Erratum to “The effects of averaging on the enhancement factor for absorption of light by carbon particles in microdroplets of water (JQSRT 72(2002), 765)”

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In my previous publication [1], I have argued that the average enhancement factor $\langle G \rangle$ for absorption of light by carbon inclusions in microdroplets of water can be as large as $\langle G \rangle \sim 25$, which is significantly larger than was previously reported [2,3]. This enhancement was attributed in Ref. [1] to the narrow morphology-dependent resonances in microspheres. It was concluded that the integral effect of such resonances is not small. However, the numerical results that supported this conclusion have been affected by a programming error. After this error was corrected, I have performed new simulations under the conditions identical to those of Ref. [1], and have found that the average enhancement factor is much smaller. For example, the correct numerical data analogous to those shown shown in Fig. 3 of Ref. [1] are presented in Fig. 1. Thus, the conclusion of Ref. [1] is not confirmed. Note that the same programing error has also affected the results of an earlier publication [4].

Although the simulations of Ref. [1] proved to be incorrect, the question of the influence of the narrow morphology-dependent resonances on the absorption enhancement factor averaged over a wide range of size parameters should not be closed. It is known that the internal field coefficients c_l and d_l can, in principle, become very large, so that $|c_l|^2$, $|d_l|^2 \gg 1$ (note that the squared amplitudes of the scattering coefficients a_l and b_l are bounded above by unity). For example, Grandy provides an example of a TM resonance for $l = 100$ and the refractive index $m = 1.45$ which occurs at $x \approx 74.89$ [5]. The line width of this resonance (considering x as a spectral variable) was estimated to be $\approx 1.38 \times 10^{-12}$, while the amplitude $|c_{100}|^2$ to be $\approx 4.89 \times 10^{12}$. The integral weight of this resonance is clearly not small. Thus, the internal field coefficients may become quite large at certain points in the two-dimensional plane of x and m (assuming that m is real). In Ref. [1], averaging over size parameters

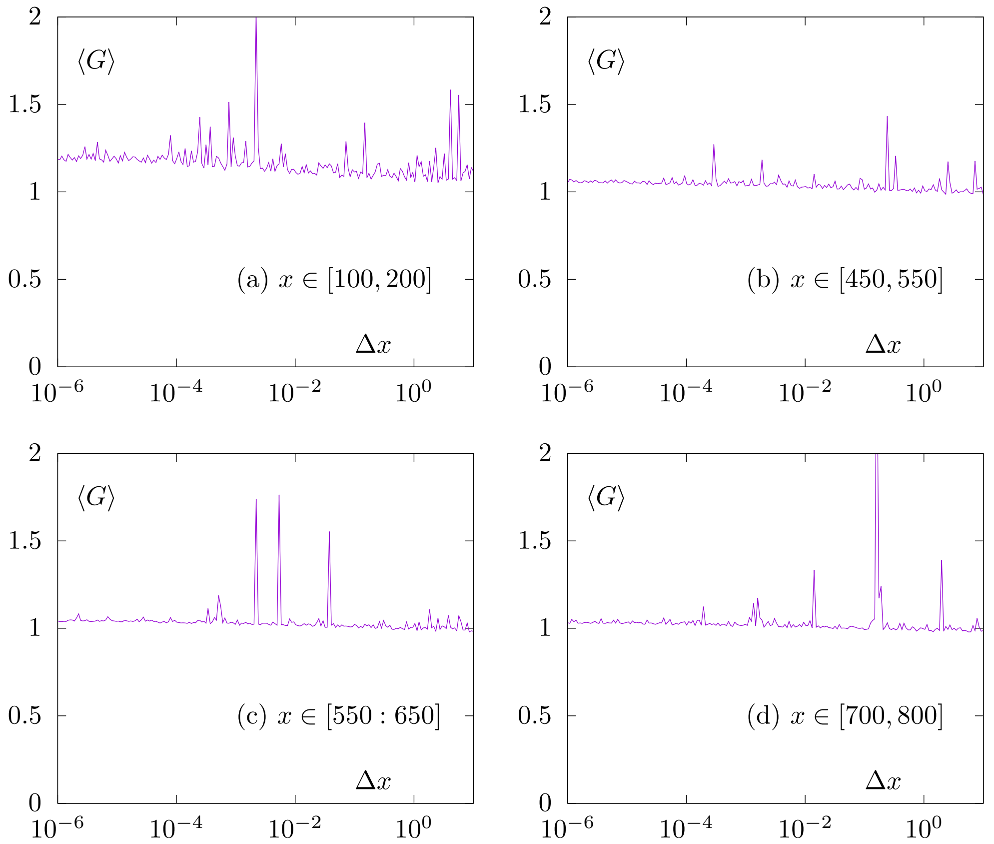

Fig. 1. Correct numerical data analogous to those shown in Fig. 3 of Ref. [1]. The average enhancement factor $\langle G \rangle$ is plotted as a function of Δx for different averaging intervals $[x_{\min}, x_{\max}]$, where $x = ka$ is the size parameter. Here $\langle G \rangle = N^{-1} \sum_{i=1}^{N} G(x_i)$ and $x_i = x_{\min} + \Delta x (i-1)$, $\Delta x = (x_{\max} - x_{\min})/(N-1)$.

was performed for a fixed value of the refractive index, $m = 1.33$. However, proper averaging must take into account variations in m, either due to the dispersion, or to the changes in the environment.

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References

[1] V. A. Markel, "The effects of averaging on the enhancement factor for absorption of light by carbon particles in micro-droplets of water," J. Quant. Spectrosc. Radiat. Transfer **72,** 765–774 (2002).

[2] P. Chylek, G. B. Lesins, G. Videen, J. G. D. Wong, R. G. Pinnick, D. Ngo, and J. D. Klett, "Black carbon and absorption of solar radiation by clouds," J. Geophys. Res. **101,** 23365–23371 (1996).

[3] G. Videen and P. Chylek, “Scattering by a composite sphere with an absorbing inclusion and effective medium approximations,” Opt. Comm. **158,** 1–6 (1998).

[4] V. A. Markel and V. M. Shalaev, “Absorption of light by soot particles in micro-droplets of water,” J. Quant. Spectrosc. Radiat. Transfer **63,** 321–339 (1999).

[5] W. T. Grandy Jr., *Scattering of Waves from Large Spheres*, Chap. 7.5 (Cambridge University Press, Cambridge, 2000).