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Tune-out Wavelengths and Polarizability for the Helium 1s2s ^{3}S State.*

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This paper is part of a joint theoretical/experimental project to test QED by measuring the tune-out wavelength of helium near the 413 nm line where the frequency-dependent polarizability vanishes [1]. As a first strep, we calculate a high-precision value for the static polarizability defined in the nonrelativistic limit as the second-order perturbation energy due to the perturbation $V = eFr\cos\theta$ where F is the electric field strength. For a two electron atom such as helium, high precision results are obtained by use of an explicitly correlated Hylleraas basis set to represent the complete set of intermediate states. We also include for the first time relativistic corrections due to the Breit interaction terms proportional to
$p_1^4 + p_2^4$, $\delta(r_{12})$, $\delta(r_1)$ and the orbit-orbit interaction [2]. For the $2\,^3S$ state of helium, we find a relativistic contribution to the polarizability with finite nuclear mass corrections included of $-0.098\,765770(9)\,a_0^3$ atomic units, where α is the fine structure constant.\\[0pt]
[1] B.M. Henson et al. Phys.\ Rev.\ Lett.\ {\bf 115}, 043004 (2015).\newline
[2] K. Pachucki and J. Sapirstein, Phys. Rev. A \textbf{63}, 012504, (2000).\newline
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Author: Mr MANALO, Jacob (University of Windsor)

Co-author: Dr DRAKE, Gordon (University of Windsor)

Presenter: Mr MANALO, Jacob (University of Windsor)

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