GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Fachbereich Physik
Institut für Theoretische Physik

CONDENSED MATTER THEORY SEMINAR

Subject: **Negative Metal Ions and Dirac Electrons in the Superconducting Antiperovskite Oxide $Sr_{3-x}SnO$**

Speaker: **Dr. Mohamed Oudah, University of British Columbia, Canada**

Date & time: **Tuesday, July 30th, 2019 at 2:00 p.m.**

Venue: **Seminar room 1.114**

Antiperovskite oxides A_3BO (A = Mg, Ca, Sr, Ba, Yb, Eu; B = Si, Ge, Sn, Pb) have recently been demonstrated to exhibit Dirac electronic dispersion near the Γ point in the Brillouin zone based on first-principles calculations [1,2]. Charge balance in this class of material, with typical A^{2+} and O^{2-}, leads to $(A^{2+})_3(B^{4-})(O^{2-})$, where the B atoms have an unusual 4- state. Such negative valance ions are consistent with theoretical calculations. Furthermore, antiperovskite oxides with heavier elements have been predicted as topological crystalline insulators [3], due to the inversion of the conduction d band of A^{2+} and the valance p band of B^{4-}.

We found the first superconductivity among the antiperovskite oxides in the hole-doped $Sr_{3-x}SnO$ [4], with evidences of zero resistivity (Fig.1 (a)) and diamagnetic Meissner signal (Fig.1 (b)). Antiperovskite oxides are unstable in air and decompose within minutes, which made handling these materials during synthesis and property measurements challenging. The initial synthesis method used suffered from uncontrolled evaporation of Sr and it was difficult to quantify the exact composition needed for superconductivity, but we overcame this hurdle after some modifications [5].

With the improved synthesis method, we successfully tuned the amount of the strontium deficiency, and the volume fraction of the superconductivity starting at 5 K was increased to about 80%. However, this compound exhibits double superconducting transitions with the critical temperatures (T_c) of about 5 and 1 K, as demonstrated in AC susceptibility measurement in Fig.1 (b). The T_c's at 5 and 1 K as a function of x in $Sr_{3-x}SnO$ based on DC magnetization and AC susceptibility have been clarified. Also, volume fraction of each superconductivity as functions of the strontium content and Mössbauer spectroscopy will be presented [6] Furthermore, the effect of deficiency on the band structure in "$Sr_{2.5}SnO$" [7] and evidence for Dirac electrons in Sr_3SnO from ^{119}Sn-NMR will also be shown [8], as well as recent μSR results.

The number of known topological materials is scarce and an even fewer number host superconductivity. Thus, the discovery of superconductivity in the antiperovskite oxides $Sr_{3-x}SnO$ is an important step forward towards studying superconductivity in topologically nontrivial materials.

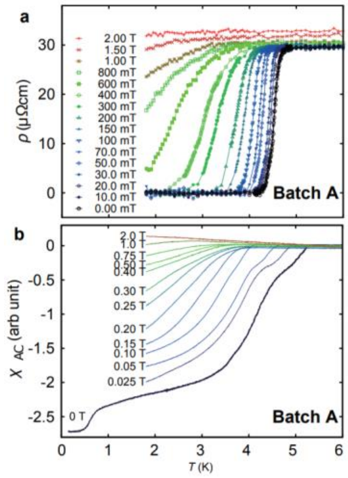

Figure 1 (a) Resistivity ρ and (b) Real part of AC susceptibility χ'_{AC} as a function of temperature of $Sr_{3-x}SnO$ under zero and various magnetic fields. The χ'_{AC} measurement under 0 T is cooled down to ~0.15 K. [4]

References
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