**Quantum read-out and fast initialization of nuclear spin qubits with electric currents**
N. Stemeroff and R. de Sousa
arXiv:1108.0699

*Nuclear spin qubits have the longest coherence times in the solid state, but their quantum read-out and initialization is a great challenge. We present a theory for the interaction of an electric current with the nuclear spins of donor impurities in semiconductors. The theory yields a sensitivity criterion for quantum detection of nuclear spin states using electrically detected magnetic resonance, as well as an all electrical method for fast qubit initialization.*

**Coulomb stability of the $4\pi$-periodic Josephson effect of Majorana fermions**
B. van Heck, F. Hassler, A. R. Akhmerov, and C. W. J. Beenakker
arXiv:1108.1095

*The Josephson energy of two superconducting islands containing Majorana fermions is a $4\pi$-periodic function of the superconducting phase difference. If the islands have a small capacitance, their ground state energy is governed by the competition of Josephson and charging energies. We calculate this ground state energy in a ring geometry, as a function of the flux–$\Phi$–enclosed by the ring, and show that the dependence on the Aharonov-Bohm phase $2e\Phi/\hbar$ remains $4\pi$-periodic regardless of the ratio of charging and Josephson energies–provided that the entire ring is in a topologically nontrivial state. If part of the ring is topologically trivial, then the charging energy induces quantum phase slips that restore the usual $2\pi$-periodicity.*

**Magnetic properties of interacting, disordered electron systems in d=2 dimensions**
P. B. Chakraborty, K. Byczuk, and D. Vollhardt
arXiv:1108.1078

*We compute the magnetic susceptibilities of interacting electrons in the presence of disorder on a two-dimensional square lattice by means of quantum Monte Carlo simulations. Clear evidence is found that at sufficiently low temperatures disorder can lead to an enhancement of the ferromagnetic susceptibility. We show that it is not related to the transition from a metal to an Anderson insulator in two dimensions, but is a rather general low temperature property of interacting, disordered electronic systems.*

**Spin-orbit-enhanced Wigner localization in quantum dots**
A. Cavalli, F. Malet, J. C. Cremon, and S. M. Reimann
arXiv:1108.0512

*We investigate quantum dots with Rashba spin-orbit coupling in the strongly-correlated regime. We show that the presence of the Rashba interaction enhances the Wigner localization in these systems, making it achievable for higher densities than those at which it is observed in Rashba-free quantum dots. Recurring shapes in the pair-correlated densities of the yrast spectrum, which might be associated with rotational and vibrational modes, are also reported.*

**Majorana fermions emerging from magnetic nanoparticles on a superconductor without spin-orbit coupling**
T.-P. Choy, J. M. Edge, A. R. Akhmerov, and C. W. J. Beenakker
arXiv:1108.0512

*There exists a variety of proposals to transform a conventional s-wave superconductor into a topological superconductor, supporting Majorana fermion mid-gap states. A necessary ingredient of these proposals is strong spin-orbit coupling. Here we propose an alternative system consisting of a one-dimensional chain of magnetic nanoparticles on a superconducting substrate. No spin-orbit coupling in the superconductor is needed. We calculate the topological quantum number of a chain of finite length, including the competing effects of disorder in the orientation of the magnetic moments and in the hopping energies, to identify the transition into the topologically nontrivial state (with Majorana fermions at the end points of the chain).*

**Spin pumping and spin transfer**
A. Brataas, Y. Tserkovnyak, G. E. W. Bauer, and P. J. Kelly
arXiv:1108.0385

*Spin pumping is the emission of a spin current by a magnetization dynamics while spin transfer stands for the excitation of magnetization by spin currents. Using Onsager's reciprocity relations we prove that spin pumping and spin-transfer torques are two fundamentally equivalent dynamic processes in magnetic structures with itinerant electrons. We review the theory of the coupled motion of the magnetization order parameter and electron for textured bulk ferromagnets (e.g. containing domain walls) and heterostructures (such as spin valves). We present first-principles calculations for the material-dependent damping parameters of magnetic alloys. Theoretical and experimental results agree in general well.*

**Quantum computing without wavefunctions: Time-dependent density functional theory for universal quantum computation**
D. G. Tempel and A. Aspuru-Guzik
arXiv:1108.0097

*We prove that the theorems of TDDFT can be applied to a class of qubit Hamiltonians that are universal for quantum computation. The theorems of TDDFT applied to universal Hamiltonians imply that single-qubit expectation values can be used as the basic variables in quantum computation and information theory, rather than wavefunctions. From a practical standpoint this opens the possibility of approximating observables of interest in quantum computations directly in terms of single-qubit quantities (i.e. as density functionals). Additionally, we also demonstrate that TDDFT provides an exact prescription for simulating universal Hamiltonians with other universal Hamiltonians that have different, and possibly easier-to-realize two-qubit interactions.*

**Decoherence in crystals of quantum molecular magnets**
S. Takahashi, I. S. Tupitsyn, J. van Tol, C. C. Beedle, D. N. Hendrickson, and P. C. E. Stamp
Nature **476**, 76 (2011)

*Quantum decoherence is a central concept in physics. Applications such as quantum information processing depend on understanding it; there are even fundamental theories proposed that go beyond quantum mechanics, in which the breakdown of quantum theory would appear as an 'intrinsic' decoherence, mimicking the more familiar environmental decoherence processes. Such applications cannot be optimized, and such theories cannot be tested, until we have a firm handle on ordinary environmental decoherence processes. Here we show that the theory for insulating electronic spin systems can make accurate and testable predictions for environmental decoherence in molecular-based quantum magnets. Experiments on molecular magnets have successfully demonstrated quantum-coherent phenomena but the decoherence processes that ultimately limit such behaviour were not well constrained. For molecular magnets, theory predicts three principal contributions to environmental decoherence: from phonons, from nuclear spins and from intermolecular dipolar interactions. We use high magnetic fields on single crystals of $Fe_8$ molecular magnets (in which the Fe ions are surrounded by organic ligands) to suppress dipolar and nuclear-spin decoherence. In these high-field experiments, we find that the decoherence time varies strongly as a function of temperature and magnetic field. The theoretical predictions are fully verified experimentally, and there are no other visible decoherence sources. In these high fields, we obtain a maximum decoherence quality-factor of* $1.49 \times 10^6$*; our investigation suggests that the environmental decoherence time can be extended up to about* 500 *microseconds, with a decoherence quality factor of* $\sim 6 \times 10^7$*, by optimizing the temperature, magnetic field and nuclear isotopic concentrations.*