GWP-S-650-10000

Radial and rotational velocity determination by minimum distance method

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With thanks to Yves Frémat for the inspiration

First solution

Input:

- Grid of template spectra (T_{eff}, log g, other params), very high resolution
- T_{eff}, log g, other params (determined by CU8) so we can select the template spectrum
- Observed spectrum: λ_i, f_i, error information
  Noise filtering?

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Algorithm:

- For a number of trial v_{rad}, for a number of trial v sin *i*:
  - "shift" the template spectrum: $F(\Lambda\ (1 + v_{rad}/c))$
  - Convolve with rotational broadening (v sin *i*)
  - Convolve with instrumental profile
  - Rebin to simulate RVS instrument => $F'(\lambda_i)$
  - $\sigma^2 = \Sigma\ (F'(\lambda_i) - f_i)^2$
- Determine v_{rad}, v sin *i* that give smallest σ
- Convert to barycentric velocity
- Determine error on this result

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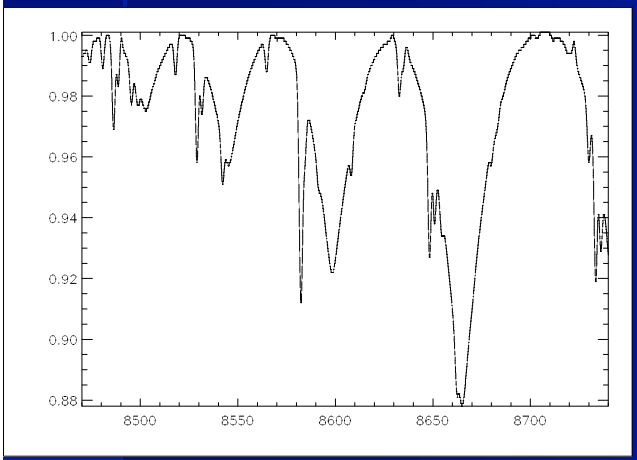
Comments on first solution:

- Efficiency: log Λ alternative
  resampling of observed spectrum: additional noise
- Optimize search of minimum sigma

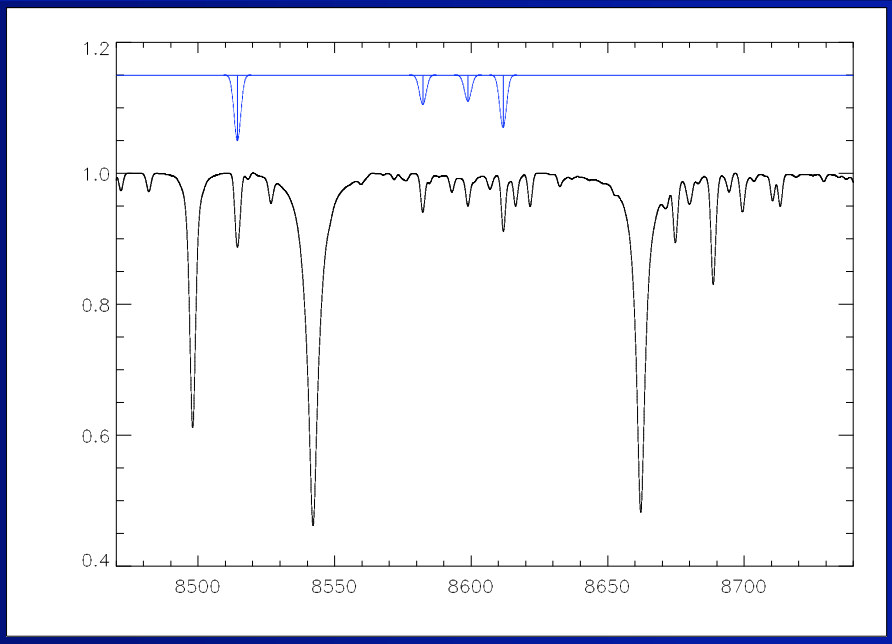


Obtaining the correct solution:

- Spectral lines used to determine T_{eff}, log g are not necessarily the best to determine v_{rad}, v sin *i*:
  Select one / a few spectral lines / use weights

Second solution: Least Squares Deconvolution

Donati et al. (1997)



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Least Squares Deconvolution

Input:

- T_{eff}, log g, other params (determined by CU8)
  so we can select the appropriate mask
- Mask
- Observed spectrum: λ_i, f_i, error information
  Noise filtering?

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Algorithm:

- Try “broadening” function
  Gaussian ⊗ rotational broadening (v sin *i*)
- Try v_{rad} shift
- Best fit of template to observed spectrum

Further refinement:

- Adjust depth of spectral lines + redetermine fit

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Advantage first solution:

- simplicity

Advantages second solution:

- Selection of spectral lines that are useful in determining v_{rad} and v sin *i*
- Adjusting depth of line improves on model spectra

- V_{rad} affected by stellar winds

  E.g. hot stars: computer codes can include effect of a stellar wind; can influence symmetry of hydrogen lines

- V sin *i* affected by non-sphericity of stars

  E.g. Be stars: “true” v sin *i* could be larger than the measured one. Non-spherical Be models could be used as template spectra

- Should we go for the most sophisticated model for each type of star, or is consistency across HR diagram more important?

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Development plan:

- Cycle 2: implement first solution (inefficient form)
  - Algorithm does not need a lot of development
  - Concentrate on Java issues / interface other WPs
- Later cycles: implement second solution
  - Use first solution as a reference point
  - Hopefully some masks available then