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High precision theory for the Rydberg states of helium up to n = 24

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There is a 10σ discrepancy between theory and experiment for the ionization energy of the $1s2s^3S_1$ state of helium [1]. In order to provide an additional check, Clausen *et al.* [2] have performed measurements for the Rydberg P-states of helium from $n = 24$ to $n = 100$ and extrapolated to $n = \infty$ to find the ionization energy. In the present work, we extend previous high-precision variational calculations [3] up to $n = 24$ using triple basis sets in Hylleraas coordinates. With the inclusion of relativistic and QED corrections, the results provide a direct theoretical test against the Clausen measurement at $n = 24$. The results are in excellent agreement, thereby confirming the 10σ discrepancy between theory and experiment for the ionization energy of the $1s2s^3S_1$ state of helium.

[1] V. Patkos, V. A. Yerokhin and K. Pachucki, Phys. Rev. A **103**, 042809 (2021).

[2] G. Clausen et al. Phys. Rev. Lett. **127**, 093001 (2021).

[3] G. W. F. Drake, M. M. Cassar and R. A. Nistor, Phys. Rev. A, **65**, 054501 (2002).

Keyword-1

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Keyword-2

Rydberg states in helium

Keyword-3

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