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Comment on “Atomic spectral line-free parameter deconvolution procedure”

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Recently Milosavljević and Poparic [Phys. Rev. E 63, 036404 (2001)] proposed a method for the deconvolution of isolated asymmetric plasma broadened atomic (neutral) spectral lines. The authors claim that their method enables a complete plasma diagnostics by applying this deconvolution on a single experimental line profile. In the present Comment the proposed deconvolution procedure and its application are reexamined.

It is assumed in Ref. [1] as well as in the Comment that the experimental profile has the form given by Eq. (2). Coming to our first point, the authors of Ref. [1] claim that the method can extract information from both laboratory and astrophysical plasmas. We should point out that this is not so simple, because laboratory plasmas are often much noisier than the test case they consider, and light from astrophysical sources is always distorted by other broadening mechanisms as well as radiative transfer.

We must also point out that even assuming no such other broadening mechanisms, the accuracy of the fitted parameters may be questionable. In the example [3], the Doppler accuracy is of very minor importance in the determination of the Stark broadening parameters, as Stark broadening dominates. Thus, if one uses the fitted $W_G$ to obtain a Doppler temperature, this will not be very accurate. Furthermore, if this Doppler temperature is used as the electron temperature $T_e$ in $R$ (assuming all temperatures equal) to determine the electron density $N_e$, $N_e$ may also involve a substantial error. Such issues have been studied in the literature, for example (within a different setting), in Refs. [4] and [5]. Conversely, if Doppler broadening dominates, the accuracy in the determination of Stark broadening parameters may be limited. Similarly, determining $N_e$ from $R$ or $w_{se}$ may well depend on the relative importance of ion vs electron broadening. If ion broadening is important and $R$ is accurately determined, then a knowledge of the temperature yields the electron density, which in principle should match with the $N_e$ and $T_e$ corresponding to $w_{se}$ and $d_{se}$ (clearly $R$, $w_{se}$, $W_G$ are not independent as they all depend on density and temperature). As the authors of Ref. [1] mention, it is only very recently that we have seen some important theoretical breakthroughs in the impact broadening of ion lines and reliable tables of electron impact widths are not yet widely available [6,7]. This is presumably why they only used $R$ to determine $N_e$ in both examples given. However, for the Ar I 430.0-nm line, the ion broadening parameter is small and impact broadening dominates, raising concerns as to the accuracy of $R$. It would be interesting to compare $N_e$ and $T_e$ from various best fitted parameters (in this case $w_{se}$, being dominant, should be the most accurately determined).

Another important issue is that in the example of the Ar I 430.01-nm line (Fig. 1 in Ref. [3]), $N_e$ was determined from the $H_β$ linewidth and $T_e$ from the plasma composition data [3]. This method of $T_e$ determination implies the equality of the electron and heavy particle (Ar) temperatures. The very
same assumption, $T_e = T_n$, with $T_n$ the temperature of argon atoms, is used in Ref. [1] to determine $N_e$ and $T_e$ from fitted values of $W_G$ and $R$ via Eqs. (2.3) and (2.7). This is a further assumption that must be checked experimentally or else assumed. Similarly, in Fig. 3 of Ref. [1] the same assumption $T_e = T_n$ is used to determine $N_e$ and $T_e$. This assumption is here probably justified, due to the relatively high $N_e$. However, the fitting curve of Fig. 3 of Ref. [1] does not resemble a $K$ profile as in Figs. 1 and 2 of Ref. [1]. No explanation of this point is given in Ref. [1].

Finally, the authors of Ref. [1] introduce an artificial weighing of the off-diagonal Jacobian elements. This does not guarantee the positive-definiteness of the Jacobian matrix [8,9], and consequently the stability and reproducibility of the iterative procedure may become questionable. For more details, see Refs. [10–12].