Theoretical evaluation of the Be$^-$ $2s2p^2\ ^4P$ hyperfine parameters and Be $2s2p\ ^3P^o$ electron-affinity

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The knowledge of the ^{7}Be$(p,\gamma)^8$B reaction factor is important in the determination of the flux of high-energy neutrinos generated in the solar core. The experimental and theoretical estimates of the relevant low-energy astrophysical S factor remain rather unreliable. However, it has been shown that the latter is linearly correlated with the quadrupole moment of ^{7}Be [1]. There is then some hope to refine the value of the needed S factor from the knowledge of the nuclear quadrupole moment. Some experiment consisting in measuring the hyperfine structure of the metastable ion Be$^-$($2s2p^2\ ^4P$) which could allow the extraction of the nuclear moment has been proposed recently [2]. The feasability of this determination depends on both the magnitude of the electric quadrupole interaction in the hyperfine structure and on the reliability of the electric field gradient which can be evaluated from atomic variational calculations.

Ab initio determination of the hyperfine parameters of Be$^-$($2s2p^2\ ^4P$) has been reported by Beck and Nicolaides [3]. We reinvestigate the calculation of these parameters using the multiconfiguration Hartree-Fock and configuration interaction methods combined with the active space concept to monitor the convergence of the various electronic contributions as a function of the orbital active set. Combining the total energies of the negative ion with those resulting from a similar study of neutral Be ($2s2p\ ^3P^o$), using the same excitation models, allows us to evaluate the electron affinity of beryllium. The preliminary results confirm the theoretical estimation of it by Olsen et al. [4] and the most recent experimental value [5].

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