4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Coexistence of ferromagnetism and *d*-wave superconductivity in $YBa_2Cu_3O_{7-x}$/ $La_{0.7}Ca_{0.3}MnO_3$ bilayer

J.-Y. Lin[1,2*], Shih-Wen Huang[2, 3], L. Andrew Wray[1], Horng-Tay Jeng[4, 5], V. T. Tra[1], J. M. Lee[6], M. C. Langner[3], J. M. Chen[6], S. Roy[2], Y. H. Chu[5,7], R. W. Schoenlein[3], and Yi-De Chuang[2]

[1]*Institute of Physics, National Chiao Tung University, Hsinchu 30010, Taiwan*
[2]*Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*
[3]*Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*
[4]*Department of Physics, National Tsing Hua University, Hsinchu 30013, Taiwan* [5]*Institute of Physics, Academia Sinica, Taipei 11529, Taiwan*
[6]*National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan*
[7]*Department of Materials Science and Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan*

Accepted for publication on 1st April 2015

Ferromagnetism and *d*-wave superconductivity are often regarded as incompatible to each other. With no crystalline materials showing the coexistence of these two orders, studying their mutual interactions remains restrictive to date. However, such studies can be performed on cuprate/manganite heterostructures where these two orders are brought into proximity. Here we show the coexistence of ferromagnetism and *d*-wave superconductivity in bulk superconducting $YBa_2Cu_3O_{7-x}$ (YBCO) grown on top of ferromagnetic $La_{0.7}Ca_{0.3}MnO_3$ (LCMO). The coexistence is present with MnO_2 interfacial termination, but absent with $La_{0.7}Ca_{0.3}O$ interfacial termination. The difference originates from distinct energetics of CuO chain and CuO_2 plane next to LCMO layer at these two interfaces such that the spin-polarized electrons transferred from manganites to cuprates are influenced differently. As such, the ferromagnetic coupling inside YBCO layer can be sustained by the enhanced double-exchange interaction. Our findings demonstrate the far-reaching impacts of interfacial interactions to bulk physical properties, and open up a new paradigm of using nanoscale heterogeneity to study the competing quantum orders in correlated electron systems.

Keywords: heterostructures, ferromagnetism, superconductivity