Correlated Nanoelectronics and the Second Quantum Revolution

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Abstract: Strongly correlated electronic materials and quantum transport of nanoelectronic systems are areas of research that have traditionally followed non-intersecting paths. With the development of complex-oxide heterostructures and nanostructures, a nascent field of Correlated Nanoelectronics has emerged. My research program makes extensive use of nanoscale reconfigurability of a complex-oxide heterostructure formed from a thin layer of $LaAlO_3$ grown on $SrTiO_3$. Like an Etch-a-Sketch toy, the $LaAlO_3/SrTiO_3$ interface can be drawn (and erased) with 2 nm resolution to create a remarkable range of quantum devices. These nanoscale devices can be "aimed" back at the materials themselves to provide insight into their inner workings. This platform has already produced two novel phases of electronic matter: one in which electrons form bound pairs without becoming superconducting, and a family of one-dimensional degenerate quantum liquids formed from n-tuples of bound electrons. A rich and growing palette of quantum building blocks are currently being explored for applications in quantum computing, quantum simulation, and quantum sensing, major goals of the Second Quantum Revolution.

Bio: Dr. Jeremy Levy is a Distinguished Professor of Physics at the University of Pittsburgh in the Department of Physics and Astronomy and Founding Director of the Pittsburgh Quantum Institute (http://pqi.org). He received an A.B. degree in physics from Harvard University in 1988, and a Ph.D. degree in physics from UC Santa Barbara in 1993. After a postdoctoral position at UC Santa Barbara, he joined the University of Pittsburgh in 1996. His research interests center around the emerging field of oxide nanoelectronics, experimental and theoretical realizations for quantum computation, semiconductor, and oxide spintronics, quantum transport and nanoscale optics, and dynamical phenomena in oxide materials and films. He is a Class of 2015 Vannevar Bush Faculty Fellow, a Fellow of the APS and AAAS, a recipient of the 2008 Nano50 Innovator Award, and the NSF Career Award. He has received the University of Pittsburgh's Chancellor's Distinguished awards for

research (2004, 2011) and teaching (2007), and the Provost Award for Excellence in Doctoral Mentoring (2022).