Title: Comparison of Voigt Profile Fitting Using Origin and Algebraic Approximation in Extracting Lorentzian Broadening for Electron Density Diagnostics

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Abstract: Accurate extraction of Lorentzian broadening from optical emission spectra is essential for estimating electron density in plasmas via Stark broadening. In this study, we compare two commonly used methods: (1) direct Voigt profile fitting using Origin, and (2) manual calculation using approximation of $\Delta\lambda_L = \frac{\Delta\lambda_V^2 - \Delta\lambda_G^2}{\Delta\lambda_V}$. It is found that the Lorentzian width obtained from the approximation can differ by 3–5% compared to direct fitting, resulting in a corresponding deviation in the estimated electron density. Direct fitting does not need manual calculation and delivers more accurate results, making it the preferred method.

In our previous work [1], we presented an algebraic approach for estimating the Lorentzian broadening component from a Voigt profile. In this work, we try to compare the discrepancy in calculated results between (1) direct Voigt profile fitting using Origin software, and (2) manual calculation of Lorentzian width using the analytical expression derived in our earlier study, $\Delta\lambda_L = \frac{\Delta\lambda_\upsilon^2 - \Delta\lambda_G^2}{\Delta\lambda_v}$.

Using (1), it is found that $\Delta\lambda_v = 2.60731$, $\Delta\lambda_L = 1.42476$, and $\Delta\lambda_G = 1.72241$.

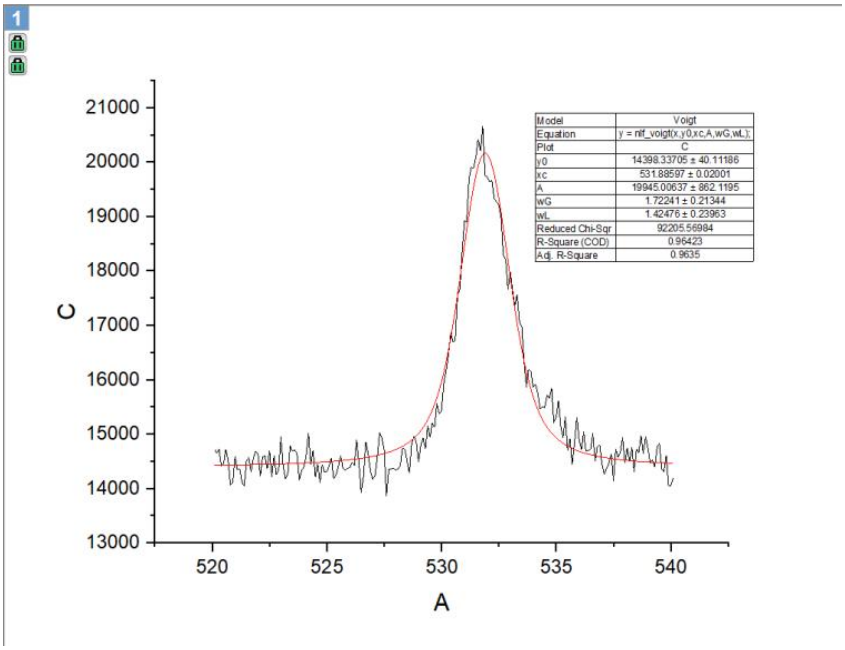

Figure 1: Direct Voigt fitting using Origin

Whereas by using (2), and by taking $\Delta\lambda_G$ and $\Delta\lambda_v$ that obtained from (1) substitute into

$$\Delta\lambda_L = \frac{\Delta\lambda_\upsilon^2 - \Delta\lambda_G^2}{\Delta\lambda_v} = \frac{2.60731^2 - 1.72241^2}{2.60731} = 1.46947$$

By comparing both calculated results in percentage difference we found that,

$$\left|\frac{1.46947 - 1.42476}{1.42476}\right| \times 100\% = \left|\frac{0.04471}{1.42476}\right| \times 100\% = 3.13\%$$

The difference is almost 0.05 nm and about 3.13% difference, which can lead to not negligible differnce if electron density, $n_e \propto \Delta\lambda_L^x$, where $x >> 1$[2] (see table 2).

In conclusion, (1) offers a more accurate and simple calculation method (no manual calculation is required) than (2), which makes it a preferred choice [2].

References

1. ZJ Chiah ESZ Mah, Algebraic Derivation of Lorentzian Broadening from Voigt Profile for Stark Broadening Analysis, viXra:2507.0082 (2025). Available at: https://vixra.org/abs/2507.0082

2. [2] G. J. Kalinka and N. P. Hawkes, A practical approximation for the Voigt function applicable to photoemission lines, Plasma Sources Sci. Technol. 24, 034001 (2015). Available at: https://doi.org/10.1088/0963-0252/24/3/034001