ANALYSIS OF CALCULATED STARK BROADENING PARAMETERS OF SINGLY IONIZED SILICON LINES

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ERIC ALLIE
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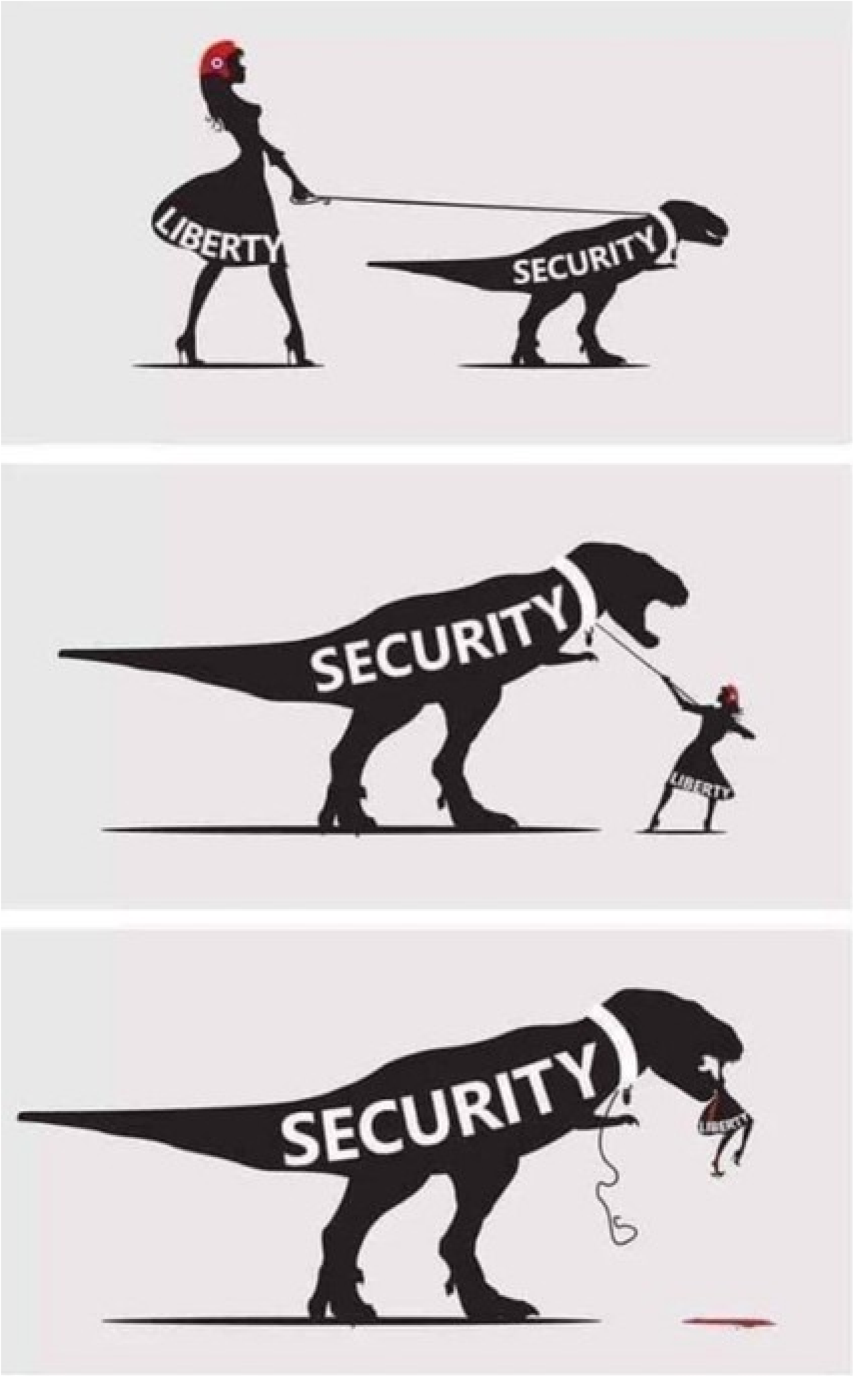
THE SCIENCE HAS CHANGED...
POLLS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WHY IONIZED SILICON

Large cosmic abundance

Special importance in solar and stellar atmospheres: stars of A, B and O type, white dwarfs

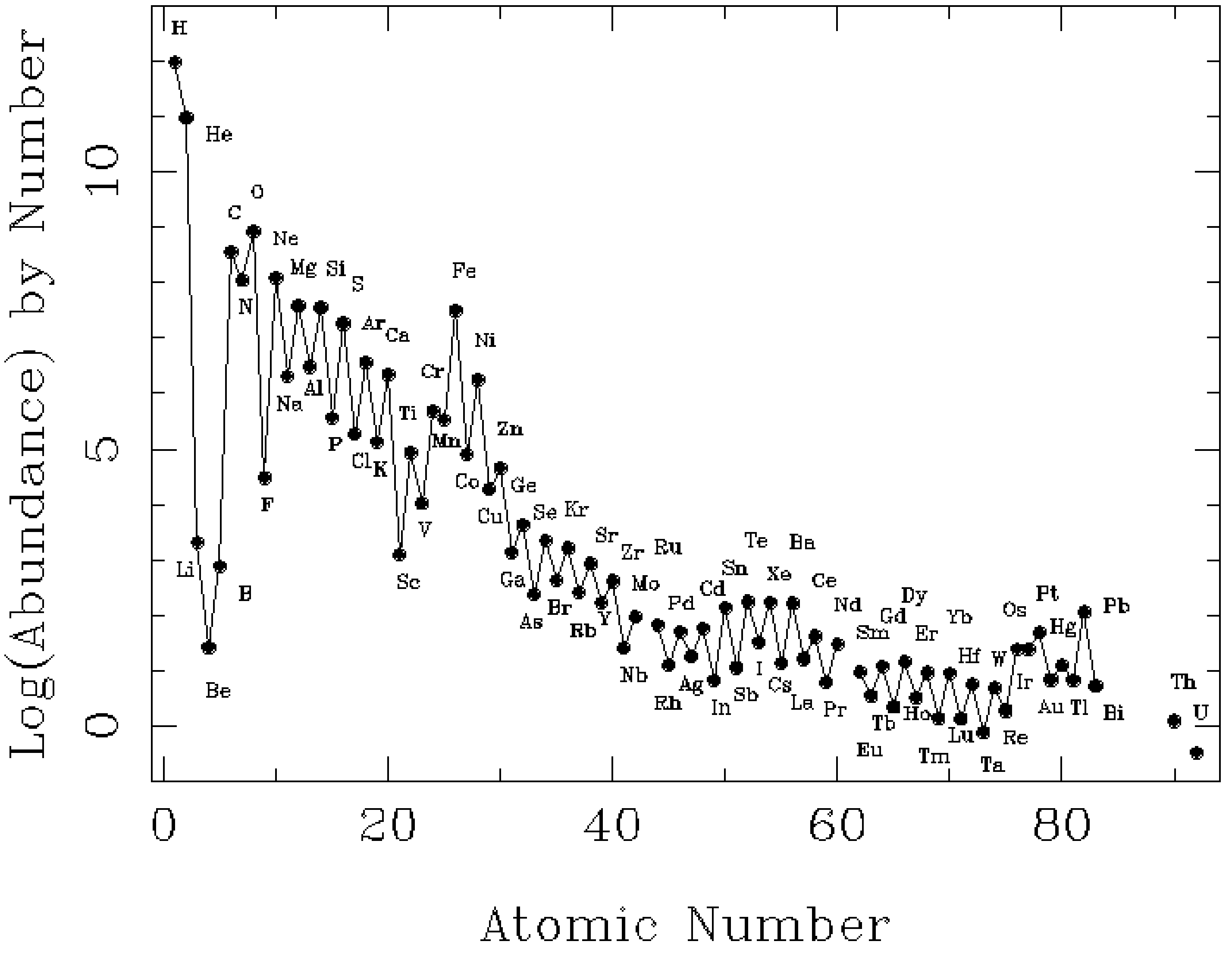
To determine diversity of supernovae

Strong lines in the absorption spectrum of hot stars

Silicon lines are principal impurities in laboratory and nuclear fusion research

Large scatter in measurements in literature

Logarithmic SAD Abundances: Log(H) = 12.0

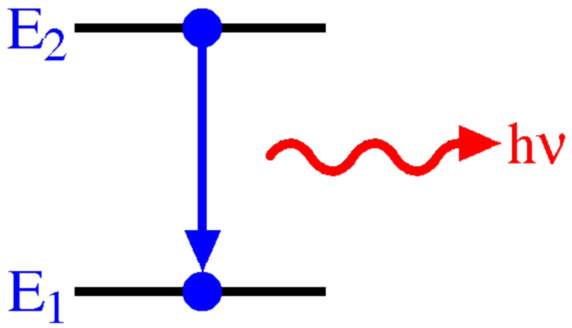


STARK broadening theory

Sahal-Bréchot theory based on the semi-classical perturbation formalism

Calculation of Stark parameters using:

- energy levels from the reference of Kramida et al. 2021



$$d = \int_0^\infty v f(v)\, dv \int_{R_3}^{R_d} 2\pi\rho\, d\rho \sin 2\varphi_p$$

$$W = 2n_e \int_0^\infty v f(v)\, dv \left[\sum_{i'\neq i} \sigma_{ii'}(v) + \sum_{f'\neq f} \sigma_{ff'}(v) + \sigma_{el} \right]$$

Conditions of interest

Temperatures: (5 000; 10 000; 20 000; 30 000; 50 000 and 100 000) K

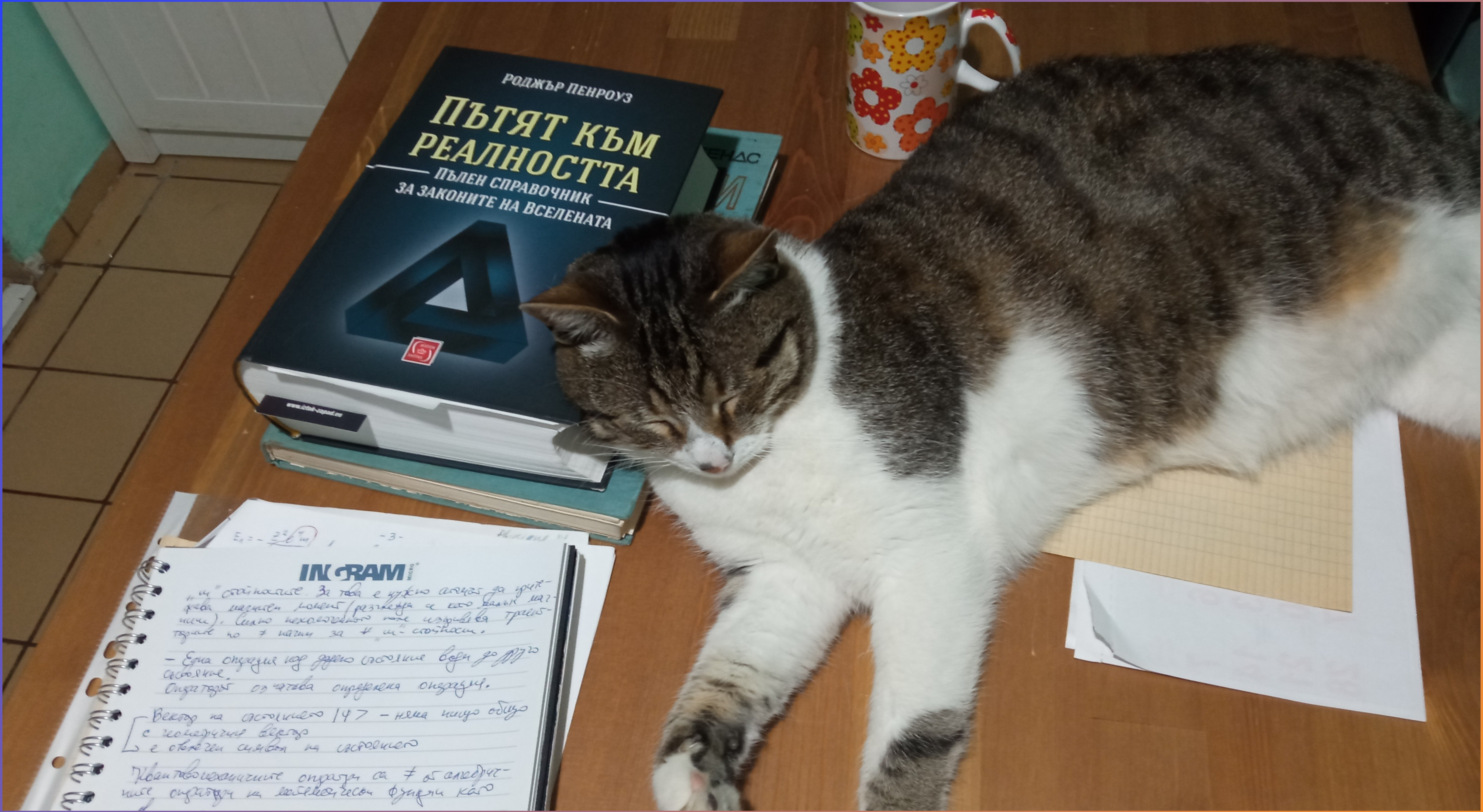
Electron density: (10^{14} – 10^{20}) cm^{-3}

Perturbers: electrons, protons and ionized helium

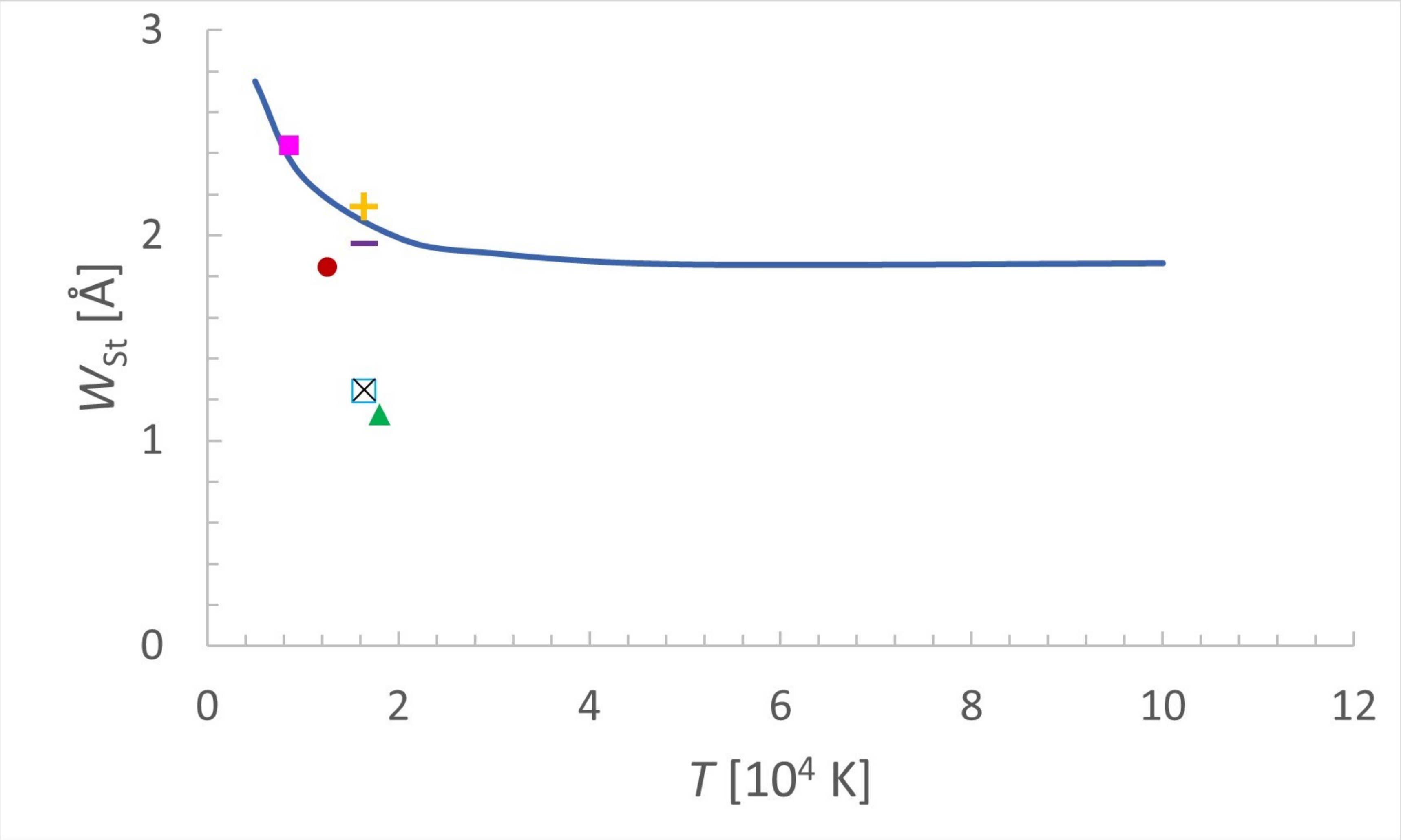
Results for Stark broadening parameters (width and shift) for 62 Si II multiplets

RESULTS

Comparison of the calculations in this work with measurements from literature


РОДЖЪР ПЕНРОУЗ
ПЪТЯТ КЪМ РЕАЛНОСТТА
ПЪЛЕН СПРАВОЧНИК ЗА ЗАКОНИТЕ НА ВСЕЛЕНАТА
INGRAM

Temperature dependence of Stark width



Si II

$3s^2 4s - 3s^2 4p$

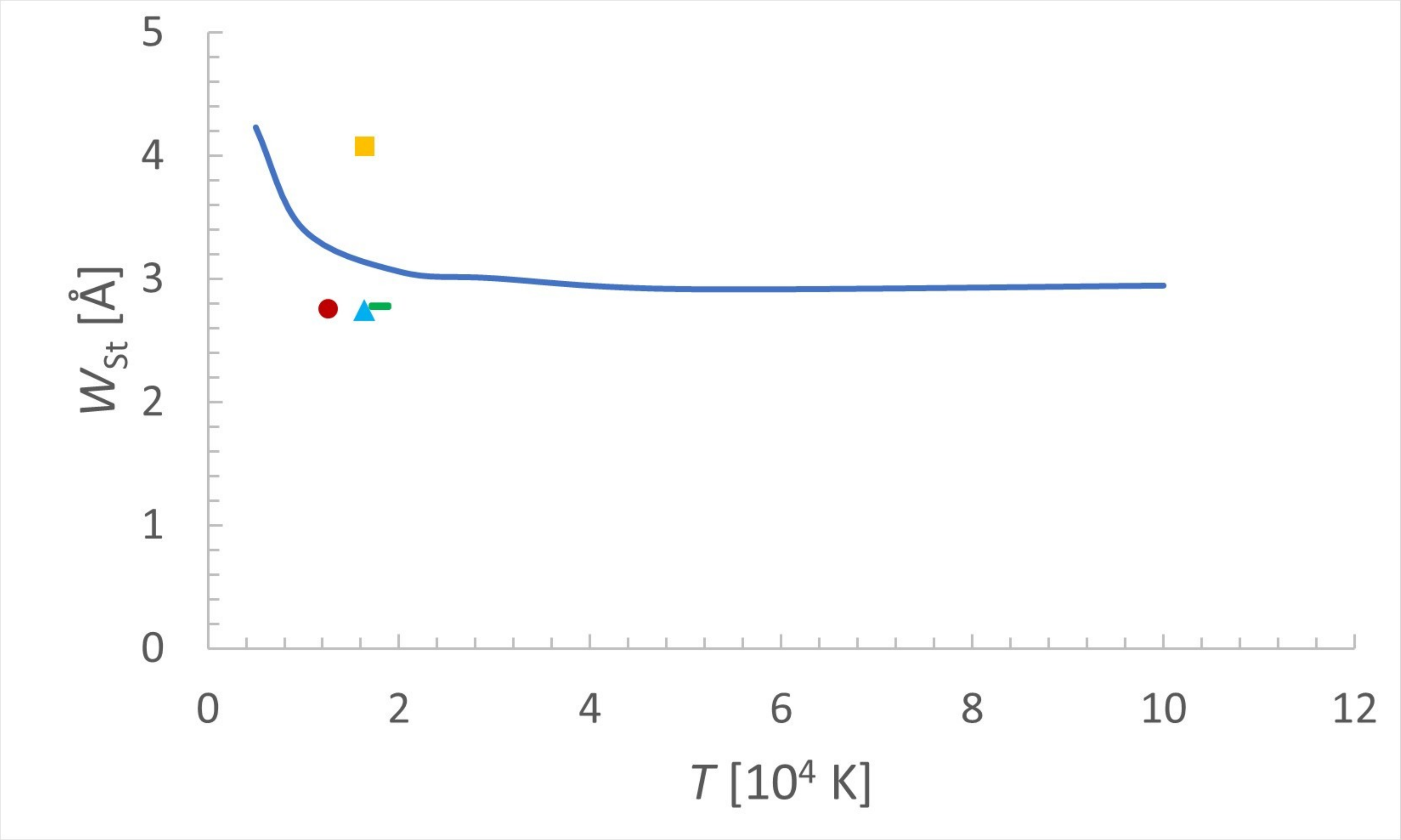
6356.9 Å

$n_e = 1.10^{17}$ cm^{-3}

- Bukvić et al. 2009
- Gonzáles et al. 2002
- Lesage et al. 1983
- Peréz et al. 1993
- Lesage et al. 1977
- Chiang et al. 1978
- Konjević et al. 1970

— This work

Temperature dependence of Stark width



Si II

$3s^24p – 3s^25s$

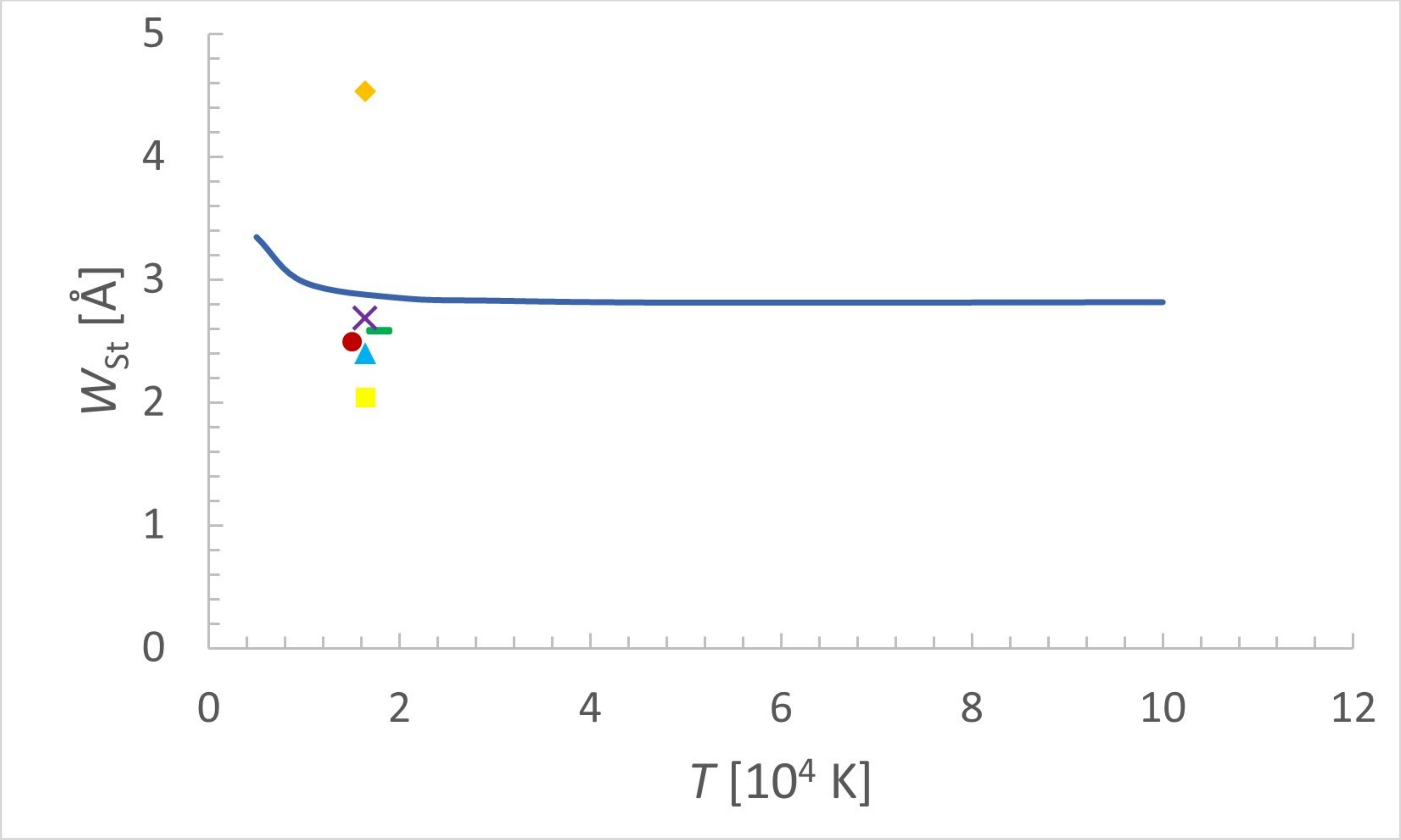
5973.4 Å

$n_e = 1.10^{17}$ cm^{-3}

- Bukvić et al. 2009
- Gonzáles et al. 2002
- Lesage et al. 1983
- Kusch et al. 1982

— This work

Temperature dependence of Stark width



Si II

$3s^2 4p - 3s^2 4d$

5052.4 Å

$n_e = 1.10^{17}$ cm^{-3}

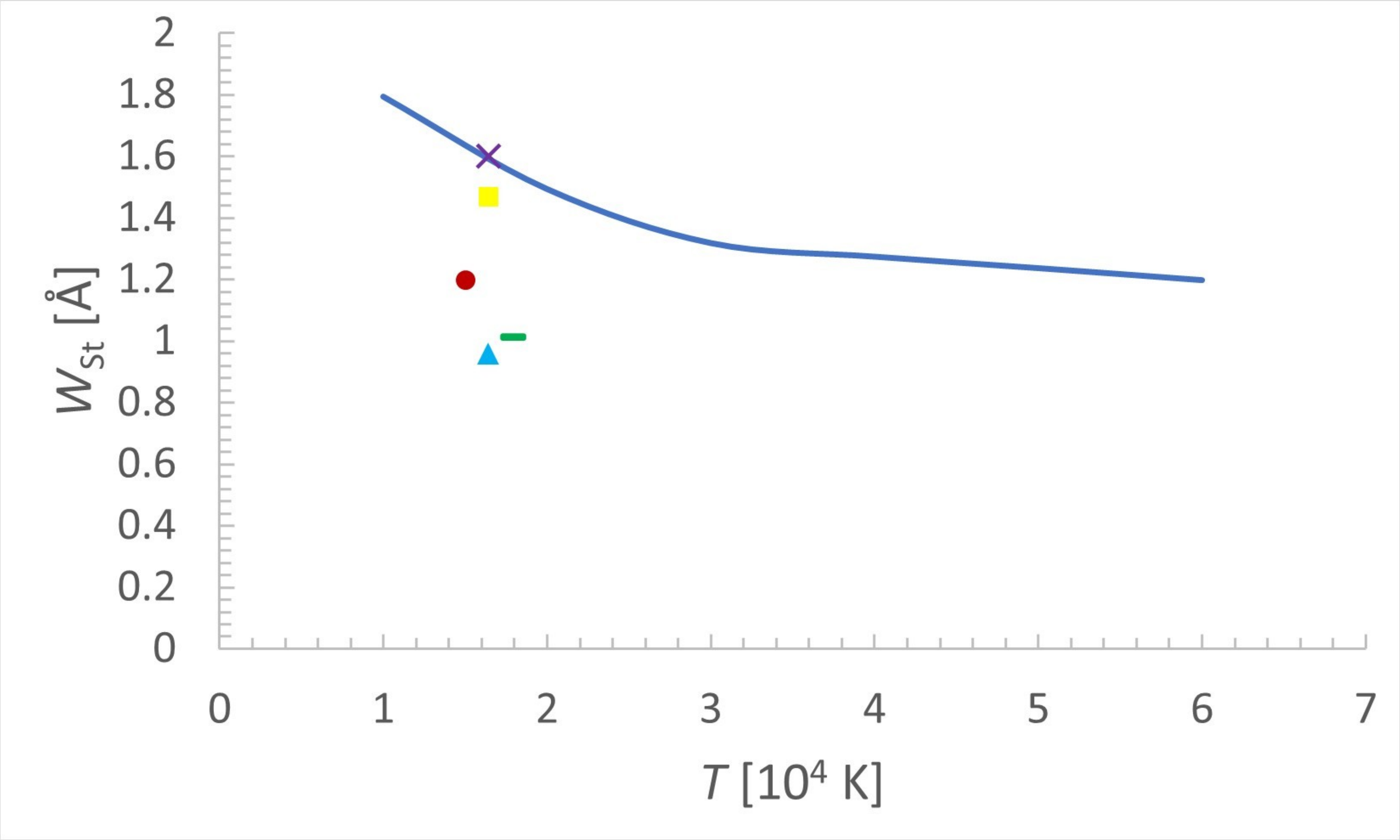
- Bukvić et al. 2009
- Gonzáles et al. 2002
- Lesage et al. 1983
- Peréz et al. 1993
- Lesage et al. 1977
- Kusch et al. 1982
- — This work

Temperature dependence of Stark width

Si II

$3s^2 3d - 3s^2 4f$

4130.9 Å



n_e = 1.10^{17} cm^{-3}

- Bukvić et al. 2009
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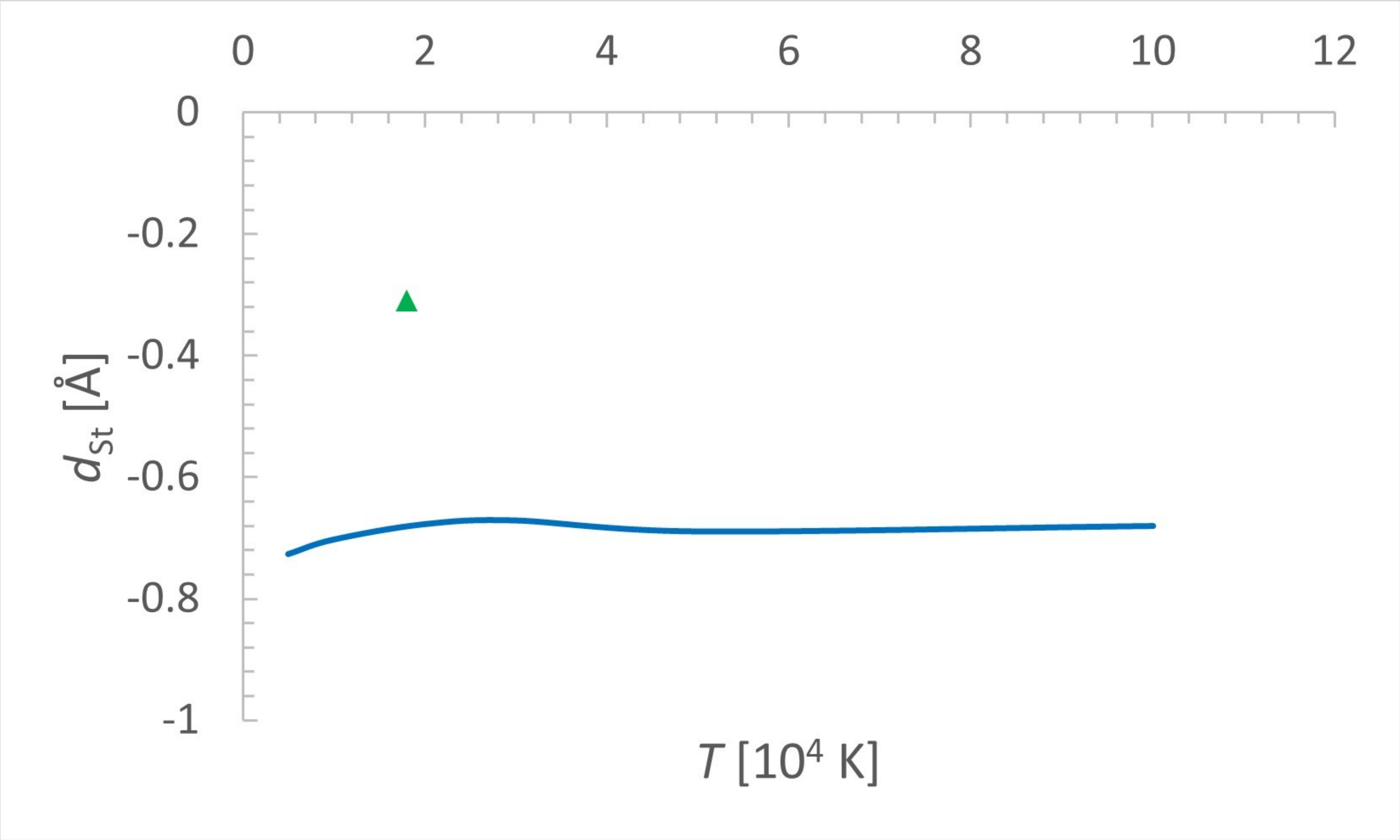
- Lesage et al. 1977
- — This work

Temperature dependence of Stark shift



Si II

$3s^24s – 3s^24p$

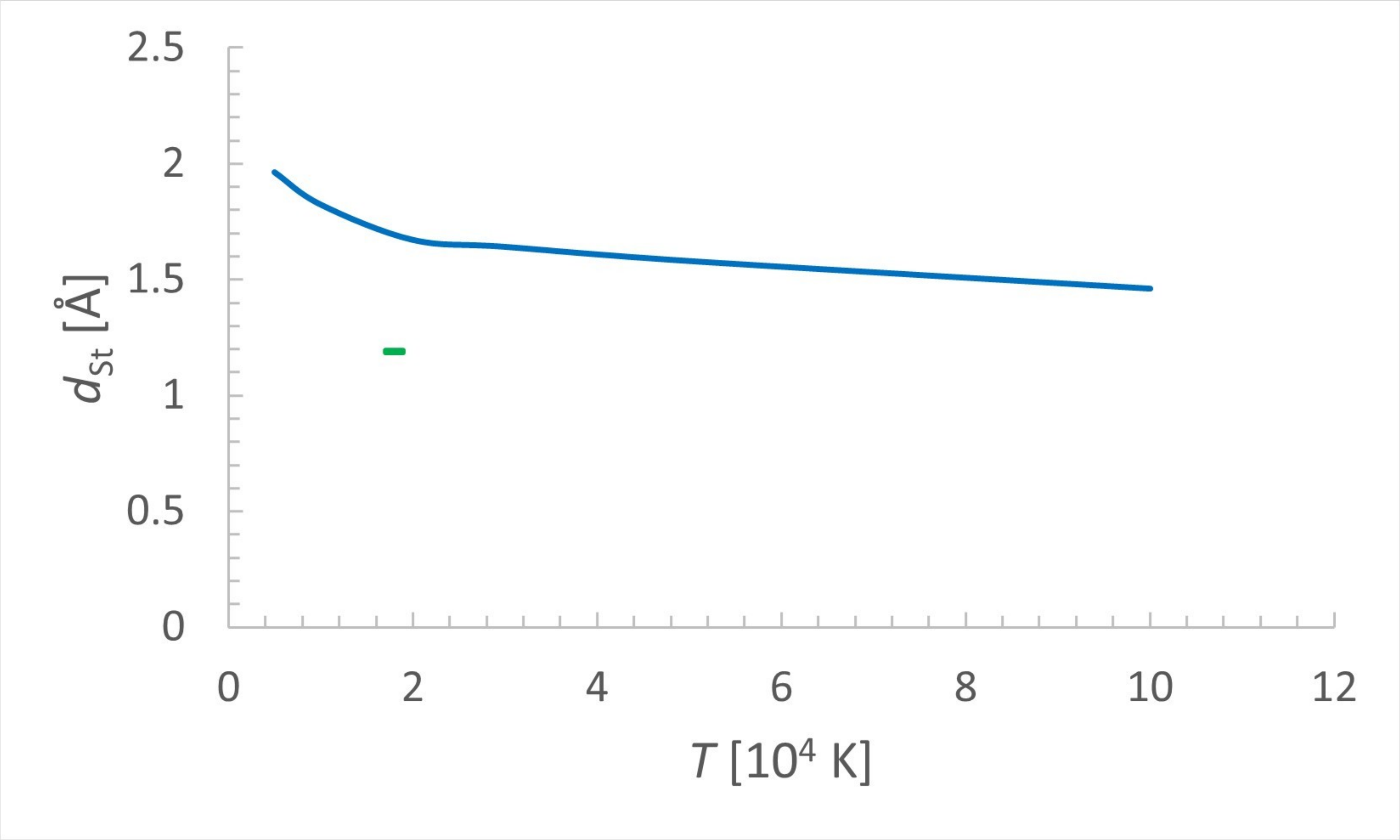
6356.9 Å

$n_e = 1.10^{17}$ cm^{-3}

• Gonzáles et al. 2002

— This work

Temperature dependence of Stark shift



Si II

$3s^2 4p – 3s^2 5s$

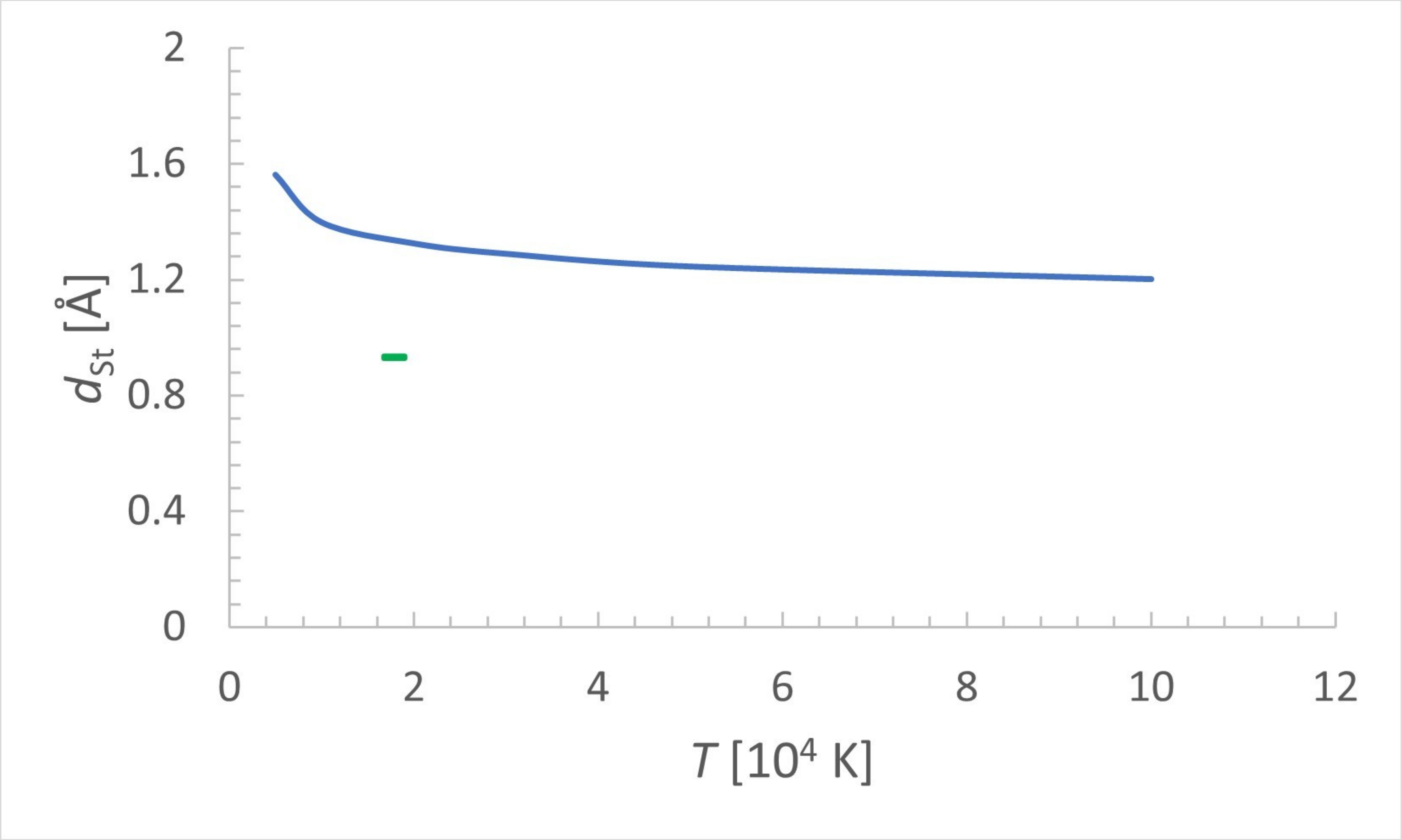
5973.4 Å

n_e = 1.10^{17} cm^{-3}

• Gonzáles et al. 2002

— This work

Temperature dependence of Stark shift



Si II

$3s^2 4p – 3s^2 4d$

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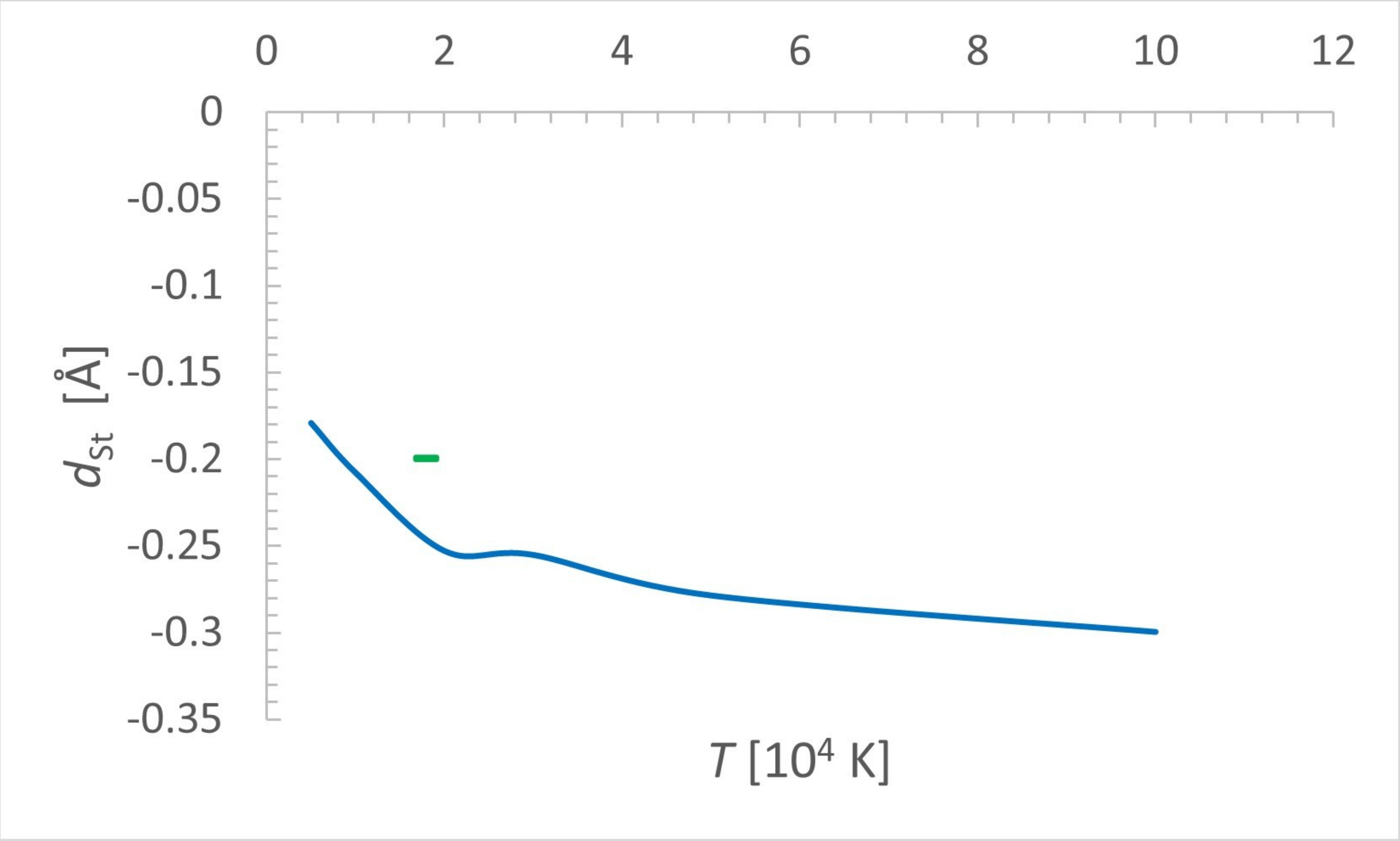
$n_e = 1.10^{17}\ cm^{-3}$

• Gonzáles et al. 2002

— This work

Temperature dependence of Stark shift



Si II

$3s^2 3d – 3s^2 4f$

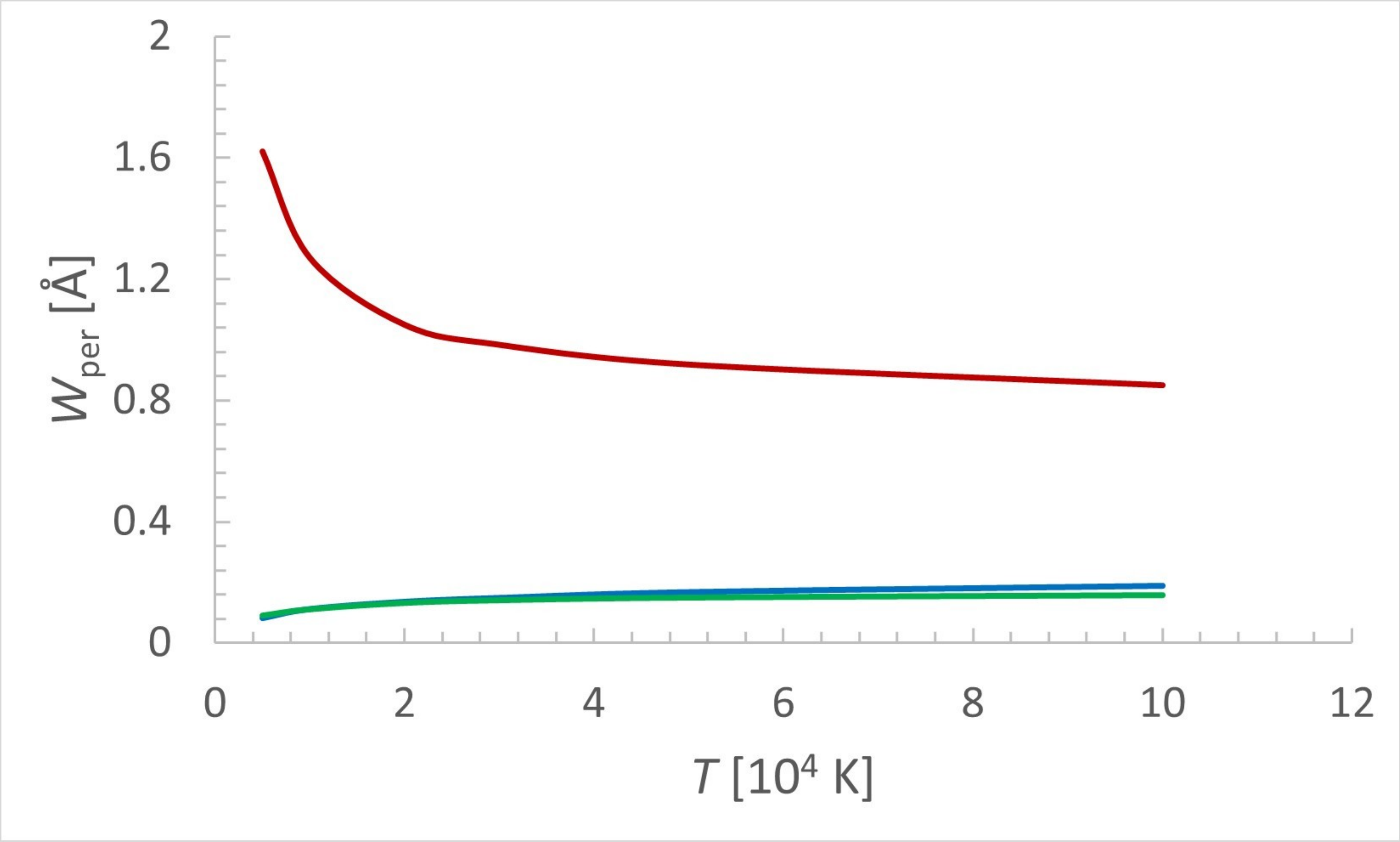
4130.9 Å

$n_e = 1.10^{17}$ cm^{-3}

• Gonzáles et al. 2002

— This work

Stark width from different perturbers



Si II

$3s^2 3d - 3s^2 4f$

4130.9 Å

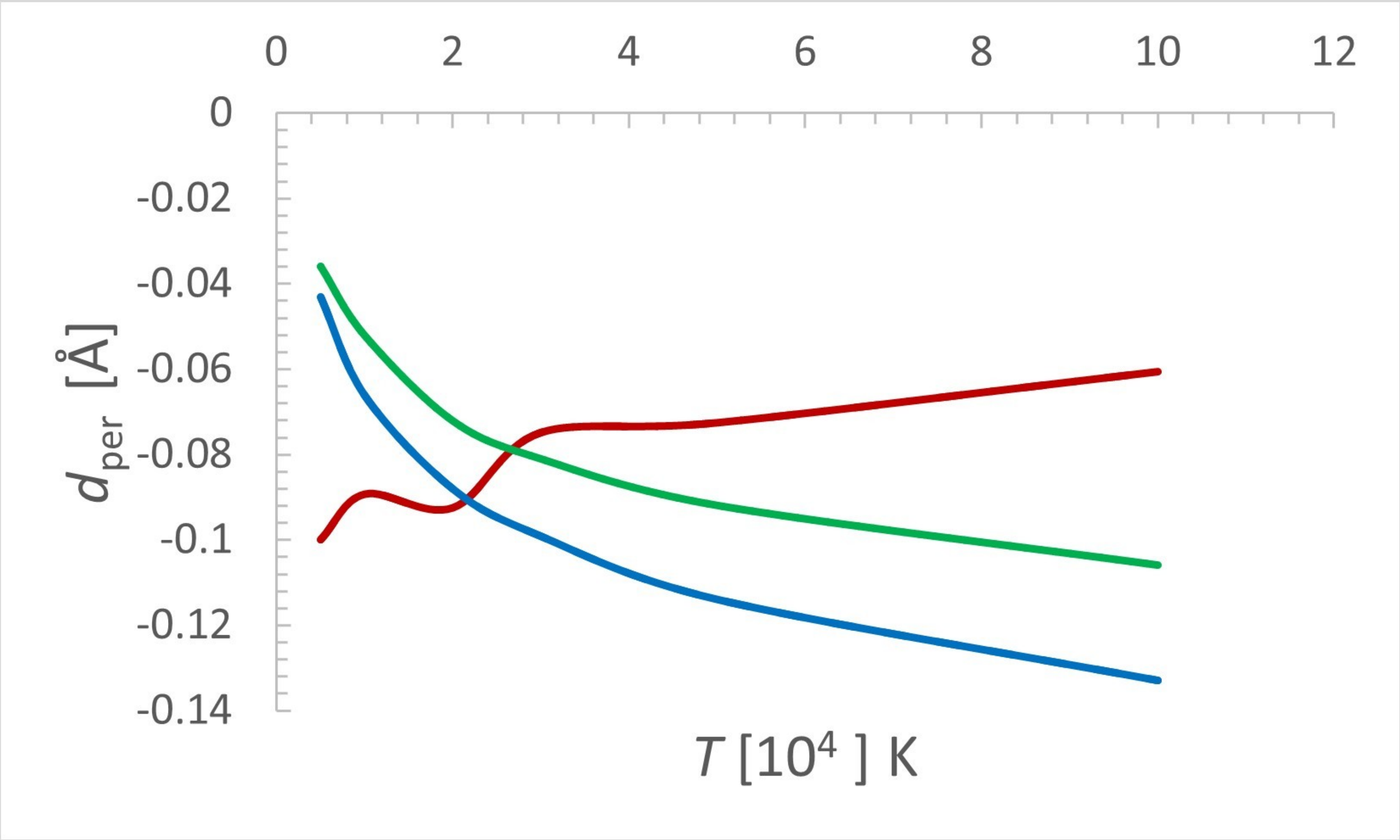
$n_e = 1.10^{17}$ cm^{-3}

— electrons

— protons

— He^+

Stark shift from different perturbers



Si II

$3s^23d – 3s^24f$

4130.9 Å

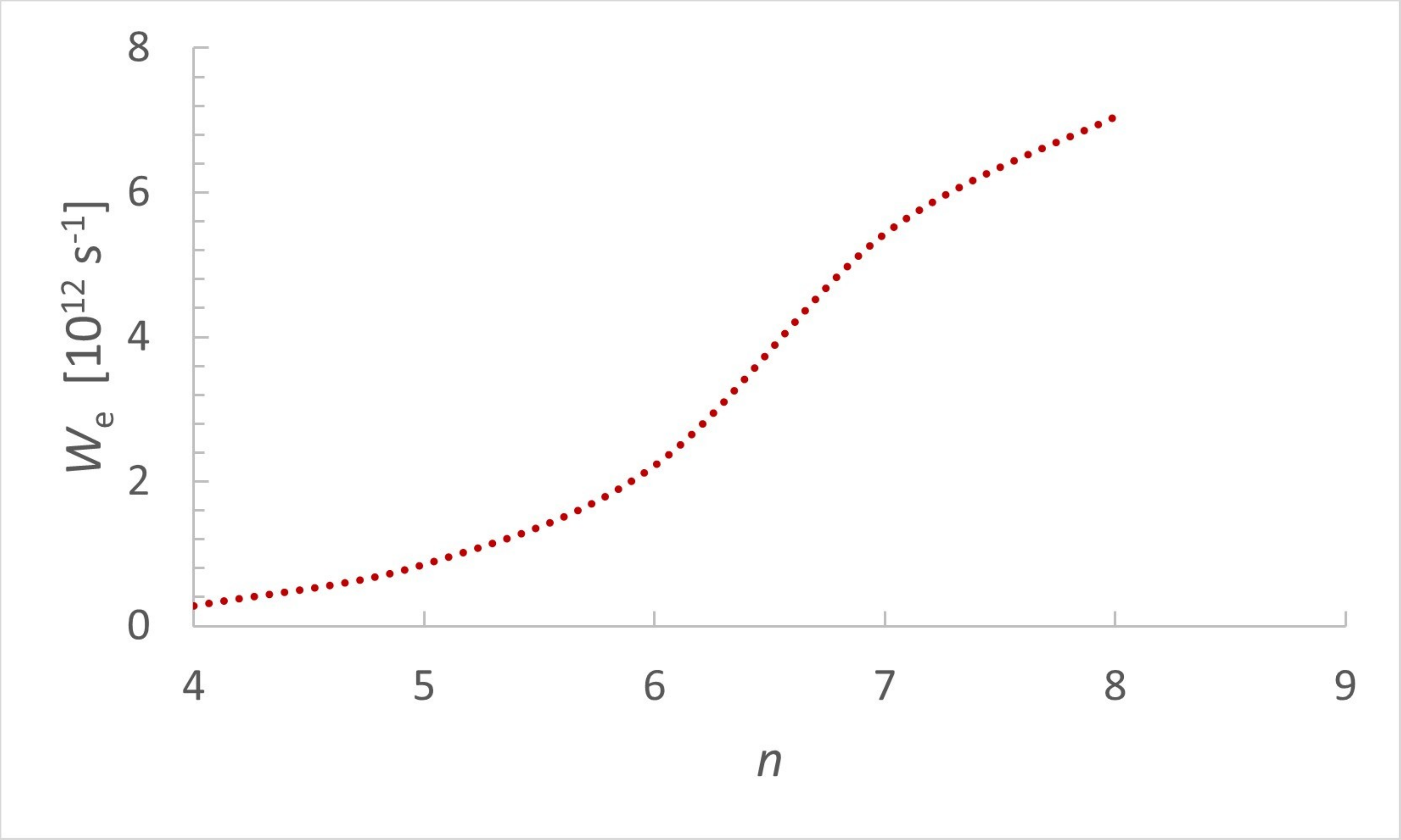
n_e = 1.10^{17} cm^{-3}

— electrons

— protons

— He^+

Electron width vs principal quantum number



Si II series

$3s^23p – 3s^2ns$

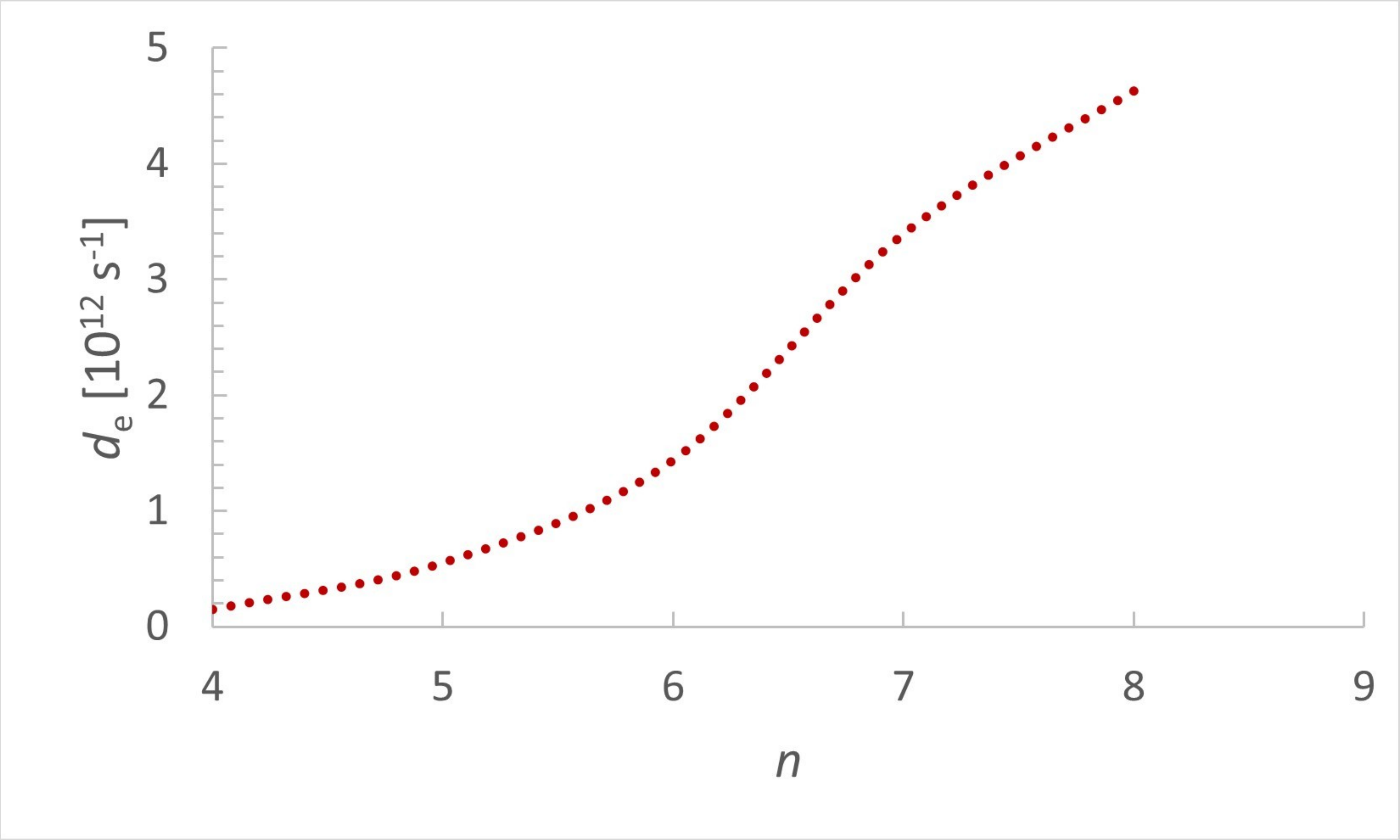
n = 4 - 8

n_e = 1.10^{17} cm^{-3}

T = 20 000 K

— electrons

Electron shift vs principal quantum number



Si II series

$3s^23p$ – $3s^2ns$

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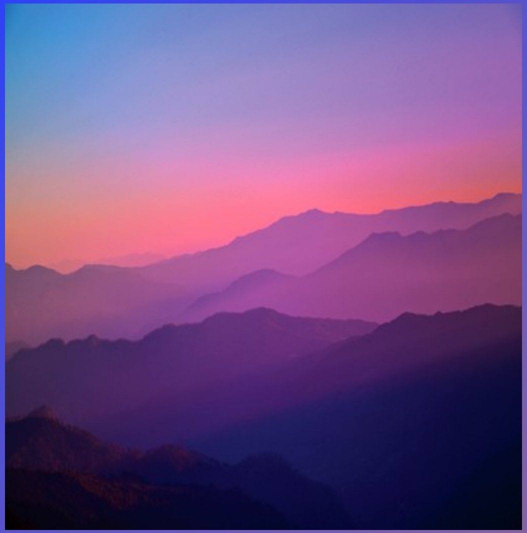

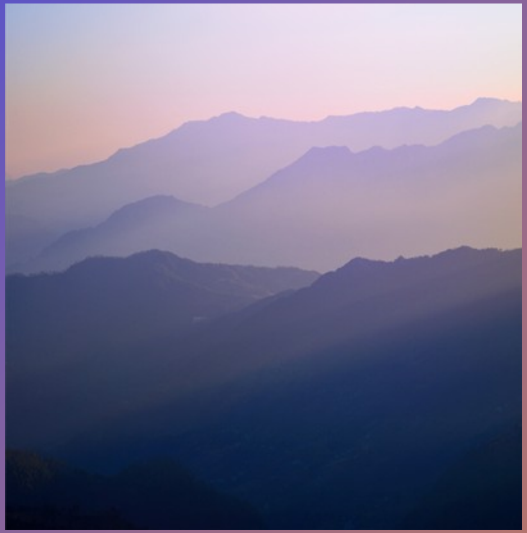

Summary

- There is a good agreement with available experimental results.
- Stark widths obtained and presented here could be applied for:
    - analysis and synthesis of Si II lines in stellar atmospheres
    - opacity calculations
    - modelling of stellar atmospheres
    - abundance determination of silicon
    - for diagnostics of laboratory plasmas and inertial fusion research.

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БЛАГОДАРЯ!