Abstract Submitted
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**Coherent control and entanglement in a decoherence-free subspace of two multi-level atoms** MARTIN KIFFNER, JÖRG EVERS, CHRISTOPH H. KEITEL, Max-Planck-Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany — Decoherence-free subspaces (DFS) in a system of two dipole-dipole interacting multi-level atoms are investigated theoretically. The ground state of each atom is a $S_0$ singlet state, and the excited state multiplet is a $P_1$ triplet. Since we consider arbitrary geometrical alignments of the atoms, all Zeeman sublevels of the atomic multiplets have to be taken into account [1]. It is shown that the collective state space of the two dipole-dipole interacting four-level atoms contains a four-dimensional DFS [2]. We describe a method that allows to populate the antisymmetric states of the DFS by means of a laser field. These antisymmetric states are identified as long-lived entangled states. Further, we show that any single-qubit operation between two states of the DFS can be induced by means of a microwave field. Typical operation times of these qubit rotations can be significantly shorter than for a nuclear spin system.

[1] M. Kiffner, J. Evers, and C. H. Keitel, arXiv:quant-ph/0611071.
[2] M. Kiffner, J. Evers, and C. H. Keitel, Phys. Rev. A in print (arXiv:quant-ph/0611084).

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