Revising the musical equal temperament
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arXiv:1508.02292 [physics.pop-ph]

Western music is predominantly based on the equal temperament with a constant semitone frequency ratio of $2^{1/12}$. Although this temperament has been in use since the 19th century and in spite of its high degree of symmetry, various musicians have repeatedly expressed their discomfort with the harmonicity of certain intervals. Recently it was suggested that this problem can be overcome by introducing a modified temperament with a constant but slightly increased frequency ratio. In this paper we confirm this conjecture quantitatively. Using entropy as a measure for harmonicity, we show numerically that the harmonic optimum is in fact obtained for frequency ratios larger than $2^{1/12}$. This suggests that the equal temperament should be replaced by a harmonized temperament as a new standard.

Reduced sensitivity to charge noise in semiconductor spin qubits via symmetric operation
M. D. Reed, B. M. Maune, R. W. Andrews, M. G. Borselli, K. Eng, M. P. Jura, A. A. Kiselev, T. D. Ladd, S. T. Merkel, I. Milosavljevic, E. J. Pritchett, M. T. Rakher, R. S. Ross, A. E. Schmitz, A. Smith, J. A. Wright, M. F. Gyure, and A. T. Hunter
arXiv:1508.01223 [quant-ph]

We demonstrate improved operation of exchange-coupled semiconductor quantum dots by substantially reducing the sensitivity of exchange operations to charge noise. The method involves biasing a double-dot symmetrically between the charge-state anti-crossings, where the derivative of the exchange energy with respect to gate voltages is minimized. Exchange remains highly tunable by adjusting the tunnel coupling. We find that this method reduces the effect of charge noise by more than a factor of five in comparison to operation near a charge-state anti-crossing, improving the number of observable exchange oscillations in our qubit by a similar factor.

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A quantum memory with near-millisecond coherence in circuit QED
M. Reagor, W. Pfaff, C. Axline, R. W. Heeres, N. Ofek, K. Sliwa, E. Holland, C. Wang, J. Blumoff, K. Chou, M. J. Hatridge, L. Frunzio, M. H. Devoret, L. Jiang, and R. J. Schoelkopf
arXiv:1508.05882 [quant-ph]

Significant advances in coherence have made superconducting quantum circuits a viable platform for fault-tolerant quantum computing. To further extend capabilities, highly coherent quantum systems could act as quantum memories for these circuits. A useful quantum memory must be rapidly addressable by qubits, while maintaining superior coherence. We demonstrate a novel superconducting microwave cavity architecture that is highly robust against major sources of loss that are encountered in the engineering of circuit QED systems. The architecture allows for near-millisecond storage of quantum states in a resonator while strong coupling between the resonator and a transmon qubit enables control, encoding, and readout at MHz rates. The observed coherence times constitute an improvement of almost an order of magnitude over those of the best available superconducting qubits. Our design is an ideal platform for studying coherent quantum optics and marks an important step towards hardware-efficient quantum computing with Josephson junction-based quantum circuits.

Giant piezoelectricity in monolayer group IV monochalcogenides: SnSe, SnS, GeSe and GeS
R. Fei, W. Li, J. Li, and L. Yang
arXiv:1508.06222 [cond-mat.mtrl-sci]

We predict enormous piezoelectric effects in intrinsic monolayer group IV monochalcogenides (MX, M=Sn or Ge, X=Se or S), including SnSe, SnS, GeSe and GeS. Using first-principle simulations based on the modern theory of polarization, we find that their characteristic piezoelectric coefficients are about two orders of magnitude larger than those of other 2D materials, such as MoS2 and GaSe, and bulk quartz and AlN which are widely used in industry. This enhancement is a result of the unique "puckered" D2h symmetry and weaker chemical bonds of monolayer group IV monochalcogenides. Given the achieved experimental advances in fabrication of monolayers, their flexible character and ability to withstand enormous strain, these 2D structures with giant piezoelectric effects may be promising for a broad range of applications, such as nano-sized sensors, piezotronics, and energy harvesting in portable electronic devices.

Measurement-based control of a mechanical oscillator at its thermal decoherence rate
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A position sensor is demonstrated that is capable of resolving the zero-point motion of a nanomechanical oscillator in the timescale of its thermal decoherence; it achieves an imprecision that is four orders of magnitude below that at the standard quantum limit and is used to feedback-cool the oscillator to a mean photon number of five.

An artificial Rb atom in a semiconductor with lifetime-limited linewidth
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arXiv:1508.06461 [quant-ph]

We report results important for the creation of a best-of-both-worlds quantum hybrid system consisting of a solid-state source of single photons and an atomic ensemble as quantum memory. We generate single photons from a GaAs quantum dot (QD) frequency-matched to the Rb D2-transitions and then use the Rb transitions to analyze spectrally the quantum dot photons. We demonstrate lifetime-limited QD linewidths (1.48 GHz) with both resonant and non-resonant excitation. The QD resonance fluorescence in the low power regime is dominated by Rayleigh scattering, a route to match quantum dot and Rb atom linewidths and to shape the temporal wave packet of the QD photons. Noise in the solid-state environment is relatively benign: there is a blinking of the resonance fluorescence at MHz rates but negligible upper state dephasing of the QD transition. We therefore establish a close-to-ideal solid-state source of single photons at a key wavelength for quantum technologies.

Quantum cognition: the possibility of processing with nuclear spins in the brain
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arXiv:1508.05929 [q-bio.NC]

The possibility that quantum processing with nuclear spins might be operative in the brain is proposed and then explored. Phosphorus is identified as the unique biological element with a nuclear spin that can serve as a qubit for such putative quantum processing - a neural qubit - while the phosphate ion is the only possible qubit-transporter. We identify the "Posner molecule", $Ca_9(PO_4)_6$, as the unique molecule that can protect the neural qubits on very long times and thereby serve as a (working) quantum-memory. A central requirement for quantum-processing is quantum entanglement. It is argued that the enzyme catalyzed chemical reaction which breaks a pyrophosphate ion into two phosphate ions can quantum entangle pairs of qubits. Posner molecules, formed by binding such phosphate pairs with extracellular calcium ions, will inherit the nuclear spin entanglement. A mechanism for transporting Posner molecules into presynaptic neurons during a "kiss and run" exocytosis, which releases neurotransmitters into the synaptic cleft, is proposed. Quantum measurements can occur when a pair of Posner molecules chemically bind and subsequently melt, releasing a shower of intra-cellular calcium ions that can trigger further neurotransmitter release and enhance the probability of post-synaptic neuron firing. Multiple entangled Posner molecules, triggering non-local quantum correlations of neuron firing rates, would provide the key mechanism for neural quantum processing. Implications, both in vitro and in vivo, are briefly mentioned.

Dephasing due to nuclear spins in large-amplitude electric dipole spin resonance
S. Chesi, L.-P. Yang, and D. Loss
arXiv:1508.06894 [cond-mat.mes-hall]