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Long-lived states of molecular hydrogen anion.

Jiří Horáček,[1] Martin Čížek,[1]

[1] *Institute of Theoretical Physics, Charles University in Prague, Czech Republic*

horacek@mbox.troja.mff.cuni.cz

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The hydrogen molecule is the most abundant and most important molecule in the Universe. In its neutral form it is well understood but the structure of the molecular anion H_2^- is much less known. According to most theoretical estimates the molecular hydrogen anion is highly unstable with the very short lifetime of the order of 10^{-15} s. The lowest hydrogen anion $^2\Sigma_u^+$ state is well known both from theoretical as well as experimental studies. Some experiments however claim to observe a long-lived metastable states of the hydrogen anion with the lifetime of the order of microseconds [1, 2] exceeding by many orders the theoretical lifetime. A more recent and elaborated experiment [3] failed however to see any hydrogen anions with the lifetime longer than 10^{-11} s. This conundrum was unambiguously solved recently by the use of the accelerator mass spectrometry [4] and the existence of metastable states with the lifetimes of microseconds was confirmed. Later the hydrogen anions were observed in high resolution mass analysis [5] and their lifetime measured [6]. The nature of the metastable states will be explained and discussed in terms of the nonlocal resonance model [4, 7]. The necessary prerequisite for these states to exist is the high rotational excitation of the hydrogen molecule.

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