Upper Critical Field of Expanded Fulleride Superconductors $Cs_{3-x}Rb_xC_{60}$ Near the Mott Transition

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Introduction

Recent pressure studies of Cs_3C_{60} compounds have revealed that superconductivity emerging out of the antiferromagnetic phase [1-3]. The observed dome-like dependence of T_c as a function of pressure (or lattice volume) is reminiscent of non-BCS mechanism of superconductivity and highlights the importance of electron correlation and Mott physics. Therefore, studies of superconducting properties beyond T_c maximum are important to understand physics behind fullerene superconductors. To access the novel regime from the T_c maximum to the antiferromagnetic phase even at ambient pressure, we prepared $Cs_{3-x}Rb_xC_{60}$ ($0 < x < 1$).

Experimental

We performed penetration depth experiments using tunnel diode oscillator (TDO) and proximity detector oscillator (PDO) up to 65 T at NHMFL-LANL down to 1.4 K for Rb_3C_{60} and Cs_2RbC_{60}.

Results and Discussion

As shown in **Figure 1**(a), H_{c2} for Cs_2RbC_{60} (T_c = 33 K) was revealed to be higher than 50 T below ~20 K and is estimated to be as high as 80 T at T = 0 K. The estimated H_{c2} clearly exceeds Pauli limiting field, $H_P = 1.84T_c$ in the weak coupling limit, which has never been expected in fulleride superconductors. In Fig. 1(b), the temperature dependence of H_{c2} is plotted in a normalized scale, H_{c2}/T_c as a function of T/T_c. H_{c2} is almost scaled with T_c for K_3C_{60} and Rb_3C_{60}, but anomalous enhancement in Cs_2RbC_{60} is obvious. These results indicate a strong enhancement of superconducting coupling with approaching the Mott transition with expanding lattice volume.

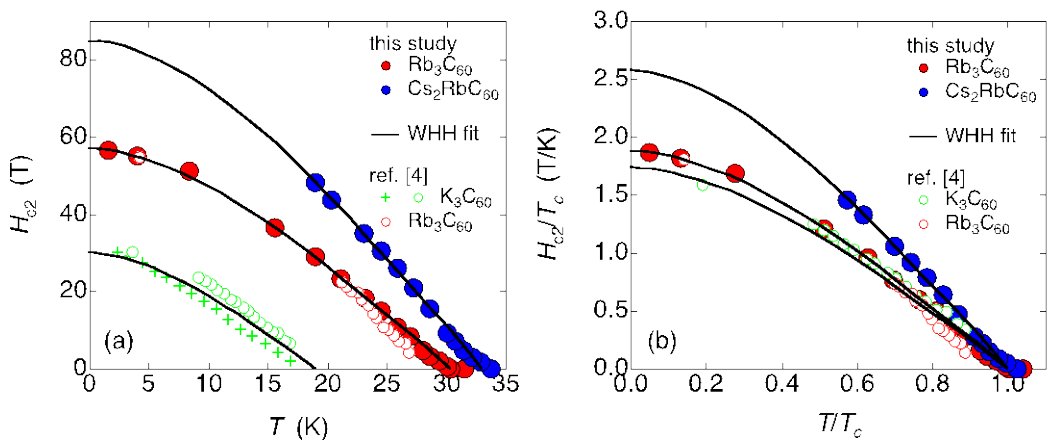

Figure 1: (a) H-T phase diagram for fulleride superconductors. Closed circles were H_{c2} determined by the present experiments. Open circles and crosses are taken from references [4]. Solid lines are fits using WHH theory. (b) H_{c2} normalized by T_c as a function of normalized temperature, T/T_c.

Conclusions

We have observed a large enhancement of H_{c2} in Cs_2RbC_{60} towards the Mott transition in fulleride superconductors.

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References

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