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14. ABSTRACT
Measurements of a single electron spin showed that the excited spin state in a GaAs single electron transistor can live for as long as 1s. However, the decoherence time in the excited state is known to be short, because of the coupling to nuclear spins. Therefore, single-electron transistors in Si quantum wells have been fabricated; it is possible in principle to make the decoherence time very long by using isotopically pure Si. Non-uniform electron density in the quantum wells has made the fabrication difficult, but a path to overcoming this has been identified. Quasi-particles with fractional charge and statistics, as well as modified Coulomb interactions, exist in a two-dimensional electron system in the fractional quantum Hall (FQH)

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Report Title

Electron Spins in Single Electron Transistors

ABSTRACT

Measurements of a single electron spin showed that the excited spin state in a GaAs single electron transistor can live for as long as 1s. However, the decoherence time in the excited state is known to be short, because of the coupling to nuclear spins. Therefore, single-electron transistors in Si quantum wells have been fabricated; it is possible in principle to make the decoherence time very long by using isotopically pure Si. Non-uniform electron density in the quantum wells has made the fabrication difficult, but a path to overcoming this has been identified. Quasi-particles with fractional charge and statistics, as well as modified Coulomb interactions, exist in a two-dimensional electron system in the fractional quantum Hall (FQH) regime. Theoretical models of the FQH state at filling fraction V=5/2 make the prediction that the wave function can encode the interchange of two quasi-particles, making this state relevant for topological quantum computing. Measurements of bias-dependent tunneling across a narrow constriction at V=5/2 exhibit temperature scaling and, from fits to the theoretical scaling form, we extracted values for the effective charge and the interaction parameter of the quasi-particles. Ranges of values obtained are consistent with those predicted by certain models of the 5/2 state.

List of papers submitted or published that acknowledge ARO support during this reporting period. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

“Two-stage Kondo effect in a four-electron artificial atom,” G. Granger, M. A. Kastner, I. Radu, M. P. Hanson and A. C. Gossard, Phys. Rev. B 72, 165309 (2005)

“Multi-island single-electron devices from self-assembled colloidal nanocrystal chains,” D. N. Weiss, X. Brokmann, L. E. Calvet, M. A. Kastner and M. G. Bawendi, Applied Physics Lett. 88, 143507 (2006)

“Surface-gated quantum Hall effect in an InAs heterostructure,” I. J. Gelfand, S. Amasha, D. M. Zumbuhl, M. A. Kastner, C. Kadow and A. C. Gossard, Appl. Phys. Lett. 88, 252105 (2006)

“Fractional quantum Hall effect in a quantum point contact at filling fraction 5/2,” J. B. Miller, I. P. Radu, D. M. Zumbuhl, E. M. Levenson-Falk, M. A. Kastner, C. M. Marcus, L. N. Pfeiffer, K. W. West, Nature Physics, 3, 561 (2007)

“Energy-dependent tunneling in a quantum dot,” K. MacLean, S. Amasha, I. P. Radu, D. M. Zumbuhl, M. A. Kastner, M. P. Hanson, A. C. Gossard, Phys. Rev. Lett. 98, 036802 (2007)

“Electrical control of spin relaxation in a quantum dot,” S. Amasha, K. MacLean, I. P. Radu, D. M. Zumbuhl, M. A. Kastner, M. P. Hanson and A. C. Gossard , Phys. Rev. Lett. 100, 046803 (2008)

“Quasi-particle properties from tunneling in the nu=5/2 fractional quantum Hall state,” I. P. Radu, J. B. Miller, C. M. Marcus, M. A. Kastner, L. N. Pfeiffer and K. W. West, Science, 320, 899 (2008)

“Spin-dependent tunneling of single electrons into an empty quantum dot,” S. Amasha, K. MacLean, I. P. Radu, D. M. Zumbuhl, M. A. Kastner, M.P. Hanson and A. C. Gossard, Phys. Rev. B 78, 041306 (2008)

Number of Papers published in peer-reviewed journals: 8.00

(b) Papers published in non-peer-reviewed journals or in conference proceedings (N/A for none)

“Prospects for Quantum Dot Implementation of Adiabatic Quantum Computers for Intractable Problems,” M. A. Kastner, Proc. IEEE 93, 1765 (2005)

Number of Papers published in non peer-reviewed journals: 1.00

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

(d) Manuscripts

Number of Manuscripts: 0.00

Number of Inventions:

Graduate Students

NAME	PERCENT_SUPPORTED
Sami Amasha	0.83
Iuliana Radu	0.16
Ghislain Granger	0.06
FTE Equivalent:	**1.05**
Total Number:	**3**

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Marc Kastner	0.00	Yes
FTE Equivalent:	**0.00**	
Total Number:	**1**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	0.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:......	0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:......	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	0.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:	0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME
Sami Amasha
Ghislain Granger

Total Number: **2**

Names of other research staff

NAME	PERCENT_SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Measurements of a single electron spin showed that the excited spin state in a GaAs single electron transistor can live for as long as 1s. However, the decoherence time in the excited state is known to be short, because of the coupling to nuclear spins. Therefore, single-electron transistors in Si quantum wells have been fabricated; it is possible in principle to make the decoherence time very long by using isotopically pure Si. Non-uniform electron density in the quantum wells has made the fabrication difficult, but a path to overcoming this has been identified. Quasi-particles with fractional charge and statistics, as well as modified Coulomb interactions, exist in a two-dimensional electron system in the fractional quantum Hall (FQH) regime. Theoretical models of the FQH state at filling fraction $\nu=5/2$ make the prediction that the wave function can encode the interchange of two quasi-particles, making this state relevant for topological quantum computing. Measurements of bias-dependent tunneling across a narrow constriction at $\nu=5/2$ exhibit temperature scaling and, from fits to the theoretical scaling form, we extracted values for the effective charge and the interaction parameter of the quasi-particles. Ranges of values obtained are consistent with those predicted by certain models of the 5/2 state.