RVS performances on rotational velocities

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abstract

- rotational line broadening
- R=11.500, RVS characteristics (Dec 2003)
- gaia simulator
- template synthetic spectra library
- no spectral mismatch assumed
- least square fit
- accuracy of v sin i

brief reminder - why v sin i?

- stellar structure, luminosity, evolution, life time etc.
- indicator of age
- mixing, peculiar stars, winds, spots
- binary systems
- presence of massive planets
- open clusters
- orientation of rotational axis - random?

simulations

- single star
- Kurucz spectra →gaia simulator → spectra for single transit, mission average (102 transits)
- library of template spectra (various v sin i)
- fit - least square method
- N=1000
- accuracy defined as: $\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}[v_{rot}^{i}(true) - v_{rot}^{i}(rec.)]^2$

effects included in gaia simulator

- spectra convolved to RVS resolution
- noise - photon, background noise (zodiacal light, faint background stars), detector noise
- pupil area, overall efficiency, exposure time etc.

- random offset in first pixel 8480±0.5×0.375 Å !

errors not included

- modeling uncertainties
- spectral mismatch
- crowding
- ....

Stellar types and v sin i

Stellar type	v sin i [km s^{-1}]
• K1 III [Fe/H]=0.0	5 km s^{-1}
• G5 MS/TO	5 km s^{-1}
• B5 MS	50, 150 km s^{-1}
• K1 III [Fe/H]=-1.5	5 km s^{-1}
• F5 MS/TO	20, 50 km s^{-1}

library step size

- "OLD" library - example, v sin i=5km s^{-1}:

  1-10 km s^{-1} Δ=1 km s^{-1}
  10-20 Δ=5 km s^{-1}
  50 - 250 Δ=50 km s^{-1}
  300 -500 Δ=100 km s^{-1}

- "NEW" library- equidistant

  K1 III, G5: 1-100 km s^{-1} : Δ=1 km s^{-1}
  F5: 0-300 km s^{-1} : Δ=2 km s^{-1}
  B5: 0-500 km s^{-1} : Δ=5 km s^{-1}

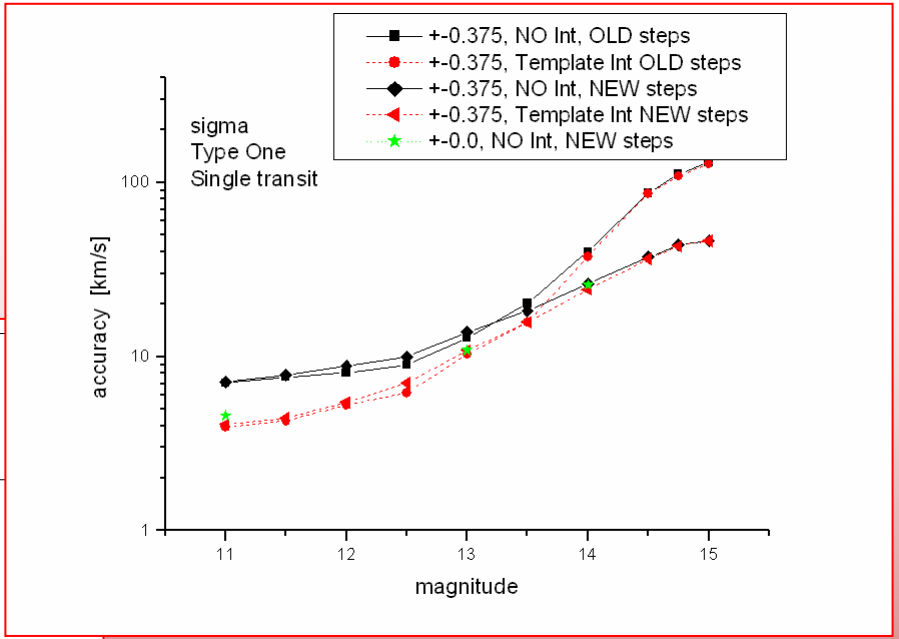
random offset λ: ±0.5*0.375 Å

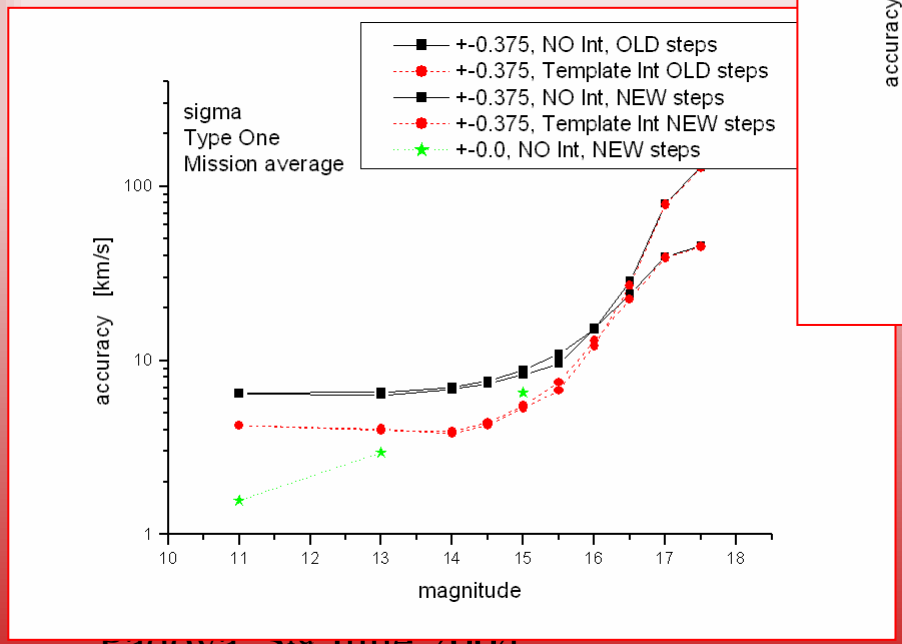
- linear interpolation - broadens lines

- l.i. on simulated spectra - higher v sini (noise!)
- l.i. on template spectra - lower v sini

tests with offset λ =0, step size in library - accuracy

- example K1 III





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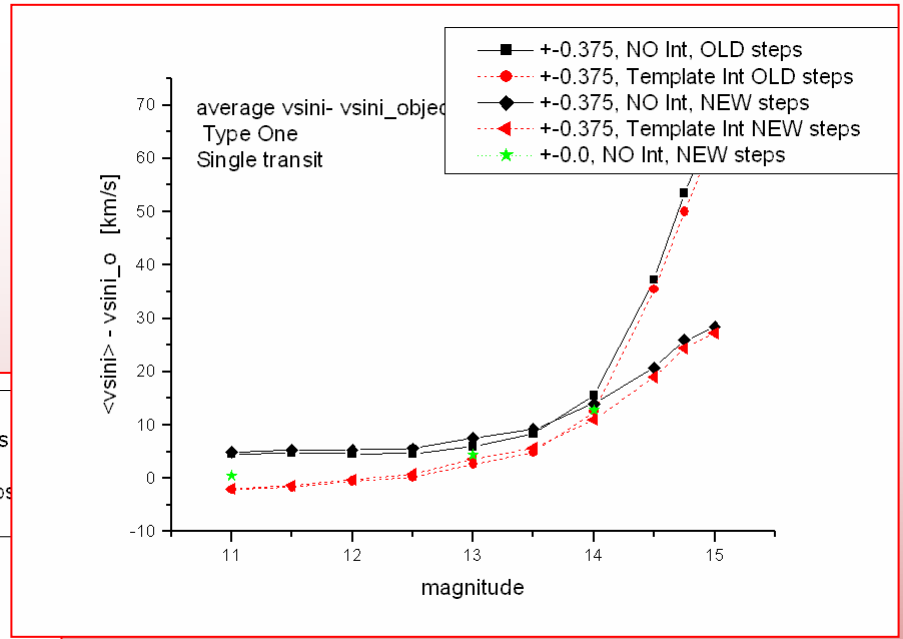
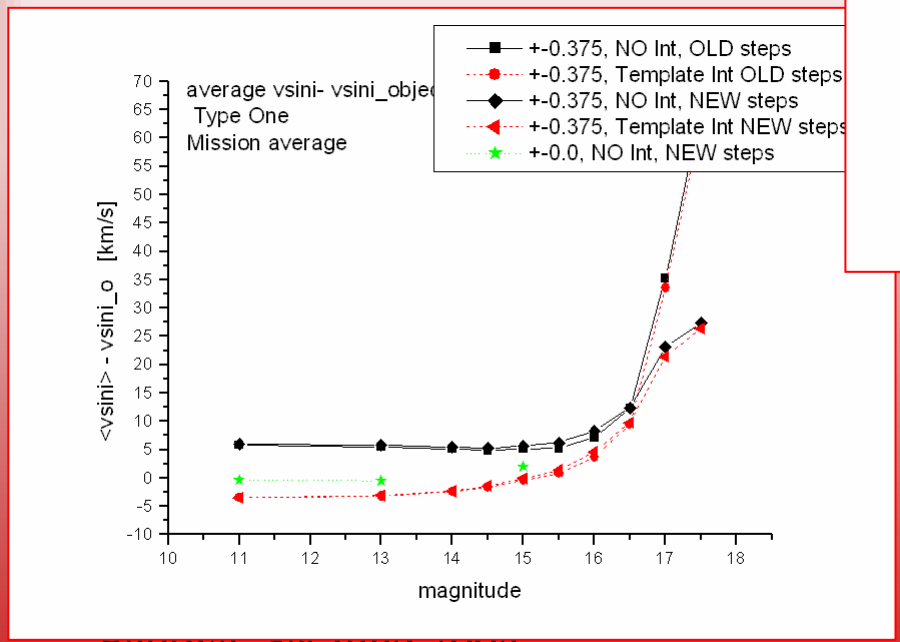
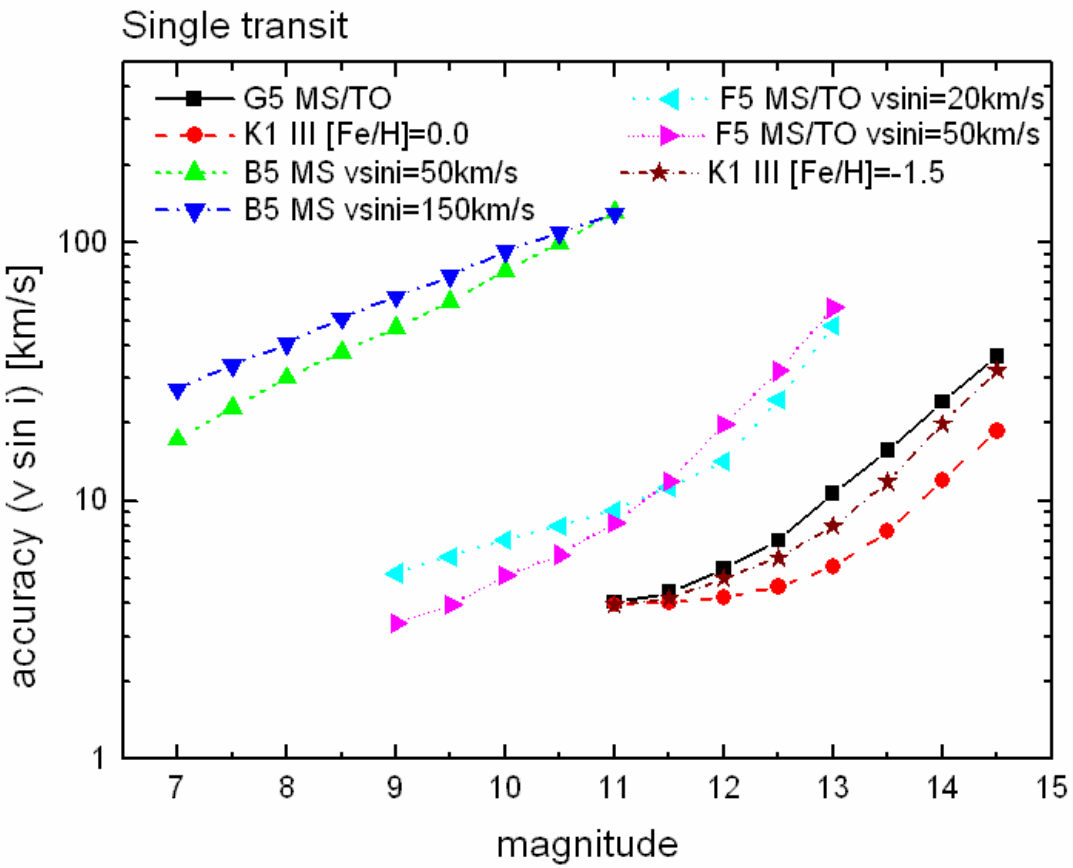
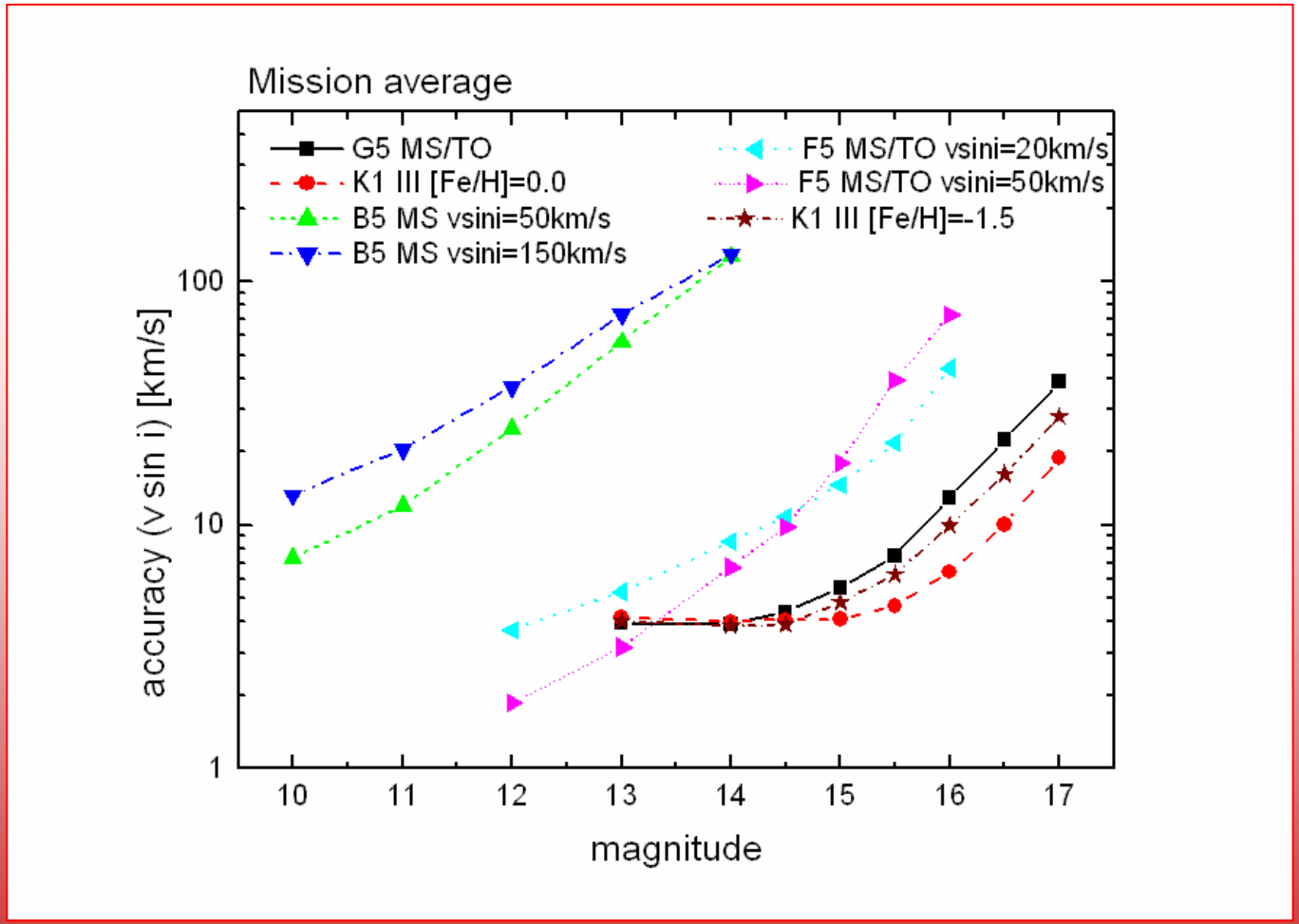




performances - single transit



performances - mission average



results and biases

- late types (5 kms^{-1})

  $\sigma_{v \sin i}$ ~ 5 kms^{-1} up to V ~ 12 (single) and 15 (mission)
- F5 MS/TO (20, 50 kms^{-1})

  10-20 kms^{-1} up to V ~ 12 (single) and 15 (mission)
- B5 MS/TO (50, 150 kms^{-1})

  10-20 kms^{-1} up to V ~ 7-8(single) and 10-11 (mission)
- bias: ~ few kms^{-1} for bright magnitudes

possible improvements and future work

- different methods - correlation peak... spots?
- random λ shift - smarter method than l.i.?
- spectral mismatch

  (0.5 in log g; 125 K in T; 0.1 dex in met.; few kms^{-1} in v_{rad})
- tests on observational spectra

suggestions?