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Computer simulation of shape effects in electrostatic and magnetostatic interactions

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It is well known that an uncharged conductor attracts charged bodies due to electrostatic induction. However, complex-shaped conductors can repel charged bodies. In this case attraction is replaced by repulsion at a certain distance between the bodies. This phenomenon is known as "repulsion effect"[1]. Examples of systems where this amazing effect can occur are known from the literature, in particular, a conducting uncharged hemisphere in the field of a point charge and a conducting uncharged thin plane with a hole in the field of electric dipole. In both cases the repulsive force occurs when a charged object is located in some places near the opening of the conductor. The change in the interaction regime is related to the shape of the conductors and, hence, to the spatial distribution of induced charges on the surface of the conductor. The presence of a hole or cavity in the conductor leads to the "repulsion effect".
In the present work we numerically investigated the "repulsion effect" for various types of uncharged conductors, the shape of which differs from the hemispherical one. The influence of the shape and thickness of the conductor on the repulsion intensity is studied. Using the example of cylindrical conductors, we have shown that a "repulsion effect" is possible for conductors with a through cavity [2]. Most of the conductors under consideration are characterized by axial symmetry. This allows us to consider conductors as a set of parallel uniformly charged thin rings. The charges of the rings were calculated by minimizing potential deviations on the conductor surface. Axial symmetry of the conductor is not necessary for the manifestation of the effect. A system without axial symmetry is presented, wherein the "repulsion effect" is also observed. It is interesting to note that the abandonment of the electroneutrality of the conductor does not lead to a sharp disappearance of the studied effect. If the conductor is slightly charged, then equally charged bodies can attract, and oppositely charged bodies can repel. Moreover, in the case of similarly charged bodies, the interaction regime may change more than once. We also investigated a possibility of the "repulsion effect"in magnetostatics by considering the interaction of a soft magnetic hemisphere with a magnetic dipole.

References

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