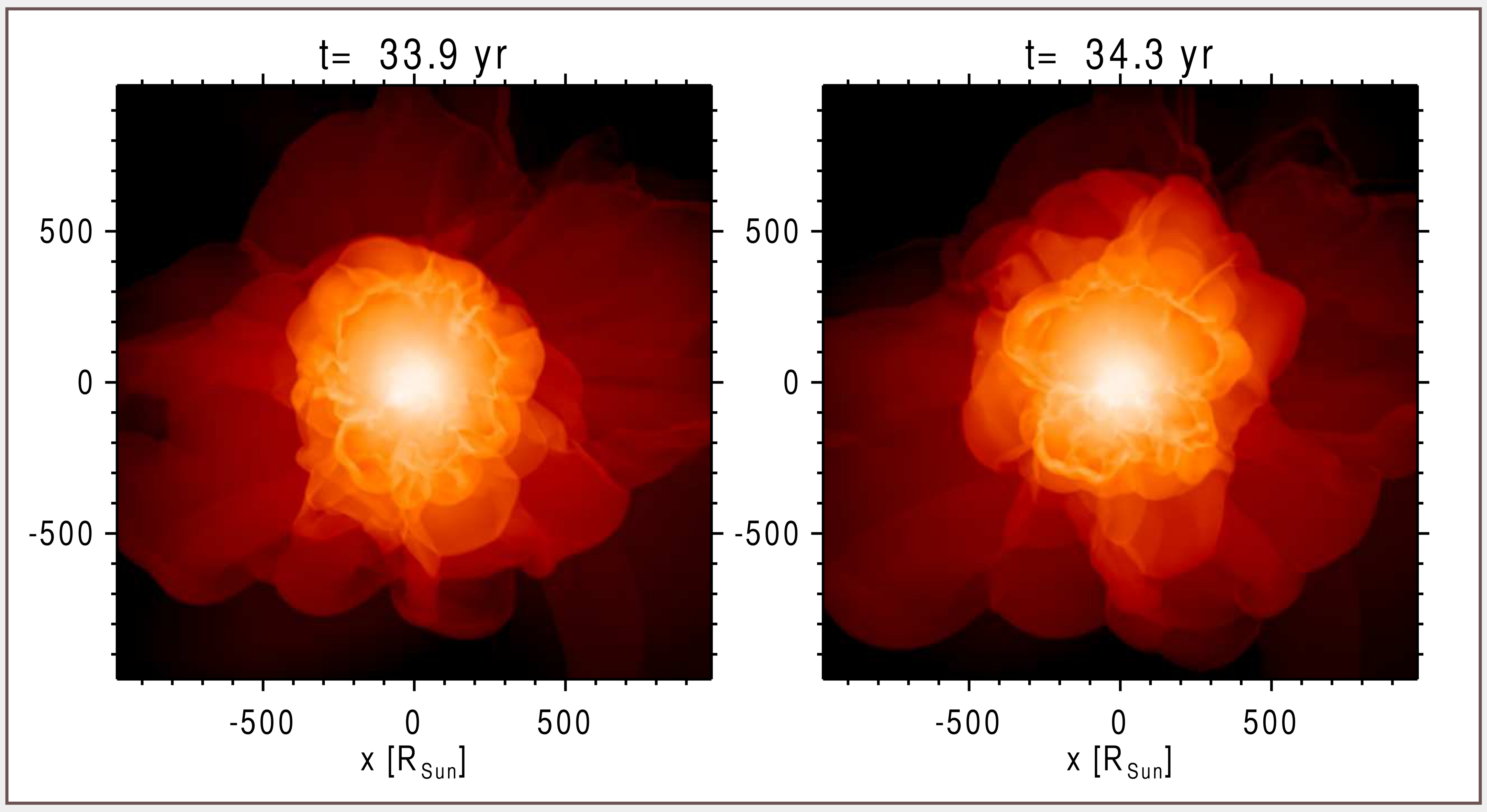
SUMMARY

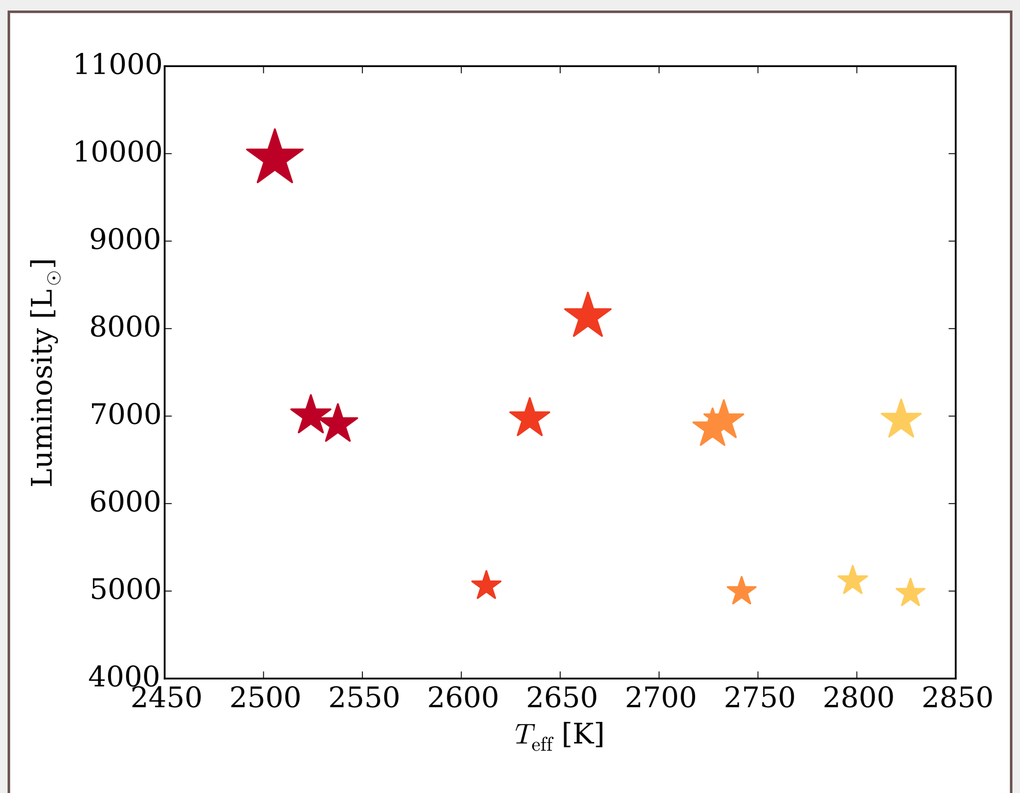
Asymptotic Giant Branch (AGB) stars are evolved stars with low to medium mass. Although they are thought to be important for the galactic chemical evolution, current theoretical models are not complete and far from explains all available observations.

A first-ever grid of pulsating AGB star models, based on 3D star-in-a-box simulations using CO^5BOLD, has been calculated (see talk by Bernd Freytag). A time series of density snap-shots of one such simulation can be seen to the right.

We compare pulsation properties and stellar parameters of the 3D models with observations and 1D pulsation models, and find good consistency. This indicates that the 3D models give a satisfactory description of the stellar interior, and can be used to investigate the interplay between self-excited pulsations, small-scale convection motions, large-scale shock fronts and dust creation.

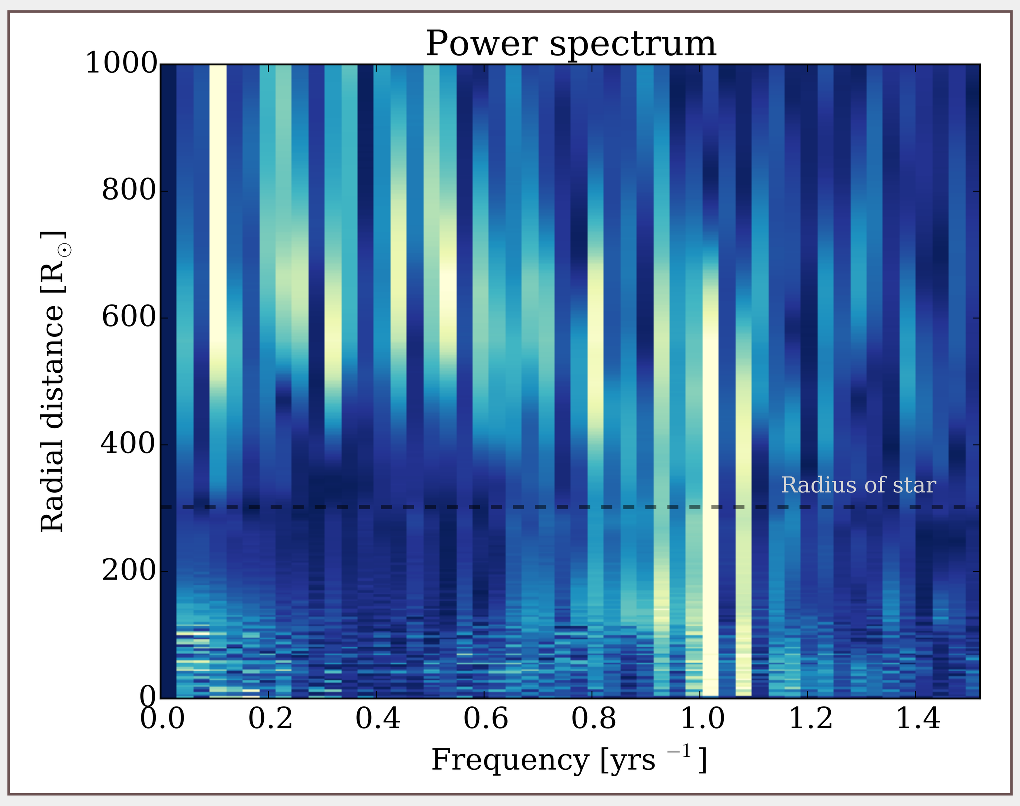


THE GRID

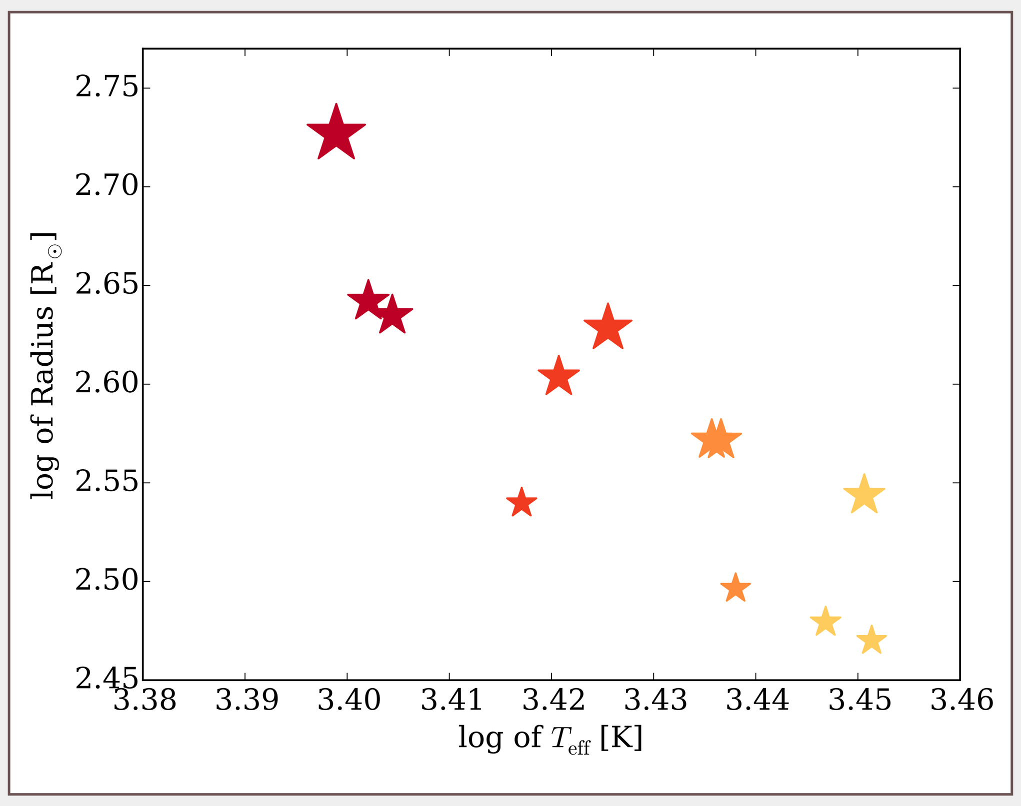


The model parameters were chosen to mirror previous 1D wind model studies of M-stars [Bladh et al., 2015], with luminosities and effective temperatures shown to the left. Larger markers indicates higher luminosity and the colour indicates temperature.

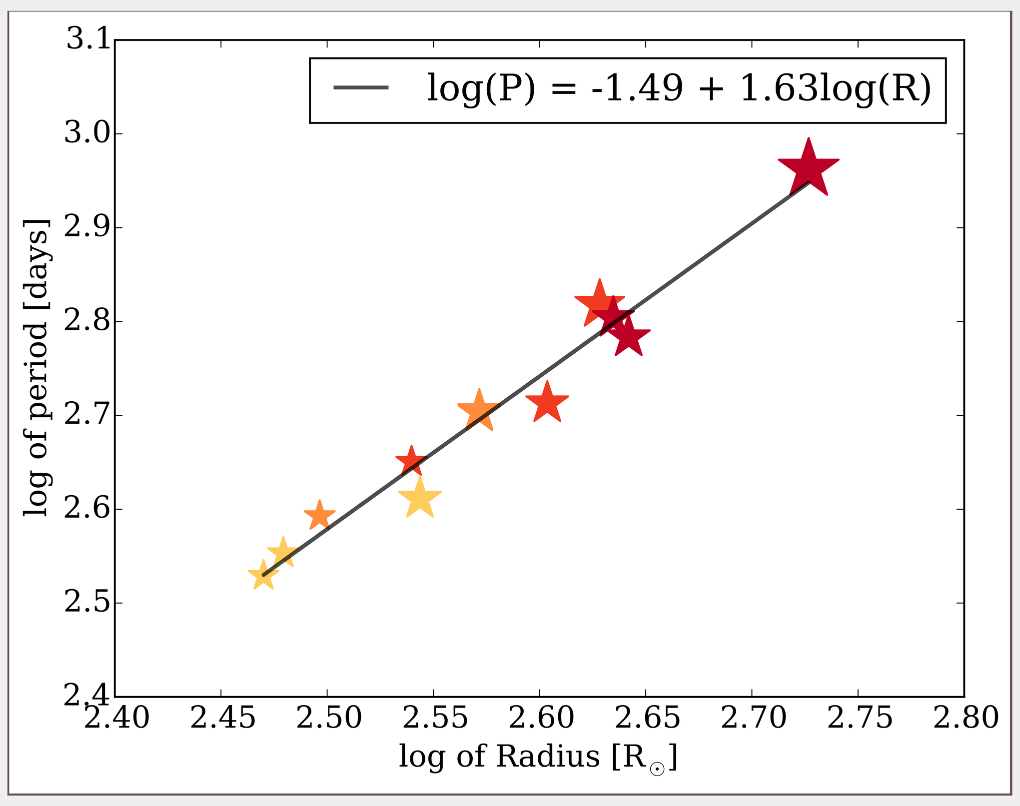
While radius, temperature and luminosity are simple model properties, the period of the AGB star model is more complicated to deduce. By looking at the Fourier power spectrum of the velocity field of the stars (example to the right) there is clearly a dominant frequency in the interior, giving the period of that particular star. The cooler outer layes pulsates on longer time scales, which results in the lower-frequency, more irregular signals at R > 300 R☉.



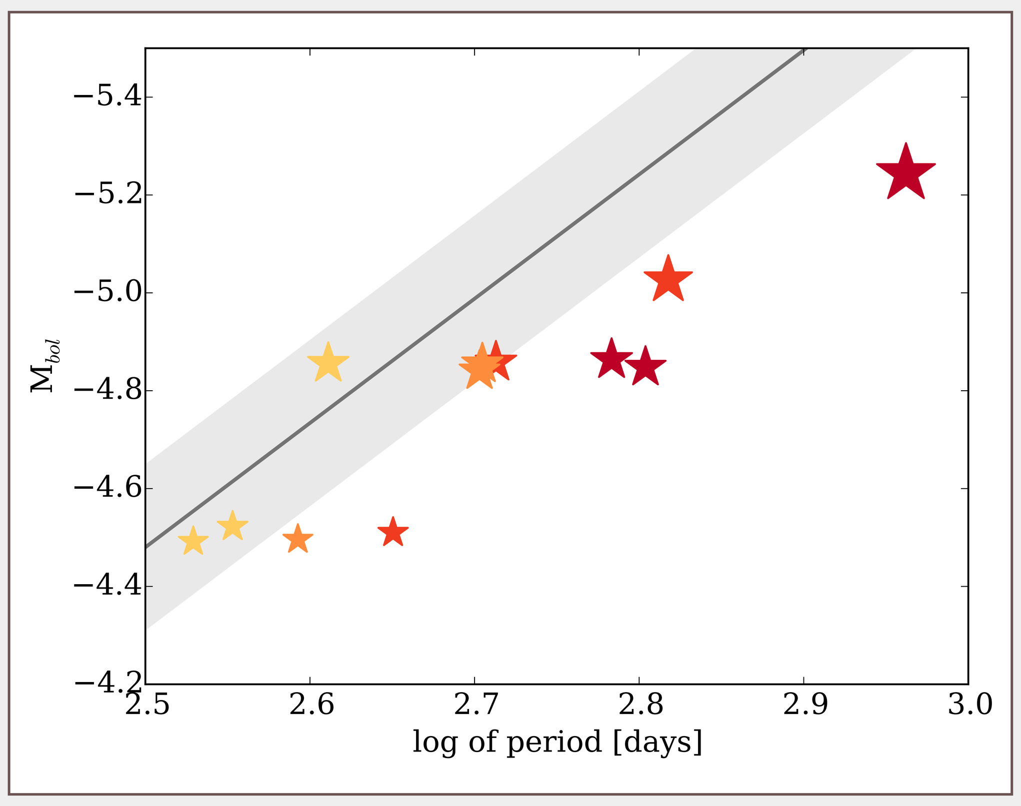
PROPERTIES OF THE MODELS



With decreasing effective temperature the radius increases, which is consistent with what is known about AGB stars. There is a spread due to the different luminosities. As seen the radius increases with increasing luminosity (marker size).



By looking at the period and radius, we can compare with 1D pulsation models [Fox&Wood, 1982]. The relationship between period and radius for 1D models is $P \propto R^{\alpha}, \alpha \approx 1.5 - 2.5$
In this work we find $\alpha = 1.63$, within the range of values predicted by 1D models.



The existence of a period-luminosity relationship for ABG stars has been known for some time, and is heavily studied (eg. Whitelock et al., 2003). The line shows such a PL relation for stars in the LMC [Whitelock et al., 2006]. The models from the grid have a similar trend, with scatter due to the different effective temperatures.