STUDY OF PRESSURE EFFECT ON THE FIELD-INDUCED ORGANIC SUPERCONDUCTOR $\kappa$-(BETS)$_2$FeBr$_4$ USING ULTRAMINIATURE PRESSURE CELLS

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Introduction
Recently, the interplay between magnetism and electric conduction in the strongly correlated electron systems has been of great interest. Here, we are reporting the measurements of the Shubnikov-de Hass (SdH) oscillations of the field-induced organic superconductor $\kappa$-(BETS)$_2$FeBr$_4$ at 3 kbar under magnetic field up to 30 T. The internal magnetic field due to iron magnetic moments could be estimated to increase from 12.7 T at ambient pressure to 28.7 T under pressure of 3 kbar.

Experimental
Gold wires of 10 $\mu$m in diameter were attached to a single crystals of $\kappa$-(BETS)$_2$FeBr$_4$ with carbon paint in a configuration for interlayer resistance measurements. The sample was then pressurized in a ultra miniature pressure cell of 7.5 mm in diameter and 12 mm in length. The cell was mounted on the rotating probe of a He3 cryostat which is in turn inserted in a He4 dewar of the 30 T magnet of the NHMFL. Angular range was limited only by the traveling length limit of the probe.

Results and Discussion
Fast Fourier Transformed spectrum of the SdH oscillations are presented in Fig. 1. In addition to oscillations from the closed orbit ($\alpha$) and those from the breakdown orbit ($\beta$), three more oscillations are observed. Among them, $\beta$-$\alpha$ oscillations arise from the combined orbit of $\alpha$ and $\beta$ orbits. $\gamma$ oscillations (not shown in the figure) from the orbit after the Fermi surface reconstruction below the antiferromagnetic transition temperature. The most peculiar in this study is the observation of new oscillations (denoted by $\delta$) which are also split into two. The origin of $\delta$ oscillations is to be investigated. The amount of splitting allows us to estimate the internal magnetic field intensity due to aligned iron magnetic moment in the crystal. Compared with its value at ambient pressure, 12.7 T, it increases substantially to 28.7 T at 3 kbar. Because the field is within the accessible field range at the NHMFL, an experiment in the hybrid magnet with a dilution refrigerator installed is very much desired as a next step, which will check the validity of the current scenario for the field-induced superconductivity in this exotic material.

Conclusions
We investigated the SdH oscillations of the field-induced organic superconductor $\kappa$-(BETS)$_2$FeBr$_4$. In addition to the already known oscillations, we observed new oscillations of which the origin is not yet clear. The internal magnetic field increased to 28.7 T under a moderate pressure of 3 kbar.

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References