Dr. Remeis-Sternwarte Bamberg
Astronomical Institute of the
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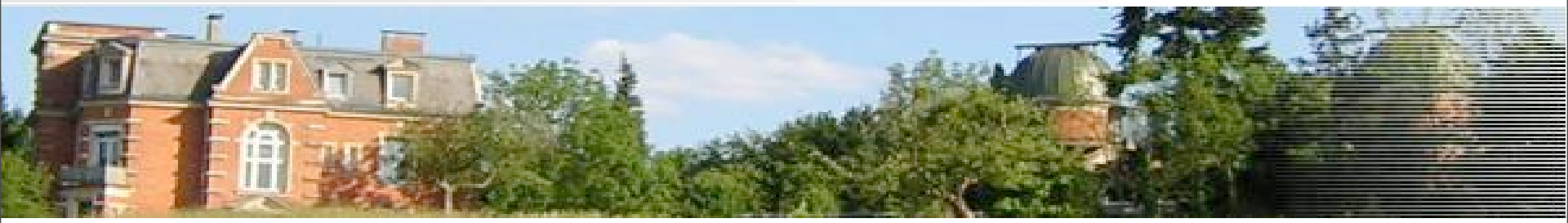
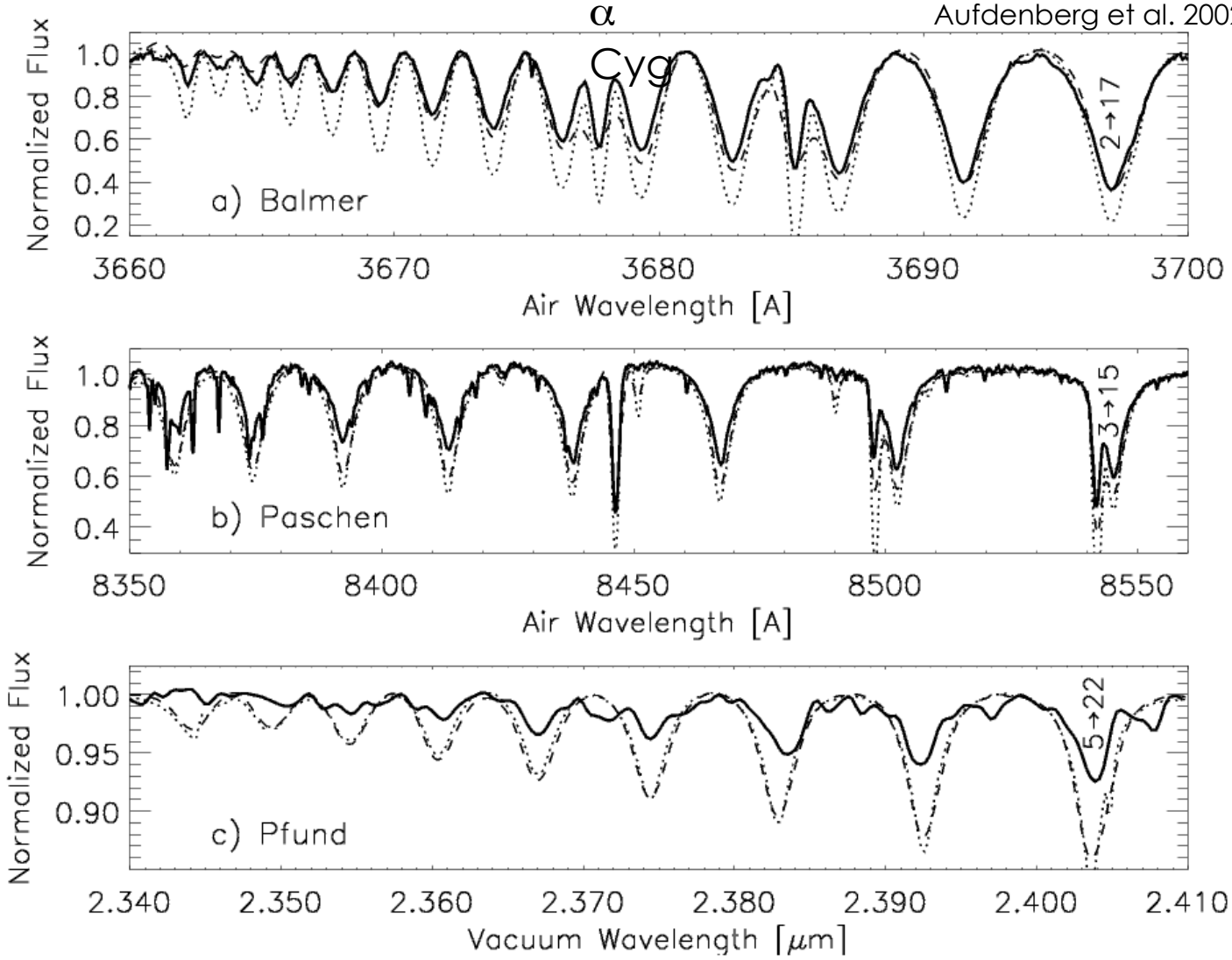


Non-LTE line formation in the IR

N. Przybilla

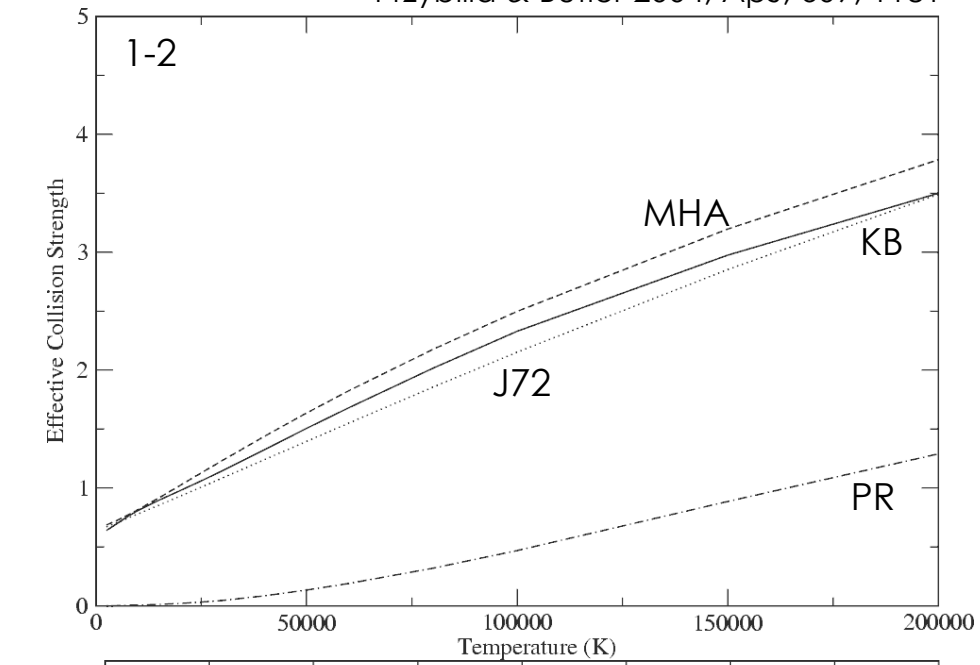
Motivation

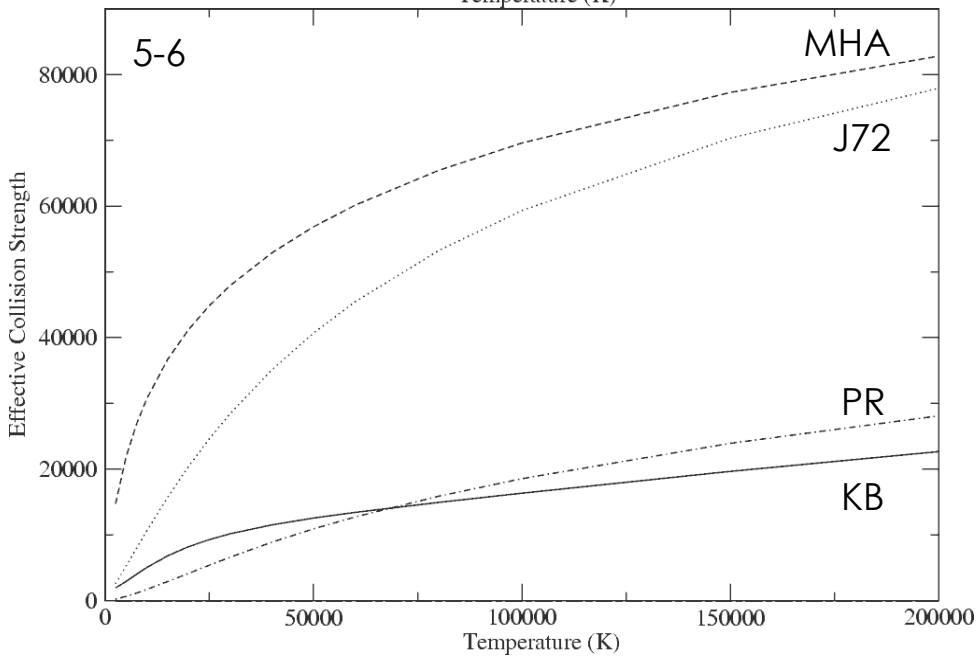


'These failures indicate that a spherically symmetric, expanding, steady state, line-blanketed, radiative equilibrium structure is not consistent with the conditions under which [...] the higher Pfund lines form.'

Aufdenberg et al.

Przybilla & Butler 2004, ApJ, 609, 1181





H lines in the NIR 1

- cross-sections for

  excitation via e⁻-collisions

  only approximate:

  - Johnson1972, ApJ, 174, 227
  - Mihalas, Heasley & Auer 1975

- new: ab-initio computations for collisions between levels up to n=7

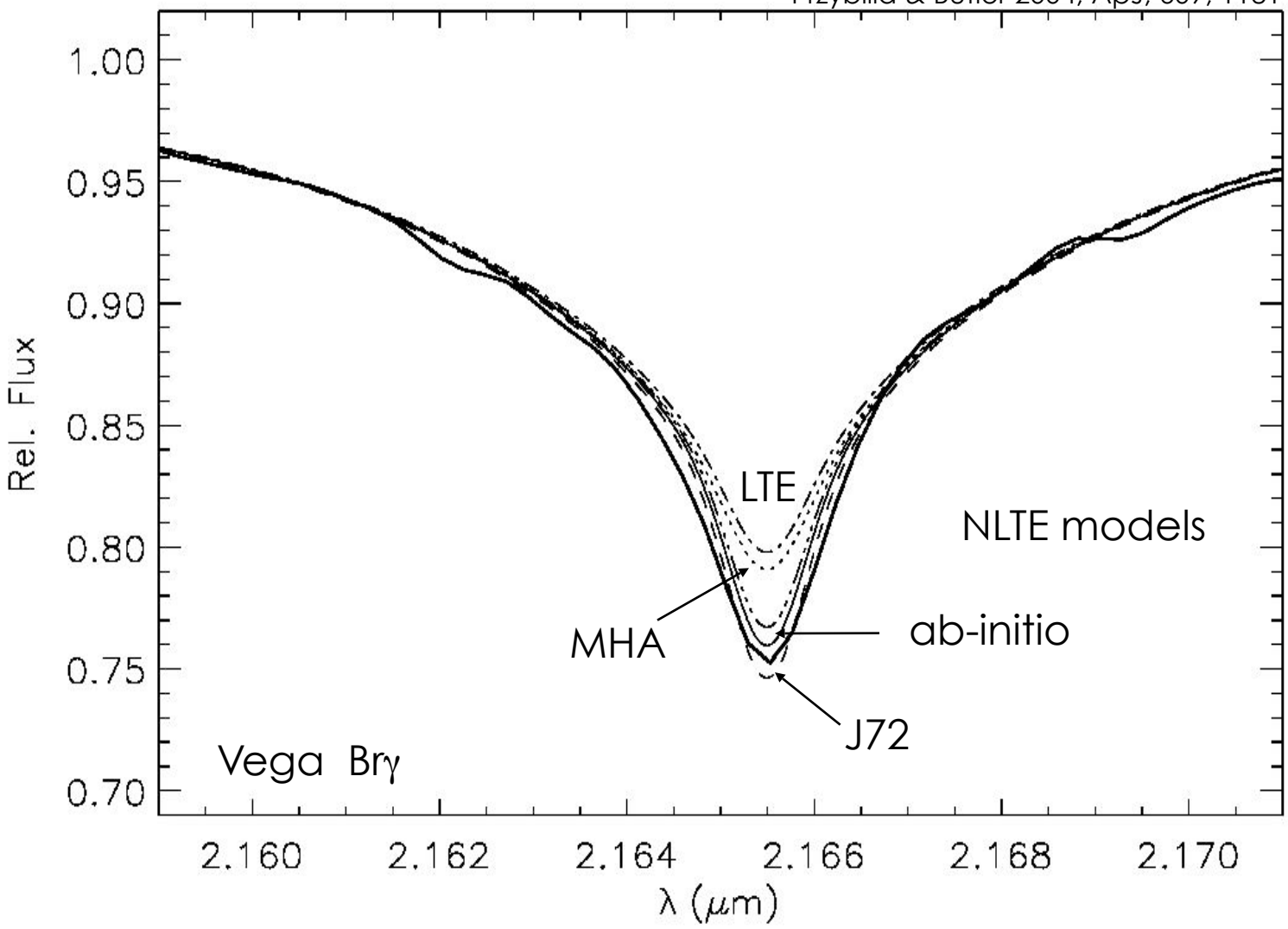
  + Percival & Richards 1978, MNRAS, 183, 329 (n≥5)

effective collision strength:

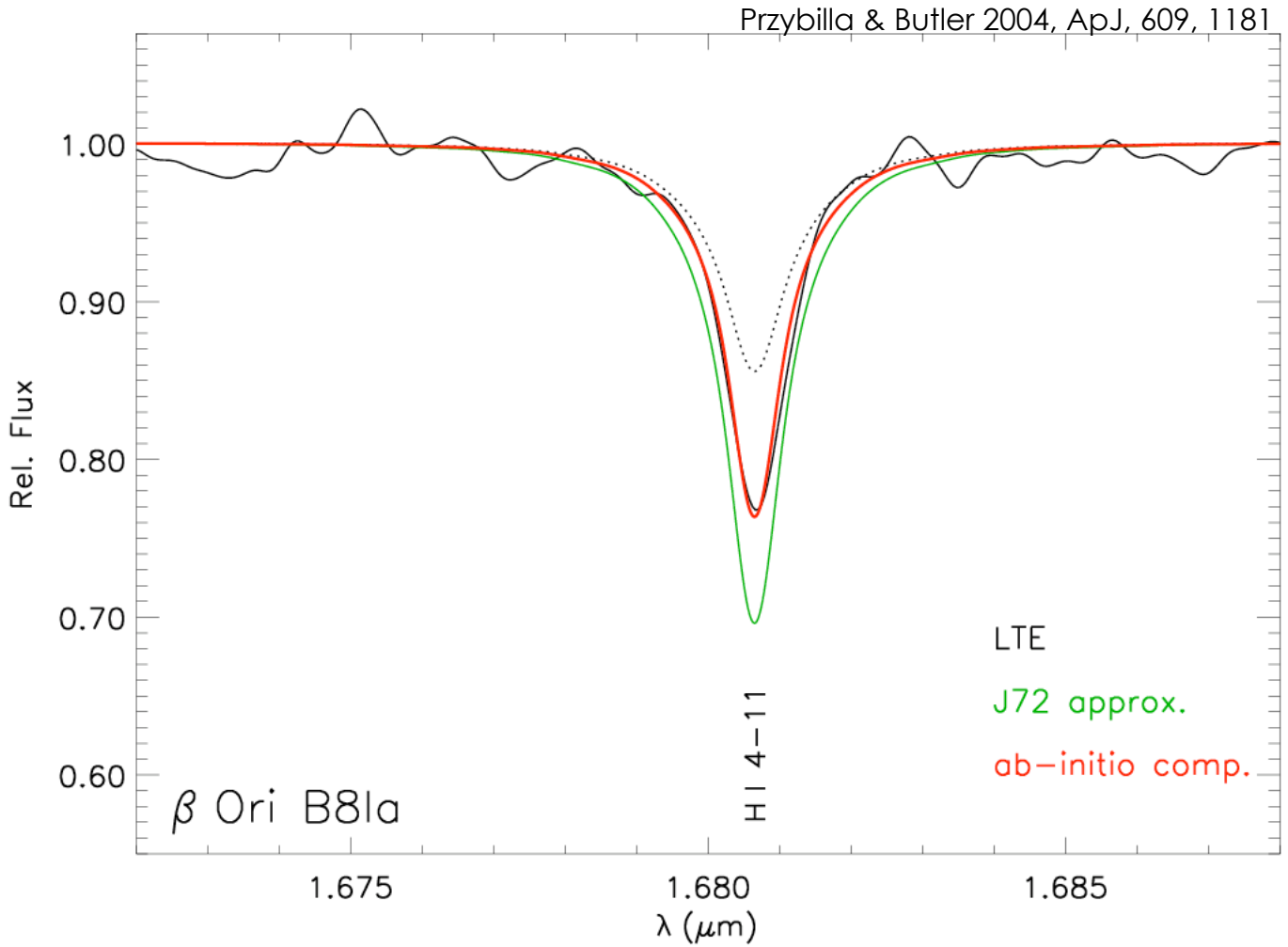
$$\Upsilon_{ij} = \int_0^\infty \Omega_{ij}\, e^{-\frac{E_j}{kT}}\, \mathrm{d}(E_j/kT)$$

H lines in the NIR 2

Przybilla & Butler 2004, ApJ, 609, 1181



H lines in the NIR 3



- NLTE-amplification in the NIR
- NIR-lines reproduced – little effect on Balmer lines

NLTE amplification

- line source function:

$$S_l = \frac{2h\nu^3/c^2}{b_i/b_j \exp(h\nu/kT) - 1}$$

- reaction to variation of b_i/b_j:

$$|\Delta S_l| = \left| \frac{S_l}{b_i/b_j - \exp(-h\nu/kT)} \Delta(b_i/b_j) \right|$$

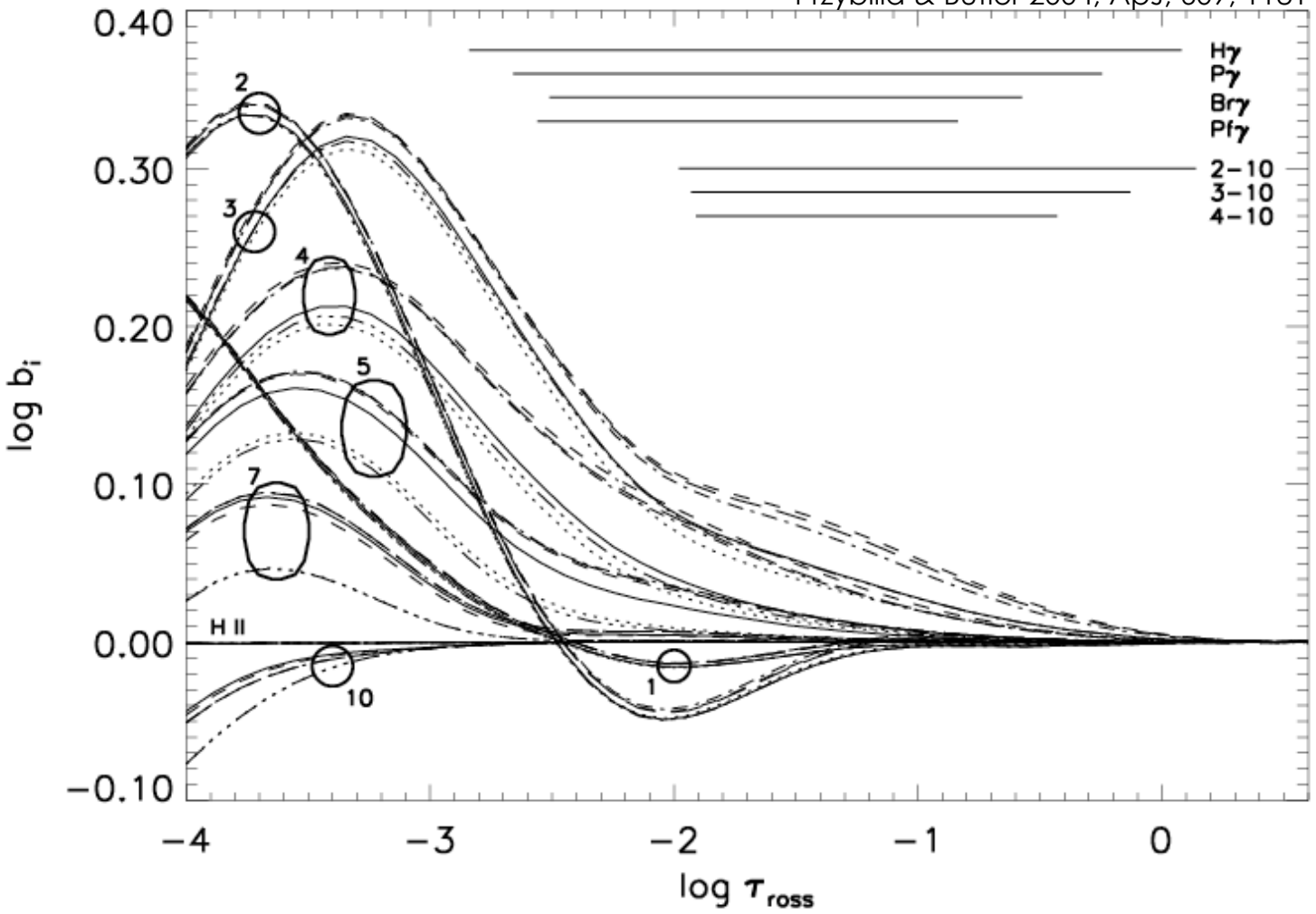
$$\approx \left| \frac{S_l}{(b_i/b_j - 1) + h\nu/kT} \Delta(b_i/b_j) \right|$$

IR in hot stars: Rayleigh-Jeans regime

- changes in b_i/b_j by a few % can give changes in W_λ by factor 2-3

H lines in the NIR 4

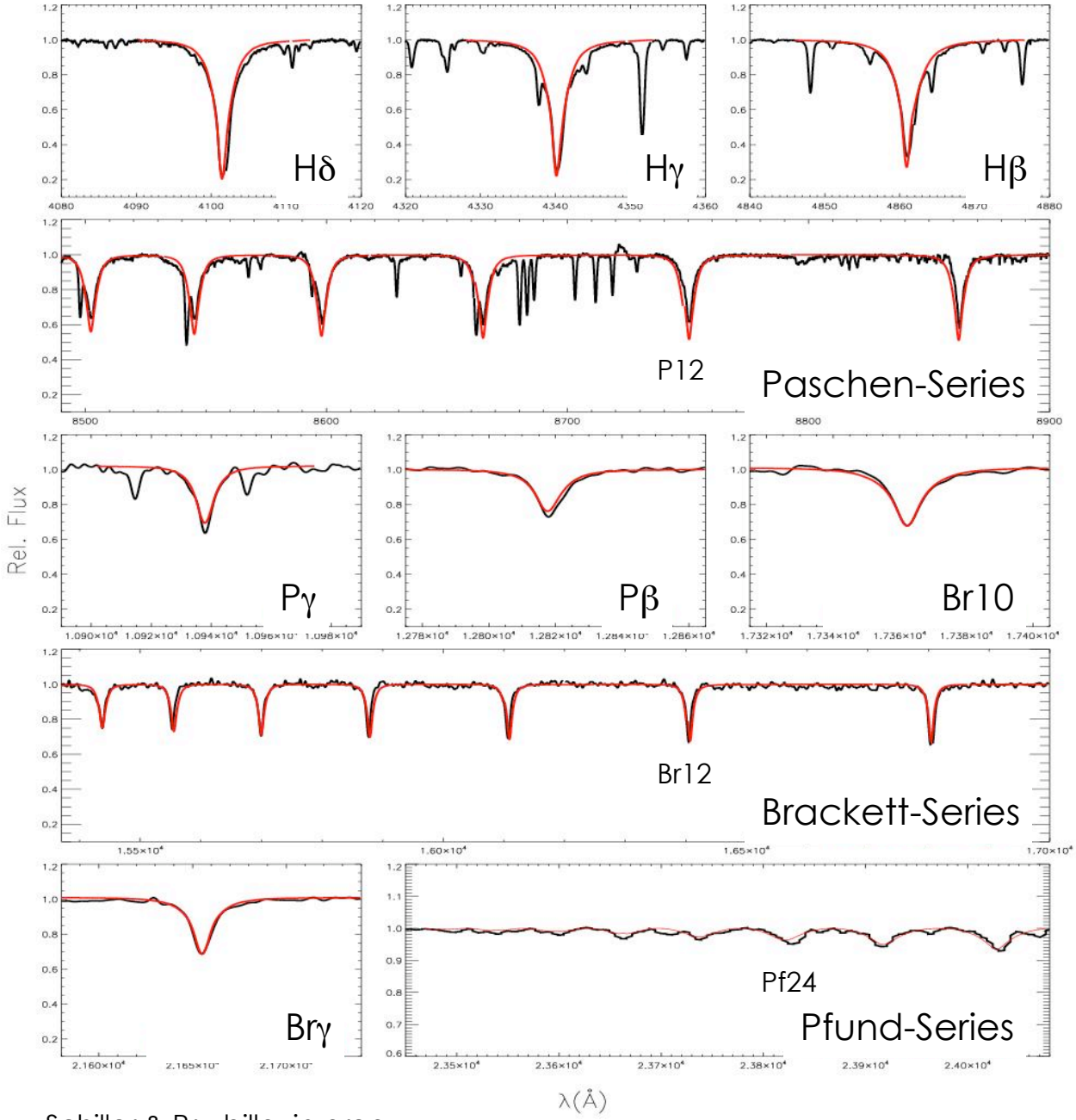
Przybilla & Butler 2004, ApJ, 609, 1181



- modulation of level occupation by variation of collisional x-sections

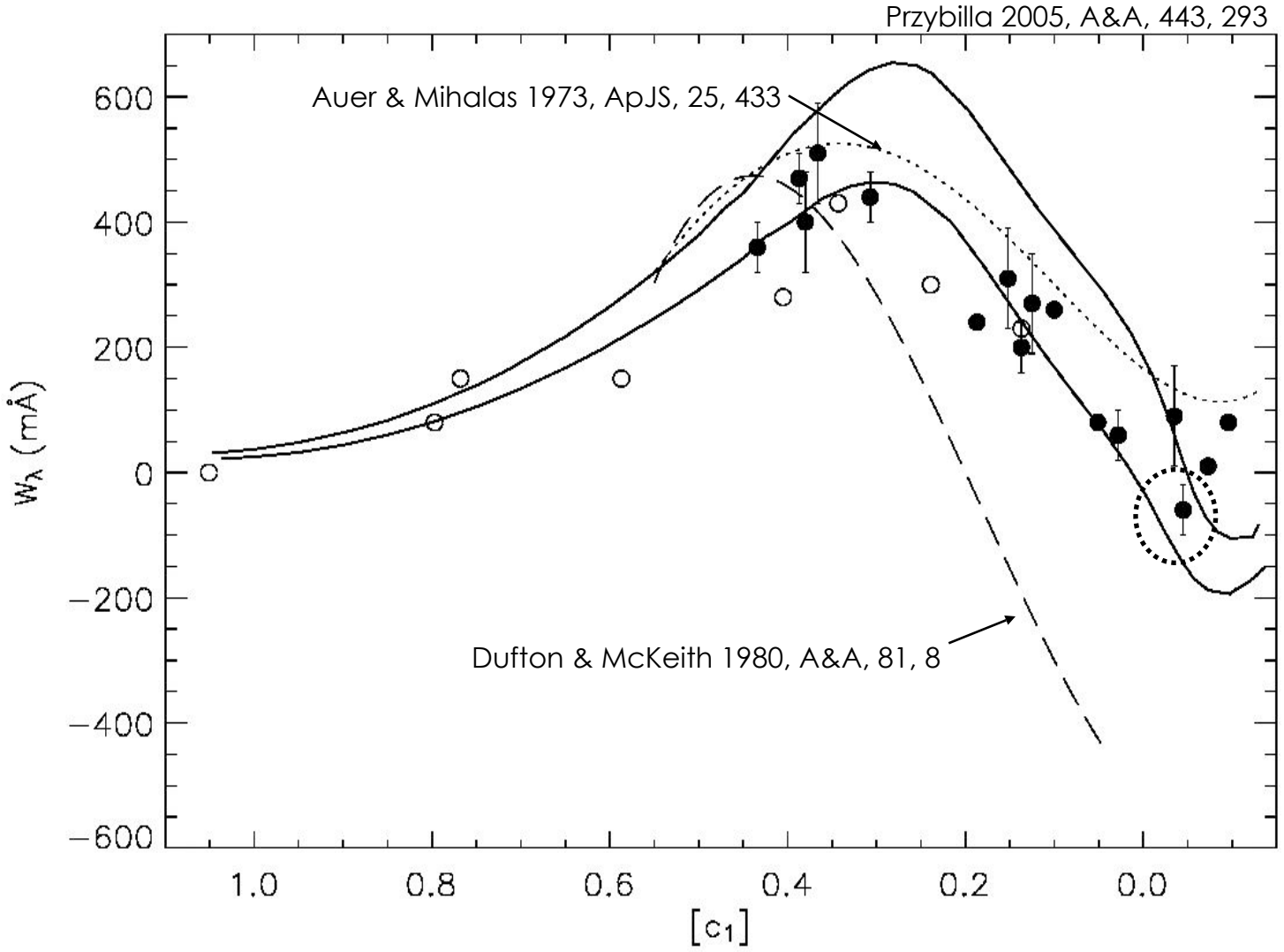
α Cyg revisited

- match may be obtained for optical + near-IR spectrum using correct atomic data



Schiller & Przybilla, in prep.

HeI 1.083 μm

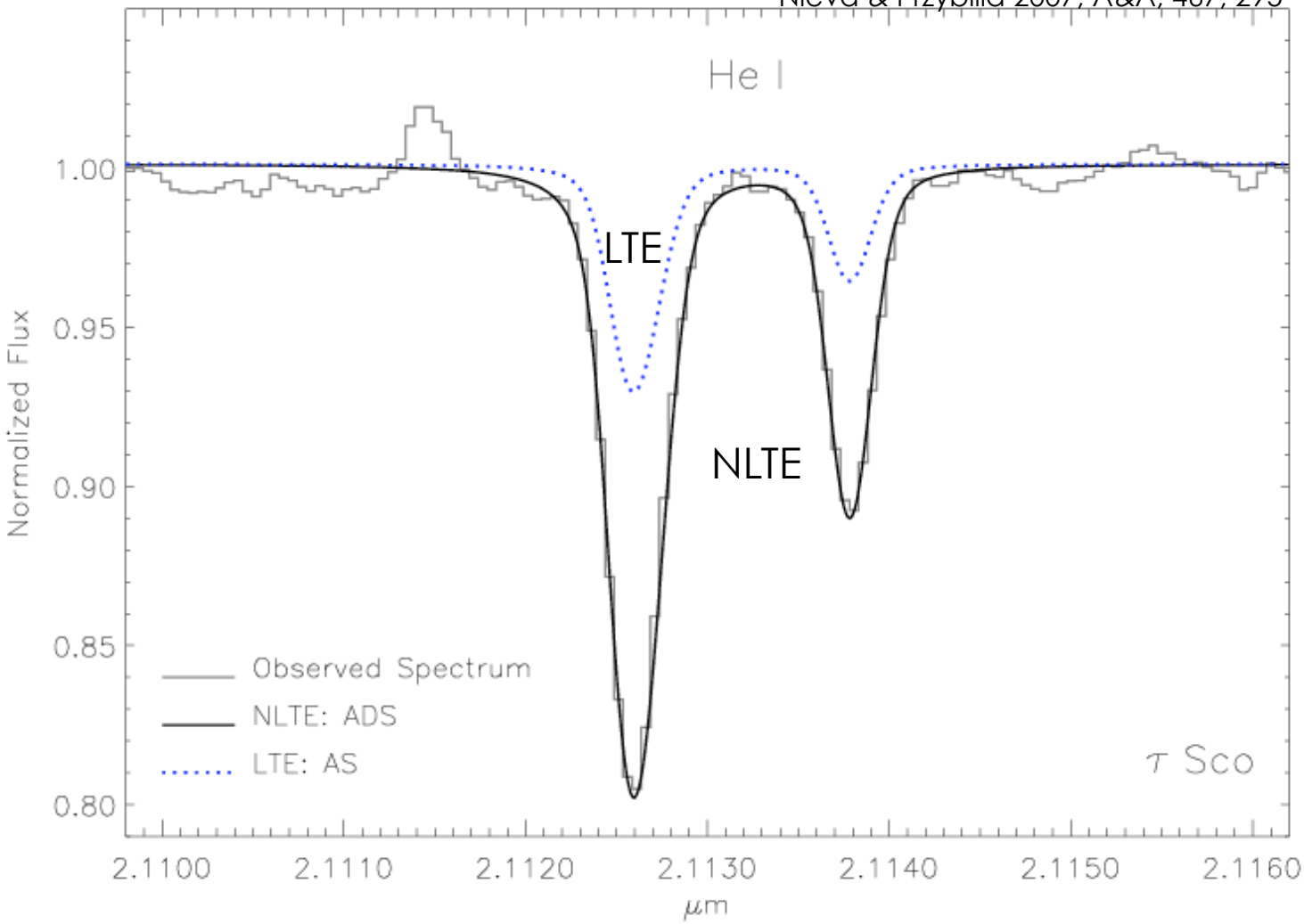


emission

- 2 effects: photoionization x-section 2s ^{3}S & line blocking

HeI K-band

Nieva & Przybilla 2007, A&A, 467, 295



Conclusions

- lines in Rayleigh-Jeans regime extremely sensitive to NLTE effects
  - ➔ amplification of NLTE effects
- hot stars: near-IR
- highly useful for model atom construction:
  - ➔ tight observational constraints

    but: good atomic data required