

Sympathetic Cooling of Antiprotons with Molecular Anions

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Abstract : Molecular anions play a central role in a wide range of fields: from atmospheric and interstellar science, anionic superhalogens to the chemistry of highly correlated systems. However, up to now the synthesis of negative ions in a controlled manner at ultracold temperatures, relevant for the processes in which they are involved, is currently limited to a few Kelvin by supersonic beam expansion followed by resistive, buffer gas or electron cooling in cryogenic environments. We present a realistic scheme for laser cooling of C²⁻ molecules to sub-Kelvin temperatures, which has so far only been achieved for a few neutral diatomic molecules. The generation of a pulsed source of C²⁻ and subsequent laser cooling techniques of C²⁻ molecules confined in a Penning trap are reviewed. Further, laser cooling of one anionic species would allow to sympathetically cool other molecular anions, electrons and antiprotons that are confined in the same trapping potential. In this presentation the status of the experiment and the feasibility of C²⁻ sympathetic Doppler laser cooling, photo-detachment cooling and AC-Stark Sisyphus cooling will be reviewed.

Keywords : antiprotons, anions, cooling of ions and molecules, Doppler cooling, photo-detachment, penning trap, Sisyphus cooling, sympathetic cooling

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