Reply to ''Line shape measurement and isolated line width calculations: Quantal versus semiclassical methods''

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(Received 29 January 1999; revised manuscript received 30 June 1999)

We cannot agree with the contention of Alexiou, Glenzer, and Lee that we were ''incorrect in stating that the experimental results are in error and that the semiclassical calculations are inapplicable'' to the broadening of the B III $2s$-$2p$ lines by electron collisions. [S1063-651X(99)07611-4]

PACS number(s): 52.70.Kz, 32.70.Jz

The preceding Comment by Alexiou, Glenzer, and Lee [1] questions some conclusions made in Ref. [2]. In the criticism in Ref. [1] of our explanation for the discrepancy between line broadening measurements and semiclassical calculations, which agree with each other, on one hand, and quantum-mechanical theory on the other hand, two major points are raised.

Beginning with the point that the semiclassical calculations are inapplicable, this has meanwhile been verified by the benchmark measurement [3] of the B III $2s$-$2p$ cross section. It agrees with fully quantum-mechanical calculations, i.e., semiclassical calculations would overestimate this most important cross section for the line broadening in our case by more than a factor of 2. Besides, it follows from Eq. (1) of the Comment [1] that about 80% of plasma electrons for $T_e = 10$ eV are allowed to penetrate the ion too deeply for the semiclassical long-range expansion of electron-ion interactions to be valid. Second, also our explanation for the excess broadening in the B III $2s$-$2p$ line profile measurements in terms of nonthermal (turbulent) motions of the test-gas ions is meanwhile supported by the observed Doppler splittings of the analogous (but narrower) C IV lines [4] in the same apparatus. The corresponding velocities therefore have a non-Maxwellian, anisotropic distribution. This invalidates the assumptions underlying Fig. 1 of Ref. [1]. We finally note that the authors of the Comment confused the turbulent-eddy size with the much larger scale length of the macroscopic flow. They also incorrectly stated that the low-frequency turbulence would affect the amplitude of Thomson scattering.

Finally, we agree that additional and independent measurements and calculations are desirable in order to resolve any remaining questions, and mention that the interested reader can find more detailed discussions in Refs. [5–7] below. (Of these, Ref. [5] mainly describes our calculations for the Ne VII $2s3s$-$2s3p$ lines, for which similar disagreements exist with both gas-liner z-pinch experiments [8] and semiclassical calculations [9] as for the B III $2s$-$2p$ lines discussed in the Comment.)

[1] S. Alexiou, S. Glenzer, R. W. Lee, preceding Comment, Phys. Rev. E **60**, 6238 (1999).
[2] H. R. Griem, Yu. V. Ralchenko, and I. Bray, Phys. Rev. E **56**, 7186 (1997).
[3] O. Woitke, N. Djurić, G. H. Dunn, M. E. Bannister, A. C. H. Smith, B. Wallbank, N. R. Badnell, and M. S. Pindzola, Phys. Rev. A **58**, 4512 (1998).
[4] S. Büscher, Th. Wrubel, I. Ahmad, and H.-J. Kunze, in *Proceedings of the 14th International Conference on Spectral Line Shapes*, edited by R. Herman, AIP Conf. Proc. No. 467 (AIP Press, New York, 1999), p. 39.
[5] Yu. V. Ralchenko, H. R. Griem, I. Bray, and D. V. Fursa, Phys. Rev. A **59**, 1890 (1999).
[6] H. R. Griem, in *Proceedings of the 14th International Conference on Spectral Line Shapes* (Ref. [4]), p. 3.
[7] H. R. Griem and Yu. V. Ralchenko, J. Quant. Spectrosc. Radiat. Transfer (to be published).
[8] Th. Wrubel, I. Ahmad, S. Büscher, H.-J. Kunze, and S. Glenzer, Phys. Rev. E **57**, 5972 (1998); see also Th. Wrubel, S. Glenzer, S. Büscher, H.-J. Kunze, and S. Alexiou, Astron. Astrophys. **306**, 1023 (1996).
[9] S. Alexiou, Phys. Rev. Lett. **75**, 3406 (1995).

