In many organic superconductors, the ratio of donor molecules to anions is represented by an integer, typically 2:1. The band filling of these compounds is 3/4, and this corresponds to effective half-filling in the presence of a dimerization gap. In contrast to stoichiometric compounds with 1/2 or 3/4 band filling, nonstoichiometric compounds have provided us opportunities to study the effects of unusual band fillings on electronic states. The title compound is a nonstoichiometric organic superconductor ($T_c = 4.0$ K) and has disordered anion molecules (Figs. 1(a)-(c)). The charge transfer degree of this salt is unknown, because of the disordered polyhalide anions. Kawamoto et al. reports the Raman spectra and the Shubnikov-de Haas (SdH) oscillation of the title compound to clarify the charge transfer degree and the Fermi surface.

The Raman spectra suggest that the infinite polyhalide chains include the asymmetric trihalide anion ($I_2Br$) and that the charge transfer degree from the donor molecule to the anion is 0.429, estimated from the lattice constants. The Fermi surface calculated on the basis of the atomic coordinates and the charge transfer degree shows that the cross-sectional area of the overlapping $\gamma$ orbit, $S_\gamma$, is 6.8% of the first Brillouin zone ($S_{BZ}$), and the $\delta$ orbit, $S_\delta$, is 42.9% of $S_{BZ}$ (Fig.1 (d)). The magnetoresistance shows an oscillating behavior above 14 T (Fig. 1(e)). The nodes are clearly found in the SdH signal; this beating behavior of the SdH oscillation originates from the warping cylindrical Fermi surface. The fast Fourier transformation spectrum shows three peaks: $\gamma$, $\delta_1$, and $\delta_2$ [Fig. 1(f)]. The observed $S_\gamma$ is 9.3(10)% of $S_{BZ}$, and those of the $\delta$ orbits ($\delta_1$ and $\delta_2$) are 42.2(10) and 44.6(10)%, respectively. The beating behavior of the SdH oscillation gives a large interlayer transfer integral ($t_\perp = 2(1)$ meV), which is consistent with the corrugated conducting sheet structure. Although the present compound has the lowest superconducting transition temperature among the MDT-TSF superconductors, the difference between the highest and lowest $T_c$'s is only $\sim$ 1.5 K. It seems that the randomness of the polyhalide anion does not dominantly affect $T_c$ in MDT-TSF superconductors. On the other hand, the effective cyclotron masses of the present compound are smaller than those of other MDT-TSF superconductors. The MDT-TSF superconductors show a trend: the higher the $T_c$ of the material, the larger the effective cyclotron mass. This indicates that mass enhancement, i.e., the many-body effect, is a major factor that increases $T_c$ for many organic superconductors.

For details, see “Disordered polyhalide anion effect on the Fermi surface of the incommensurate organic superconductor (MDT-TSF)I$_{0.77}$B$_{0.52}$”, Phys. Rev. B 84, 094518 (2011) by T. Kawamoto (A02), T. Mori (A01), K. Enomoto, T. Konoike (A03), T. Terashima, S. Uji (A03), H. Kitagawa, K. Takimiya, and T. Otsubo. This article is selected as an “Editors’ Suggestion” in Phys. Rev. B.