Shielding the "Fifth Force"?

Fischbach *et al.* recently claimed[1] that if there existed a "fifth force" coupled to electrons then there could be observable shielding effects in conducting materials. In this Comment we point out that the proposed mechanism would result in a negligible shielding of fifth-force couplings.

The force on an isolated object in a uniform field depends only its charge and is independent of its polarizability. Therefore, the force due to the uniform component of a fifth-force field is unaffected by polarization. In the case of a nonuniform fifth-force field, any fifth-force polarization effects are suppressed by a factor of 10^{36} by electrostatic forces, as we show below. Therefore, in contrast with the claims of Ref. 1, fifth-force shielding effects would be unobservable and quantities such as $B-2L$ and $N-Z$ can be used interchangeably in characterizing ordinary bulk matter.

Consider a conductor acted on by an external fifth-force field. The free electrons in the conductor will arrange themselves such that the net force on any free charge is zero. The force on a free electron is (neglecting gravity)

$$\mathbf{F}_{\text{net}}=\mathbf{F}^5_{\text{ext}}+\mathbf{F}^5_{\text{ind}}+\mathbf{F}^{\text{em}}_{\text{ind}}, \tag{1}$$

where $\mathbf{F}^5_{\text{ext}}$ is due to the applied fifth-force field and $\mathbf{F}^5_{\text{ind}}$ and $\mathbf{F}^{\text{em}}_{\text{ind}}$ arise from induced (i.e., polarization) fifth-force and electric fields. The $\mathbf{F}_{\text{net}}=0$ condition then becomes

$$-\mathbf{F}^5_{\text{ext}}=\mathbf{F}^5_{\text{ind}}+\mathbf{F}^{\text{em}}_{\text{ind}}, \tag{2}$$

where both induced fields arise from the same displacement of the free electrons. Experiment[2] has shown that if it exists, the fifth force has a strength that is at most comparable to gravity, i.e., $\approx 10^{-36}$ of electromagnetism, so that the electron displacement required in order to satisfy Eq. (2) is 10^{-36} of that which would be required in the absence of electrostatic forces. Any coupling of this tremendously suppressed fifth-force charge polarization to fifth-force field gradients is of no experimental consequence. Similar reasoning precludes any appreciable screening of fifth-force fields by conducting materials that surround the experimental apparatus.

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[1]E. Fischbach, H. T. Kloor, C. Talmadge, S. H. Aronson, and G. T. Gillies, Phys. Rev. Lett. **60**, 74 (1988).

[2]See, for example, E. G. Adelberger *et al.*, Phys. Rev. Lett. **59**, 849 (1987).