Comment on "Bose-Glass Melting in YBaCuO Crystals with Correlated Disorder"

In a recent Letter [1], Krusin-Elbaum *et al.* report that the irreversibility line $H_{\rm irr}(T)$ (IL) in YBaCuO crystals with columnar defects as determined from the peak in the out-of-phase component χ'' undergoes an abrupt crossover at field $B_{\rm cr} \approx \frac{1}{2}B_\Phi$ (where B_Φ is the matching field, i.e., the field at which the number of vortices and defects are equal). It has been assumed [1] that at low fields the IL tracks the melting transition of the Bose glass.

The identification of the Bose-glass (BG) melting temperature $T_{\rm BG}$ to the peak position of $\chi'' T_{\chi''}$ [1] is dependent on both the amplitude of the ac field $h_{\rm ac}$ (Fig. 1 in Ref. [1]) and frequency f (the variation in $T_c - T_{\chi''}$ is ≈ 1 K for f from 0.1 to 1 MHz [1]). As has been shown in Ref. [2], the peak in χ'' marks the coincidence of the flux penetration depth with the relevant sample dimension. Thus, this peak is not directly related either to the onset of the irreversibility or to the $T_{\rm BG}$ which is characterized by the disappearance of the Ohmic behavior [3]. We point out that the criteria which is *frequency amplitude, and sample dimensions dependent* cannot be used for the identification of a true phase transition and that the choice of such a criteria invalidates the conclusions of Ref. [1] about the state of the vortex system.

We choose the onset temperature of the low-frequency third harmonic $\chi_3 T_{|\chi_3|}$ to track the BG transition with the use of Hall probe magnetometry (see Ref. [4]). This choice can be justified by the fact that the onset is very sharp, and that $T_{|\chi_3|}$ becomes frequency independent at low f and $h_{\rm ac}$ (for $f = 1-7$ Hz and $h_{\rm ac} = 0.1-1.5$ Oe). With such low frequencies and excitation amplitudes, the absence of the linear resistivity above 10^{-11} Ω cm can be detected by the appearance of the third harmonic response, as discussed in Ref. [4]. Several YBaCuO single crystals from the same source as those in Ref. [1] were irradiated along the c axis with 5.8 GeV Pb ions. The inset in Fig. 1 shows that the difference between $T_{\chi''}$ and $T_{|\chi_3|}$ grows with increasing H. While the $H(T_{\chi''})$ dependence does demonstrate an inflection point which resembles the "abrupt crossover" of Ref. [1]; the $H(T_{|\chi_3|})$ line does not undergo such a behavior. We now test Eq. (3) of Ref. [1] for $T_{\rm BG}$. Neglecting $b = B/H_{c2}$ and subtracting both sides of Eq. (3) of Ref. [1] from unity, we obtain the independence of $(1 - T_{\rm BG}/T_c)(1+\gamma)$ on B_Φ (γ is a disorder-related parameter which is H and T independent and is proportional to $B_\Phi^{1/2}$, see Ref. [1]). Figure 1 (the main frame) presents data for the $T_{\rm BG}$ which collapse onto a single curve for $B_\Phi = 1000-20\,000$ G. The only fitting parameter is the coefficient of proportionality between γ and $B_\Phi^{1/2}$. Interestingly, Eq. (3) of Ref. [1] seems to work even for fields above the matching one. Linearity of the transition $B_{\rm BG}(T)$ at high fields *is dose dependent* being proportional to $1+\gamma$. *No abrupt change* in the behavior at a field of the order of B_Φ can be seen. These experimental observations are in contradiction with those of Ref. [1] and are in excellent agreement with theory [Ref. [3] and Eq. (3) of Ref. [1]].

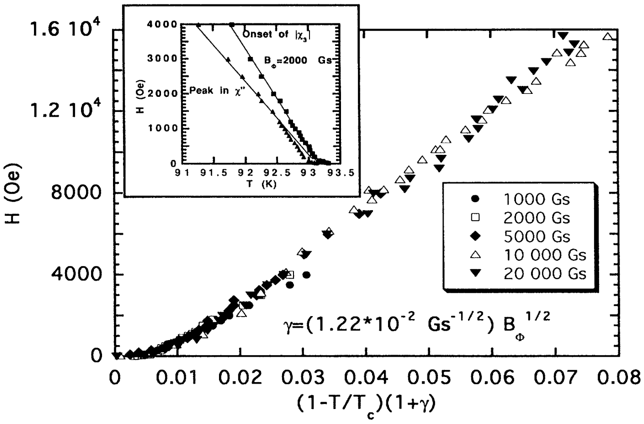

FIG. 1. Onset of the third harmonic response in YBaCuO single crystals. B_Φ is indicated in the legend. Data are presented to check Eq. (3) of Ref. [1]; see the text. Inset: $T_{\chi''}$ and $T_{|\chi_3|}$ for $B_\Phi = 2000$ G. Solid straight lines are plotted through high-filed data points.

The BG transition occurs in the regime of collectively pinned vortices where multiple columns are involved. The matching field does not have significant influence on the phase transition [Ref. [3(b)]] which persists far above B_Φ with no sign of qualitative change in either the phase diagram or the critical exponents [5].

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