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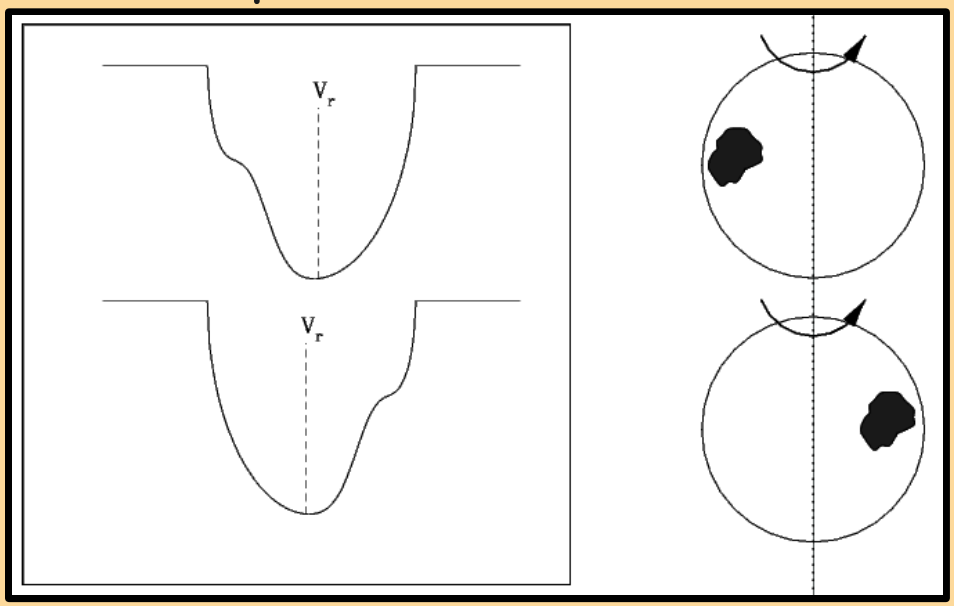
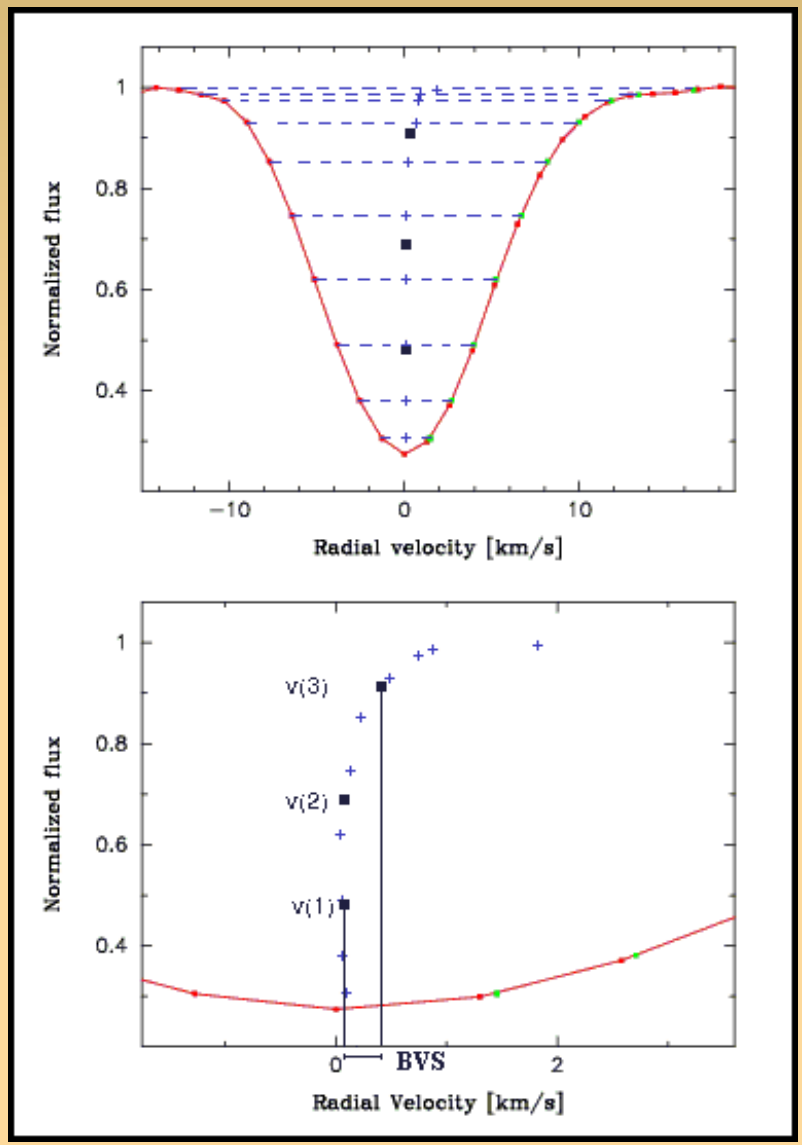
Radial velocity stability of red giants

Spots

- Spots on the surface of the rotating star cause distortion in line shapes and generate radial velocity variations.
- We may analyse the shapes of the spectral lines using line bisector technique.



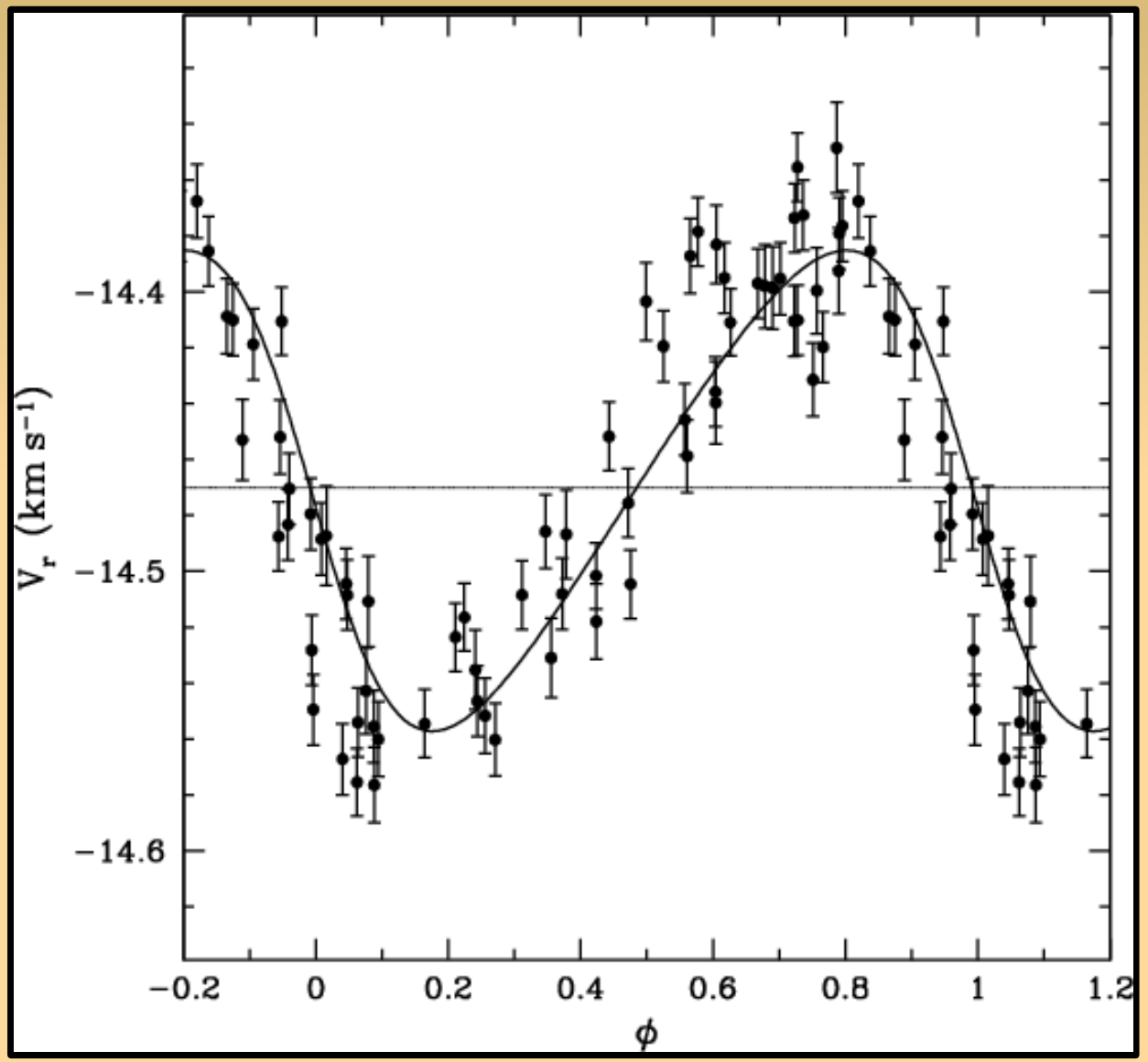


HD 166435 – false planet host star

- Keplerian fit to the radial velocity data:
- P = 3.7987 day,
- e = 0.2,
- K = 83 m/s.

- However the rms of the residuals to the fit is 28 m/s, which is large compared to the typical ELODIE precision of 10 m/s.

Credit: Queloz, D. et al. 2001, A&A, 379, 279.



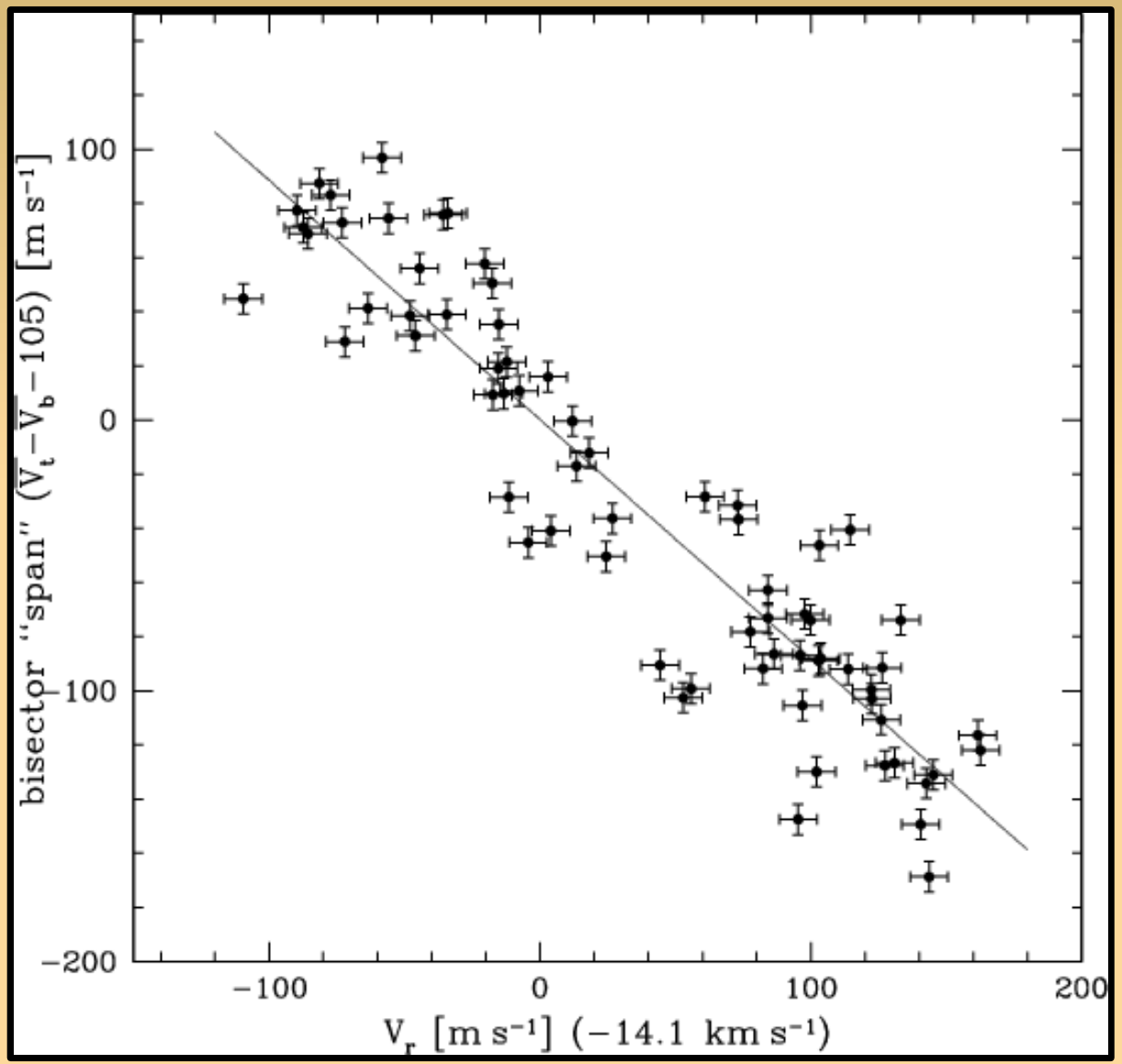
HD 166435 – BVS vs RV

- Relationship between the orientation of the bisectors (BVS) and the radial velocity:

  BVS = -0.88*RV

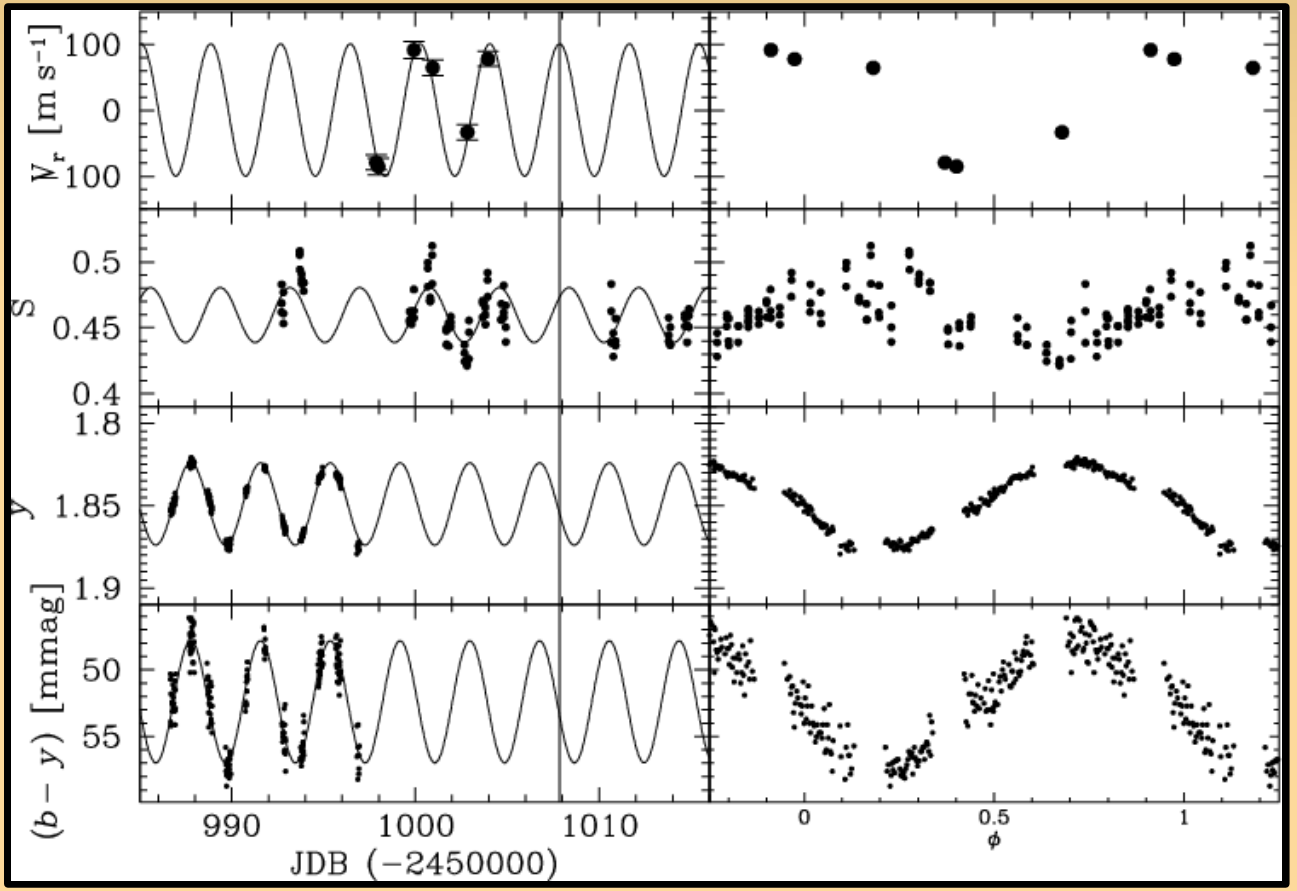
- Conclusion: radial velocity variations originate in the stellar atmosphere and not from reflex motion of the whole star.

Credit: Queloz, D. et al. 2001, A&A, 379, 279.



HD 166435 – photometry

- 326 observations with the 0.8 m automatic photoelectric telescope at Fairborn Observatory in Arizona.
- Period in photometry – 3.7995 +/- 0.0005 d.



Credit: Queloz, D. et al. 2001, A&A, 379, 279.

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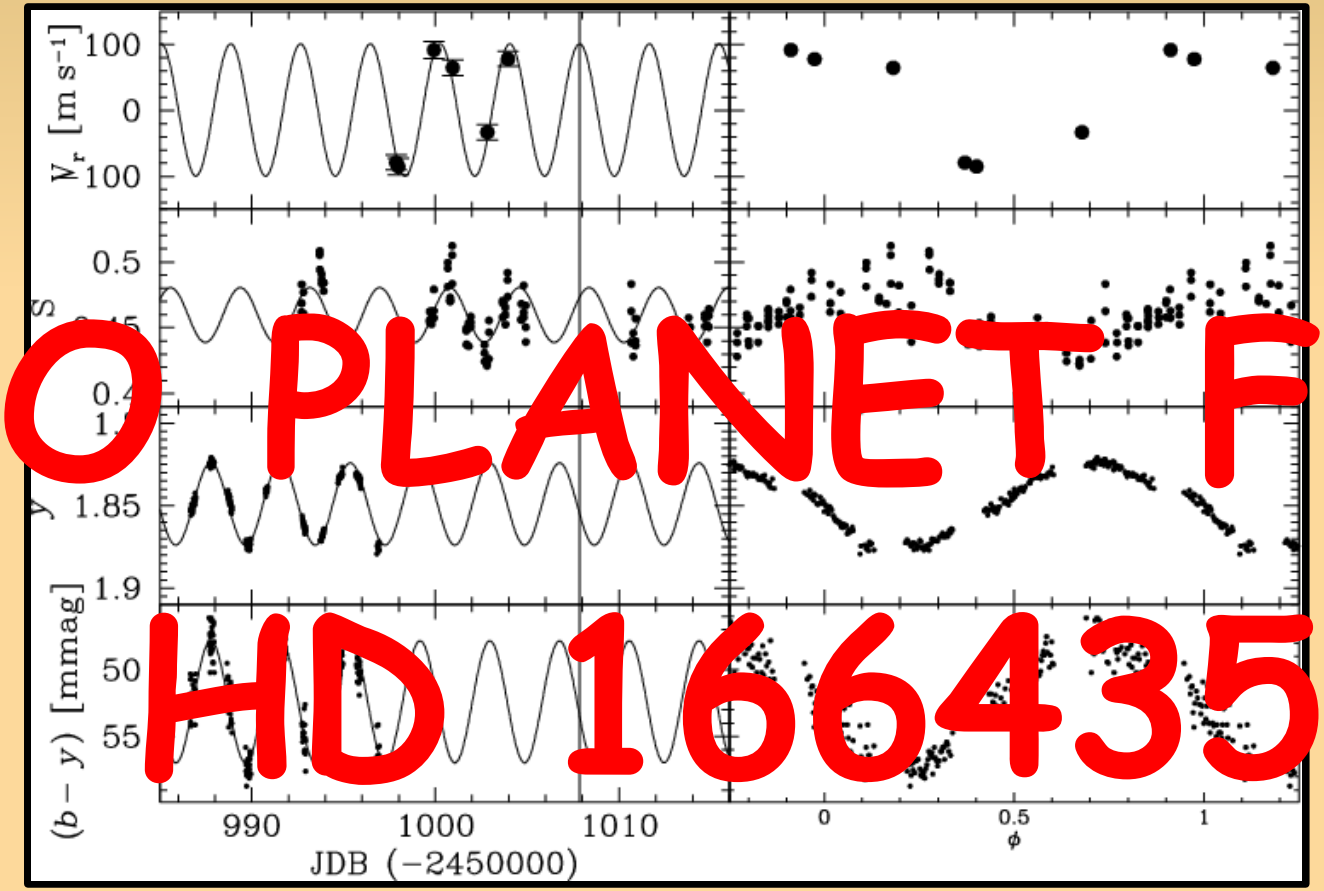
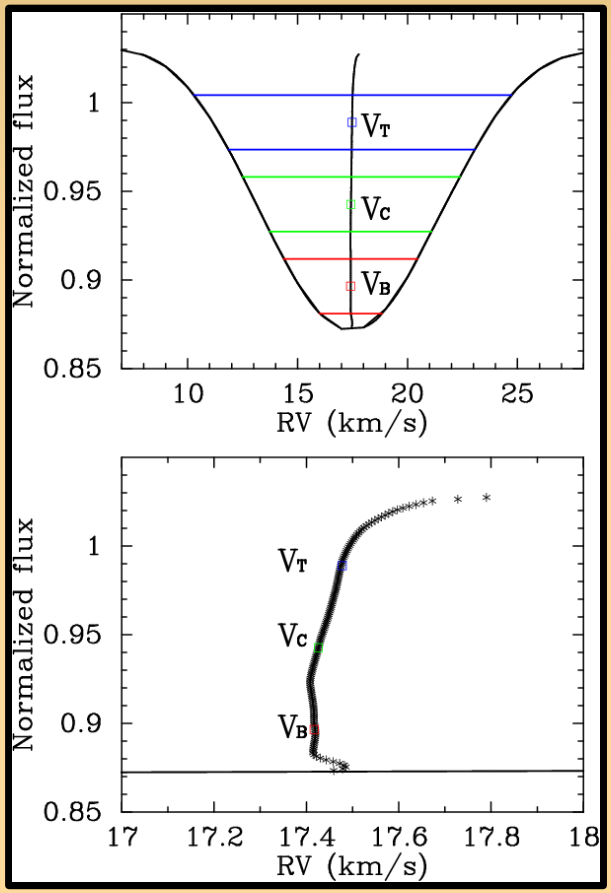


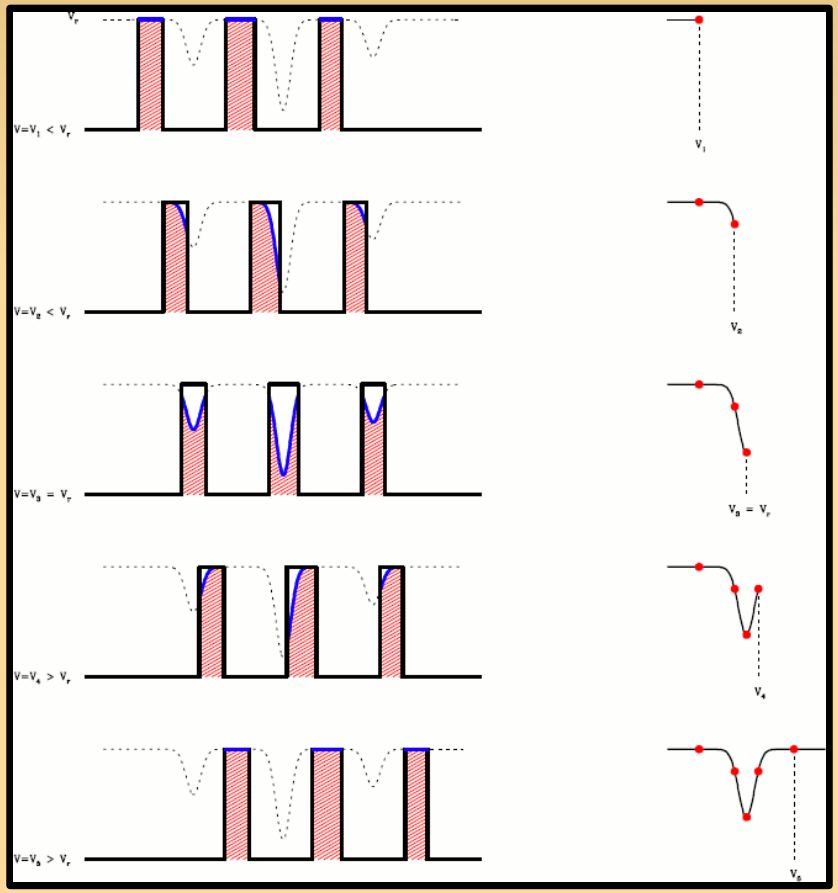
NO PLANET FOR HD 166435

Credit: Queloz, D. et al. 2001, A&A, 379, 279.

CCF, BVS and BC

- CCF represents a mean spectral-line profile of lines selected by the mask.
- $BVS = V_T - V_B$, $BC = (V_T - V_C) - (V_C - V_B)$, EW_{CCF}.

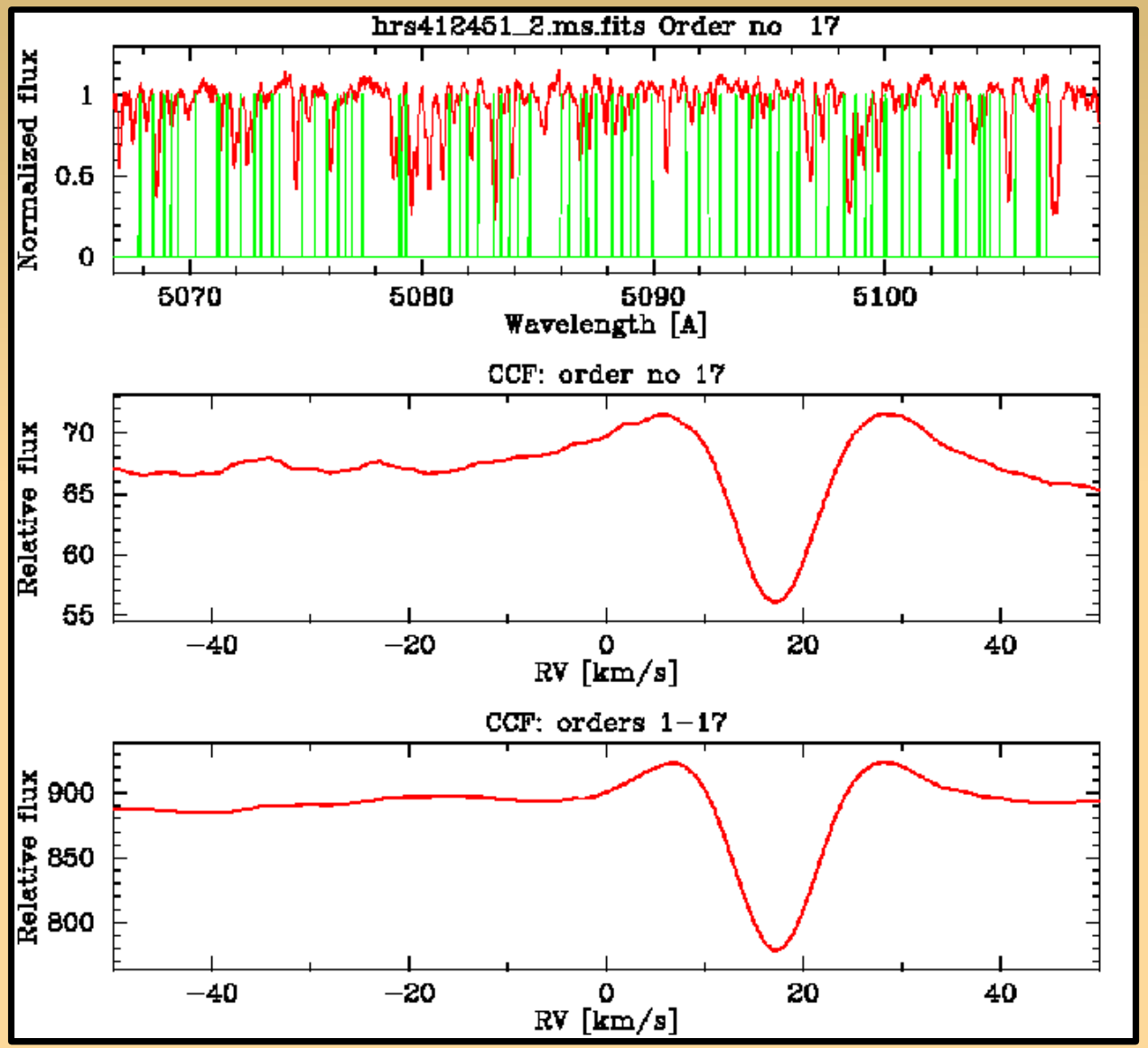




Credit: Melo. C. H. F., 2000, Ph.D. Thesis, Geneva Observatory.

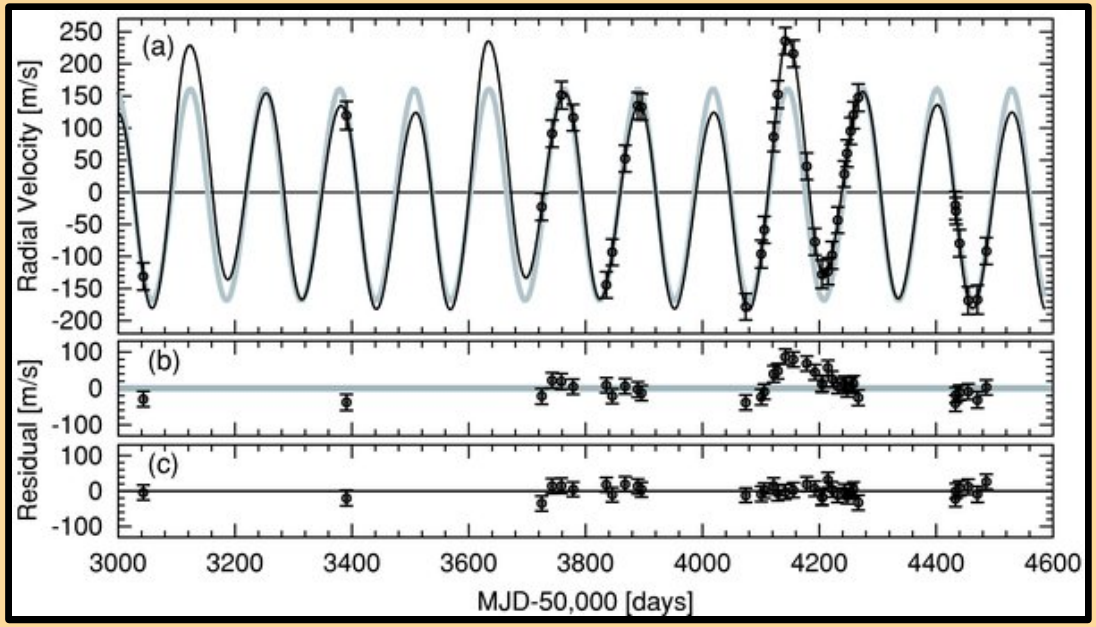
CCFs in the case of I_2 method

- We have to remove iodine lines from the stellar spectra in each segment of the spectrum separately, during radial velocity measurements.
- After removing I_2 lines we construct CCFs order by order and add them to obtain CCF for all 17 orders.

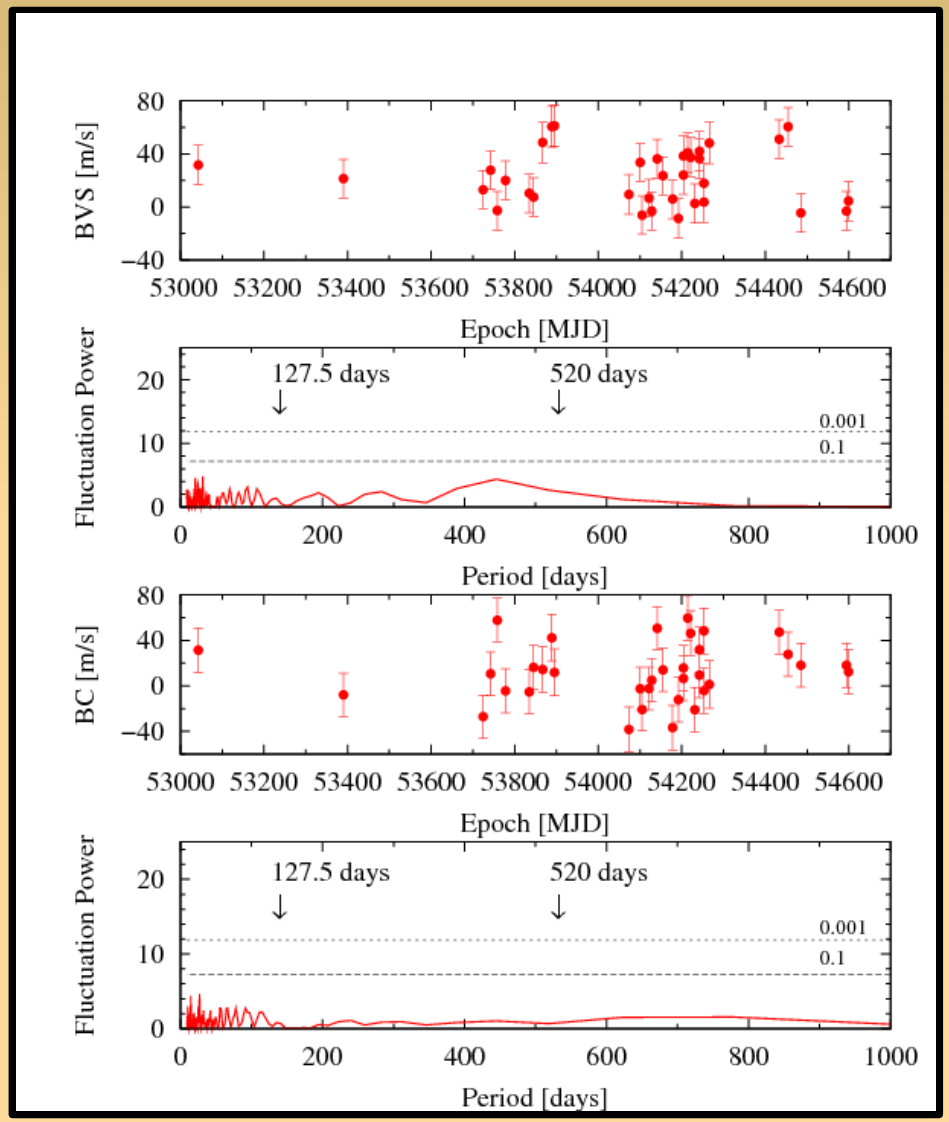


HD 102272

- HD 102272 b: P = 127.5 day,
  M sin(i) = 5.9 M_J
- HD 102272 c: P = 520 days,
  M sin(i) = 2.6 M_J
- Photometry from *Hipparcos*, NSVS



Niedzielski, A., et al., 2009, ApJ, 693, 276



Nowak, G., et. al., 2010, EASPS, 42, 165

Conclusions

- Stellar variability, like non-radial pulsations, or spots combined with stellar rotation can mimic planetary signature in the radial velocity data. Therefore, especially in the case of red giants, it is important to verify the source of the RV variations.

- Line bisector technique allows to find the source of the radial velocity variability also in the case of the I_2 method.

- Current precision of our bisector measurements is ~20 m/s.

- Photometry is very important to confirm stellar nature of the radial velocity variations.

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