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Molecular Lattice Clocks in the Optical Domain[1]

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Weakly bound molecules promise unparalleled sensitivity to temporal variations of the proton-to-electron mass ratio[2] and in searches for new interactions beyond the Standard Model[3]. Both applications, however, rely on measurements of vibrational state positions of yet unrealized accuracy. To mitigate this, we propose to observe clock $^1S_0$-$^3P_0$ transitions in weakly bound bosonic $^{174}Yb_2$ molecules[4] facilitated by applying an external magnetic field[5]. We predict the positions of molecular clock lines using photoassociation spectroscopy data for the ground state [6], and ab initio long range parameters[7] and the recently measured ^{174}Yb $^1S_0$-$^3P_0$ scattering length[8] for clock state vibrational energies. The necessary ground state Yb_2 molecules could be efficiently produced by STIRAP. Thanks to favorable Franck-Condon factors the magnetically induced molecular Rabi frequencies can be comparable to the atomic Rabi frequencies under same laser intensities and magnetic fields. Using new ab initio potentials[9] we also evaluate the sensitivity of the excited clock states to changes in the proton-to-electron mass ratio.

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[2]Zelevinsky T, Kotochigova S, Ye J, Phys. Rev. Lett. 100 043201 (2008)
[3]Borkowski M, Buchachenko AA, Ciuryo R, Julienne PS, Yamada H, Kikuchi Y, Takasu Y, Takahashi Y 2018 Sci. Rep. 9, 14807 (2019)
[4]Borkowski M, Phys. Rev. Lett. 120 083202 (2018)
[5]Taichenachev AV, et al. Phys. Rev. Lett. 96 083001 (2006)
[6]Borkowski M, Buchachenko AA, Ciuryo R, Julienne PS, Yamada H, Kikuchi Y, Takahashi K, Takasu Y, and Takahashi Y Phys. Rev. A 96 063405 (2017)
[7]Porsev SG, Safronova MS, Derevianko A, and Clark CW Phys. Rev. A 89 012711 (2014)
[8]Franchi L, et al. New J. Phys. 19 103037 (2017)
[9]P. Tecmer, et al., Int. J. Quant. Chem. 119, e25983 (2019)