

# **Stark broadening of Cr II spectral lines in stellar atmospheres**

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# Introduction

Ionized chromium spectral lines:

- Ae/Be Herbig Star V 380 Ori, 25 Cr II lines (Shevchenko, 1994)
- $\alpha$  UMi (Polaris) and HR 7308 (Andrievsky et al. 1994)
- XX Oph, 58 emission Cr II lines (Meril, 1951)
- Ap 53 Cam (Babel and Lanz, 1992)

## *Experiment on the Stark broadening of Cr II spectral lines*

- T-tube plasma (Rathore, Lakićević, Čuk, Purić, 1984, Phys.Lett.A, 100, 31)

3120.36 Å

3124.94 Å and

3132.05 Å of the multiplet 5 ( $4s\ 4D - 4p\ 4F^o$ )

- 2065.65 Å (Lakićević, 1983).

- 1dex higher than the theoretical values (Kurucz, 1993)

- Ap star HD 133972 (Kochukhov , Tsymbal, Ryabchikova, Makaganyuk, Bagnulo, 2006) 3421.202 Å and 3422.732 Å (multiplet 3) → experimental data for multiplet 5

Stark broadening may change the spectral line equivalent widths by 10-45% (Popović, Dimitrijević, Ryabchikova, 1999, A&A, 350, 719  
Popović, Simić, Milovanović, Dimitrijević, 2001, ApJS, 135, 109  
Dimitrijević, Ryabchikova, Popović, Shulyak, Tsymbal, 2003, A&A, 404, 1099  
Dimitrijević, Ryabchikova, Popović, Shulyak, Kahn, 2005, A&A, 435, 1191)

*Obtained Stark broadening data are used for comparison with Cr II lines observed in the spectrum (from the ESO archive) of the Ap star HD 133792 and the influence of Stark broadening and stratification are discussed.*

# Results and Discussion

## Stark broadening calculations

- atomic energy levels (Wiese and Musgrove, 1989)
- method Bates and Damgaard (1949)
- semiclassical perturbation approach (Sahal - Bréchet, 1969a,b)

*Stark widths and shifts for the seven Cr II multiplets*

*perturber density  $10^{14} \text{cm}^{-3}$*

*temperatures 5000- 100000 K*

Investigation of the Stark broadening effect preferably in the spectra of chemically peculiar (Ap) stars

*Strong dependence of the Cr abundance in Ap stars on the effective temperature with a maximum between 9000 - 10000 K (Ryabchikova et al. 2004).*

Ap star HD 133792 (Kochukhov et al. 2006)

- spectrum obtained with the UVES instrument of the ESO VLT on 26 February 2002 in the program 68.D-0254 and retrieved through the ESO archive.

- $T_{\text{eff}} = 9400 \text{ K}$ ,  $\log g = 3.7$

- Cr overabundance +2.6 dex relative to the solar Cr abundance

- SYNTH3 (Kochukhov, 2006) ← SYNTH (Piskunov, 1992)

- Stark damping-parameters calculated here



**Fig. 1.** Comparison between the observed Cr II 3403.30 Å line profile (dots) and synthetic calculations with the Stark parameters from present paper (full red line) and those from Kurucz (1993) (blue dashed line).

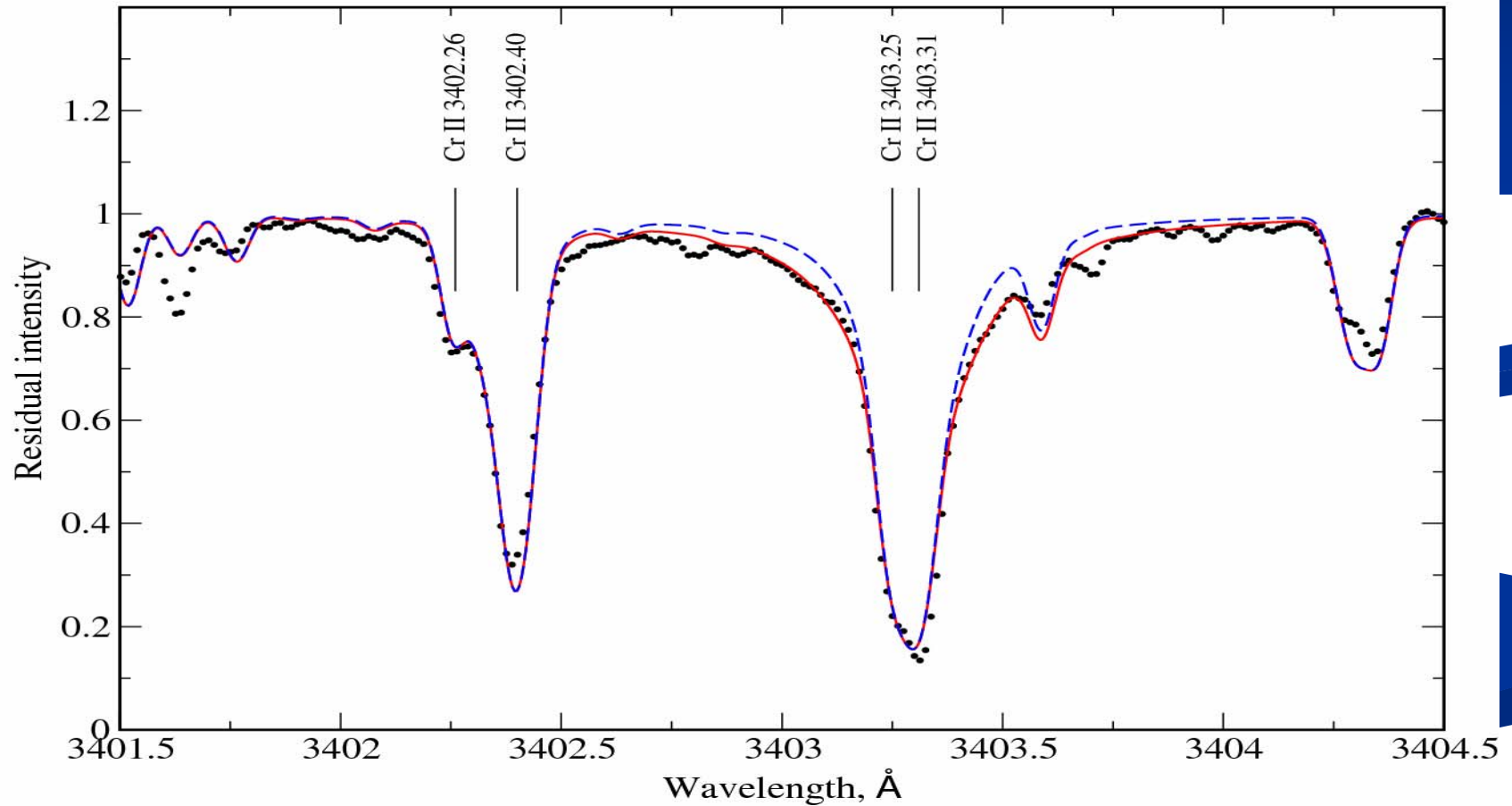


Fig. 2. The same as in Fig. 1. but for the Cr II 3408.76 Å line.

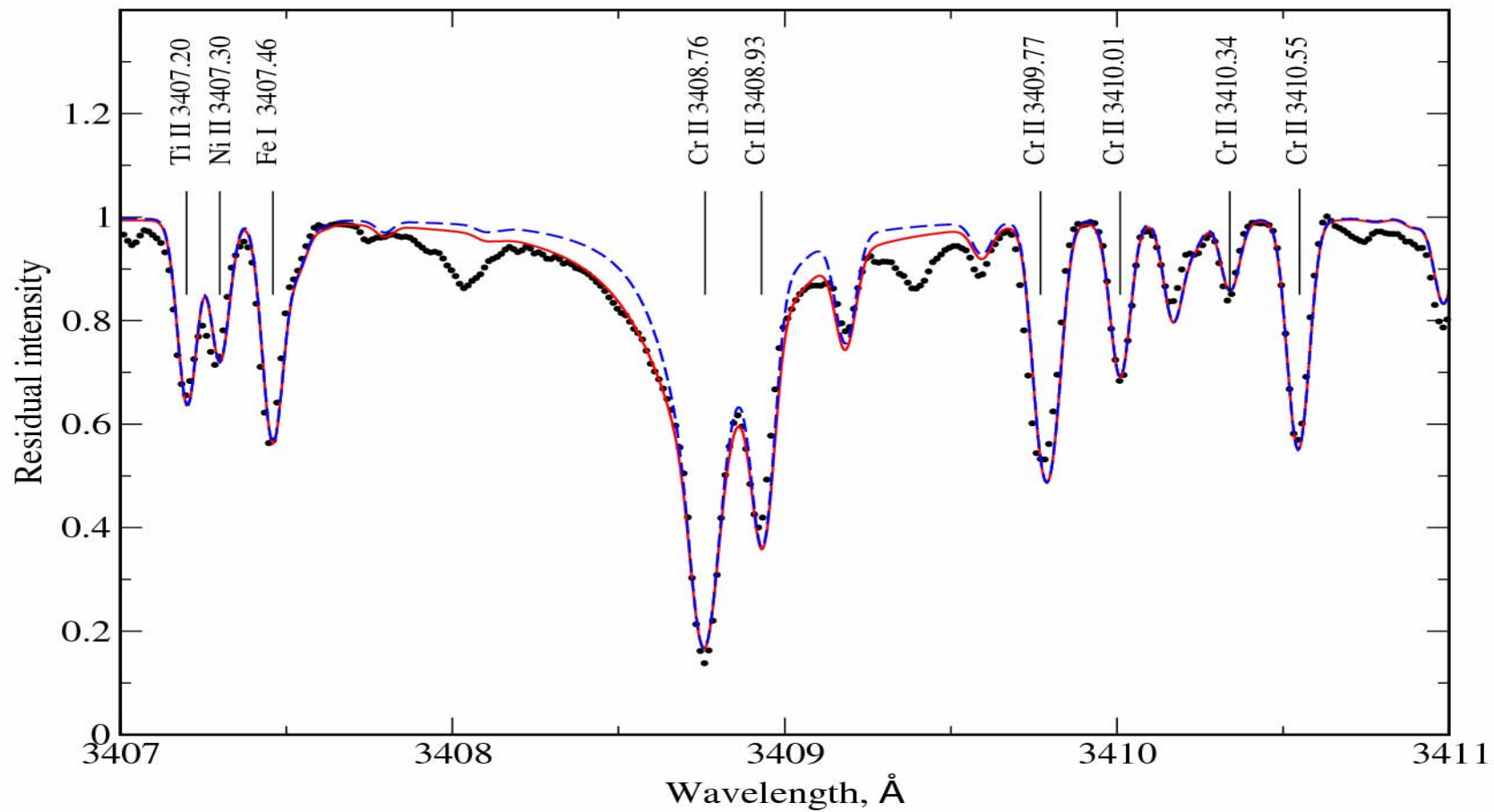
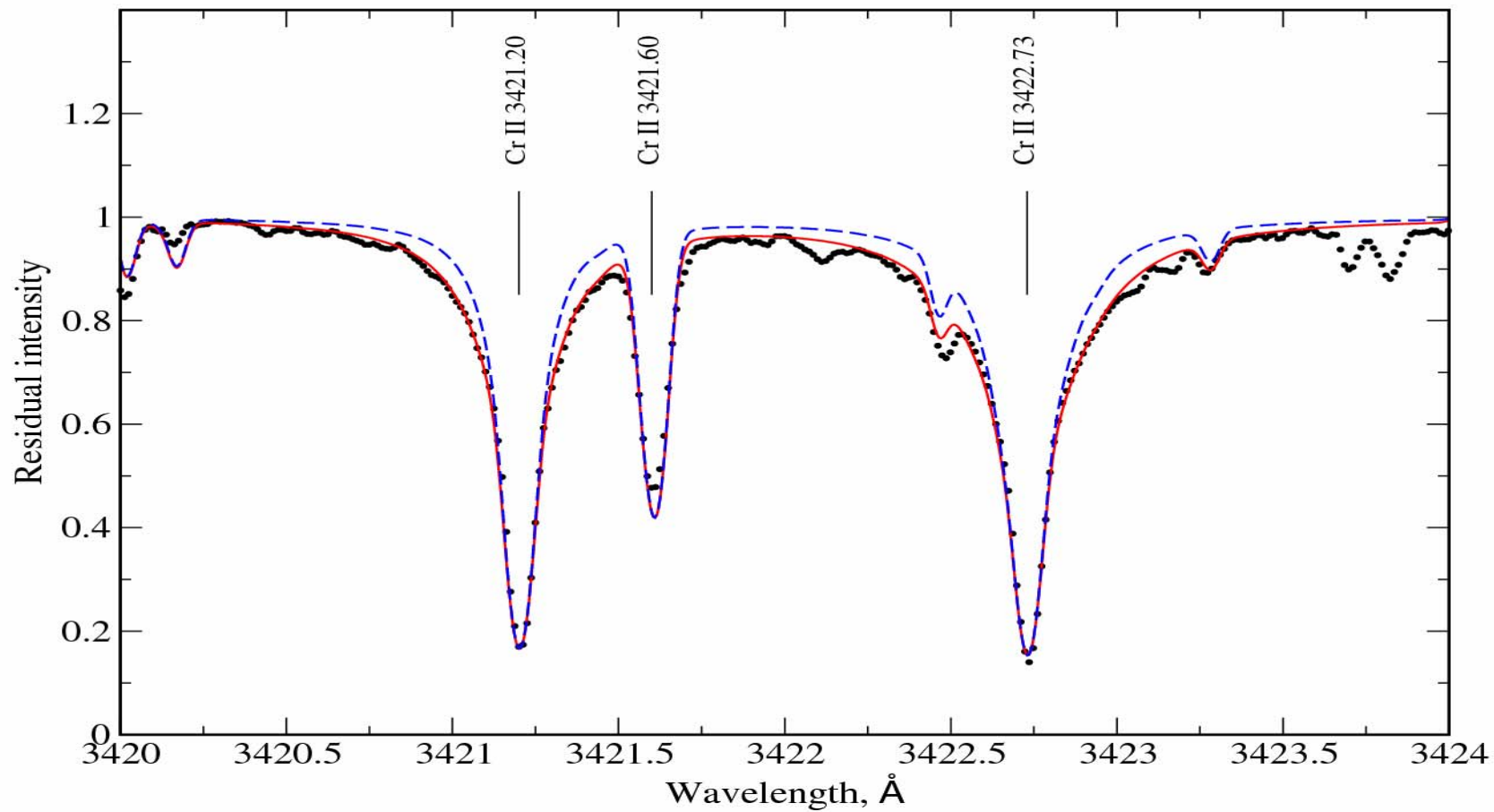
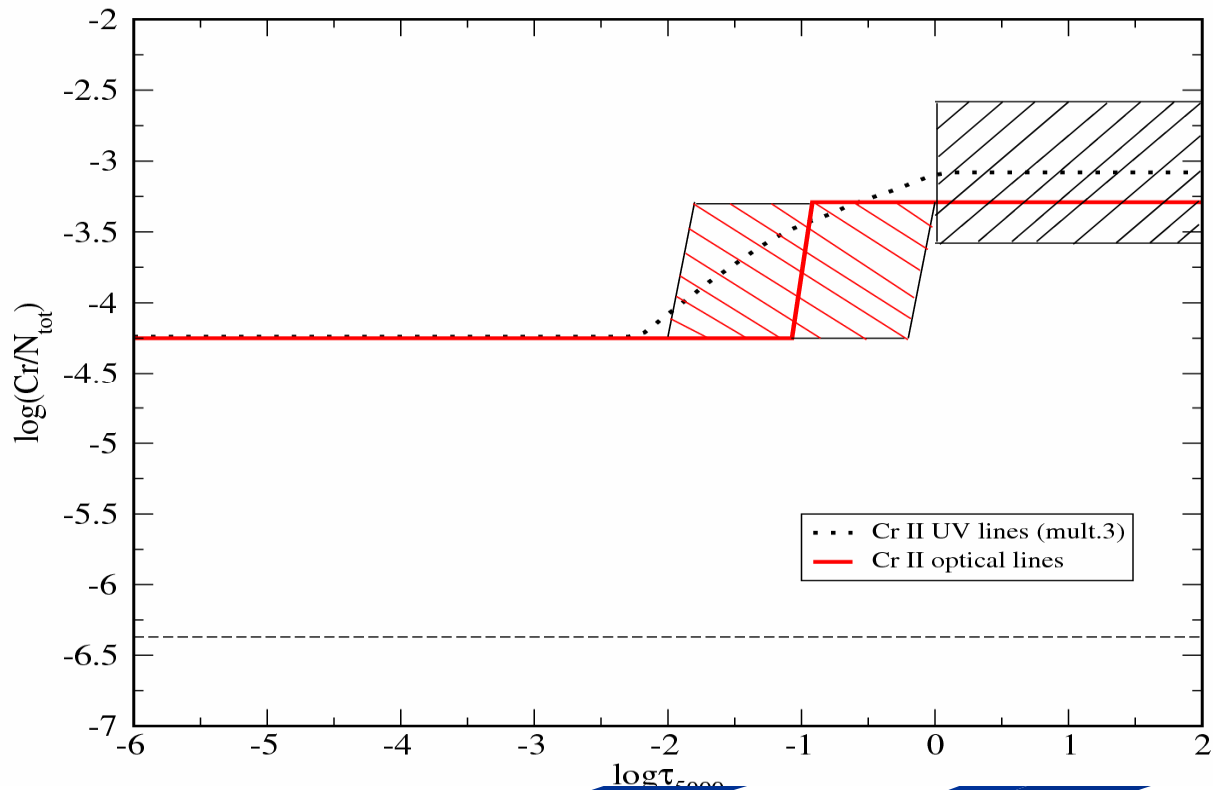


Fig. 3. The same as in Fig. 1. but for the Cr II 3421.20, 3422.73 Å lines.



**Fig. 4.** Comparison between Cr distributions derived using UVmult. 3 lines only (dotted line) and using optical Cr lines only (solid line). The dashed line shows the solar solar atmospheric Cr abundance. Dashed areas mark maximal error boxes .



*From our investigation we can conclude:*

- that newly calculated Stark widths for a number of strong Cr II lines agree with the scarce laboratory data and provide a good fit to the line profiles observed in Ap stars*
- that the line wings of Cr II lines (see e.g. Cr II 3421.20 Å in Fig. 3) in the Ap stars are caused by the Stark-broadening mechanism*

*Thank you for attention!*

