State preparation for rovibrational transition frequency measurement of HD^+

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The rovibrational transition frequency of HD^+ molecular ions can be used to determine the fundamental physical constants (such as mp/me), test the quantum electrodynamics (QED) of three-body systems and search for new physics beyond the Standard Model [1-2]. Internal state preparation of the HD^+ ions plays a vital role for improving signal-to-noise ratio in the rovibrational spectroscopic measurement. Here, we report a method for producing ultracold HD^+ molecular ions populated in a rotational ground state in an ion trap [3]. The state-selected HD^+ ions are generated via [2+1'] resonance-enhanced threshold photoionization (RETPI) and subsequently sympathetic cooling by the laser-cooled Be^+ ions. The effect of electric field of the ion trap on the RETPI process of neutral HD molecules and the blackbody radiation (BBR) on the population evolution of rotational states of the generated polar HD^+ ions have been studied. This method of generating ultracold state-selected HD^+ ions is beneficial for the studies in the precision rovibrational spectroscopy, state-controlled cold chemical reaction, and quantum logic spectroscopy.

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