Non-destructive spectroscopy on cold molecular ions

J. Mur-Petit, J. Pérez-Ríos, J. Campos-Martínez, M. I. Hernández,
S. Willitsch and J. J. García-Ripoll

\(^a\)Instituto de Física Fundamental (IFF-CSIC), Spain
\(^b\)Department of Chemistry, University of Basel, Switzerland

We propose an efficient and accurate scheme to perform spectroscopy of molecular ions by implementing quantum logic between an atomic ion and a molecular ion. Our proposal relies on a hybrid manipulation of the system, using optical forces for the atomic ion and magnetic field gradients on the molecular ions. The gate may operate in times that range from 10 μs to 1 ms and it is insensitive to the temperature of the ion crystal. One immediate application is the non-destructive measurement of a molecular hyperfine state, thus improving on recent advances in initializing cold molecular ions in a well-defined quantum state [1].