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Master equation with quantized atomic motion including dipole-dipole interactions[1] FRANÇOIS DAMANET, Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, Bât. B15, B - 4000 Liège, Belgium, DANIEL BRAUN, Institut für theoritische Physik, Universität Tübingen, 72076 Tübingen, Germany, JOHN MARTIN, Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, Bât. B15, B - 4000 Liège, Belgium — We derive a markovian master equation for the internal dynamics of an ensemble of two-level atoms including all effects related to the quantization of their motion [1]. Our equation provides a unifying picture of the consequences of recoil and indistinguishability of atoms beyond the Lamb-Dicke regime on both their dissipative and conservative dynamics, and is relevant for experiments with ultracold trapped atoms. We give general expressions for the decay rates and the dipole-dipole shifts for any motional states, and we find analytical formulas for a number of relevant states (Gaussian states, Fock states and thermal states). In particular, we show that the dipole-dipole interactions and cooperative photon emission can be modulated through the external state of motion. The effects predicted should be experimentally observable with Rydberg atoms [2].

[1] F. Damanet, D. Braun, and J. Martin, arXiv:1512.06676v2.
[2] K. Afrousheh, P. Bohlouli-Zanjani, D. Vagale, A. Mugford, M. Fedorov, and J. D. D. Martin, Phys. Rev. Lett. **93**, 233001 (2004).

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