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Spectroscopic Constants and Rovibrational Energies of the Helium-Antihydrogen System: A Study by Discrete Variable Representation Method

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INTRODUCTION

Investigations in the spectroscopy field are intensively made to check CPT symmetry breakdown. This clearly shows the importance of theoretical spectroscopic predictions about the interaction of normal matter and antimatter. In an earlier work, Strasburger *et al* [1] determined the potential energy curve for the $He\acute{H}$ interaction in the ground state within the Born-Oppenheimer approximation. In this work we have calculated the rovibrational properties from the Strasburger and Chojnacki PEC (SC PEC) by solving the Nuclear Schrödinger Equation using Discrete Variable Representation Method. The current theoretical predictions are expected to be useful in the future experimental investigations.

METHODS

The rovibrational energies $E_{\upsilon,J}$ were obtained by solving the Nuclear Schrodinger Equation using the Discrete Variable Representation (DVR) method. Namely, we have evaluated ω_e , $\omega_e x_e$, $\omega_e y_e$, α_e and γ_e spectroscopic constants.

In this work, we have used four different analytical forms to represent the effective potential for the nuclei in motion: generalized Rydberg of sixth degree (Ryd6), Bond-Order of six degree (BO6) and the deformed versions of these potentials by imposing the *d*-Exponential function (*d*Ryd 6 and *d*BO6) as well.

RESULTS AND DISCUSSION

Figure 1a shows both the $H_e\acute{H}$ Strasburger and Chojnacki (SC PEC) PEC and fitted PEC with *d*BO 6 analytical function. Figure 1b presents the Rovibrational levels for the $H_e\acute{H}$ interaction obtained using *d*Ryd6 PEC to represent the effective potential.

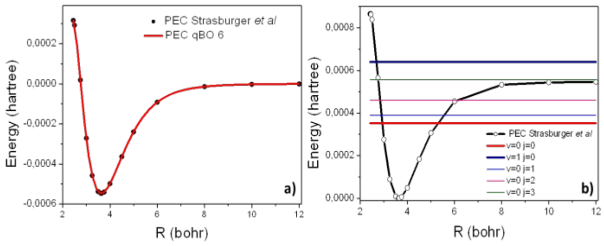

Figure 1. a) Fitted PEC using d-Bond Order as analytical form and b) Rovibrational levels obtained through the PEC described in a).

From this theoretical results, we found bounded states for $\upsilon=0$ and $J=0,1$ and 2 in agreement with Ref. 2 where for rotational quantum numbers $J\leq3$ bound states are feasible. The spectroscopic constants shows a fairly agreement independently of the analytical form employed: $\omega_e=93\,cm^{-1}$, $\omega_e x_e=23\,cm^{-1}$, $\omega_e y_e=5\,cm^{-1}$ and $B_e=5.7\,cm^{-1}$.

CONCLUSIONS

We found bounded states for $\upsilon=0$ and $J=0,1$ and 2 in agreement with Ref. 2 where for rotational quantum numbers $J\leq3$ bound states are feasible. The spectroscopic constants shows a fairly agreement independently of the analytical form employed. For the first time the spectroscopic constants for ordinary matter and antimatter interaction have been calculated and the results will provide a comparison source to further theoretical and experimental works.

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