Evidence of a multiple boson emission in 1111 Fe-based compounds

S. A. Kuzmichev[1,2], T. E. Kuzmicheva[2] and N. D. Zhigadlo[3]

(1) Department of Low Temperature Physics and Superconductivity, M.V. Lomonosov Moscow State University 119991 Moscow, Russia
(2) Laboratory of Strongly Correlated Electron Systems, P.N. Lebedev Physical Institute, Russian Academy of Sciences 119991 Moscow, Russia
(3) Department of Chemistry and Biochemistry, University of Bern - Freiestrasse 3, CH-3012 Bern, Switzerland

We studied a reproducible fine structure observed in dynamic conductance spectra of high transparent Andreev arrays in $Sm_{1-x}Th_xOFeAs$ superconductors with various thorium concentrations (x = 0.08–0.3) and critical temperatures T_c = 26–50 K. This structure is unambiguously caused by those current carriers, excited during the process of multiple Andreev reflections (MAR) in superconductor – normal metal – superconductor (SnS) ballistic contact, which released their excess energy (up to $2\Delta_L$) through the sequential boson emission of one and the same energy (see Fig. 1) [1].

The determined energy of the bosonic mode reaches $\varepsilon_0 \approx 15$ meV for optimal compounds with T_c = 50 K and resembles that determined by us earlier for $GdO_{1-x}F_xFeAs$ with similar T_c [2]. One cannot attribute the observed bosonic resonance with the Leggett mode or optic phonon mode. Within the studied range of T_c, this energy as well as the large Δ_L and the small Δ_S superconducting gaps, nearly scales with critical temperature [3], having the characteristic ratio $\varepsilon_0 / k_BT_c \approx 3.2$ (while $2\Delta_L / k_BT_c \approx 5.3$) and resembles the expected energy $\Delta_L + \Delta_S$ of spin exciton (Fig. 2) and spectral density enhancement in s^{+-} and s^{++} states, respectively.

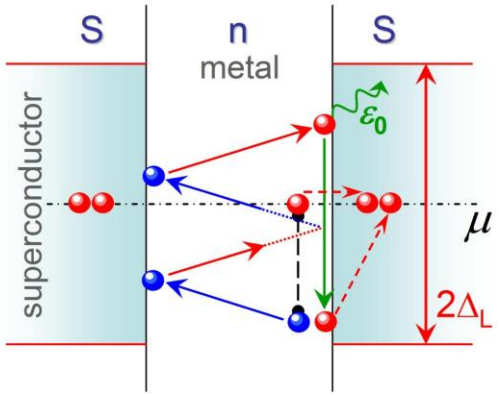

Fig. 1. *Resonant boson emission during MAR process in SnS Andreev contact ($\varepsilon_0 < 2\Delta_L$).*

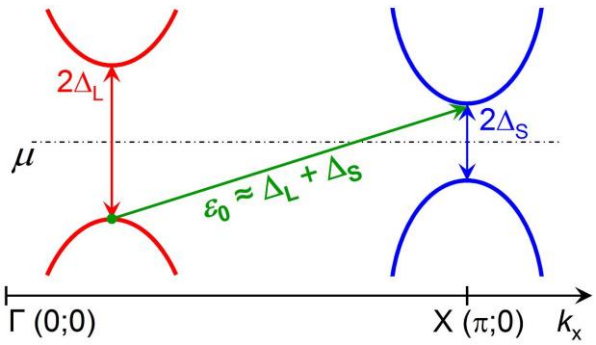

Fig. 2. *Spin exciton characteristic energy $\varepsilon_0 \approx \Delta_L + \Delta_S$ and Γ–X momentum in two-gap superconductor ($T < T_c$).*

We thank V. M. Pudalov and H. Kontani for fruitful discussions.
The work was supported by RFBR grant 17-02-00805-a.

1. S.A. Kuzmichev, T.E. Kuzmicheva, N.D. Zhigadlo, Europhysics Letters **119**, 17007 (2017)
2. S.A. Kuzmichev, T.E. Kuzmicheva, JETP Letters **105**, 671 (2017)
3. T.E. Kuzmicheva, S.A. Kuzmichev, K.S. Pervakov, V.M. Pudalov, and N.D. Zhigadlo, Phys. Rev. B **95**, 094507 (2017)