Comment on "Conductivity of Underdoped $YBa_2Cu_3O_{7-\delta}$: Evidence for Incoherent Pair Correlations in the Pseudogap Regime"

In a recent Letter, Leridon *et al.* [1] claimed that their analysis of the resistivity $\rho(T)$ from the fluctuation regime to high temperatures could apply to both optimally doped and underdoped $YBa_2Cu_3O_{7-\delta}$ (YBCO) films. With the inclusion of the variable range hopping (VRH) transport for the underdoped samples, the parameters thus obtained were further linked to the characteristics of the pseudogap. In this Comment, we point out that the attempt to describe $\rho(T)$ of underdoped YBCO in [1] is no more than a phenomenological model as many other models [2], and leads to implausible negative residual resistivity. The conclusions given in [1], which distinguished certain pseudogap scenarios such as incoherent pairing from others, were not based on concrete evidence.

Leridon *et al.* did not provide results for extremely underdoped cases. Therefore we have analyzed $\rho(T)$ of *a single YBCO thin film* from optimal doping to deep underdoping, prepared by an encapsulated bulk annealing method [3], following the same model in [1]. Although the model in [1] seems to well describe $\rho(T)$ of the present sample, the fitting parameters listed in Table I raise disturbing obscurities. If b in [1] represented the residual resistivity, by conventional wisdom b should have always been positive and associated with the impurity or defect concentration in samples. However, once the VRH term was included for further underdoped cases, b suddenly changed to large negative values. This large negative b, which simply resulted from the compensating of the overshot of the VRH term at low temperatures (see Fig. 1), was artificial due to fitting and did not carry any physical meaning.

Furthermore, Δ^* was mainly derived from the difference at high temperatures between the solid line and the data in Fig. 1 through the second term of the model in [1]. It is noted that the doping dependence of Δ^* derived this way is controversial and in contrast to the photoemission data, although there is still no clear consensus on the evolution of Δ^* near the metal-insulator transition. Anyway, an alternative explanation of the high T paraconductivity by a total energy cutoff, which involved no pseudogap effect, was reported [4].

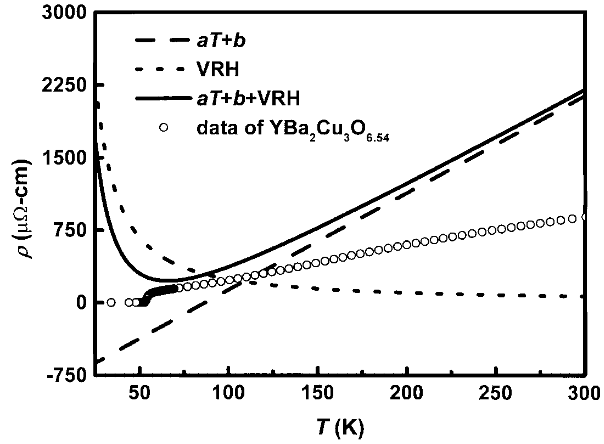

FIG. 1. The open circles are the ρ-T curve of $YBa_2Cu_3O_{6.54}$. The dashed and dotted lines are the linear term ($aT + b$) and VRH term, respectively. The solid line is the sum of both (the first term of the model in [1]).

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TABLE I. Fitting parameters, which notations are the same as those in [1], for various oxygen contents of a single $YBa_2Cu_3O_{7-\delta}$ thin film. The VRH transport was included for the oxygen contents below 6.80.

Sample	T_c (K)	a ($\mu\Omega$ cm K^{-1})	b ($\mu\Omega$ cm)	ξ_{c0} (Å)	ε_0	ρ_1 ($\mu\Omega$ cm)	T_0 (K)	T (K)	Δ^* (meV)
$YBa_2Cu_3O_{6.90}$	90.3	1.44	1.86	2.25	0.11	···	···	100.5	8.6
$YBa_2Cu_3O_{6.84}$	89.4	1.93	26.87	1.16	1.08	···	···	262.6	22.6
$YBa_2Cu_3O_{6.80}$	85.7	2.67	29.04	0.86	1.28	···	···	307.8	26.5
$YBa_2Cu_3O_{6.76}$	76.9	6.30	−414.43	0.65	2.82	0.63	86088.5	1295.4	111.6
$YBa_2Cu_3O_{6.54}$	57.6	10.04	−874.79	0.58	1.71	1.00	89844.8	318.8	27.5
$YBa_2Cu_3O_{6.50}$	51.7	10.55	−883.52	0.55	0.92	0.86	98663.3	129.3	11.1
$YBa_2Cu_3O_{6.41}$	27.5	10.88	−873.59	0.39	0.65	1.83	91172.8	52.5	4.5

