Fast evaluation of complex line shapes in plasma

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Line-shape analysis is an invaluable tool for diagnostics of laboratory and space plasmas [1]. Line-shape calculations typically rely on complex numerical codes, consuming substantial computational resources. This is particularly true for computer simulation methods [2].

In practice, one often needs to repeat the calculations multiple times over a range of plasma parameters while, e.g., obtaining the best fit of an experimental spectrum. Moreover, due to a combination of instrumental limitations (finite spatial and temporal resolutions) and intrinsic plasma effects (such as fluctuations driven by turbulent motion), the experimental spectra inevitably represent a weighted average over a distribution of plasma parameters, leading to non-trivial alterations in the observed line shapes [3]. Accounting for such distributions of plasma parameters in a line-shape model further increases the number of calculations required.

Evidently, a fast interpolating procedure is desired to obtain a line profile based only on a limited number of pre-calculated line shapes. It can be done rather straightforwardly in specific applications (for example, see Ref. [4]), but not in the general case. Here, a technique for line-shape interpolation (or morphing) will be discussed, and examples of its application will be presented, including inlining accurate line shapes in a collisional-radiative model.

References

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