tunneling. As the dot is depleted by a surface gate, the thermopower oscillates about zero with a period corresponding to the removal of a single electron. The shape of these oscillations is fitted reasonably well by a linear response expression for thermopower which assumes metallic conduction.

† Also at Toshiba Cambridge Research Centre, Cambridge, (UK).

14:54

O24 3 Coulomb Blockade Oscillations in a Quantum Dot formed by an Impurity J.T. NICHOLLS, J.E.F. FROST, M. PEPPER, D.A. RITCHIE, and G.A.C. JONES Cavendish Laboratory, Cambridge (UK) — We have observed Coulomb Blockade oscillations in a quantum dot where confinement is provided by a potential fluctuation due to an impurity situated close to one of the gates of a submicron GaAs/$Al_xGa_{1-x}As$ split-gate transistor. The current-voltage (I-V) characteristics of this dot shows a charging energy that increases from 0.5 meV to 2.1 meV as the gate voltage is swept towards pinch-off. When there is a fixed number of electrons on the dot, we have followed the coupling between the dot and the two-dimensional electron gas as a function of perpendicular magnetic field. Excitations within the dot give rise to structure on the order of 1 meV in the I-V characteristics.

15:06

O24 4 **Evidence for Spin Singlet-Triplet Transitions of Two Electrons in a Quantum Dot Observed via Single-Electron Tunneling.** Bo Su and V.J. Goldman, *SUNY at Stony Brook*, J.E. Cunningham, *AT&T Bell Labs.* -- We have recently reported the observation of single-electron tunneling through size-quantized well states in submicron devices fabricated from double-barrier AlGaAs/GaAs heterostructures.[1] Sharp rising steps appear in *I-V* curves, *N*-th step appears at a voltage V_N when the Coulomb blockade for tunneling of *N*-th electron into the well is overcome. As a function of magnetic field *B*, we observe $V_2(B)$ to exhibit cusps down, while $V_3(B)$ exhibits cusps up at the same *B*. Such behavior is expected to manifest the spin singlet-triplet transitions of the two-electron state confined in the well of the DBRTS. The values of *B* corresponding to the observed transitions are in a reasonable agreement with those in the numerical calculations of Wagner *et al.*.[2]

[1] V.J.Goldman, B.Su and J.E.Cunningham, in "*Nanostructures and Mesoscopic Systems*", ed. by W.P.Kirk and M.A.Reed (Academic Press, NY, 1991), p. 173; B.Su, V.J.Goldman and J.E.Cunningham, Science, 255, 313 (1992); Phys. Rev. B 46, 7644 (1992).

[2] M.Wagner, U.Merkt and A.V.Chaplik, Phys. Rev. B 45, 1951 (1992).

15:18

O24 5 **Precision Capacitance Bridge using a Single Electron Tunneling Electrometer.** RUBY N. GHOSH, EDWIN R. WILLIAMS, National Institute of Standards and Technology. -- The charge of the electron can be determined by placing a known number of electrons on a calibrated capacitor and measuring the voltage drop across the capacitor.[1] Recent developments in single electron tunneling (SET), devices which exploit the Coulomb blockade of tunneling onto an isolated island, have shown how to fabricate an electrometer with sufficient charge sensitivity[2] (10^{-4} e/√Hz at 10Hz) to measure the electronic charge. We report on a cryogenic capacitance bridge experiment using an SET electrometer to determine the capacitance ratio of two fused silica capacitors in a dilution refrigerator. We investigate questions of fundamental importance for the experiment to measure e, such as 1) the leakage rate of a capacitor at cryogenic temperatures, 2) the optimum circuit parameters for coupling the electrometer to the capacitance bridge while maintaining the electrometer sensitivity, 3) methods to minimize stray capacitance and 4) techniques to reduce charge noise.

[1] E. R. Williams, R. N. Ghosh and J. M. Martinis, J. of Res. of NIST 97, 299 (1992).

[2] G. Zimmerli, T. M. Eiles, R. L. Kautz and J. M. Martinis, Appl. Phys. Lett. 61, 237 (1992).

15:30

O24 6 Coexistence of the SET and Bloch Oscillations. K.K. LIKHAREV, A.N. KOROTKOV, and D.V. AVERIN, SUNY-Stony Brook*. --- We have carried out an analysis of low-temperature transport properties of "slim" semiconductor superlattices of small (practically, submicron) cross-section, biased by a fixed dc voltage. It was found that current through these structures can exhibit fast "Bloch" oscillations of frequency f_B=eV/h (where V is the dc voltage per one superlattice period), modulated by slower "Single-Electron-Tunneling" (SET) oscillations of frequency f_S=I/e (where I is the dc current). This coexistence means that electrons can exhibit their wave and particle properties simultaneously. We will discuss ways to observe this effect experimentally using phase locking of both Bloch and SET oscillations by external radiation of appropriate frequencies.

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15:42

O24 7 Electron-electron Interaction Effects on Resonant Tunneling through Vertical Quantum Dots. L.E. HENRICKSON, A.J. GLICK, and D.F. BARBE, Univ. of Maryland, College Park; G.W. BRYANT*, US Army Research Laboratory.--Current/voltage characteristics of quantum dots are governed by a combination of single-particle resonant tunneling and electron-electron interactions. Using Green's function techniques, we investigate the effect of electron-electron interactions on resonant tunneling through single and coupled vertical quantum dots. The system of dots is described by a two-dimensional Hubbard-like model consisting of a rectangular lattice of sites partitioned into one or more dots with strong intradot hopping and weak interdot hopping. The model incorporates a 1/r interaction potential which extends over all sites. This two-dimensional model allows us to assess the importance of lateral degrees of freedom on the Coulomb blockade effect. In the present study, dot sizes of up to 12 sites and 12 electrons are considered. The calculated Green's functions, which are constructed from many-body eigenstates, include the effects of the electron interaction potential to all orders.

**Work done as a National Research Council-US Army Research Laboratory Senior Research Associate.*

15:54

O24 8 Noise Effects on Coulomb Blockade and Zero-Bias Resistance in Small Capacitance Tunnel Junctions. R. F. O'Connell and G. Y. Hu, Louisiana State University.*-The zero-bias resistance in small capacitance tunnel junctions was recently measured by Cleland, Schmidt and Clarke and these authors used a quantum Langevin model (which enabled them to include quantum smearing of the Coulomb blockade) to explain the data.[1] Their model takes into account Nyquist noise generated in the leads but here we extend it to include all sources of Nyquist noise with emphasis on the noise generated in the junction itself. This enables us to get better agreement with the experimental data, particularly for junctions with high tunnel resistance and high resistance leads.

*Supported by the Office of Naval Research.

[1] A. N. Cleland et al., Phys. Rev. B 45, 2950 (1992).

16:06

O24 9 Experimental Considerations for Observing Single Electron Tunneling at Room Temperature*. M.D. REEVE, O.G. SYMKO and S. LIANG, Department of Physics, University of Utah, Salt Lake City, Utah 84112. - We have studied single electron