Commensurate and incommensurate charge order in Fe$_2$OBO$_3$

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Oak Ridge TN 37831 — Charge order CO in the form of a Wigner crystal had
been proposed by Attfield et al. [Nature 396, 655 (1998)] based on measurements,
particularly Mössbauer spectroscopy, on polycrystalline Fe$_2$OBO$_3$, but no super-
structure due to the CO had been detected. We have grown the first single crystals
of pure Fe$_2$OBO$_3$, and resistivity and thermal analysis indicate not one, but two
transitions associated with CO. To elucidate the nature of these two transitions a
synchrotron study was performed. At low $T$ a superstructure corresponding to a dou-
bling of the $a$ axis was observed for the first time. The phase between the two phase
transitions, in contrast, exhibits an incommensurate modulation with propagation
vector $(\frac{1}{2},0,\tau)$, $\tau$ increasing with $T$ towards $\frac{1}{2}$. Resonances in the energy-dependence
of the scattered intensity around the Fe $K$ edge suggest that the modulations in both
phases are indeed associated with CO.