

## Radiative Cooling of Polyne Anions: $C_4H^-$ and $C_6H^-$

Boxing Zhu<sup>1</sup>, James N. Bull<sup>2</sup>, José Navarro Navarrete<sup>1</sup>, Alice Schmidt-May<sup>1</sup>, Henrik Cederquist<sup>1</sup>, Henning T. Schmidt<sup>1</sup>, Henning Zettergren<sup>1</sup>, and Mark H. Stockett<sup>1</sup>

<sup>1</sup> Department of Physics, Stockholm University, SE-10691 Stockholm, Sweden

<sup>2</sup> School of Chemistry, Norwich Research Park, University of East Anglia, Norwich NR4 7TJ, United Kingdom

Contact email: [zhu.boxing@fysik.su.se](mailto:zhu.boxing@fysik.su.se)

The time-dependent photodetachment action spectra of the linear hydrocarbon anions  $C_4H^-$  and  $C_6H^-$  are investigated using the cryogenic electrostatic ion storage ring DESIREE. Radiative cooling characteristics of the ions on the millisecond to second timescale are probed by monitoring changes in the spectra as the ions cool by spontaneous infrared (IR) emission. A simple harmonic cascade (SHC) model is used to model the cooling processes. The cooling rates, extracted using Non-negative Matrix Factorization (NMF), are fit with  $1/e$  lifetimes of  $19 \pm 2$  s and  $3.0 \pm 0.2$  s for  $C_4H^-$  and  $C_6H^-$ , respectively. For  $C_4H^-$ , the adiabatic detachment energy is determined from the cold ions' photodetachment spectra to be  $3.45 \pm 0.02$  eV. The photodetachment spectrum and the ultraslow radiative cooling dynamics interpreted in the present work provide important data for understanding the thermal cooling properties of linear hydrocarbon anions and for refining the formation and destruction processes of these anions in astrochemical models.

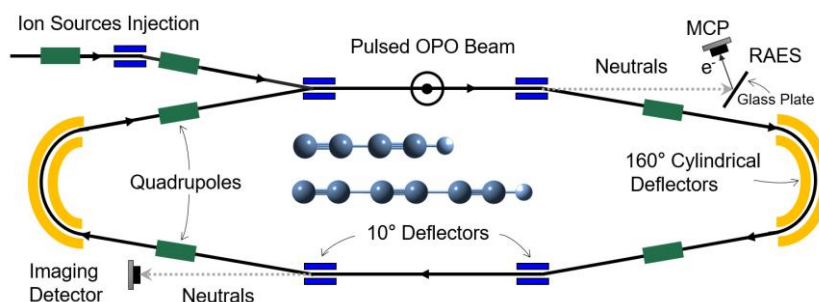


FIG. 1: Schematic drawing of the DESIREE ion storage ring. The OPO laser beam interacts perpendicularly with the ion beam on the RAES detector side. Neutral products formed through photodetachment along the straight section are detected by the microchannel plate (MCP) detector.

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