Reply to ''Comment on 'Long-range electrostatic interactions between like-charged colloids: Steric and confinement effects' ''

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In his Comment to [Phys. Rev. E **60**, 6530 (1999)], Mateescu shows that while the effective interactions remain repulsive when the specific size of the microions is taken into account via a Modified Poisson-Boltzmann equation, a similar conclusion cannot be reached for the situation of complete lateral confinement. This point is correct but has already been considered in a more general study [Phys. Rev. E **62**, R1465 (2000), where repulsion is generically obtained]; moreover, we argue that it illustrates the irrelevancy of the notion of pair potential in completely confined configurations, as shown in a simple example.

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In his Comment [1] to our work [2], Mateescu establishes that the situation of finite lateral confinement does not necessarily lead to a repulsive effective pair potential between like charged colloids in an electrolyte, thus invalidating one of the conclusions reached in [2]. Although correct, this precise point has already been considered and incorporated in the more general analysis presented in [3] where we focused on the limit of infinite lateral extension for the confining cylinder, and obtained rigorously a generic effective repulsion [4]. Moreover, it is worthwhile to stress that the counterexample provided by Mateescu illustrates the inapplicability of the pair potential concept, as becomes clear below. Consider the situation of two colloids confined in a finite-length cylinder $\mathcal{C}$ with Neumann boundary conditions (vanishing normal electric field). The method of image charges allows to construct the equivalent infinite series of image colloids as depicted in Fig. 1. If we assume the effective interactions repulsive in $\mathcal{C}$ (as in Fig. 1), it is sufficient to notice that the boundary conditions of $\mathcal{C}'$ are also of the Neumann type, in order to obtain that the effective forces in the cylinder $\mathcal{C}'$ are attractive. Conversely, attractive interactions in $\mathcal{C}$ correspond to effective repulsions in $\mathcal{C}'$. This shows that with Neumann boundary conditions, any repulsive configuration can be mapped onto an attractive one in a closely related cell, and that the resulting effective attraction and/or repulsion is a spurious effect of image charges. Consequently, the situation of complete lateral confinement is irrelevant when discussing the sign of an effective pair potential.

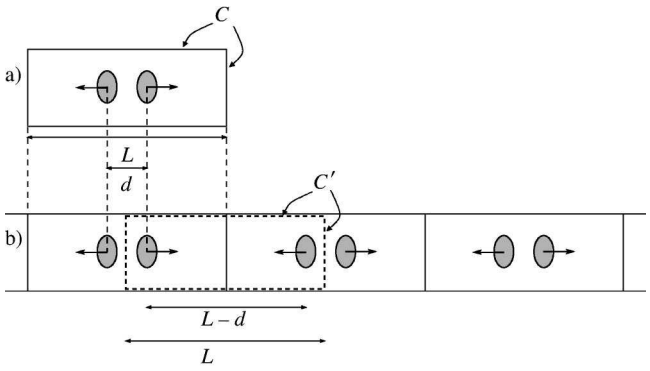

FIG. 1. The two electrostatically equivalent configurations (a) two colloids immersed in a cylinder $\mathcal{C}$ of length L with mirror symmetry; (b) the series of aligned image colloids (every midplane between two adjacent colloids is a plane of symmetry for the whole charge distribution). The cylinder $\mathcal{C}'$ of length L is indicated by the thick dashed line. In $\mathcal{C}$, the distance between the colloids is d, whereas in $\mathcal{C}'$, this distance is $L-d$. The straight simple arrows indicate the direction of the effective force acting on the colloids (repulsive in $\mathcal{C}$ and consequently attractive in $\mathcal{C}'$).

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[1] E. M. Mateescu, preceding Comment, Phys. Rev. E **64**, 013401 (2001).
[2] E. Trizac and J. L. Raimbault, Phys. Rev. E **60**, 6530 (1999).
[3] E. Trizac, Phys. Rev. E **62**, R1465 (2000).
[4] In this limit, Eq. (8) of Ref. [3] is equivalent to relation (7) in [1].

