ON THE STARK BROADENING IN HOT STARS

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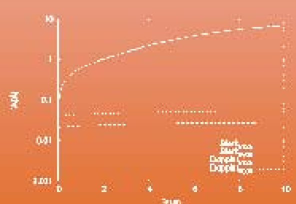
In hot star atmospheres exist conditions where Stark widths are comparable and even larger than the thermal Doppler widths, so that the corresponding line broadening parameters are of importance for the hot star plasma investigation. Here, we investigated theoretically the influence of collisions with charged particles on heavy metal spectral line profiles for Te I, Cr II and Sn III in spectra of A stars and white dwarfs. We applied semiclassical perturbation theory. When it can not be applied in an adequate way, due to the lack of reliable atomic data, we used modified semiempirical theory.

Neutral Tellurium

Using the semiclassical perturbation method we obtained Stark widths and shifts of two Te I multiplets for a perturber density of 10^{16} cm^{-3} and temperatures from 2500 up to 50000 K. Calculations were performed using the atomic energy levels given in Moore (1971). The needed oscillator strengths were calculated by using the Coulomb approximation method described in Bates & Damgaard (1949) and the tables in Oertel & Shomo (1968). For higher levels, the method described in van Regemorter et al. (1979) was applied.

Fig. 1. Thermal Doppler and Stark widths for Te I 5125.2 and 9903.9 Å spectral lines for a DB white dwarf atmosphere model: T_{eff} = 15000 K, *log* g = 7 (Wickramasinghe, 1972), as a function of optical depth τ_{5150}.



Singly Ionized Chromium

Table 1. Stark broadening parameters for four Cr II $3d^5$ - $3d^4 4p$ spectral lines. With W is denoted FWHM (e - electrons, p - protons) and with d shift. Perturber density: 10^{17} cm^{-3}, SC method.

TRANSITION	T(K)	W_e(Å)	d_e(Å)	W_p(Å)	d_p(Å)
	5000	0.514E-01	-0.334E-03	0.148E-02	-0.542E-04
CrII	10000	0.382E-01	-0.379E-03	0.268E-02	-0.120E-03
$^6S-^6P^o$	20000	0.282E-01	-0.438E-03	0.382E-02	-0.232E-03
2066.4 Å	30000	0.238E-01	-0.425E-03	0.431E-02	-0.311E-03
C=0.15E+21	50000	0.196E-01	-0.460E-03	0.473E-02	-0.405E-03
	100000	0.157E-01	-0.515E-03	0.528E-02	-0.547E-03
	5000	0.392	0.738E-01	0.102E-01	0.117E-02
CrII	10000	0.294	0.491E-01	0.175E-01	0.244E-02
$^4F-^4D^o$	20000	0.212	0.379E-01	0.214E-01	0.416E-02
4588.2 Å	30000	0.182	0.319E-01	0.258E-01	0.505E-02
C=0.20E+21	50000	0.153	0.265E-01	0.295E-01	0.639E-02
	100000	0.133	0.219E-01	0.329E-01	0.770E-02
	5000	0.489	0.743E-01	0.120E-01	0.874E-03
CrII	10000	0.358	[illegible]	0.209E-01	0.188E-02
$^4F-^4F^o$	20000	0.268	0.394E-01	0.283E-01	0.337E-02
5279.6 Å	30000	0.229	0.339E-01	0.325E-01	0.425E-02
C=0.53E+21	50000	0.194	0.274E-01	0.357E-01	0.546E-02
	100000	0.165	0.220E-01	0.398E-01	0.679E-02
	5000	0.793	0.264	0.144E-01	0.411E-02
CrII	10000	0.577	0.197	0.258E-01	0.806E-02
$^4F-^4F^o$	20000	0.425	0.155	0.368E-01	0.127E-01
6073.4 Å	30000	0.357	0.134	0.414E-01	0.156E-01
C=0.70E+21	50000	0.294	0.110	0.459E-01	0.184E-01
	100000	0.253	0.920E-01	0.521E-01	0.221E-01

Fig. 2. Stark widths for resonant Cr II spectral lines as a function of temperature.

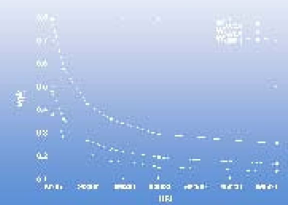


Fig. 3. Comparison of the Cr II 4588.2 Å line profile ("a") without Stark broadening contribution and with this contribution for different Cr abundances log Cr/H: ("b") Solar one, ("c") -3.75, ("d") -3.25 , ("e") -2.75. The atmosphere model: T_{eff} = 8750 K, *log* g= 4 (Piskunov, 1992).

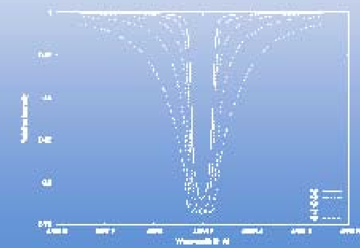
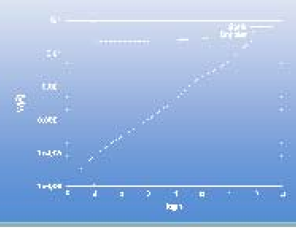


Fig. 4. Thermal Doppler and Stark widths for Cr II 4588.2 Å for a model: T_{eff} = 10000 K, *log* g = 4.5 (Kurucz, 1979) of an A type star, as a function of the Rosseland optical depth.



Doubly Ionized Tin

Table 2: Electron- and proton-impact broadening parameters for Sn III 5226.2 Å obtained by using semiclassical perturbation approach for perturber density of $10^{17}cm^{-3}$ and temperatures from 10000 up to 150000 K.

Transition	T(K)	W_{e^-}(Å)	d_{e^-}(Å)	W_{p^-}(Å)	d_{p^+}(Å)
	10000	1.30	0.146	0.301E 01	0.207E 01
Sn III	20000	1.05	-0.957E-01	0.915E-01	-0.339E-01
$6s\ ^1S_0 - 6p\ ^1P^o_1$	30000	0.907	0.856E 01	0.758E 01	0.426E 01
5226.2 Å	50000	0.785	-0.960E-01	0.569E-01	-0.513E-01
C= 0.24E+21	100000	0.675	0.846E 01	0.102	0.619E 01
	150000	0.625	-0.758E-01	0.111	-0.686E-01

Table 3: Stark widths for Sn III 5226.2 Å obtained by using modified semiempirical approach for perturber density of $10^{17}cm^{-3}$ and temperatures from 2500 up to 50000 K.

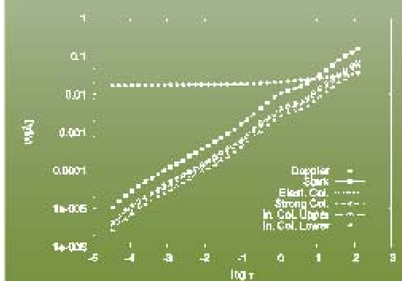
Transition	T(K)	W(Å)
	2500	2.217
	5000	1.567
$6s\ ^1S_0 - 6p\ ^1P^o_1$	10000	1.105
5226.2Å	20000	0.784
	30000	0.640
	50000	0.514

Table 4: Comparison between W_m-experimental Stark width with theoretical: W_{se}-semiempirical, W_{sc}-semiclassical and W_{mse}-modified semiempirical.

Transition	W_m(Å)	Rel. error	$\frac{W_m}{W_{se}}$	$\frac{W_m}{W_{sc}}$	$\frac{W_m}{W_{mse}}$
Sn III $6s\ ^1S_0 - 6p\ ^1P^o_1$ 5226.2 Å	1.22	51%	1.70	0.92	1.15

Here, we presented Stark widths and contributions of different collision processes to the total Stark width in comparison with Doppler one. In this case, elastic and strong collisions and inelastic collision from upper levels have a similar contribution to the full Stark width as well as the similar behaviour with temperature.

Fig. 5. Thermal Doppler, Stark and contributions of different collision processes to the total Stark width of Sn III 6s $^1S_0$ - 6p $^1P^o_1$ line as functions of optical depth for an A type star (Kurucz, 1979) model:T_{eff} = 10000 K and *log* g = 4.5.



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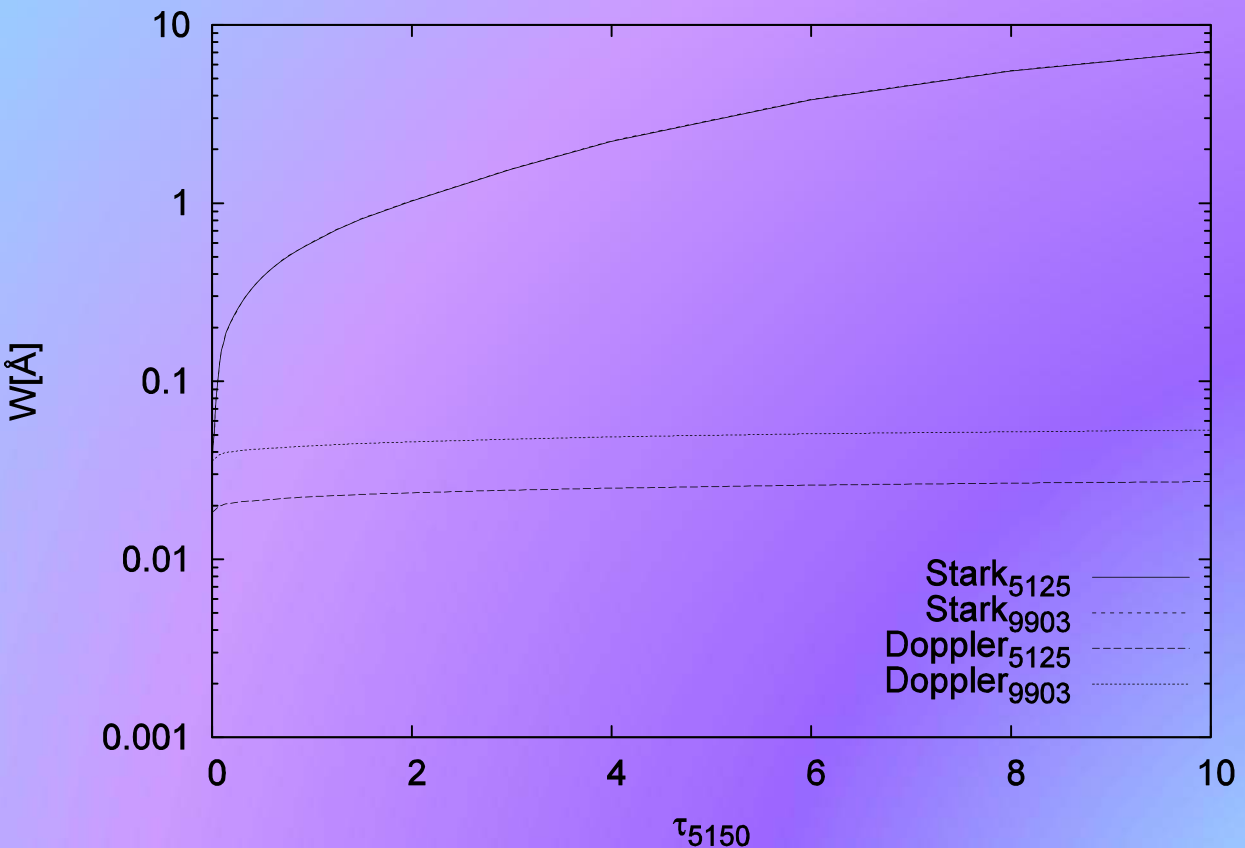
Te I



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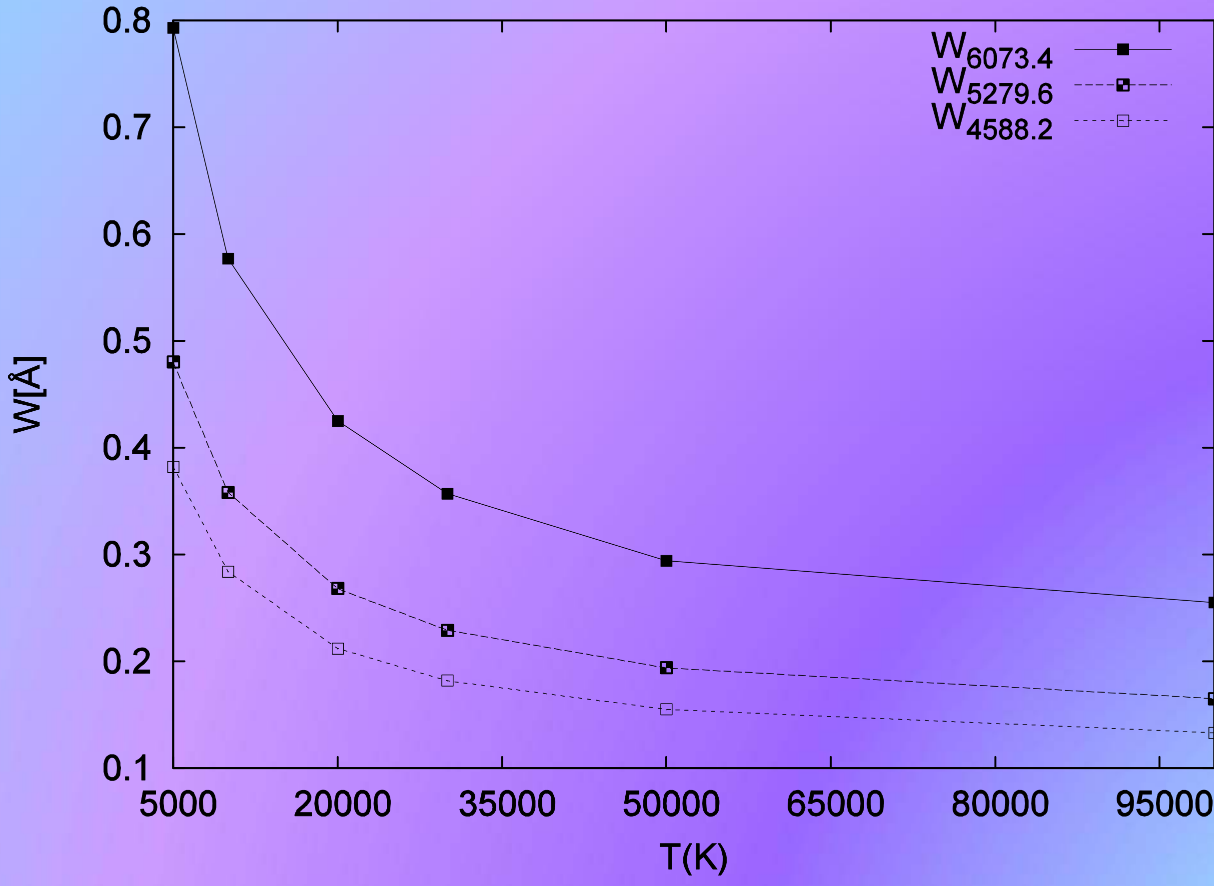
Cr II



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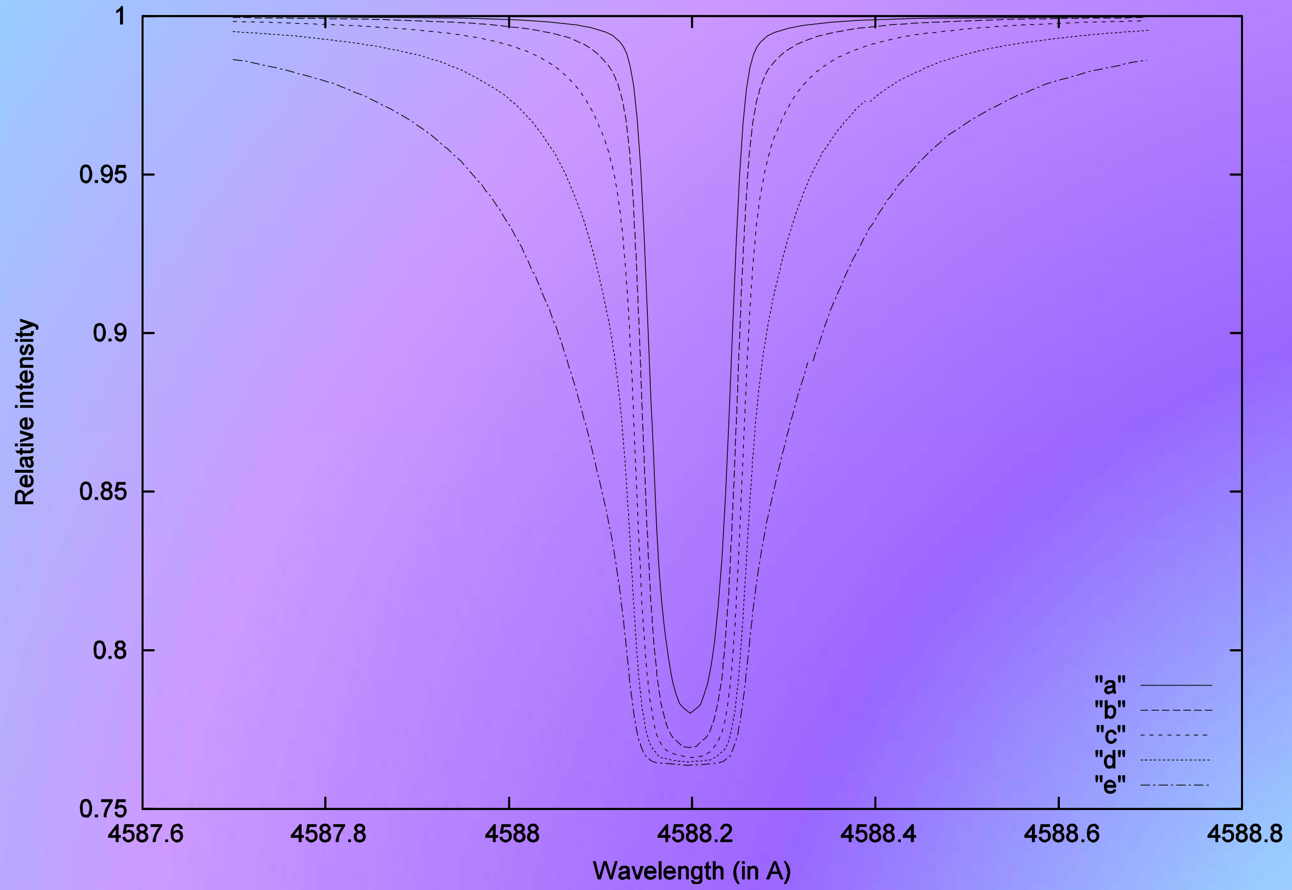

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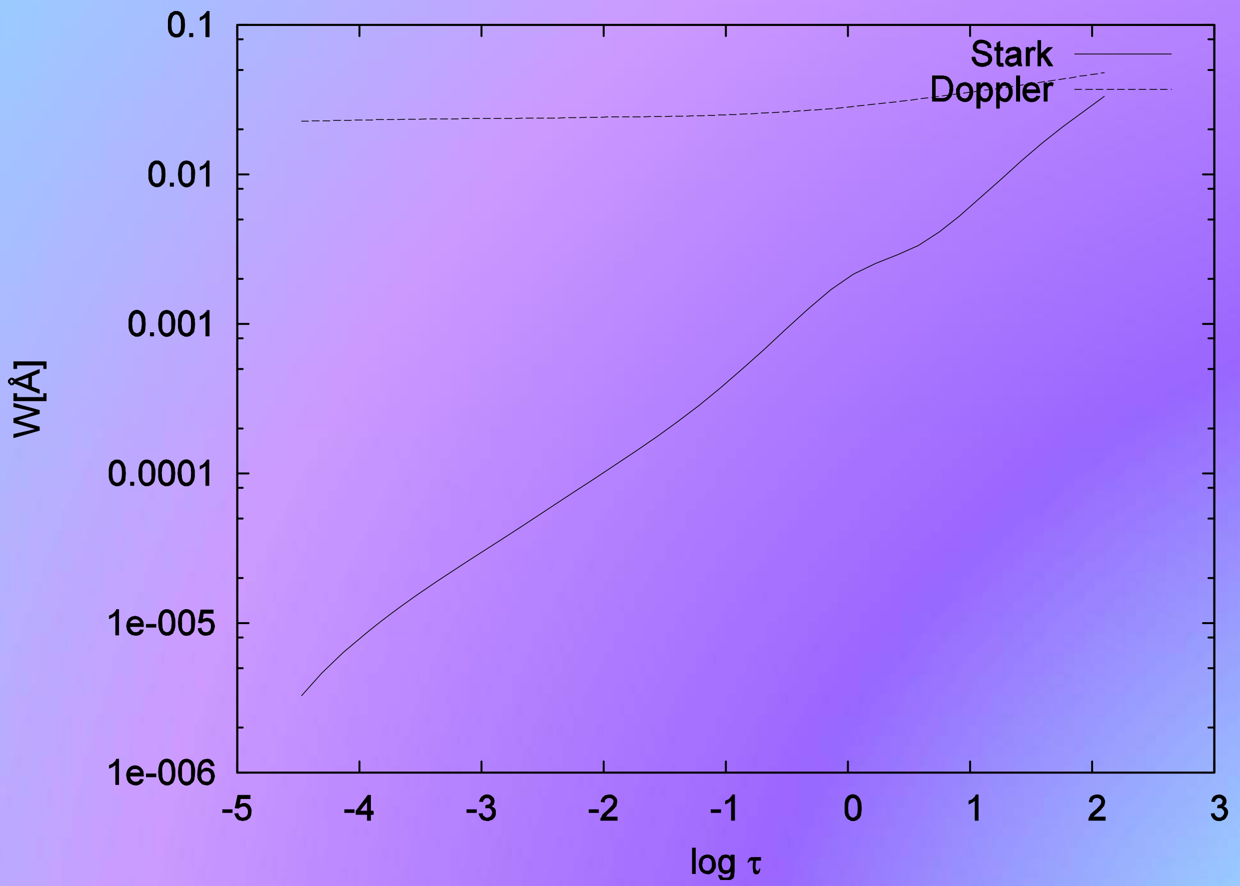

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Sn III

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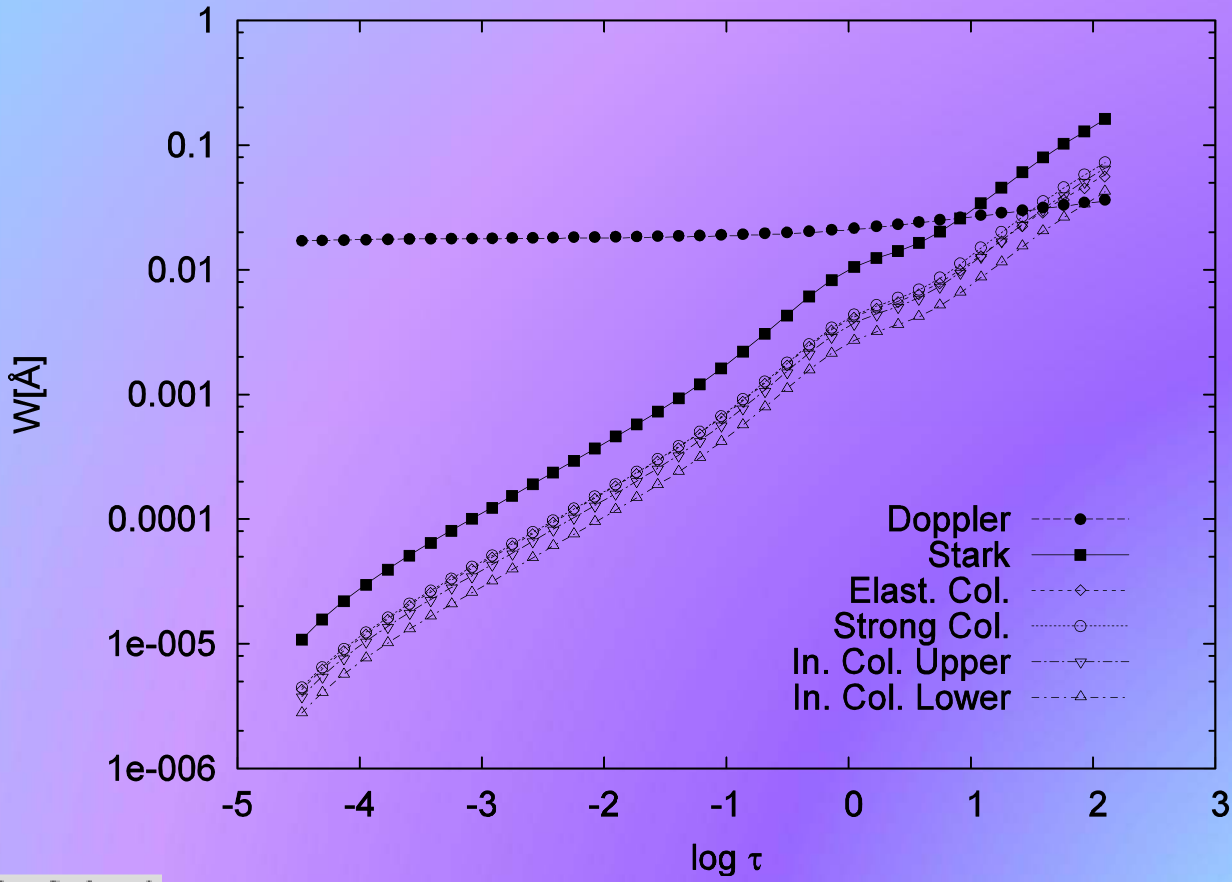

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