Vsini & Vmac determination

- General methods
- Some examples

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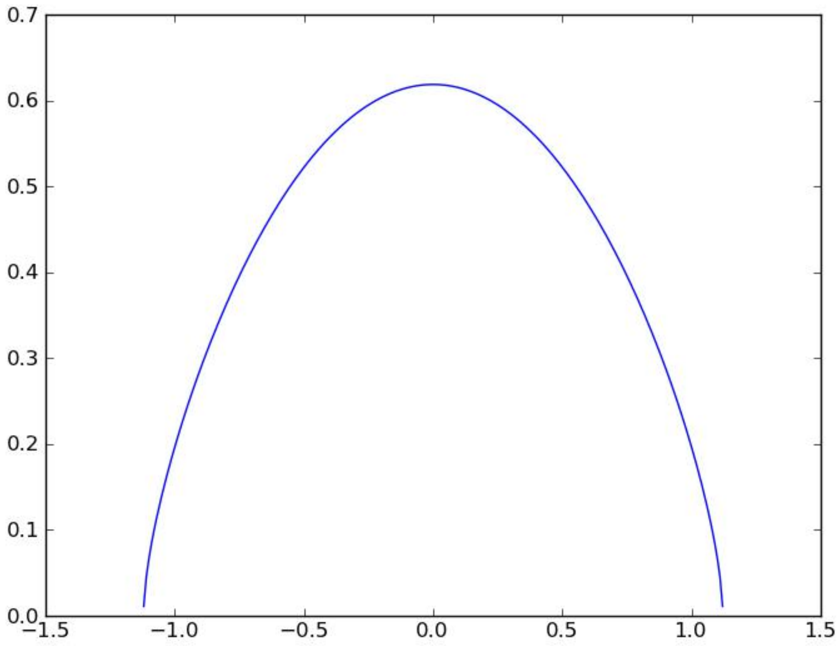
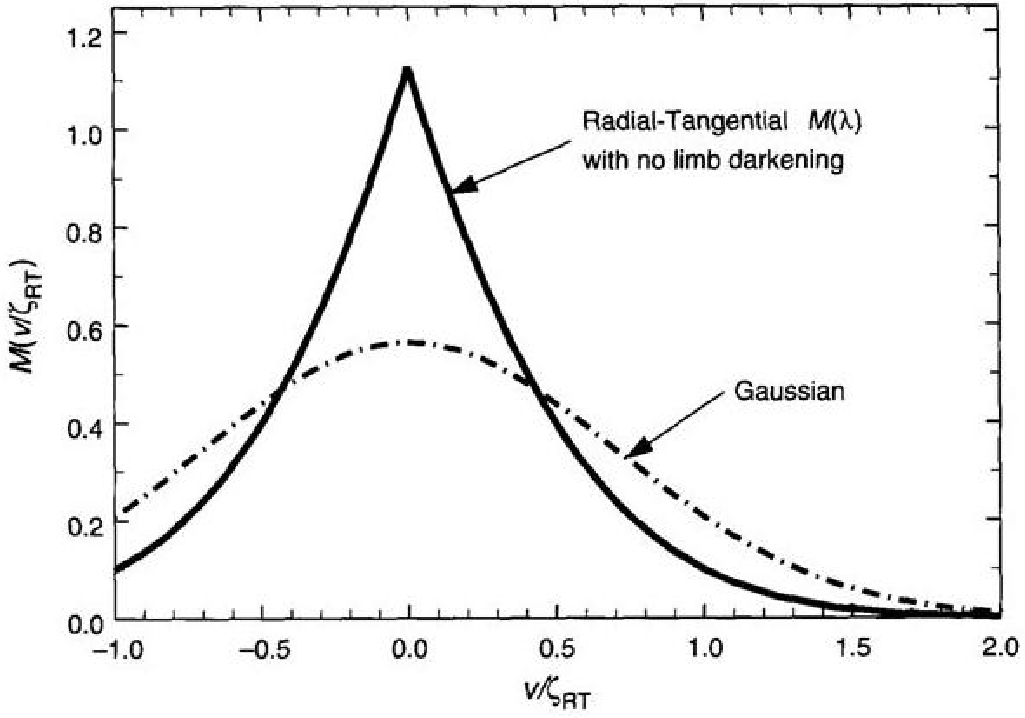
- Some examples

Vsini: rotational kernel



Vmac: radial-tangential kernel

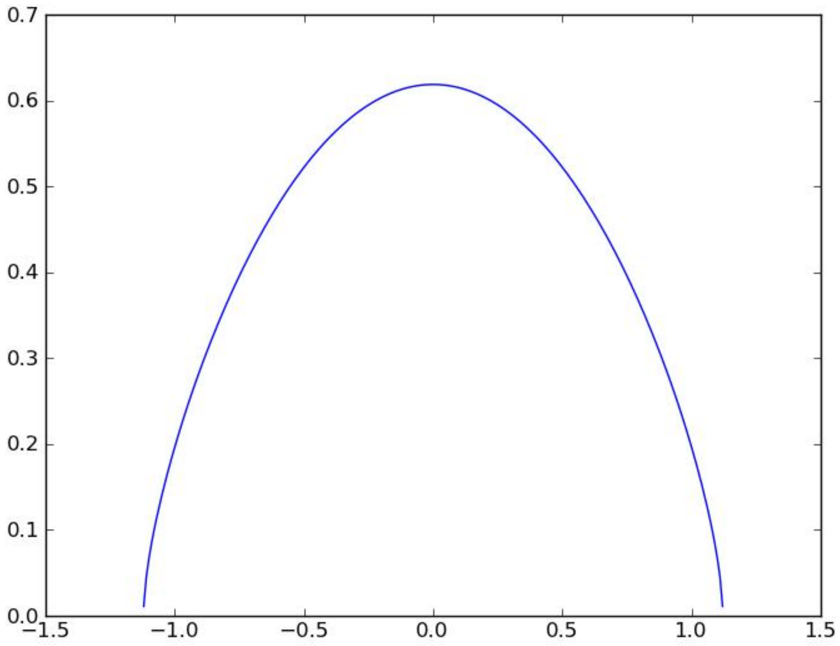


Vsini & Vmac determination

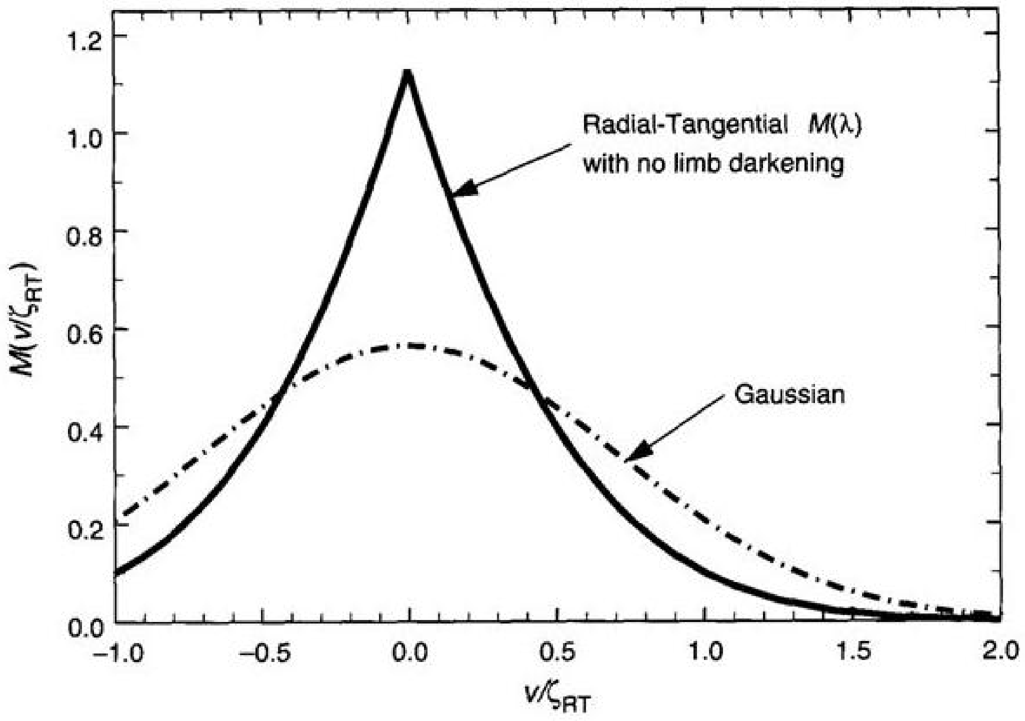
- General methods
- Some examples

This will lead to different line shapes

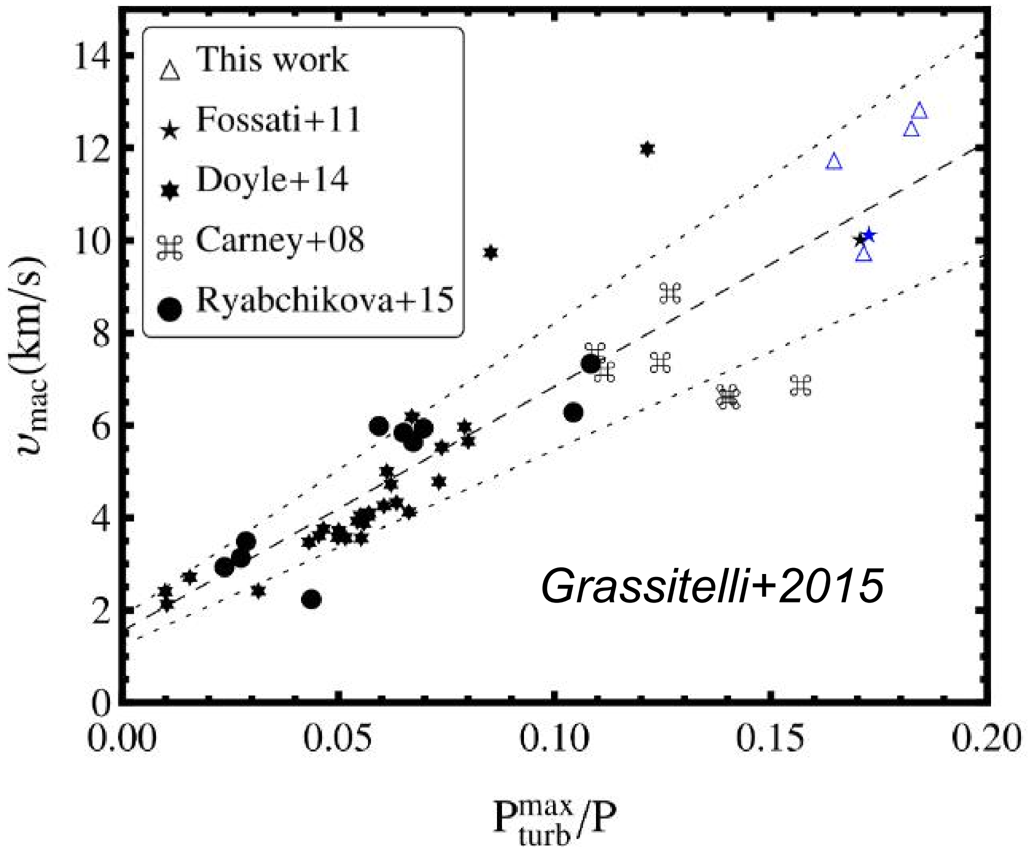
Vsini: rotational kernel

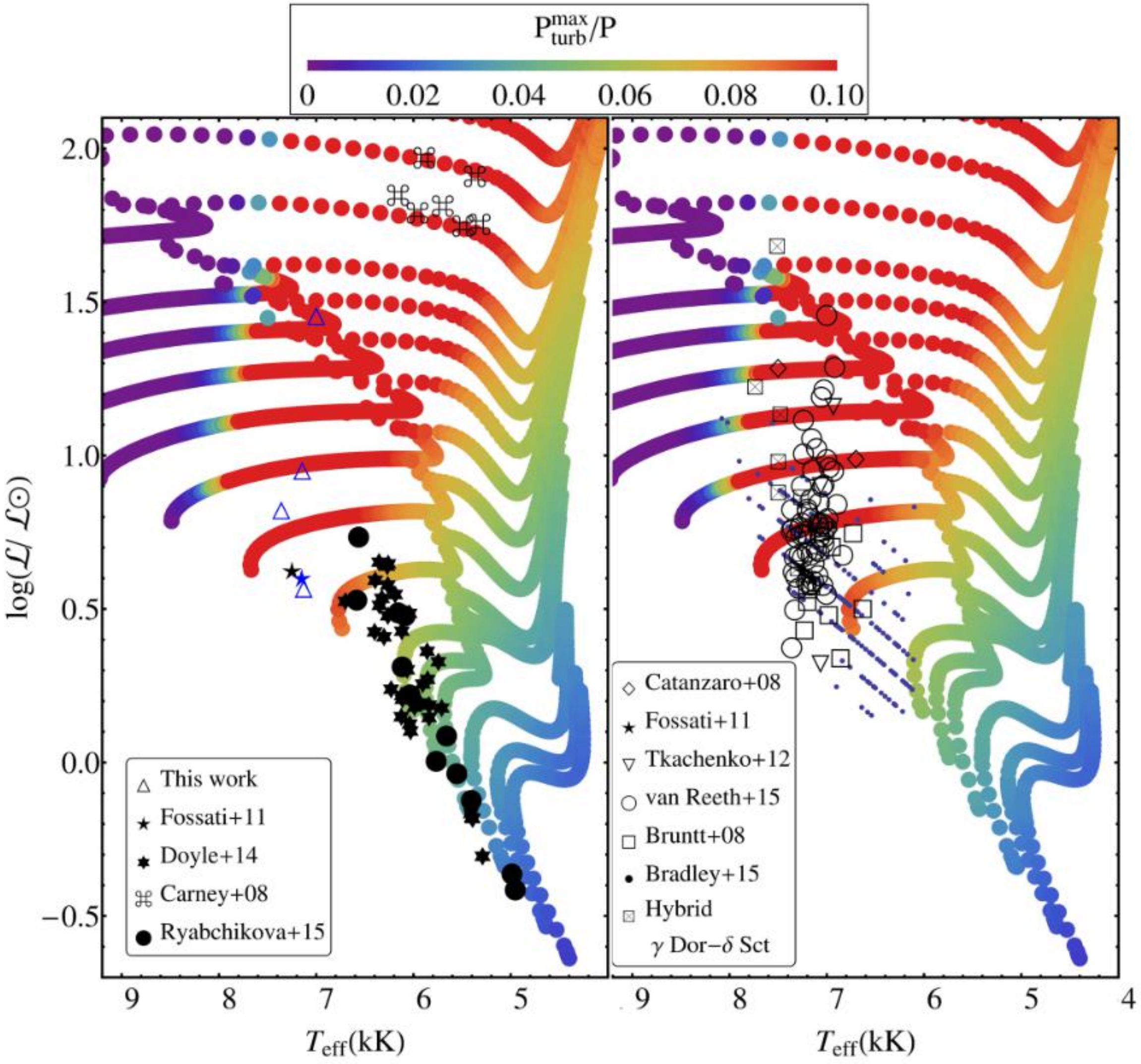


Vmac: radial-tangential kernel



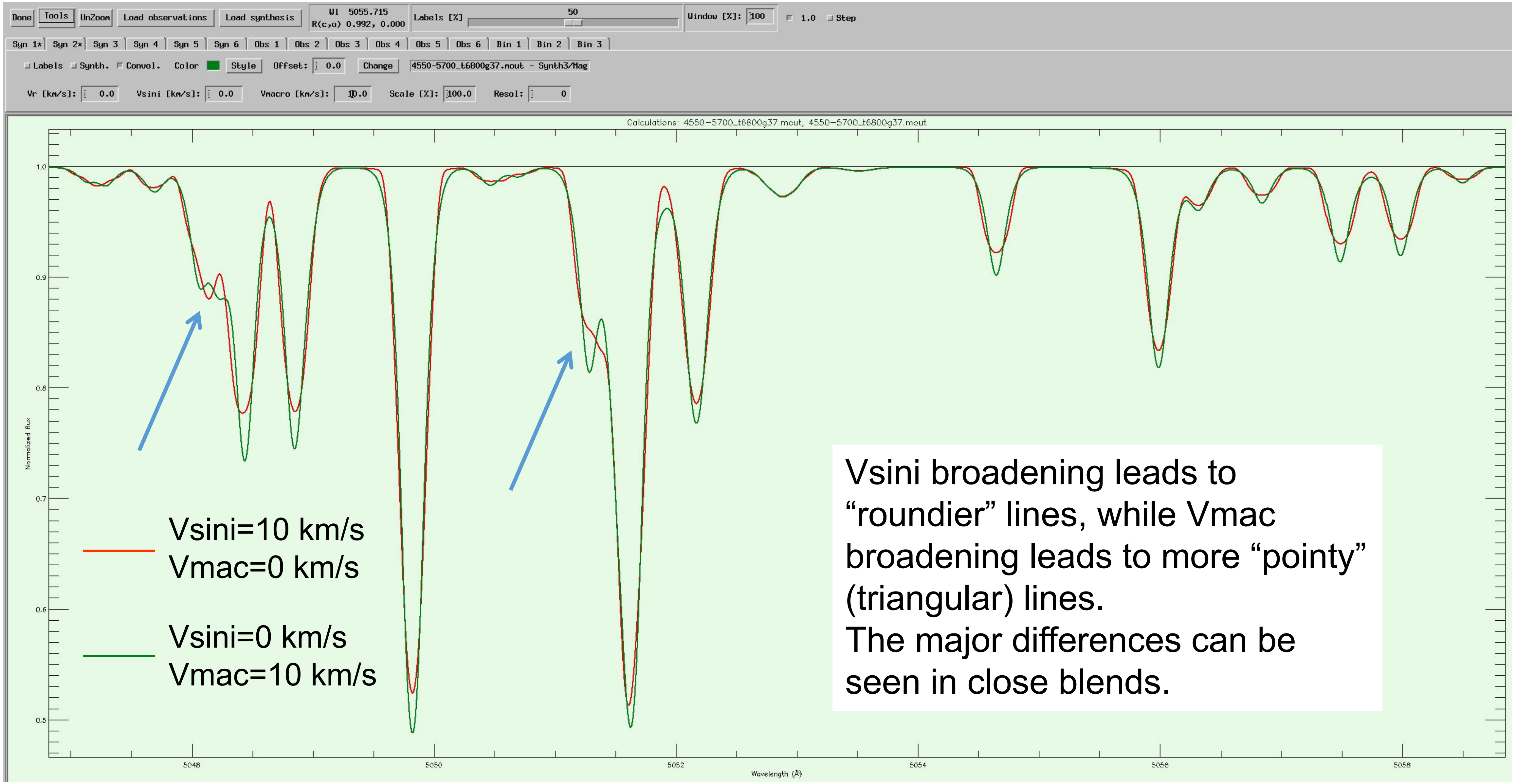
Vsini & Vmac: origin of Vmac





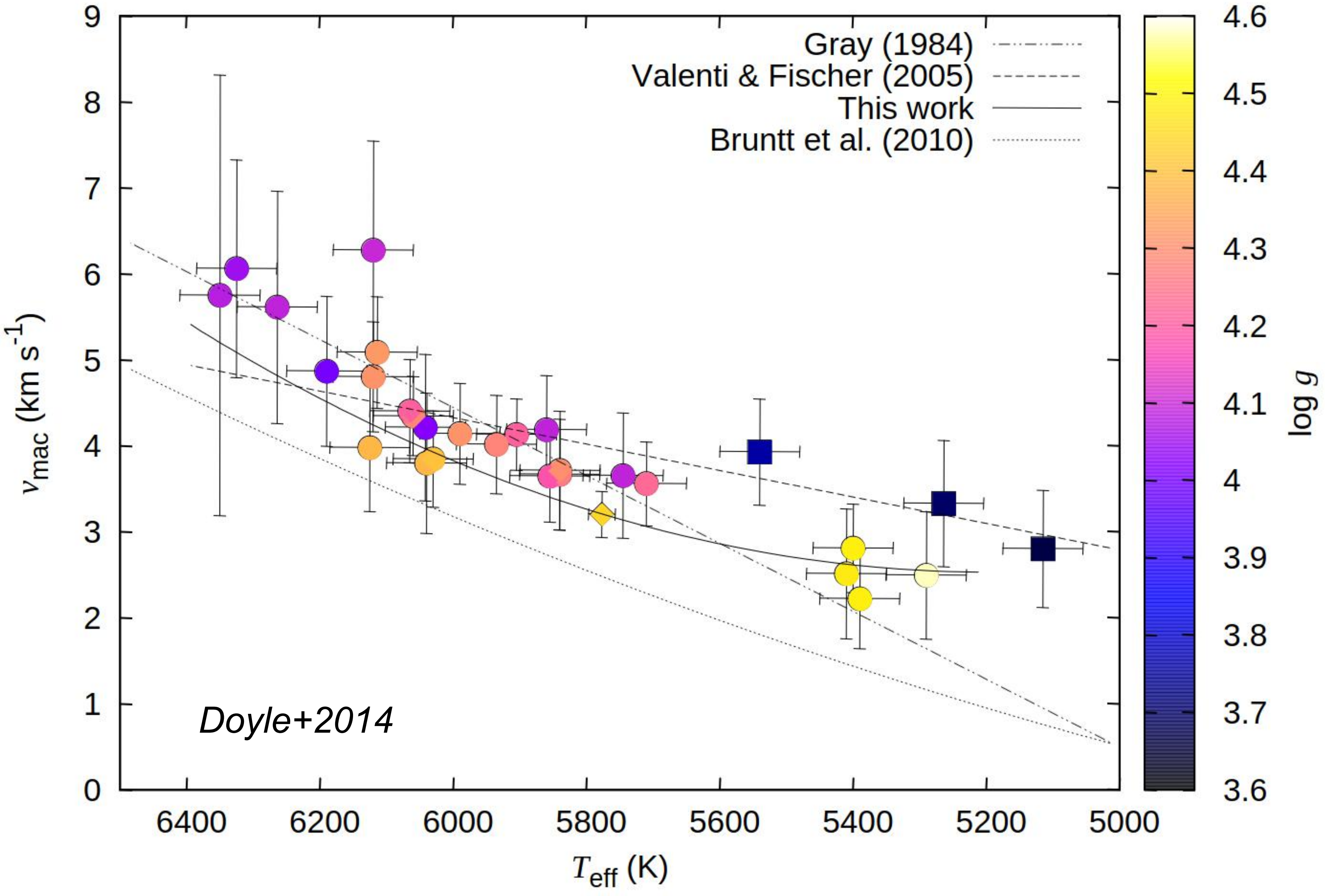
Macroturbulence broadening is the manifestation of turbulent pressure (i.e. convection) in the upper atmospheric layers

Vsini & Vmac: different line shapes

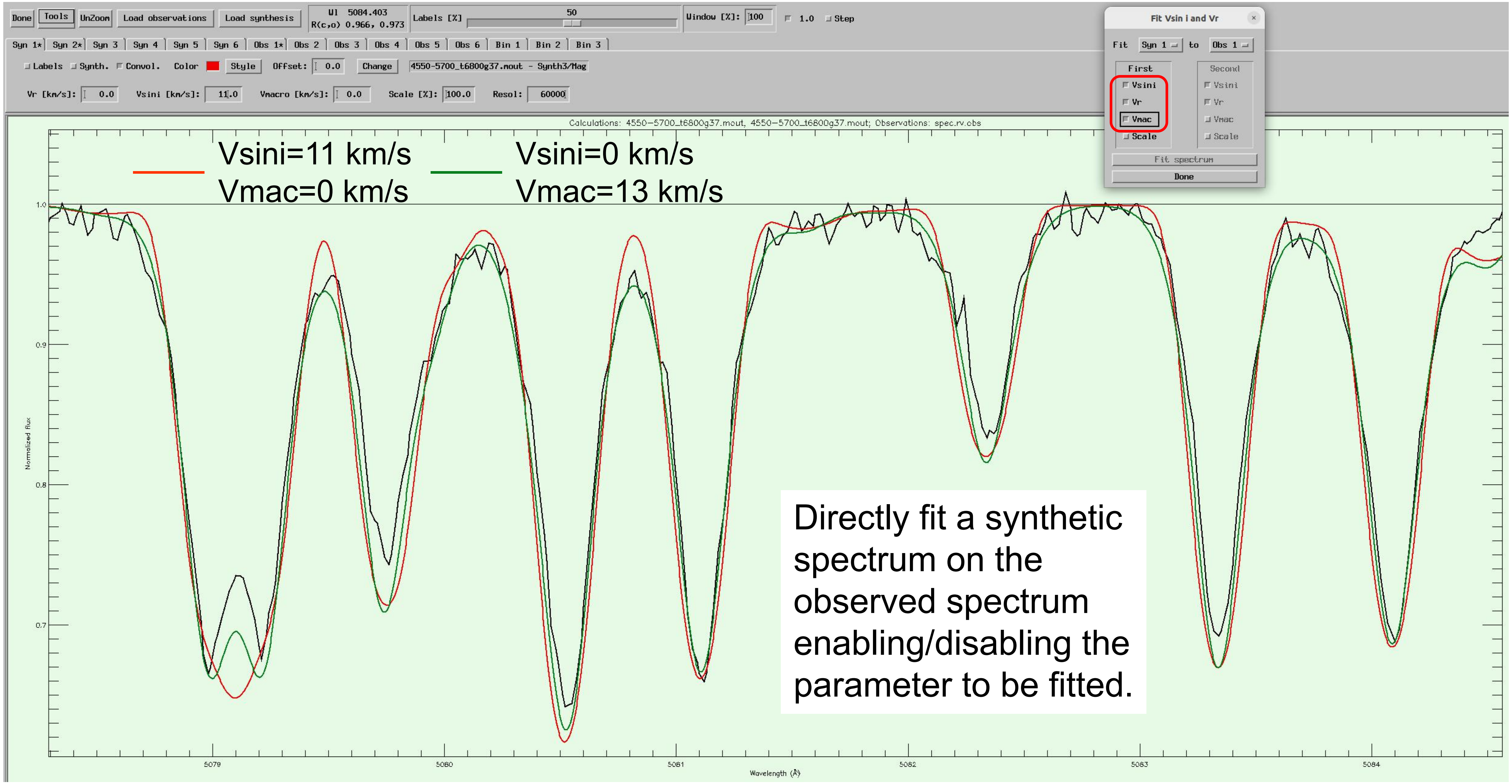


Vsini broadening leads to "roundier" lines, while Vmac broadening leads to more "pointy" (triangular) lines.
The major differences can be seen in close blends.

Vsini & Vmac: literature calibrations



Vsini & Vmac: how to measure - an extreme case



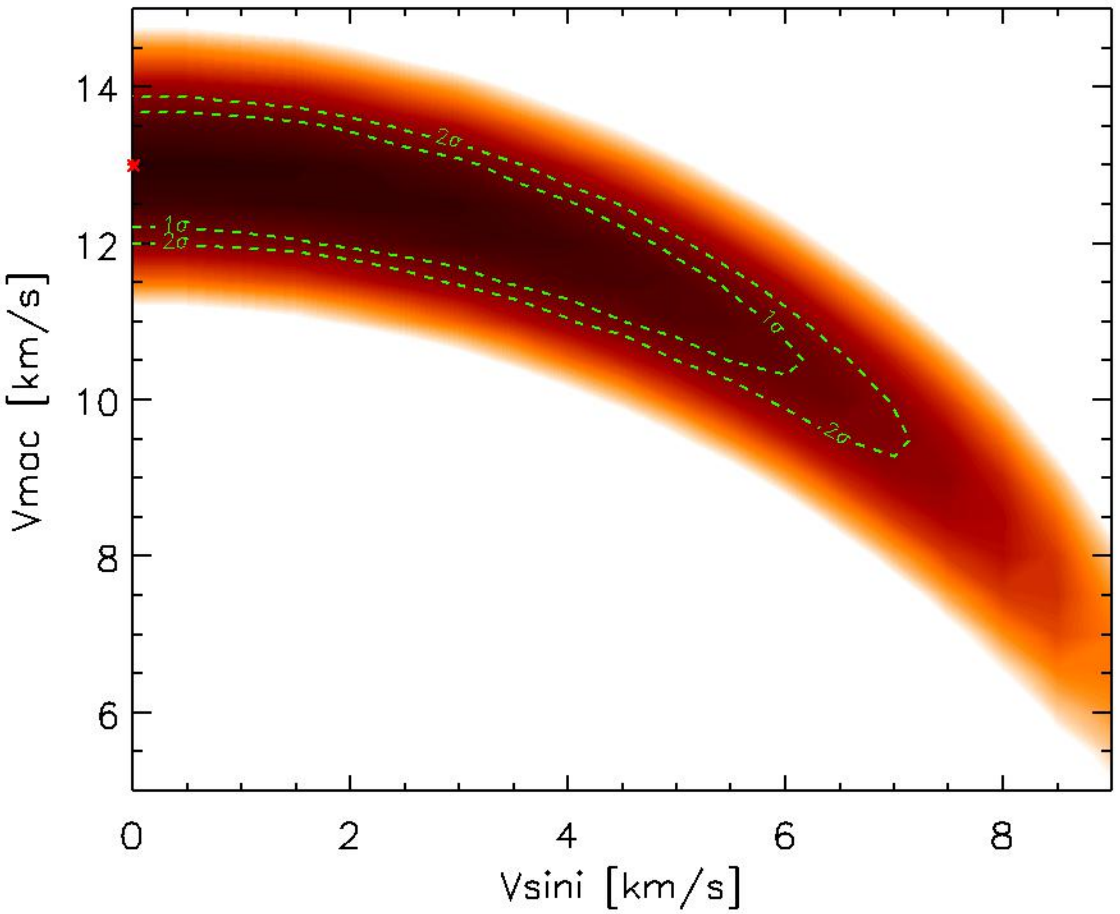
Directly fit a synthetic spectrum on the observed spectrum enabling/disabling the parameter to be fitted.

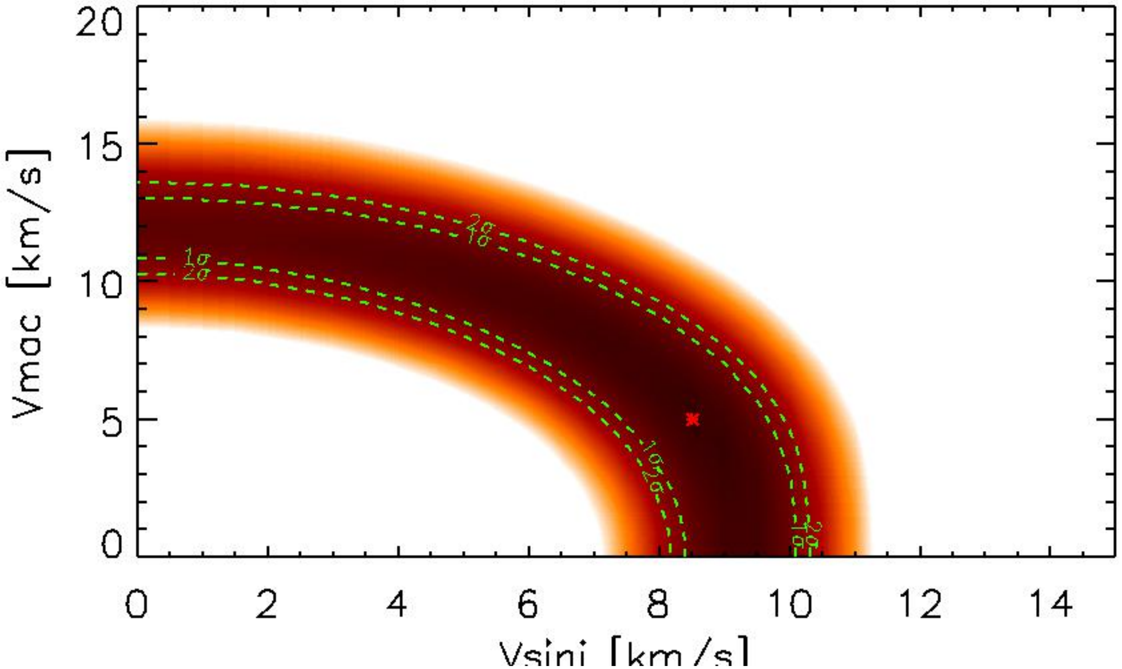
Vsini & Vmac: how to measure

- Use as many lines as possible
- Use a synthetic spectrum with as good parameters as possible
- Use lines for which their strength matches well the observed spectrum (weaker than observed lines will underestimate broadening, while stronger than observed lines will overestimate broadening)
- !!!!!! Do not forget Vmac or you'll risk to overestimate Vsini !!!!!!
- As shown before, certain blends are great for disentangling Vsini and Vmac

Yet, Vsini and Vmac are typically correlated.

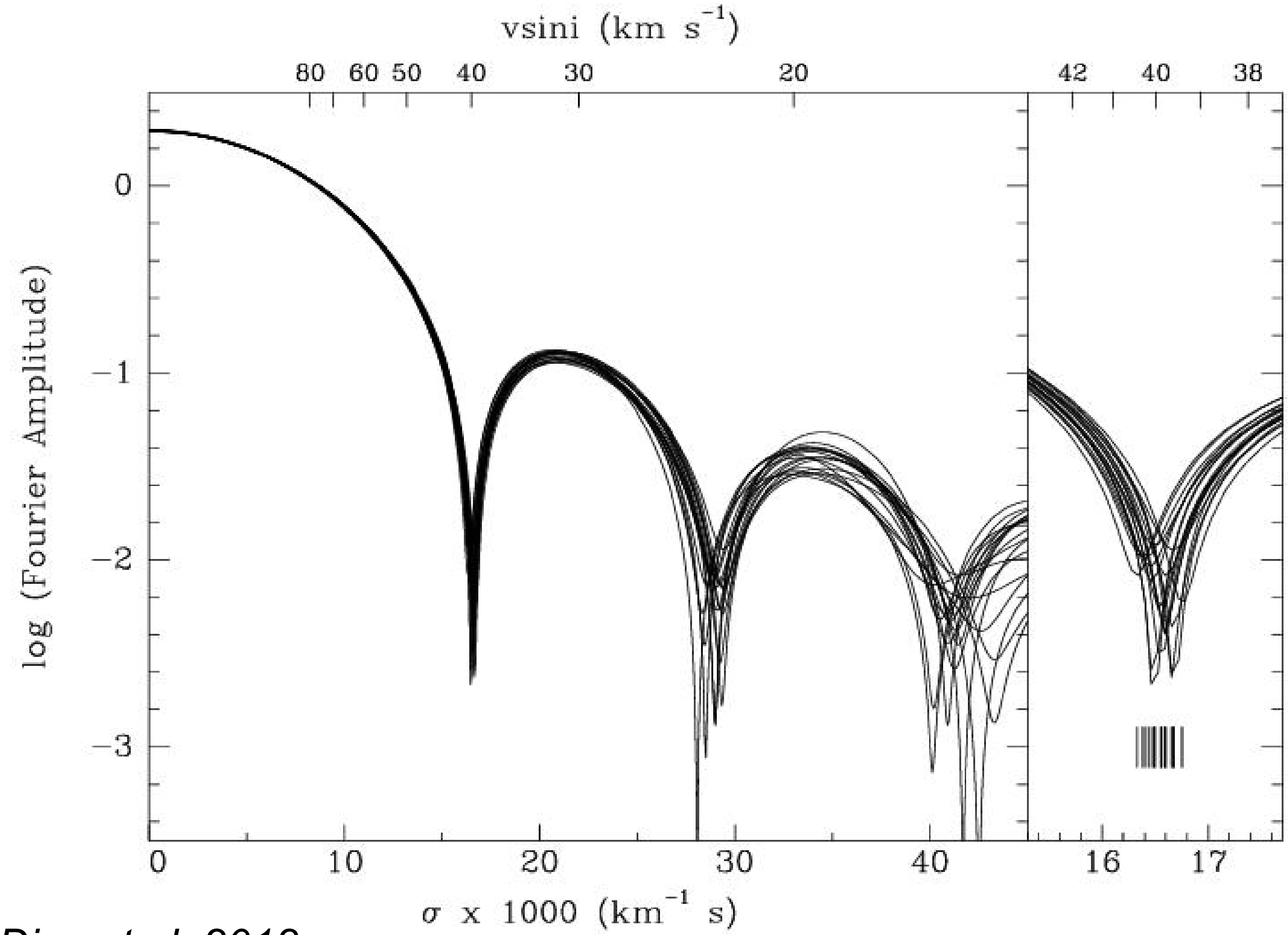
Vsini & Vmac: how to measure





These shapes and contours depend on actual stellar Vsini/Vmac values and on data quality

Vsini & Vmac: how to measure

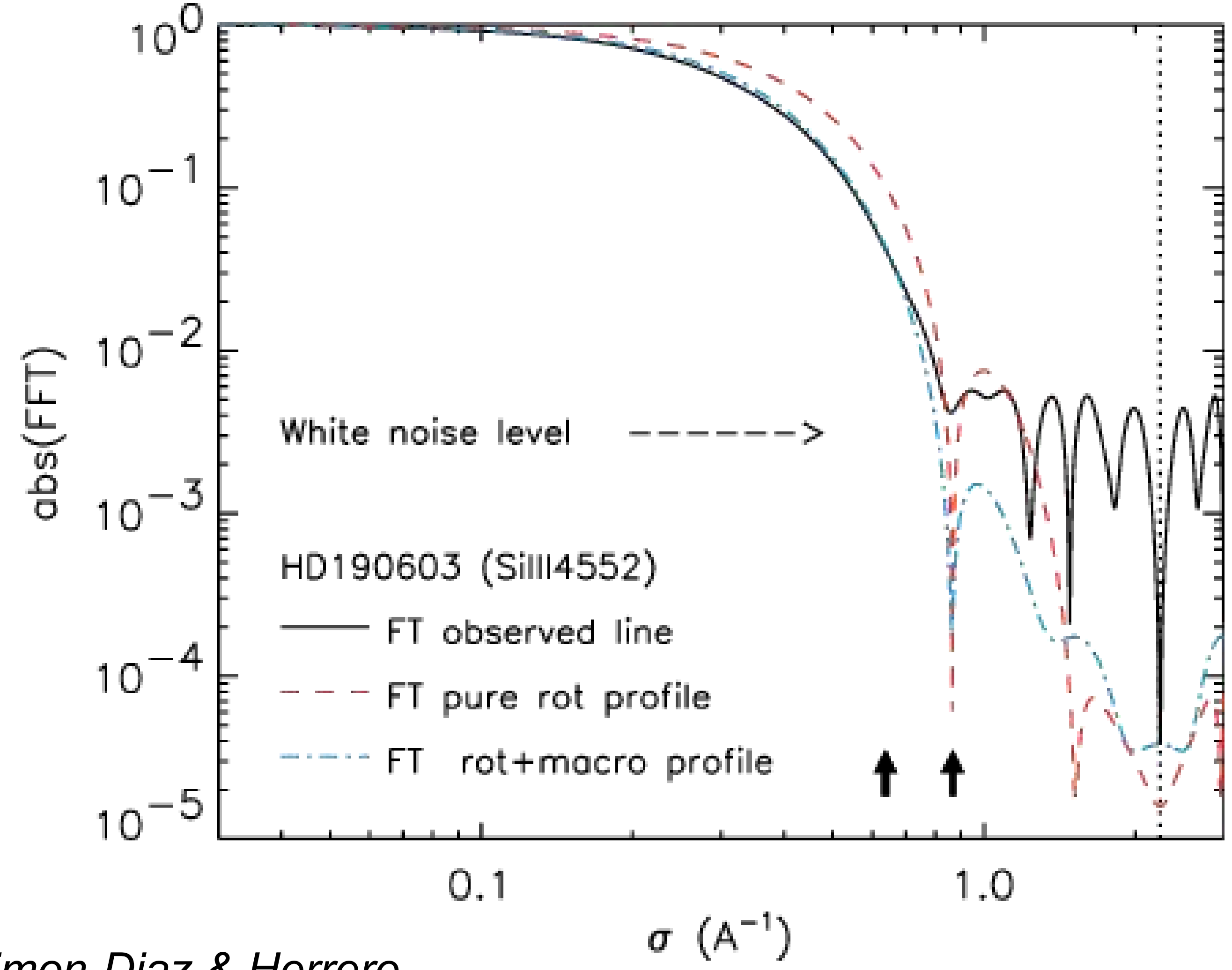


Diaz et al. 2018

The position of the first minimum of the Fourier transform of a spectral line gives the Vsini value, once the x-axis has been appropriately calibrated.

- David Gray, The observation and analysis of stellar photospheres
- Reiners & Schmitt 2002
- Simon-Diaz & Herrero 2014
- Diaz et al. 2018

Vsini & Vmac: how to measure



Macroturbulence changes the shape of the side lobes, which can thus be used to measure Vmac

Simon-Diaz & Herrero 2014

Vsini & Vmac: how to measure

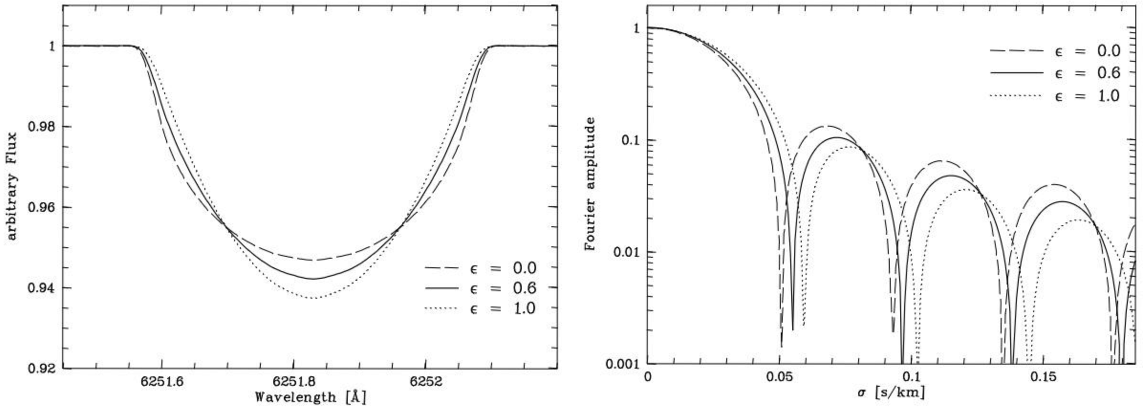


Fig. 2. Absorption line profiles for $v \sin i = 12\ \mathrm{km\,s^{-1}}$ and rigid rotation ($\alpha = 0$; $i = 90°$) in data domain (left) and Fourier domain (right). Three different cases of limb darkening ($\epsilon = 0.0, \epsilon = 0.6$ and $\epsilon = 1.0$) are indicated by dashed, solid and dotted lines, respectively. Note that in Fourier domain the ordinate is plotted with logarithmic scale, while in data domain it is a linear scale.

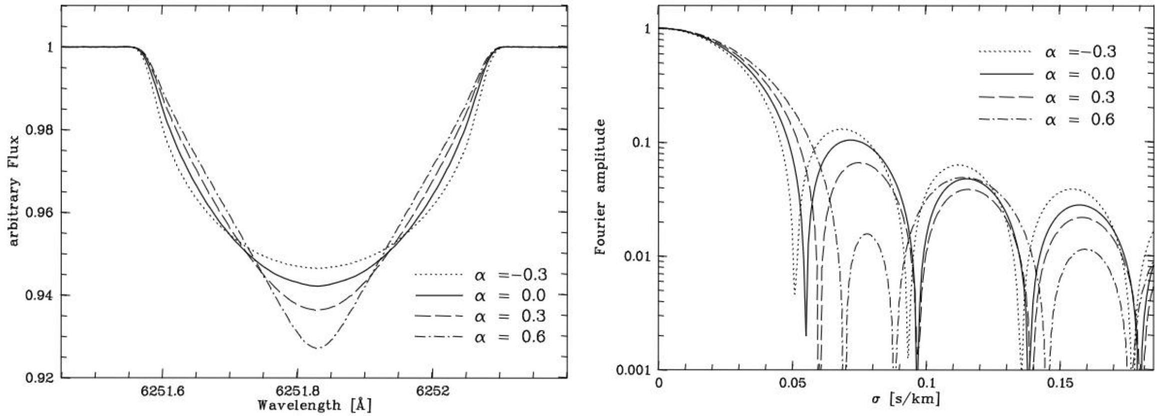


Fig. 3. Absorption line profiles as in Fig. 2 for limb darkening $\epsilon = 0.6$ and $i = 90°$. Different cases of differential rotation ($\alpha = -0.3, \alpha = 0.0, \alpha = 0.3$ and $\alpha = 0.6$) are indicated. In the Fourier domain the different behaviour of the first sidelobe is evident, it narrows for larger differential rotation, while it's amplitude lessens. The amplitude of the second sidelobe changes slightly.

The position of the minima and of the shape of the side lobes enable one to also measure differential rotation and stellar inclination, but depend also on limb darkening.
This is a very powerful technique, but it is difficult to disentangle the different parameters.

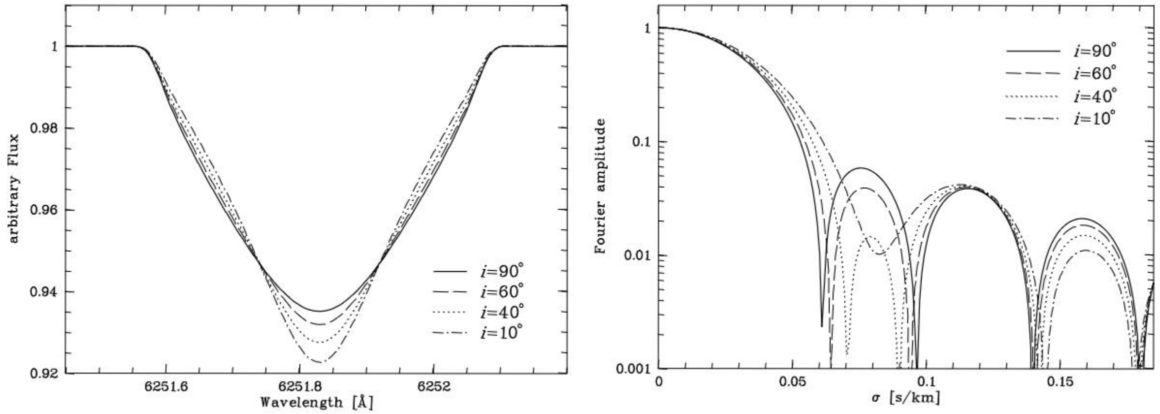


Fig. 4. Absorption line profiles as in Fig. 2 for limb darkening $\epsilon = 0.6$ and differential rotation ($\alpha = 0.35$). Different inclination angles at constant $v \sin i$ ($i = 90°, i = 60°, i = 40°$ and $i = 10°$) are indicated. The behaviour of the first sidelobe with smaller inclination is comparable to the case of larger differential rotation. The amplitude of the second sidelobe remains constant.

Reiners & Schmitt 2002