Condensed Matter Seminar

Dr. James S. Clarke

(Intel Corporation)

"From a Grain of Sand to a Quantum Computer"

Date/Time: *Monday, September 27, 2021*

4:00pm -5:00pm

Virtual Meeting

Zoom Link: https://virginiatech.zoom.us/j/81567947167
Passcode: 222901

Abstract: Today's quantum processors are limited to 10's of entangled quantum bits. If you believe the hype, a commercially relevant system is just around the corner that can outperform our largest supercomputers. The reality, however, is that we are still at mile 1 of a marathon. There are many unanswered fundamental questions. At Intel, our approach is to rely on the continued evolution of Moore's Law to build qubit arrays with a high degree of process control.
Here, we present progress toward the realization of 300mm spin qubit devices in a production environment. This includes

(i) isotopically purified 28 Si epi substrates with a compelling substrate quality
(ii) design of a custom qubit layout,
(iii) integration of spin qubit devices using immersion lithography, moving from classical transistor structures to full spin qubits, and
(iv) the realization of quantum dots in a nested gate design novel to a 300mm process line.

In addition, this talk will focus on two bottlenecks to moving beyond today's few-qubit devices. The first bottleneck is in the interconnect design of the quantum circuit. Today's qubits have personalities. Individual control of each qubit is required. A small quantum processor today has multiple RF and DC wires per qubit. This is a brute force approach to wiring and will not scale to the millions of qubits needed for large applications.
The second bottleneck relates to the speed of information turns in quantum development.
Fabrication of spin qubits in a silicon substrate bares similarity to conventional transistors from advanced CMOS technologies.

James Clarke is the director of the Quantum Hardware research group within Intel's Components Research Organization. James Launched Intel's Quantum Computing effort in 2015, as well as research partnership with QuTech (TU Delft and TNO). His group's primary focus is to use Intel's process expertise to develop scalable qubit arrays. In 2018, James worked with industry leaders and the Intel policy group to influence the U.S. National Quantum Initiative Act. Prior to his current role, James managed a group focused on interconnect research at advanced technology nodes as well as evaluating new materials and paradigms for interconnect performance. He has c0-authored more than 100 pages and has over 50 patents. Prior to joining Intel in 2001, James completed a B.S. in chemistry at Indiana University, a Ph.D. in physical chemistry at Harvard University and post-doctoral fellowship in physical organic chemistry at ETH, Zürich. He is also a member of IEEE.

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