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Collapse of electrons to a donor cluster in $SrTiO_3$ HAN FU, KONSTANTIN REICH, BORIS SHKLOVSKII, University of Minnesota — It is known that when a nucleus has charge Ze where $Z > 137$, electrons collapse onto the nucleus resulting in a net charge $Z_n < Z$. This effect is due to the relativistic dispersion law. Here a similar effect is found for a donor cluster in $SrTiO_3$ (STO), but with a different origin (see Phys. Rev. B 92, 035204 (2015)). At low temperatures, STO has an enormously large dielectric constant and the nonlinear dielectric response becomes dominant when the electric field is still small. This leads to the collapse of electrons into a charged spherical donor cluster with radius R when its total charge number Z exceeds a critical value $Z_c \simeq R/a$ where a is the lattice constant. The net charge $Z_n e$ grows with Z until Z exceeds $Z^* \simeq (R/a)^{9/7}$. After this point, the charge of the compact core Z_n remains $\simeq Z^*$, while the rest Z^* electrons form a sparse Thomas-Fermi electron atmosphere around it. We show that the thermal ionization of such two-scale atoms easily strips the outer atmosphere while the inner core remains preserved. We extend our results to the case of long cylindrical clusters. We discuss how our predictions can be tested by measuring conductivity of chain of discs of charge on the STO surface.

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