STABILITY OF SMALL POSITRONIC ATOMS IN GROUND AND EXCITED STATES

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Introduction. Studying the dynamical stability of positron-atom and positron-molecule complexes provides an insight into the physics and chemistry of low energy positrons and their interaction with matter. Beams of low energy positrons have applications in medical imaging (positron emission tomography) and materials science (positron annihilation spectroscopy). The first theoretical confirmation of the stability of a positronic atom (e+Li) was obtained back in 1997 [1]. However, many facts remain undiscovered. In particular, this concerns the existence of excited states.

Computational method. We have developed a computational approach that is capable of solving for bound states of few-body systems with very high precision [2, 3]. High accuracy and reliability is critical for weakly bound states of positrons with atoms. The approach is based on the variational method complemented with the use of explicitly correlated Gaussian basis functions.

Results and conclusions. We have investigated the stability of positronic lithium, positronic beryllium, and positronic boron. Based on the results of our calculations, we have obtained a rigorous confirmation that a positron can attached to the beryllium atom and form an excited $1s^2 2s^2 p\ ^3P^\circ$ state. This state has the advantage of being the lowest excited state of Be and having a long (exceeding seconds) lifetime against radiative decay. We have computed its binding energy and estimated the electron-positron annihilation rate, which turned out to be significantly different from the one in the ground state. This work should stimulate future experimental efforts to perform spectroscopic measurements that involve the ground to excited state transition in this and other similar systems. We have also demonstrated that the boron atom cannot bind a positron in the ground state as was previously suggested [4].

References.

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