D'Anna et al. Reply: In the preceding Comment [2], P. A. Osomsky and M. Aronson's that his vortex many-body theory [4] explains the observations reported in a recent Letter [1]. Indeed, we provide here some arguments to show the lack of a satisfactory explanation within the known theoretical framework.

We start by summarizing our results. For the magnetic field tilted away from the c-axis, there is a decrease in temperature we observe, not the Hall sign reversal to negative values just below $T_c$, and, secondly, a sharp decrease below the negative values of the Hall conductivity at the vortex-lattice melting temperature $T_m$. The Hall angle tends to small values in the Letter.

We have two main scenarios to explain our data. One follows the vortex many-body idea [2] in which vortex-lattice defects provide the negative Hall contribution. The other neglects vortex-vortex interactions [3] and, in consequence, explains the Hall behavior in terms of microscopically electronic processes which affect the vortex-core. Both explanations lead to difficulties, or need speculative arguments to test the data.

The difficulty with the many-body scenario is that the negative Hall contribution arises from vortex-lattice defects. For the defects to exist, the vortex-lattice must exist, at least locally, and must be pinned. But the negative Hall contribution starts above $T_c$ since the Hall voltage starts to deviate from the positive normal state level above $T_c$, as shown for example in Fig. 1. In consequence, the many-body scenario requires a locally ordered vortex-lattice and pinning at $T > T_c$, which is difficult to accept. Nevertheless, one can speculate that vortex-lattice defects become relevant for the Hall and longitudinal behavior below the vortex-lattice melting transition. Just below the melting transition vortex-lattice defects might contribute to the anelastic or plastic motion under the effect of large dc currents, as noisy Hall angle and Hall conductivity observed in Fig. 1. It seems to suggest, but this scenario is not considered in ref. [2] and it requires further development.

In the single-vortex scenario the Hall conductivity is closely related to microscopic electronic processes which determine the vortex core structure. In the BCS dirty limit scenario, and assuming a particle-hole asymmetry such that the vortices are negatively charged, the hydrodynamic contribution can drive the vortex Hall conductivity to a sign opposite to the normal state [4], possibly accounting for the Hall sign reversal, but severe discrepancies with the doping dependence remain unexplained [3].

An alternative microscopic explanation can be constructed considering negatively charged preformed electron-pairs which Bose condense at $T_c$ [3]. In a pure Bose-Einstein condensation scenario, the core contributions to the Hall force and damping core clients are absent, and one expects a large zero-temperature vortex Hall conductivity and Hall angle. This Bose-Einstein scenario is tempting because it is consistent with our finding of a very large Hall conductivity in the vortex-solid. But the immediate consequence will be that the vortex-lattice melting transition has a microscopic origin, that is the Bose condensation of preformed bosons. Although this supports the similar conclusion deduced from the observation that critical amplitude fluctuations persist at zero down to the vortex-lattice melting transition [4], it remains speculative and further theoretical work is necessary. Moreover, the Hall angle is small, suggesting that the core damping term is relevant, possibly because of the d-wave nature of the vortex-core in high-$T_c$ superconductors.

In conclusion, we think that the contested argument that no existing theoretical model fully explains our observations is true. We recognize that the vortex many-body theory may explain part of our data, notably the contribution of vortex-lattice defects to the Hall conductivity in solid phase, but fails to account for the liquid and superconducting behavior. On the other hand, a microscopic single-vortex theory taking into account the d-wave pairing symmetry and details of the Fermi surface might explain the Hall behavior in the liquid and solid phase. But at this stage, these are speculative scenarios.

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