Superconductivity in the Zintl intermetallic compound Ca$_{11}$Bi$_{10-x}$ MIHAI STURZA, HAN FEI, CHRIS-TOS MALLIAKAS, HELMUT CLAUS, DUCK YOUNG CHUNG, Argonne Na-tional Laboratory, MERCOURI KANATZIDIS, Department of Chemistry, North-western University, MATERIALS SCIENCE DIVISION, ARGONNE NATIONAL LABORATORY TEAM, DEPARTMENT OF CHEMISTRY, NORTHWESTERN UNIVERSITY COLLABORATION — The recent discovery of the iron-based superconductors with unconventional superconductivity as a new class of superconductors has attracted great attention and triggered extensive research for new compounds. We report the new superconductor Ca$_{11}$Bi$_{10-x}$, which is in fact a Zintl phase. The structure of Ca$_{11}$Bi$_{10}$ contains three discrete anionic fragments: isolated Bi$_3^{2-}$ ions, dumbbells of Bi$_2^{2-}$ and square planar rings of Bi$_4^{4-}$ surrounded by Ca$_2^{2+}$ cations. The Bi$_4^{4-}$ squares and the Bi$_2^{2-}$ dumbbells interact with one another through Bi—Bi bonding to form an extended 3D framework. The extended three-dimensional Bi-Bi interactions are responsible for the metallic behavior observed above $T_c$. Electronic band structure calculations at the density functional theory (DFT) level confirm the metallic character of the material. Defects in the form of vacancies on the Bi-sites were also found using single crystal X-ray analysis. The unexpected finding is that unlike most superconductors Ca$_{11}$Bi$_{10-x}$ has very low carrier density. The Ca$_{11}$Bi$_{10-x}$ system is the first member of the intermetallic class M$_{11}$X$_{10}$ (M=Ca, Sr, Ba; X=Bi, Sb) that exhibits superconductivity suggesting that a broader family of Bi or Sb-containing superconductors may exist.

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