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Comment on “Large Enhancement in High-Energy Photoionization of Fe XVII and Missing Continuum Plasma Opacity”

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Recent R-matrix calculations claim to produce a significant enhancement in the opacity of neon-like Fe XVII due to atomic core excitations [1] and assert that this enhancement is consistent with recent measurements of higher-than-predicted iron opacities [2]. This comment shows that the standard opacity models [3-7] which have already been directly compared with experimental data [2,7] produce photon absorption cross-sections for Fe XVII that are effectively equivalent to the R-matrix opacities reported in [1]. Thus, the new R-matrix results cannot be expected to significantly impact the existing discrepancies between theory and experiment because they produce neither a “large enhancement” nor account for “missing continuum plasma opacity” relative to standard models.

All models that satisfy the f-sum rule [7] and include the same initial and final electronic configurations can be expected to produce similar opacities (*e.g.* [8]). This is demonstrated in Fig.1, which compares calculated opacities for Fe XVII from five standard models to the R-matrix and OP results from [1]. The models have been restricted to the Fe XVII ion and normalized to a 0.195 abundance but are otherwise the same as those previously published [2,7]. Both R-matrix and standard models include spectral features associated with autoionizing states and inner-shell electrons that are evident in measured data but neglected in OP [1,9]. Thus the opacity enhancements of R-matrix over OP reported in [1] illustrate the deficiencies of OP rather than the merits of R-matrix.

Table 1 gives relative opacities for Fe XVII to help quantify the similarities between R-matrix and standard models and their mutual differences with measurements. Both R-matrix and standard models yield larger total Rosseland mean opacities than OP, confirming the importance of transitions missing in OP. However, the Rosseland weighting function peaks near 17 Å while the most profound discrepancies between theory and experiment are in the 7 - 9 Å monochromatic continuum range. Here, the average opacities from all models (as well as cold reference opacities [10] representing photoionization from a fully occupied L-shell) are significantly smaller than the experimental data. In this critical range, R-matrix is smaller even than OP. Thus the results reported in [1] appear unlikely to resolve this discrepancy between theory and experiments.

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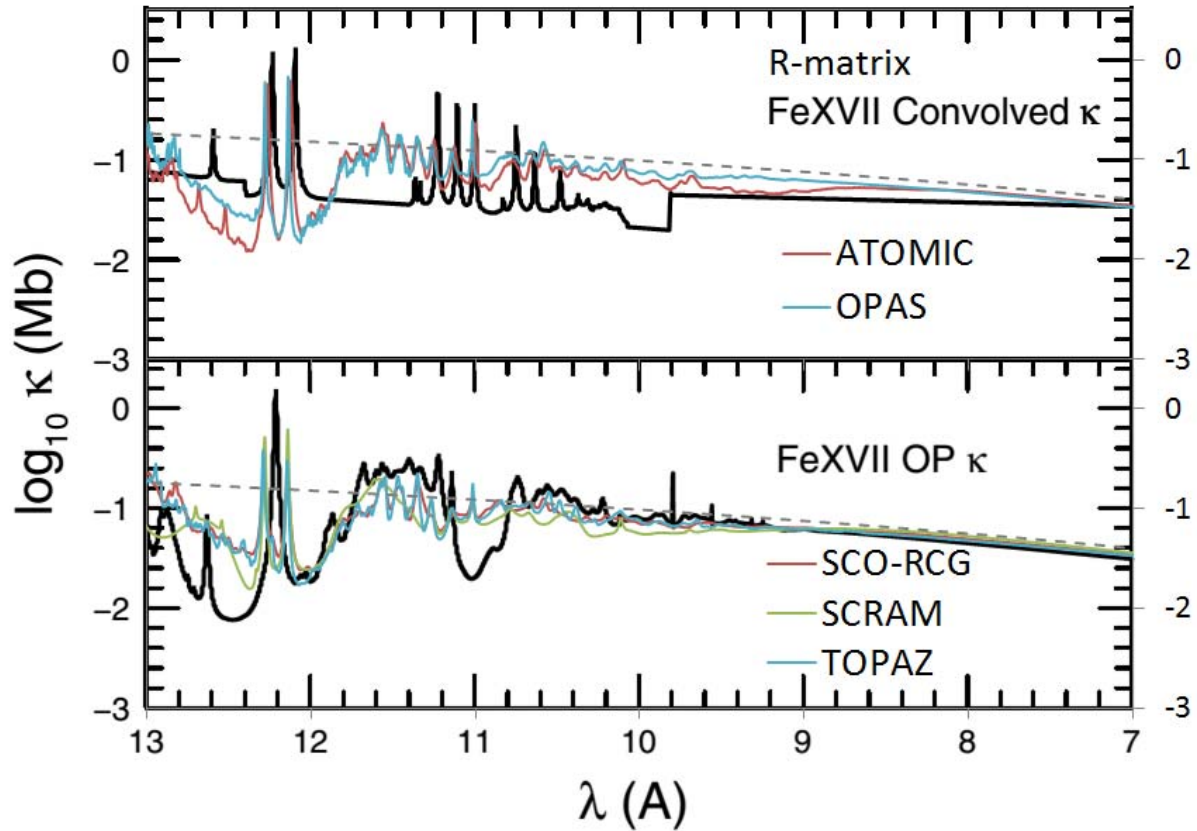


Fig.1 (Color online; adapted from Fig. 5 of Ref. [1]) Opacities of FeXVII at a temperature of 2.1×10^6 K, free electron number density of $3.1 \times 10^{22} \text{ cm}^{-3}$, and abundance of 0.195. Dashed lines are $0.195 \times$ the cold reference opacity [10], representing a fully occupied L-shell.

Table 1 Rosseland mean opacities κ_R of Fe XVII normalized to the OP value demonstrate that both R-matrix and standard models are significantly larger than OP. Average Fe XVII opacities $\langle \kappa \rangle$ in the 7-9 Å continuum region normalized to experimental data [2] show deficits in all models.

Source	κ_R (total) relative to OP [1]	$\langle \kappa \rangle$ (7 – 9 Å) relative to experiment [2]
OP [1]	1.00	0.59*
R-matrix [1]	1.35	0.52*
ATOMIC [3]	1.32	0.60
OPAS [4]	1.55	0.62
SCO-RCG [5]	1.37	0.65
SCRAM [6]	1.27	0.68
TOPAZ [7]	1.21	0.62
Cold [10]		0.74
Experiment [2]		1.00

* Estimated from Fig. 5 of Ref. [1].

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