

## Non-destructive spectroscopy on cold molecular ions

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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  $\mu$ s 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].

<sup>1</sup>X. Tong, A. H. Winney and S. Willitsch, *Phys. Rev. Lett.* **105**, 143001 (2010).