In “Low-temperature electron mobility in doped semiconductors with high dielectric constant”, Nazaryan and Feigel’man propose a new theory of electron-impurity scattering for semiconductors with large dielectric constant and sufficiently doped to be on the metallic side of the metal-insulator transition.

The paper is interesting and timely. The theory proposed here is not only new but can be applied to a broad variety of materials in which the conventional picture of scattering by charged impurities does not explain the experimental data. Therefore, I think this paper is suitable for Scipost.

However, I have a few reservations about theory/experiment comparison and remarks about the clarity of presentation.

i) In the introduction, they write: “Another omnipresent type of scattering is provided by short-range random potentials, but this one leads to density - independent scattering cross-section, thus $\mu_{short} \propto n^{-4/3}$”. Why? As far as I see, if there is a random distribution of potential wells with a density of n, the average distance in three dimensions and the mean-free-path would be $\propto n^{-1/3}$ and therefore $\mu_{short} \propto \frac{\ell}{k_F} \propto n^{-2/3}$. Would the authors explain?

ii) Equation 10 yields an expression for mobility, including the parameter GF. G, has the dimension of volume and F is a force. The authors do not discuss the physical meanings of these two parameters. Presumably G is set by elastic properties of the crystal (Young Modulus and the Poisson ratio) and F is the elastic force generated by the impurity. The authors use F as a fitting parameter. Why should F be independent of impurity concentration? If F varies just a little with n then the postulated μ∝n^(-2/3) will no more be true.

iii) I think the authors should tell their readers that in the case of strontium titanate, two experimental groups find that $\mu \propto n^{-\alpha}$ with $\alpha \cong 5/6$ in both Nb-doped strontium titanate (Tomioka et al. arXiv:2203.16208) and in oxygen-reduced strontium titanate (Wang et al. npj Quantum Materials 4 : 61 (2019)). In the latter study, it was also found that when STO is doped with Ca, α decreases from 0.84 to 0.58. Therefore, the experimental data does confirm that the mobility has a power law dependence, and the carefully quantified exponent is close to 0.67, but different from it.

iv) It is also worth noticing that the variation of the exponent with Ca content indicates a role played by the dielectric constant (which varies when Ca is introduce). Now, dielectric constant of the material is absent in Equation 10. On the other hand, it does play a role in the picture drawn in reference 1.

v) The authors write that “a vacancy or a substitutional atom … breaks down the symmetry of elastic media around it”. In the case of ABO3 perovskytes, this is true of oxygen vacancies, but not of A-site or B-site substitution at least if the impurities do not interact with each other. This brings us back to the meaning of F and its concentration dependence. (See ii). One Nb atom will not break the local symmetry, but two Nb atoms will create a distortion along the segment connecting them.