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Quantum nature of two-dimensional electron gas confinement at $LaAlO_3/SrTiO_3$ interfaces KAROLINA JANICKA, Department of Physics and Astronomy, University of Nebraska Lincoln, JULIAN VELEV, Department of Physics, Institute for Functional Nanomaterials, University of Puerto Rico, EVGENY TSYMBAL, Department of Physics and Astronomy, University of Nebraska Lincoln — Replace this text with your abstract body. The discovery of highly conducting interface between two insulating oxides $LaAlO_3$ and $SrTiO_3$ has attracted significant interest due to possible applications in all-oxide electronic devices. The two-dimensional electron gas (2DEG) formed at $LaAlO_3/SrTiO_3$ interfaces exhibits extremely high mobility and high density of carriers. Stimulated by this discovery we perform density functional calculations to understand the mechanism controlling the confinement width of the two-dimensional electron gas (2DEG) at $LaAlO_3/SrTiO_3$ interfaces. We find that the 2DEG confinement can be explained by the formation of metal induced gap states (MIGS) in the band gap of $SrTiO_3$. These states are formed as the result of quantum-mechanical tunneling of the charge created at the interface due to electronic reconstruction. The penetration depth of the MIGS into the insulator is controlled by the lowest-decay-rate evanescent states of $SrTiO_3$, as determined by its complex band structure. Our calculations predict that the 2DEG is confined in $SrTiO_3$ within about 1 nm at the interface.

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