# SPECTROSCOPY OF ANTHRACENE IN HELIUM NANODROPLETS

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Absorption bands of anthracene cations ($An^+$) and hydrogenated An cations ($AnH^+$) have been measured in an ultracold weakly inter-acting helium (He) environment by means of mass spectrometry. Shifts of absorption band positions as a function of the number of attached messenger atoms or molecules can be deduced.

## 1. Introduction

Polycyclic aromatic hydrocarbons (PAHs) are promising candidates for being carriers of diffuse interstellar bands (DIBs) [1]. So far, more than 500 DIBs have been observed of which only five could unambiguously be assigned to $C_{60}^+$ [3]. Measuring absorption profiles of PAHs under astrophysically relevant conditions is therefore of great interest.

In this study $An^+$ and protonated An molecules ($AnH^+$) were isolated in ultracold helium nanodroplets (HNDs). In order to release the species of interest from the HNDs and make them accessible for mass spectrometry, the droplets were collided with a stainless steel surface. $An^+$ and $AnH^+$ ions with up to some tens of He atoms, respectively $H_2$ molecules as messenger species attached, were measured in a time-of-flight (TOF) mass spectrometer. Probing $AnHe_n^+$, respectively $AnH(H_2)_m^+$, with a pulsed tunable laser, absorption spectra were obtained by recording a decrease in the ion yield at certain masses (figures 1 and 2). This decrease is caused by He atoms or $H_2$ molecules boiling off after excitation with a laser photon.

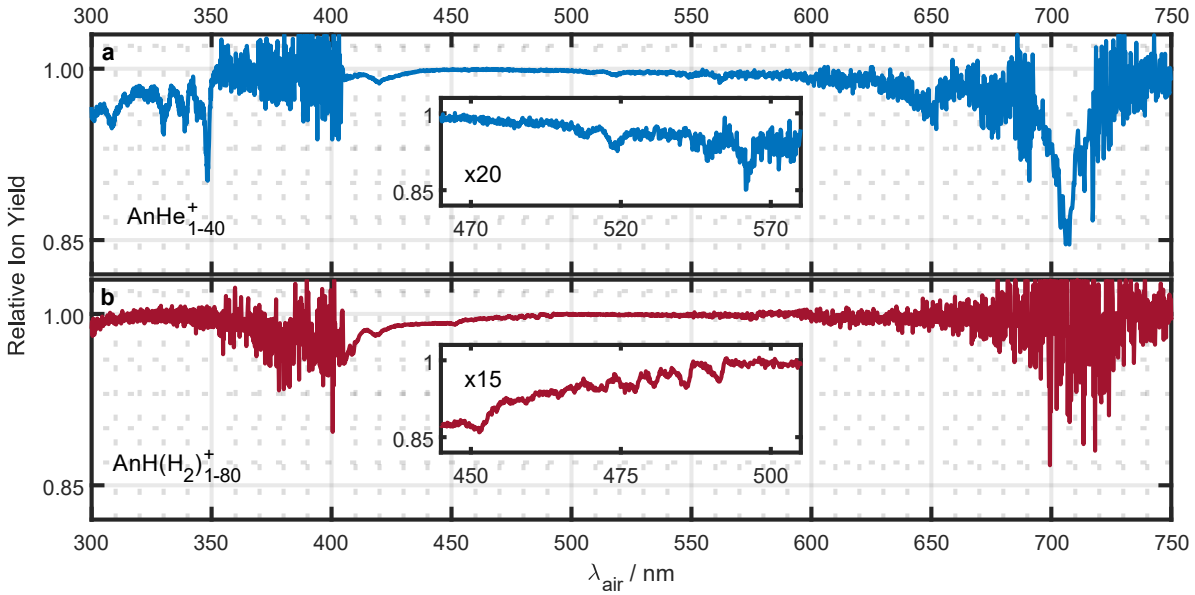


Fig. 1. Absorption spectra of $He_n$ (a) and $(H_2)_m$ (b) tagged $An^+$ and $AnH^+$. The decrease of 40 (top), respectively 80 (bottom) mass channels was combined for a better signal-to-noise ratio, which, however, amounts to an increased width of the absorption bands.

## 2. Results

Several absorption bands were observed for He and $H_2$ tagged $An^+$ and $AnH^+$ (figure 1), which correspond well with previous measurements of $An^+$ in argon matrices [4] and $AnH^+$ in the gas phase

[5]. A shift of the absorption band position is expected from tagging species with messenger atoms or molecules [6]. This shift is small when the messenger is He or $H_2$ and can be deduced from our absorption spectra, as can be seen in figure 2.

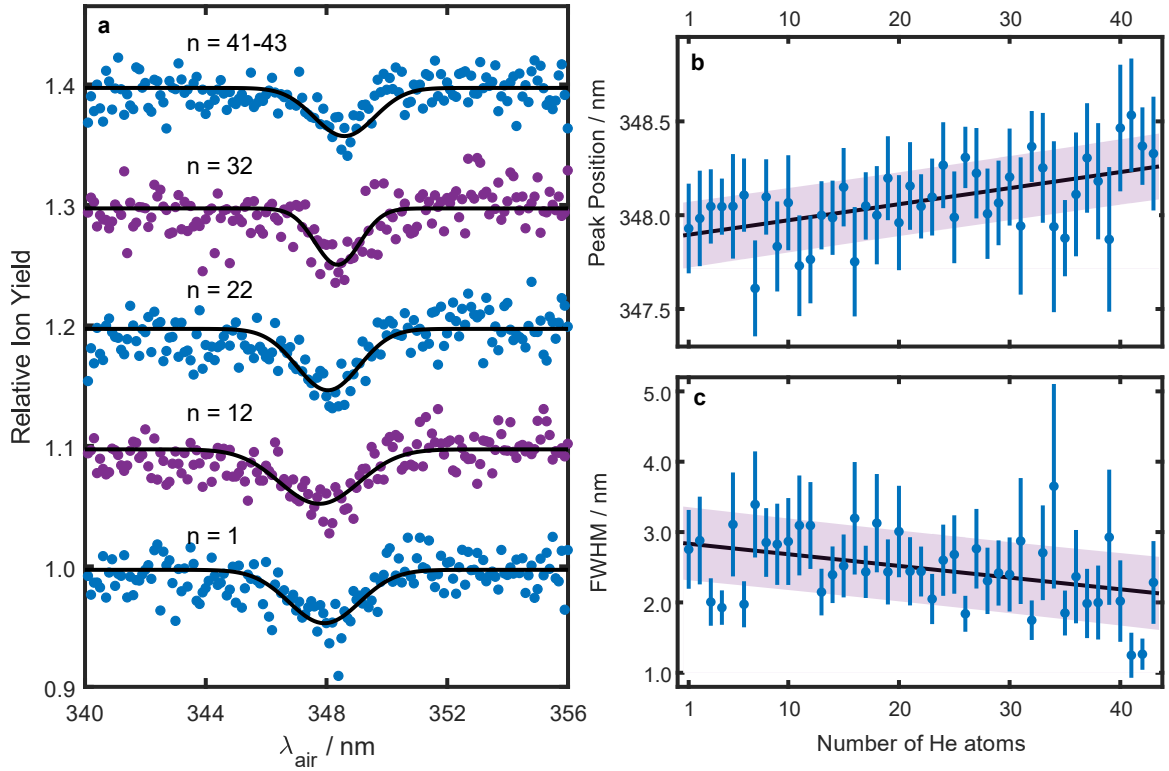


Fig. 2. Peak shift of the absorption band of $An^+$ at 348 nm as a function of the number of attached He atoms. (a) Band positions were determined by fitting gaussians to the decrease of the $AnHe_n^+$ signal. A selection of the relative ion yields at different mass channels with fitted curves is shown in (a). (b) The absorption band position shifts linearly up to about 40 attached He atoms, with about 0.01 nm/He atom. (c) The FWHM of the absorption band decreases linearly with an increasing number of attached He atoms.

## 3. References


[1] Salama, F., Galazutdinov, G. A., Krełowski, J., Allamandola, L. J., & Musaev, F. A. 1999 *The Astrophysical Journal*, *526*(1), 265.

[2] Fan, H., Hobbs, L. M., Dahlstrom, J. A., Welty, D. E., York, D. G., Rachford, B., ... & Zhao, G. 2019 *The Astrophysical Journal*, *878*(2), 151.

[3] Linnartz, H., Cami, J., Cordiner, M., Cox, N. L. J., Ehrenfreund, P., Foing, B., ... & Scheier, P. 2020 *Journal of Molecular Spectroscopy*, *367*, 111243.

[4] Szczepanski, J., Vala, M., Talbi, D., Parisel, O., & Ellinger, Y. 1993 *The Journal of chemical physics*, *98*(6), 4494-4511.

[5] Alata, I., Dedonder, C., Broquier, M., Marceca, E., & Jouvet, C. 2010 *Journal of the American Chemical Society*, *132*(49), 17483-17489.

[6] Holz, M., Campbell, E. K., Rice, C. A., & Maier, J. P. 2017 *Journal of Molecular Spectroscopy*, *332*, 22-25.