Ong *et al.* Reply: Our experiments [1–3] persuade us that the Meissner transition at T_c in hole-doped cuprates is driven by the loss of long-range phase coherence caused by singular phase fluctuations, a scenario at odds with the mean-field (MF), Gaussian Ginzburg Landau (GGL) approach advocated by Cabo, Mosqueira, and Vidal [4].

A characteristic MF feature is the linear decrease to zero of the upper critical field $H_{c2}(T) \sim (1 - t)$ near T_c ($t = T/T_c$, with T the temperature). In sharp contrast, magnetization (M) and Nernst data in intense fields H show that, in hole-doped cuprates, $H_{c2}(T)$ remains very large up to T_c [1–3]. Figure 1(a) shows curves of M in optimal (OP) $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi 2212) measured in fields H to 45 T.

The estimated H_{c2} values remain significantly higher than 45 T as T is raised above 86 K. The curves directly contradict previous, inferred $H_{c2} \sim (1 - t)$ behavior, mostly from data taken below 5 T (see Fig. 3 of Ref. [3] for curves in OP $YBa_2Cu_3O_7$).

A second incompatibility with the GGL approach is the striking nonlinearity of the M-H curves in Bi 2212 [Fig. 1(b)] [2]. Between 105 K and T_c, the magnetization displays the fractional power-law behavior $M \sim -H^{1/\delta}$ in weak fields [2]. The exponent $\delta(T)$ grows from 1 to ~15 as T falls from 105 K to T_c. This unusual field dependence is in conflict with the Gaussian treatment of fluctuations. Other incompatibilities with GGL theory include the anomalous increase in $|M|$ above H_{c1} for $T < T_c$ (see Ref. [2] for full discussion).

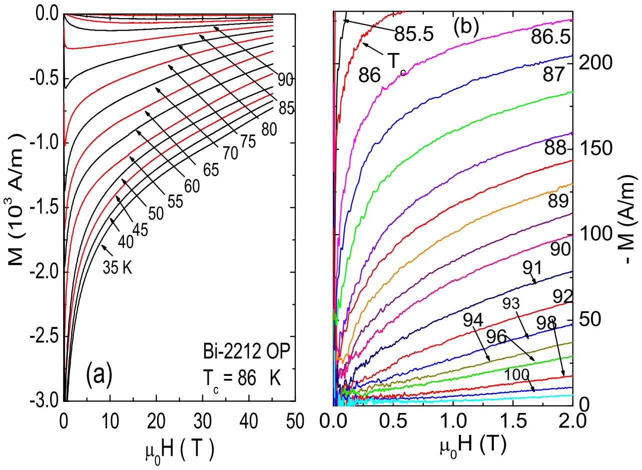

FIG. 1 (color online). Magnetization curves in OP Bi 2212. Panel (a) shows M measured up to 45 T at T from 35 K to above 90 K ($T_c = 86$ K). Below 70 K, $|M|$ decreases as log$H$ over a very broad field interval [1], but above 70 K, M vs H shows anomalous features such as the separatrix T_s (~85 K) at which M is independent of H below ~5 T. In large H, $|M|$ again decreases as log$H$. $H_{c2}(T)$, defined as where $M \rightarrow 0$, remains high at values 100–150 T even when T_c is exceeded, in sharp contrast to GGL (MF) predictions (previous experiments on M stop at 5 T). Panel (b) displays the strong curvature of M above T_c in weak H (<2 T) [2]. The curves display persistent negative curvature consistent with $M \sim -H^{1/\delta}$ with a T-dependent $\delta(T)$ up to ~105 K.

In light of the fundamental incompatibilities, fitting the T dependence of $M(T, H)$ at a single value of H is not an enlightening exercise. As shown in Ref. [2], $|M(T, H)|$ with $H = 10$ Oe actually diverges exponentially as T decreases towards T_c from above, instead of as a power law in $(t - 1)$. Approaches based on phase-disordering schemes, e.g., the Kosterlitz-Thouless transition [5] or the anisotropic 3D XY model [6] seem more productive.

Further, the GGL fits lead to parameters that are highly unreliable. In optimal Bi 2212, the experiment gives $H_{c2}(0) = 150$–200 T, whereas the fit in Ref. [4] predicts 330 T. In underdoped LSCO ($x = 0.1$), we find $H_{c2}(0) \sim 80$ T, whereas a similar analysis [7] predicts 26–28 T. Such a low H_{c2} is ruled out by experiment [3,8].

Other evidence exists for the survival of the pair condensate amplitude high above T_c in the pseudogap state. These include the Nernst effect [3], kinetic inductance [9], and measurements of the gap [10,11].

These anomalies are completely outside the purview of Gaussian fluctuations that underlie the GGL approach, regardless of the cutoff scheme adopted.

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