Detection of a first-order superconducting transition in Sr_2RuO_4 by ultra-high-resolution magnetostriction measurements

Yohei Kono[1], Shunichiro Kittaka[1], Toshiro Sakakibara[2], Naoki Kikugawa[3], Taichi Terashima[3], Shinya Uji[3,4], Dmitry Sokolov[5], Kazushige Machida[6]

[1] *Department of Physics, Chuo University, Bunkyo-ku, Tokyo 112-8551, Japan*
[2]*The Institute for Solid State Physics, The University of Tokyo, Kashiwa, Chiba 277-8581, Japan*
[3]*National Institute for Materials Science, Tsukuba, Ibaraki 305-0003, Japan*
[4]*Graduate School of Pure and Applied Sciences, University of Tsukuba, Tsukuba 305-8577, Japan*
[5]*Max Planck Institute for Chemical Physics of Solids, Nothnitzer Str. 40, 01187 Dresden, Germany*
[6]*Department of Physics, Ritsumeikan University, Kusatsu, Shiga 525-8577, Japan*

Sr_2RuO_4 has been intensively investigated as one of novel unconventional superconductors for the last two decades [1]. The gap symmetry of the superconducting (SC) state, however, has still been an open problem. Recently, there have been several reports indicating a first-order SC transition occurring under a magnetic field precisely controlled parallel to the *ab* plane: a sharp entropy change observed by the magnetocaloric effect [2] and a sharp magnetization jump [3], involving hysteresis at the upper critical field H_{c2}. Recent improvements of NMR measurements have revealed a significant change of the Knight shift below the H_{c2} for the magnetic field along the *ab* plane [4,5] in contrast to the previous study [6]. These notable features imply pair-breaking mechanism derived from a strong Pauli-paramagnetic effect.

Motivated by these previous studies, we performed ultra-high-resolution magnetostriction measurements on a single crystal sample of Sr_2RuO_4 along the *c* axis with the magnetic field parallel to the *ab* plane. We have succeeded in detecting a small first-order SC transition signal on the magnetostriction of the sample (~0.1 Å) with improving a home-made capacitively-detected diameter for a resolution far better than 0.01 Å. The magnetization and specific-heat measurements were also conducted on the same sample, the results of which are in agreement with the magnetostriction data. Although a weak anomaly was detected in the magnetostriction slightly below the first-order transition field, a clear evidence for the occurrence of a Fulde-Ferrell-Larkin-Ovchinnikov transition was not provided in the present measurements.

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E-mail for corresponding author: kono@phys.chuo-u.ac.jp