

Towards High Resolution Spectroscopy of Nitrogen Ions

Tuesday, 28 June 2022 17:05 (3 minutes)

High resolution spectroscopy of molecules is a prime candidate to measure potential temporal changes in the proton-to-electron mass ratio, μ [1]. These potential changes can be detected by comparing vibrational or rotational transitions in molecules to optical atomic transitions.

In our experiment, a vibrational Raman transition in a nitrogen ion will be compared to a quadrupole transition in a calcium ion. The N_2^+ ion has systematic shifts better than the best optical atomic clocks to date. To perform precision spectroscopy, a single nitrogen ion will be co-trapped in a linear Paul trap with a $^{40}\text{Ca}^+$ ion. This calcium ion will act as a frequency reference and be used for the cooling and state detection of the nitrogen ion.

Prerequisite to this is the preparation of $^{14}\text{N}_2^+$ in a specific rovibronic state. Recently, a $2+1'$ resonance-enhanced multiphoton ionisation (REMPI) scheme was developed, using the $a^1\Sigma_g^+(v=6) \leftarrow X^1\Sigma_g^+(v=0)$ band in $^{14}\text{N}_2$ for the resonant excitation. This scheme demonstrated a fidelity of >99% for loading into the rovibronic ground state [2]. However, simulations show that the high amplitude and inhomogeneous electric fields of the ion trap broaden the ionisation threshold and prevent state-selective loading in many cases. Rapidly switching the trap off during loading can reduce the electric field and can mitigate this to allow state selective loading of the ion trap [3].

[1] M. Kajita et al., Physical Review A 89, 032509 (2014).

[2] A. Gardner et al., Scientific Reports 9, 506 (2019).

[3] L. Blackburn et al., Scientific Reports 10, 18449 (2020).

Primary authors: SHEPHERD, Amber (University of Sussex); Ms BLACKBURN, Laura (University of Sussex); Prof. KELLER, Matthias (University of Sussex)

Presenter: SHEPHERD, Amber (University of Sussex)

Session Classification: Posters