Mercury dimer interatomic potentials for quantum-mechanics tests and photoassociation experiments in a MOT

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Overview
Recently, a precise knowledge about potential energy (PE) curves of mercury dimer (Fig. 1) has been engaged in experiments of femtosecond photoassociation spectroscopy (Fig. 2). Photoassociation of Hg, femtosecond dynamics, and quantum dynamical wave packet description of these reactions [1] as well as coherent bond formation of Hg obtained in the femtosecond time scale [2] have been reported. Furthermore, results of Hg spectroscopy are employed in fundamental experimental tests of quantum mechanics, particularly a realization of EPR gedankenexperiment and isotopic-free tests of the Bell inequalities in a regime different from those using photons [3] (Fig. 3). The description of these reactions is given in a review of the EXAFS experiment on Hg according to Refs. [1,2]. Generally, a description of these reactions [1] as well as coherent bond formation of Hg obtained in the femtosecond time scale [2] have been reported.

Improved characteristics based on rigorous analysis of the F0 (6P1) X0 (6S0) Transition (Fig. 10) provided improved D1 atomic asymptotes. They were used in the simulation of the Fano-Condor profile of the transition. A simultaneous simulation of the v’=0 and v’=1 vibrational progressions in the E1 (6P1) X0 (6S0) transition provided an improved model for the D1 atomic asymptotes (see Table 1).

References

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Fig. 1. Experimental setup for the FTIR and EPR experiments. The FTIR setup includes an Infrared spectrometer, a vacuum chamber, and a computer for data acquisition. The EPR setup includes a spectrometer, a microwave source, and a computer for data analysis. The experimental protocol is described in detail in the text.

Fig. 2. Femtosecond photoassociation spectroscopy. The data were obtained using a femtosecond laser source and a photoionization detection system. The spectrum shows the vibrational structure of the X0 (6S0) band, with vibrational quantum numbers v = 0, ±1, ±2. The isotopic shifts of the X0 (6S0) band are shown in Fig. 3.

Fig. 3. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 4.

Fig. 4. The results of the isotopic shift analysis for the D1 (6P1) X0 (6S0) Transition. The isotopic shifts are shown in Fig. 3. The isotopic shifts are shown in Fig. 3. The isotopic shifts are shown in Fig. 3.

Fig. 5. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 6. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 7. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 8. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 9. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 10. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.

Fig. 11. Isotopic-shift analysis of the D1 (6P1) X0 (6S0) Transition. The data were obtained using a spectroscopic technique and analyzed using a theoretical model. The isotopic shifts are shown in Fig. 3.