González *et al.* Reply: In a recent Letter [1] we reported the results of a Monte Carlo simulation of shot-noise suppression associated with long-range Coulomb interaction in nondegenerate diffusive conductors. In the case of a 3D momentum space, and for elastic scattering characterized by an energy-independent scattering time τ, within numerical uncertainty the suppression factor γ was found to be about $1/3$ under the following asymptotic conditions: (i) $qU \gg k_B T$, applied voltage much larger than the thermal value; (ii) $L \gg \ell, L_{Dc}$, length of the conductor much greater than both the elastic mean free path (diffusive transport regime) and the Debye length (strong space-charge effects). Once these conditions are fulfilled, the $1/3$ suppression exhibits several *universal properties* [2], namely, it is independent of material parameters, applied voltage, value of the scattering time, screening length, and carrier injective statistics. In view of the repeated appearance of the $1/3$ suppression factor in diffusive conductors under different physical conditions [3], in [1] we briefly speculated about the possibility that this result could be a *universal* phenomenon originating from some unifying concept. However, we were not sustaining the *universality* of the $1/3$ reduction in nondegenerate conductors found in our simulations. Indeed, as already stressed by Landauer [4], such a universality is spoiled by the fact that for a 2D momentum space we found $\gamma \approx 1/2$. In any case, for a given dimensionality the above mentioned *universal properties* of the suppression factor still apply.

Recently, our Monte Carlo results have been analytically interpreted by Beenakker [5] on the basis of a Boltzmann-Langevin approach applied to the case of space-charge limited current conditions within a drift-diffusion current modeling. A satisfactory agreement between analytical and numerical calculations has been obtained, even if the diffusion current has been neglected in the analytical derivations. Here the $1/3$ and $1/2$ reductions are found approximately to occur, and the following argument against the *universality* is also provided. Even if for a given dimensionality there is no dependence on material parameters, shot-noise suppression does depend on the energy dependence of the scattering time. In particular, for a 3D momentum space and for $\tau(\varepsilon) \propto \varepsilon^{-1/2}$, a value of $\gamma = 0.407$ is predicted. This value is slightly above the $1/3$ suppression factor obtained for an energy-independent τ.

In his Comment, Nagaev [6] provides a similar argument to demonstrate that the $1/3$ suppression is *nonuniversal*. By means of the Boltzmann-Langevin equation, he shows that, for the specific dependence $\tau(\varepsilon) \propto \varepsilon^{-3/2}$, the fluctuations of the distribution function averaged over momentum directions are not affected by the fluctuations of the self-consistent electric field. As a result, Coulomb interaction does not suppress shot noise (i.e., $\gamma = 1$).

We have performed Monte Carlo simulations with energy-dependent scattering times which, within the uncertainty of the calculations, confirm both Beenakker [5] and Nagaev [6] analytical predictions. Under far-from-equilibrium conditions ($qU \gg k_B T$), for $\tau(\varepsilon) \propto \varepsilon^{-1/2}$ we have obtained values of γ in the range 0.42–0.44, and for $\tau(\varepsilon) \propto \varepsilon^{-3/2}$ in the range 0.80–1.1. The higher dispersion of the second case is due to the fact that in the Monte Carlo simulations the achievement of diffusive conditions along the whole sample is not a simple task. There exists a large difference in carrier energy along the active region, which may result (for very high U) in a range of scattering times differing for more than 3 orders of magnitude in going from opposite contacts.

In summary, we agree with the main conclusion of Nagaev's Comment. In contrast to disordered degenerate conductors, whose kinetics is determined by the scattering time at the Fermi surface (this fact leading to the *universality* of the $1/3$ suppression factor [7]), in nondegenerate conductors all electrons with different energies contribute to the noise, and the suppression factor becomes sensitive to the energy dependence of the scattering time. Certainly, Nagaev's Comment sheds new light on the subject of shot-noise suppression in nondegenerate conductors, and strengthens the possibility to utilize shot-noise measurements as a tool to probe the dominating scattering mechanism in diffusive conductors by making use of the sensitivity of the noise suppression factor to $\tau(\varepsilon)$ dependencies

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[1] T. González, C. González, J. Mateos, D. Pardo, L. Reggiani, O. M. Bulashenko, and J. M. Rubí, Phys. Rev. Lett. **80**, 2901 (1998).
[2] T. González, J. Mateos, D. Pardo, O. M. Bulashenko, and L. Reggiani, Phys. Rev. B (to be published).
[3] C. W. J. Beenakker and M. Büttiker, Phys. Rev. B **46**, 1889 (1992); K. E. Nagaev, Phys. Lett. A **169**, 103 (1992); M. J. M. de Jong and C. W. J. Beenakker, Phys. Rev. B **51**, 16 867 (1995); R. Landauer, Physica (Amsterdam) **227B**, 156 (1996).
[4] R. Landauer, Nature (London) **392**, 658 (1998).
[5] C. W. J. Beenakker, Phys. Rev. Lett. **82**, 2761 (1999).
[6] K. E. Nagaev, preceding Comment, Phys. Rev. Lett. **83**, 1267 (1999).
[7] E. V. Sukhorukov and D. Loss, Phys. Rev. Lett. **80**, 4959 (1998).

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