FIRST IDENTIFICATION OF A $^2\Delta$ STATE OF CaH IN THE VISIBLE REGION.

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Calcium monohydride CaH is a simple diatomic molecule found in the Sun and other stars. The A-X electronic spectrum of CaH has been a useful probe for classifying stars. This has lead to nearly a century of spectroscopic work on CaH, with the first laboratory spectrum being the $C^2\Sigma^+$ - $X^2\Sigma^+$ transition in the near-UV region reported by Mulliken.[a]

We have recently been working on this molecule in the visible and ultraviolet regions and have identified many new vibrational levels of the B/B′ state using Laser Induced Fluorescence (LIF). Our primary interest has been the detailed investigation of the B/B′ state which has a double-minimum potential energy function. Our previous LIF work was on vibrational levels in the energy regime lying above the potential energy barrier between the two wells.[b, c] We were able to confirm the strong irregularity in the vibrational energy spacings that had been predicted by the quantum chemical study of Carlsund-Levin *et al*.[d] This irregularity is due to interaction between the vibrational levels of the B/B′ and D states.

We have also investigated the energy regime which starts from just below the minimum of the higher lying outer potential well and continues to just above the potential energy barrier between the two wells. There we identified the A-X(4, 0) and B/B′-X(3 or 5, 0) bands and also new vibronic levels around 18,400-20,000 cm^{-1} which do not belong to any of the A, B, or E states. We conclude that these new levels belong to the previously unobserved lowest lying $^2\Delta$ state.

We are investigating evidence for possible interactions with other electronic states. We also outline the current status of our work and future prospects as we continue our program of delineating the vibrational levels of the B state over their full energy range: starting at the energy of the minimum of the inner well, progressing through the energy of the minimum of the outer well, the energy of the barrier, and on towards the dissociation limit.

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[a] R. S. Mulliken, *Phys. Rev.* **25**, 509 (1925).

[b] K. Watanabe, N. Yoneyama, K. Uchida, K. Kobayashi, F. Matsushima, Y. Moriwaki, S. C. Ross, *Chem. Phys. Lett.* **657**, 1 (2016).

[c] K. Watanabe, I. Tani, K. Kobayashi, Y. Moriwaki, S. C. Ross, *Chem. Phys. Lett.* **710**, 11 (2018).

[d] C. Carlsund-Levin, N. Elander, A. Nunez, A. Scrinzi, *Phys. Scripta* **65**, 306 (2002).