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Electronic spectroscopy of neutral and ionized PAHs in inert gas matrices

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Outline

- ① **Introduction: Astrophysical background and experimental techniques**
- ② **Absorption spectra of PAH mixtures**
- ③ **Absorption spectra of ionized PAHs**

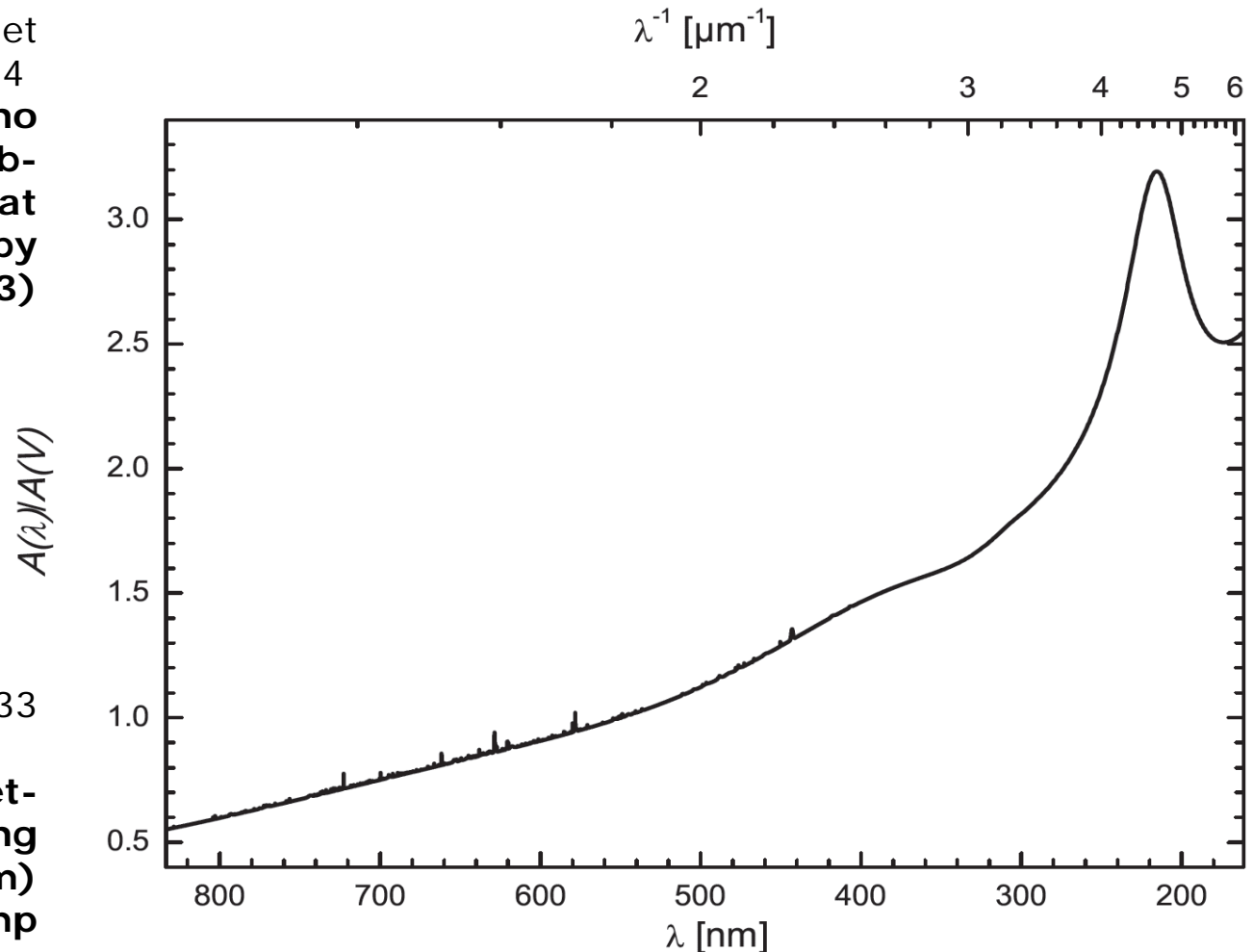
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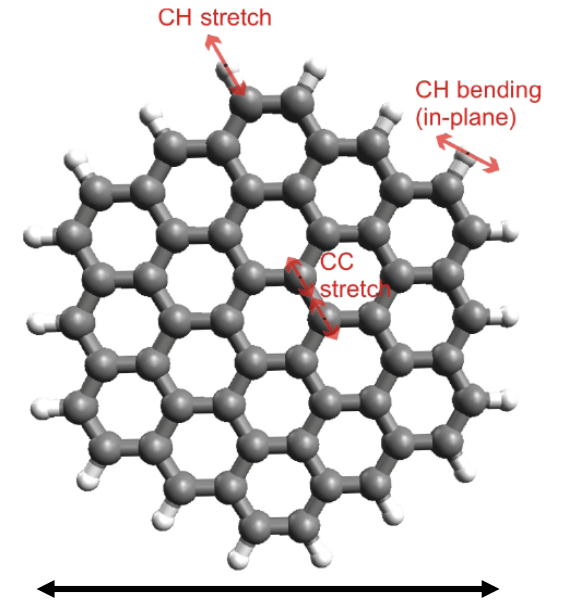
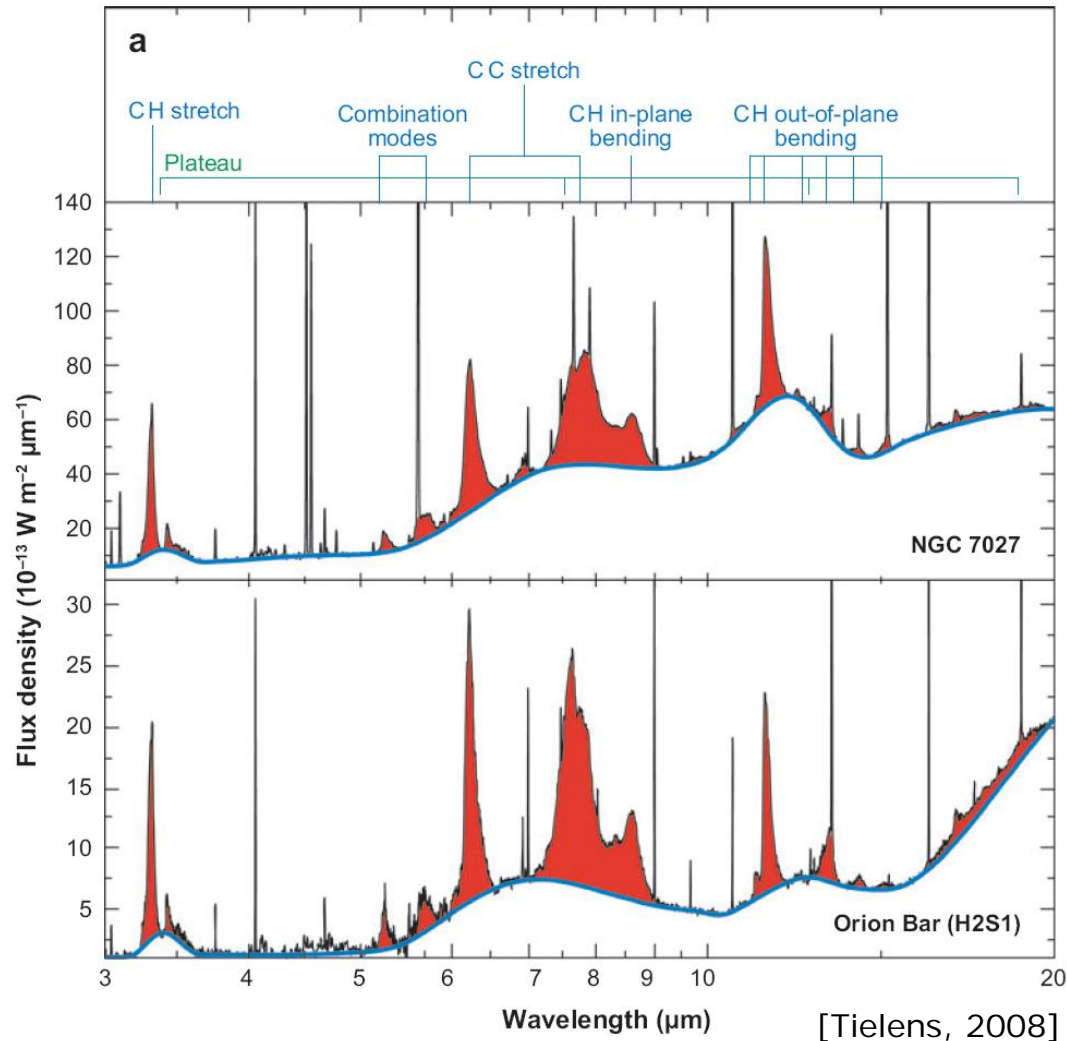
Interstellar extinction curve: DIBs & UV bump

- Gredel et al., A&A 530 (2011) A26; Salama et al., ApJ 728 (2011) 154
→ for $\lambda < 400$ nm, no narrow DIB-like absorption bands that could be caused by polyatomic ($N > 3$) molecules

- Xiang et al., ApJ 733 (2011) 91
→ no correlation between nine strong DIBs (570 - 638 nm) and the UV bump (217.5 nm)

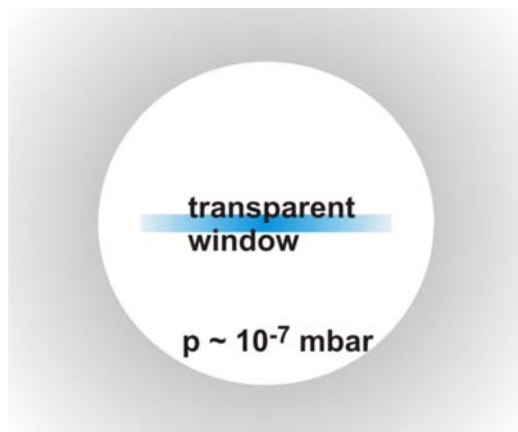


Aromatic IR emission bands

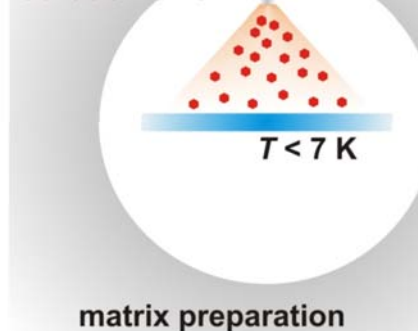


~ 1 nm; ca. 20 hexagons;
ca. 50 C and 20 H atoms

Absorption spectra via matrix isolation spectroscopy



gas flow 2 – 8 ml min⁻¹
duration 0.25 – 4 h

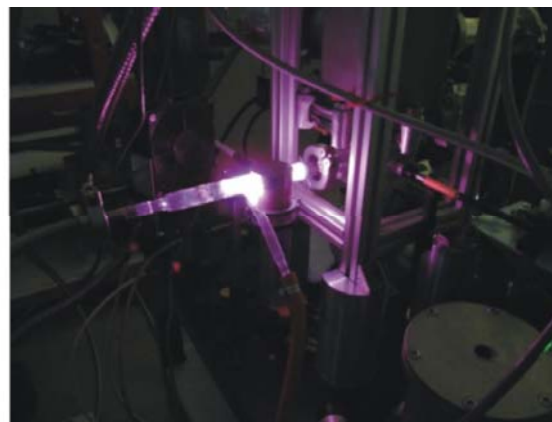
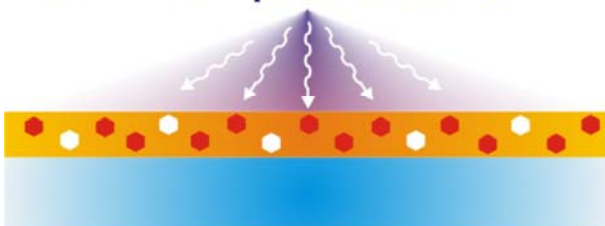


$$N_{\text{Ne}} \times N_{\text{molecule}}^{-1} \approx 300 - 30'000$$

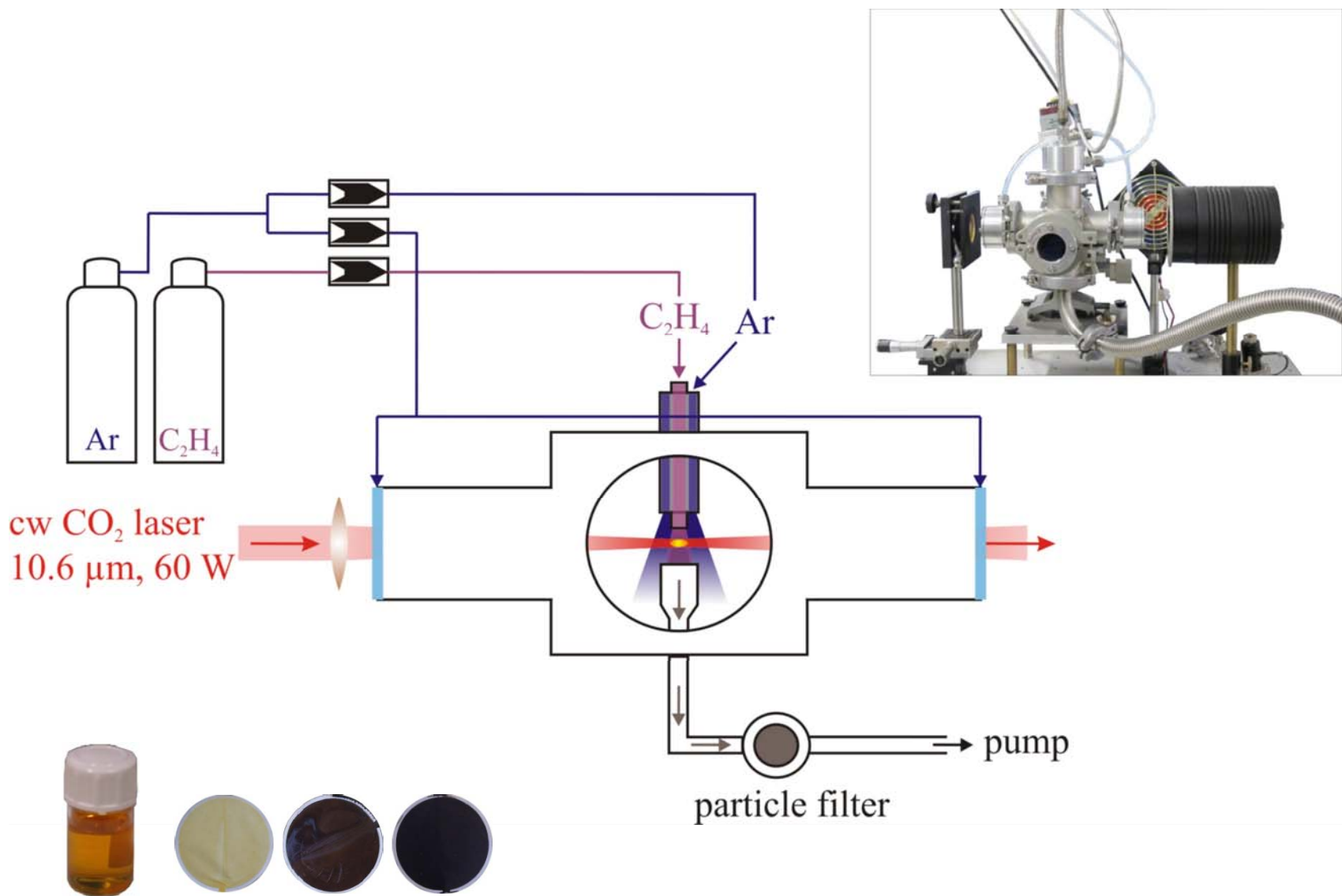


matrix preparation

10.2 – 11.8 eV (122 – 105 nm)
 $10^{15} - 10^{16}$ photons m⁻² s⁻¹



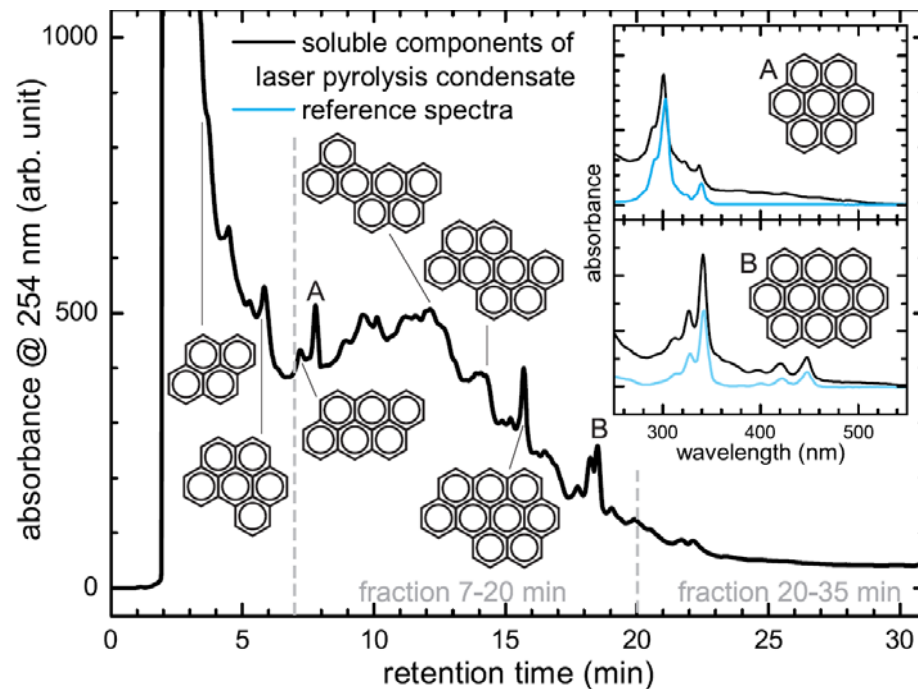
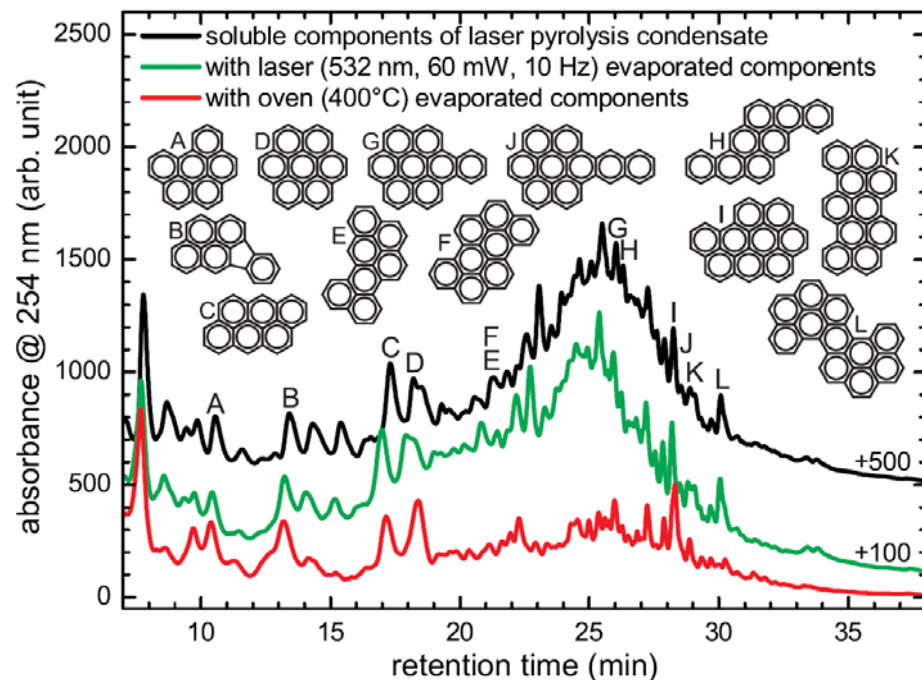
PAH synthesis via laser pyrolysis



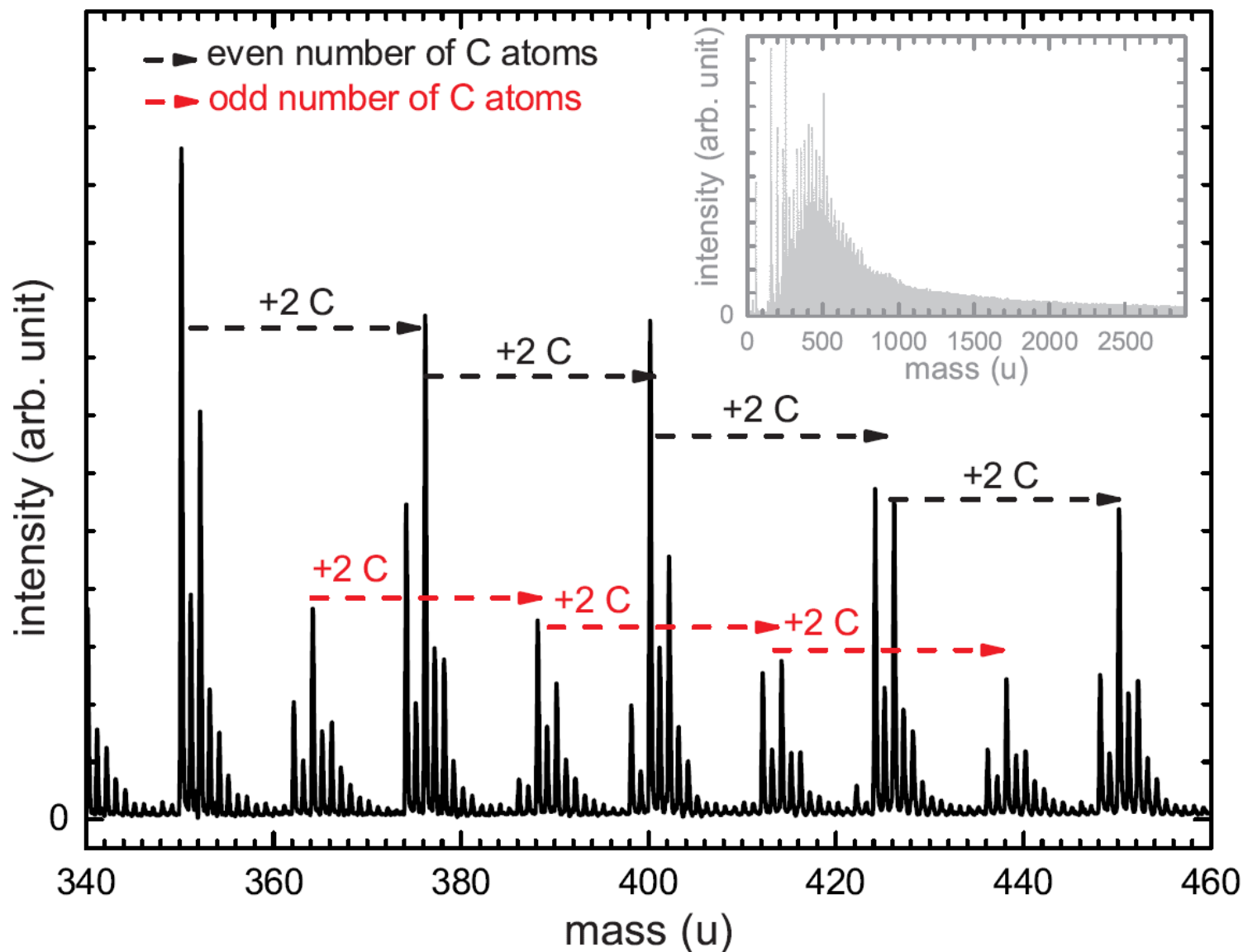
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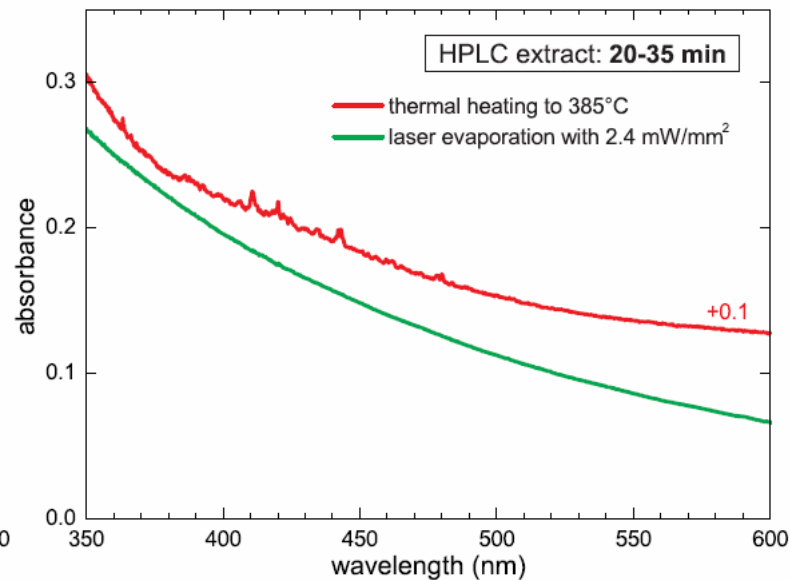
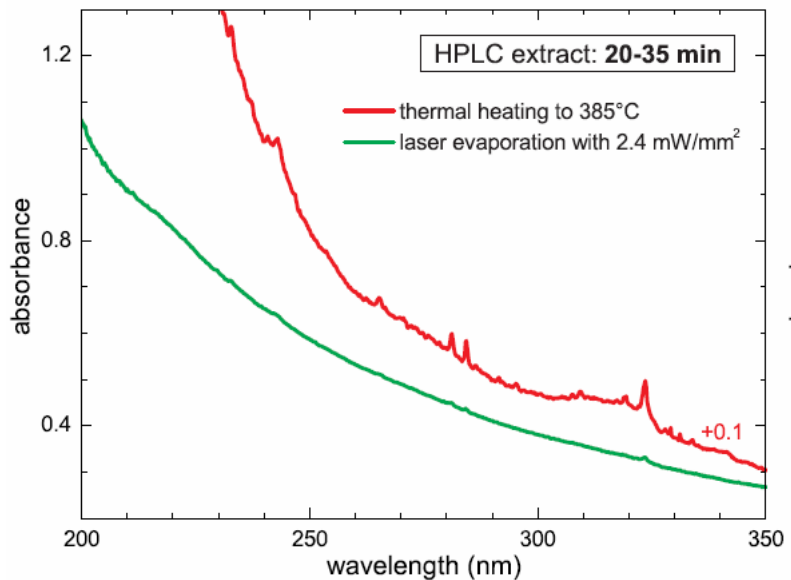
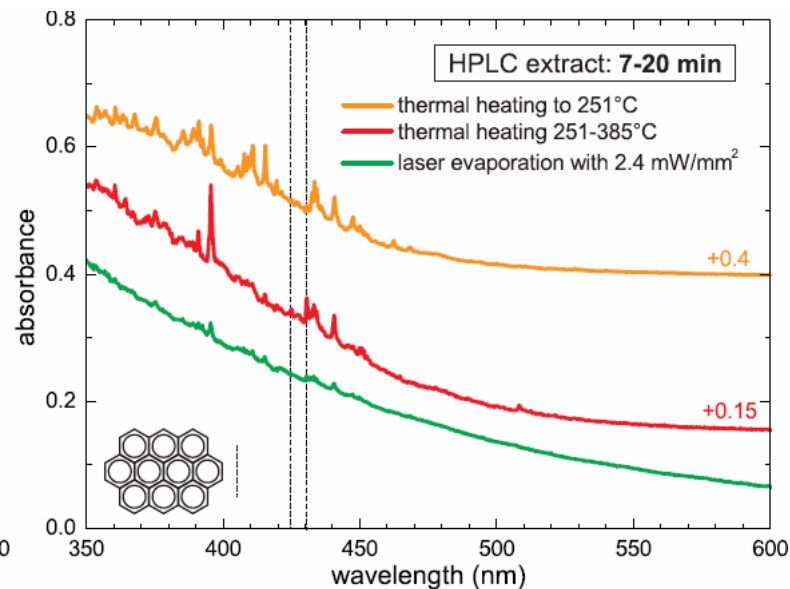
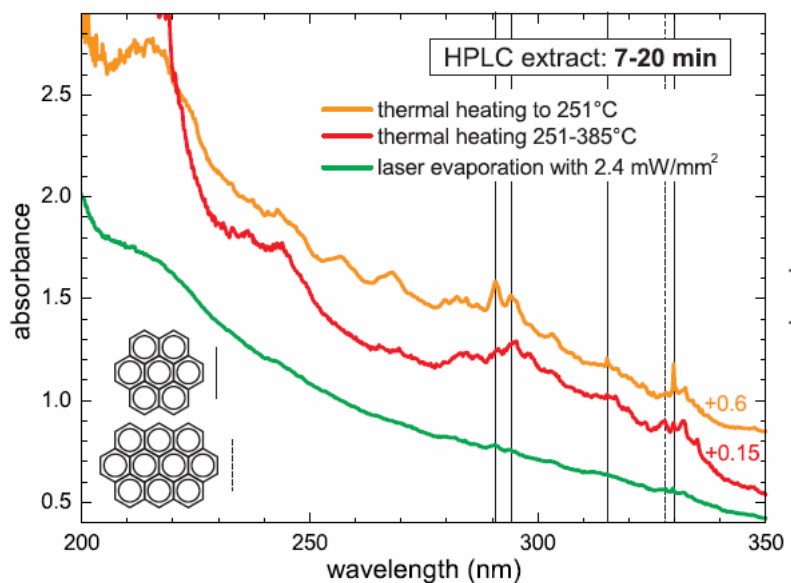
HPLC analysis of soluble condensate



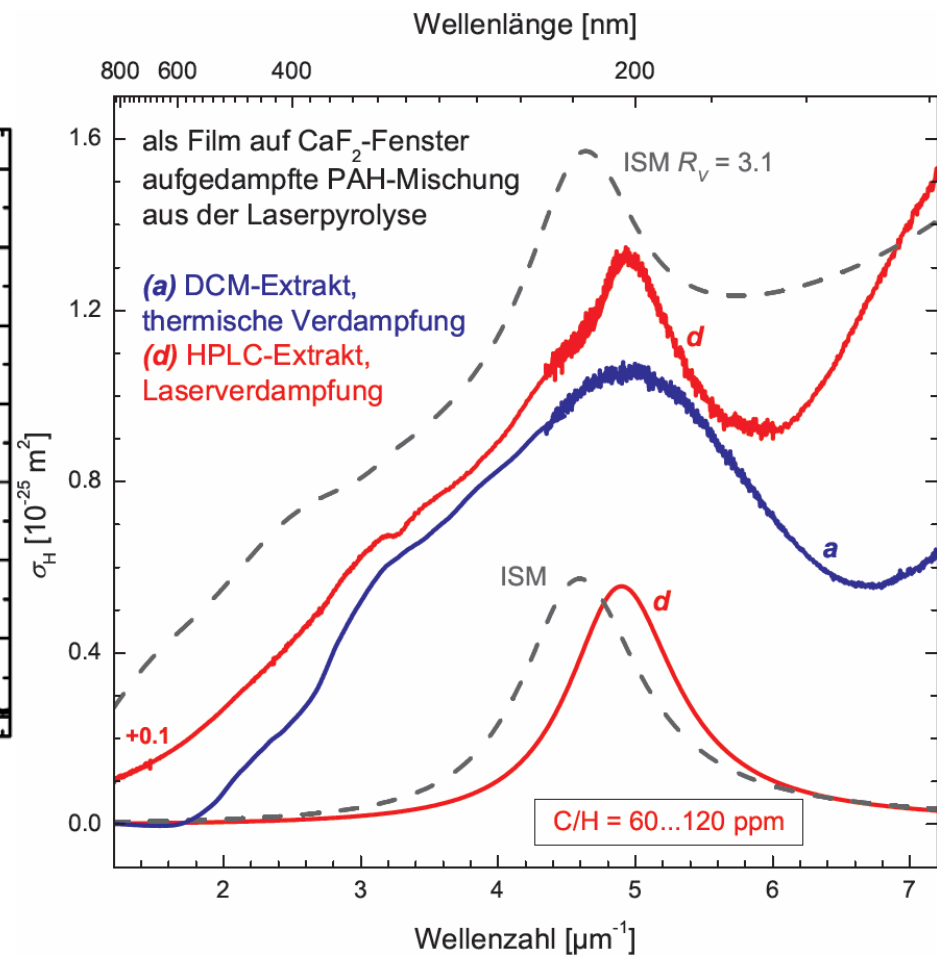
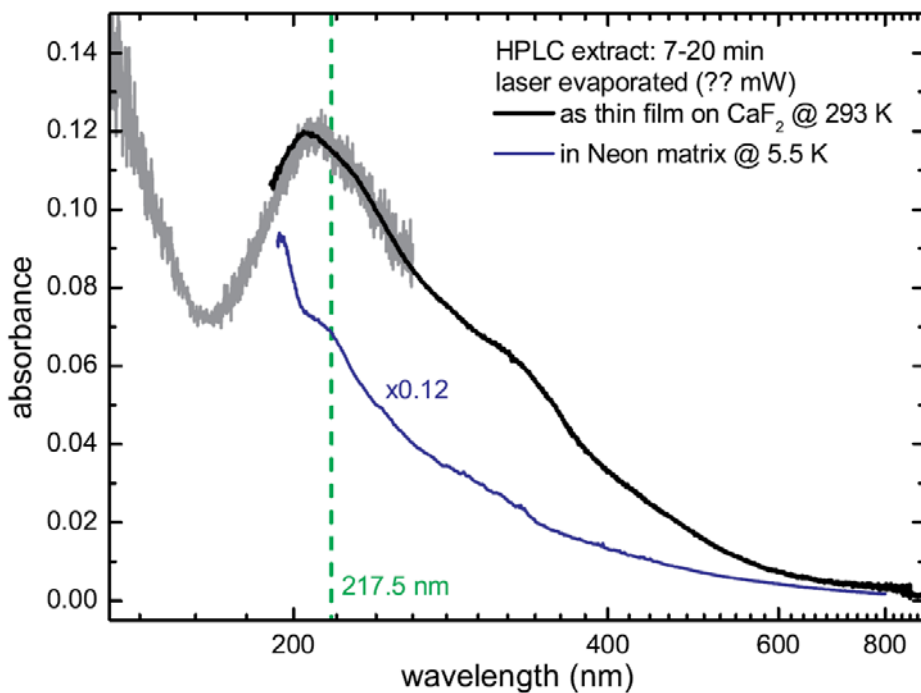
MALDI-TOF measurements of laser pyrolysis condensate



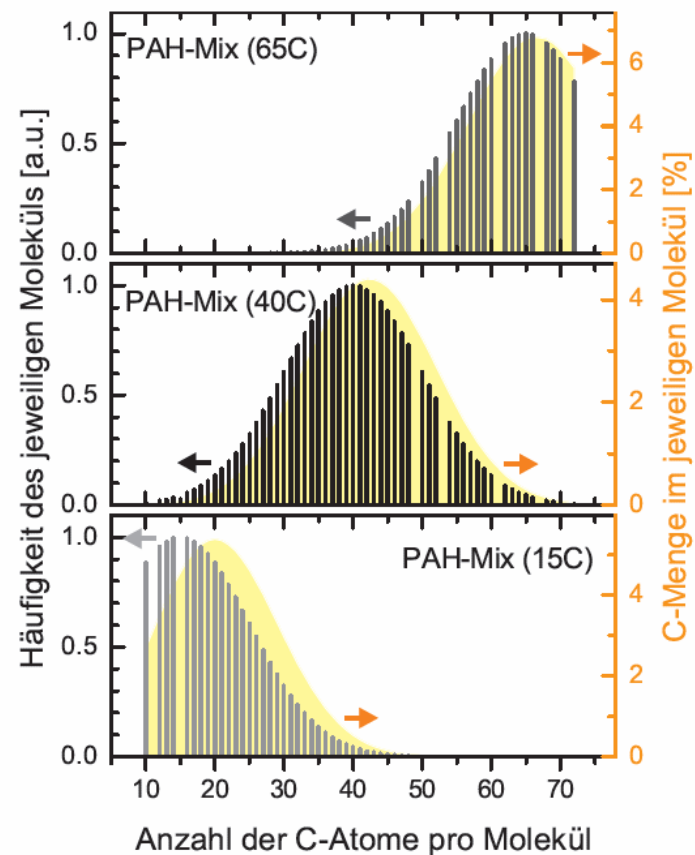
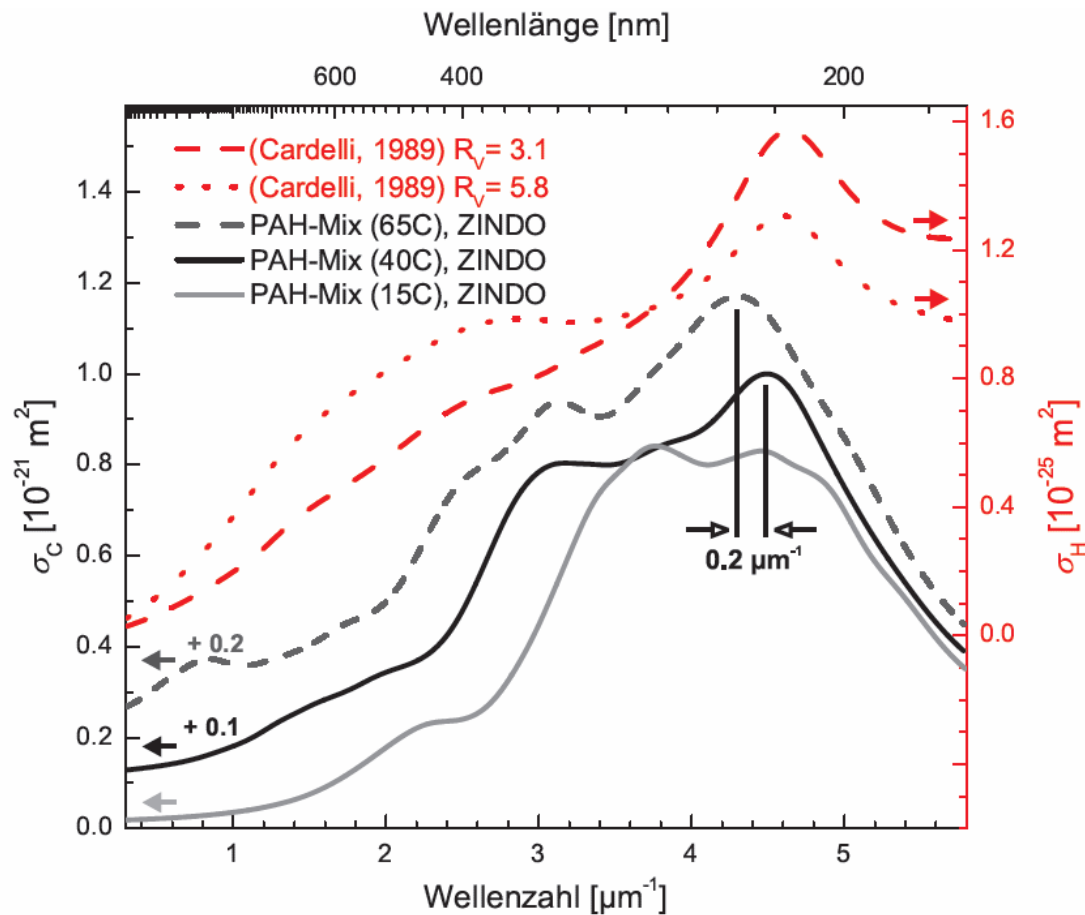
Absorption spectra of different PAH mixtures in Ne @ 6 K



Absorption spectra of PAH mixtures as thin solid film



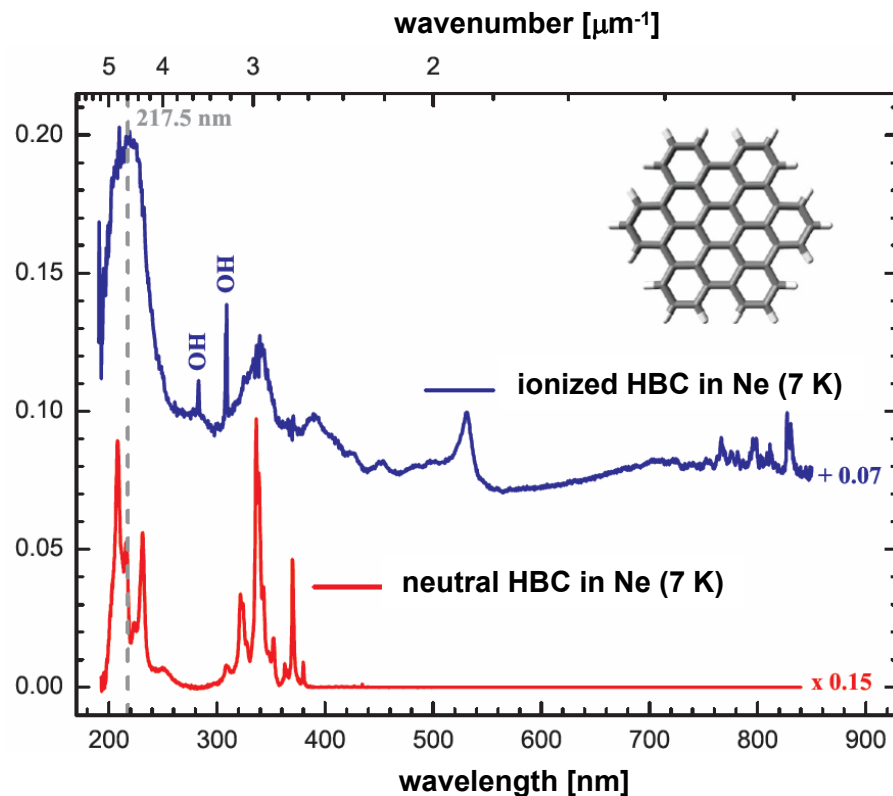
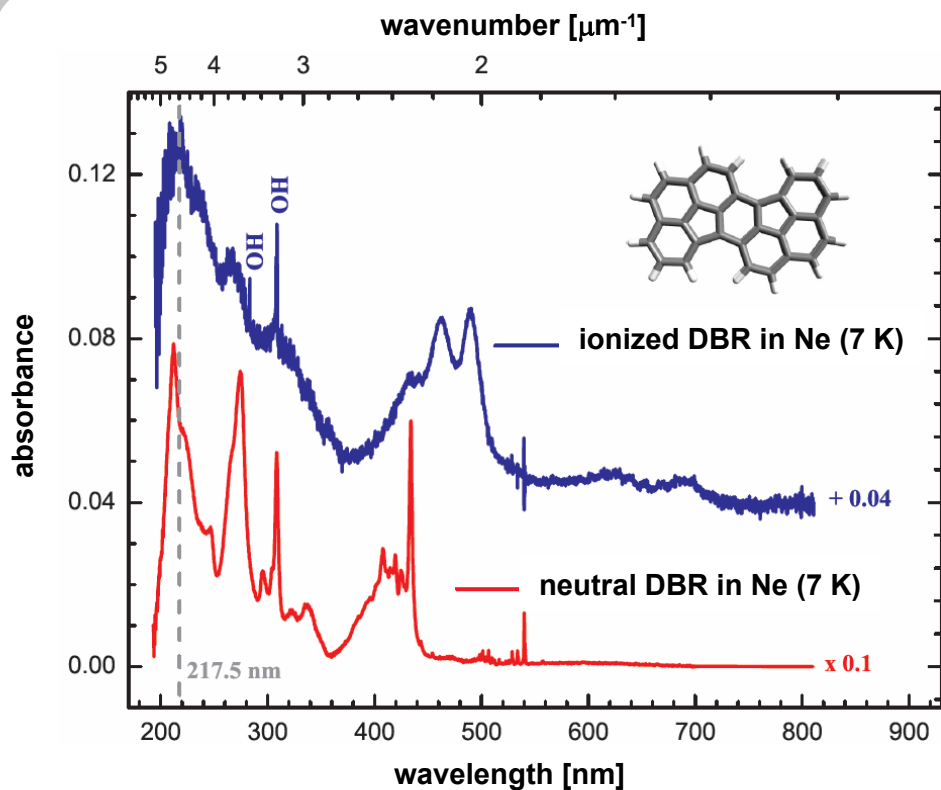
Semi-empirically calculated absorption spectra of PAH mixtures



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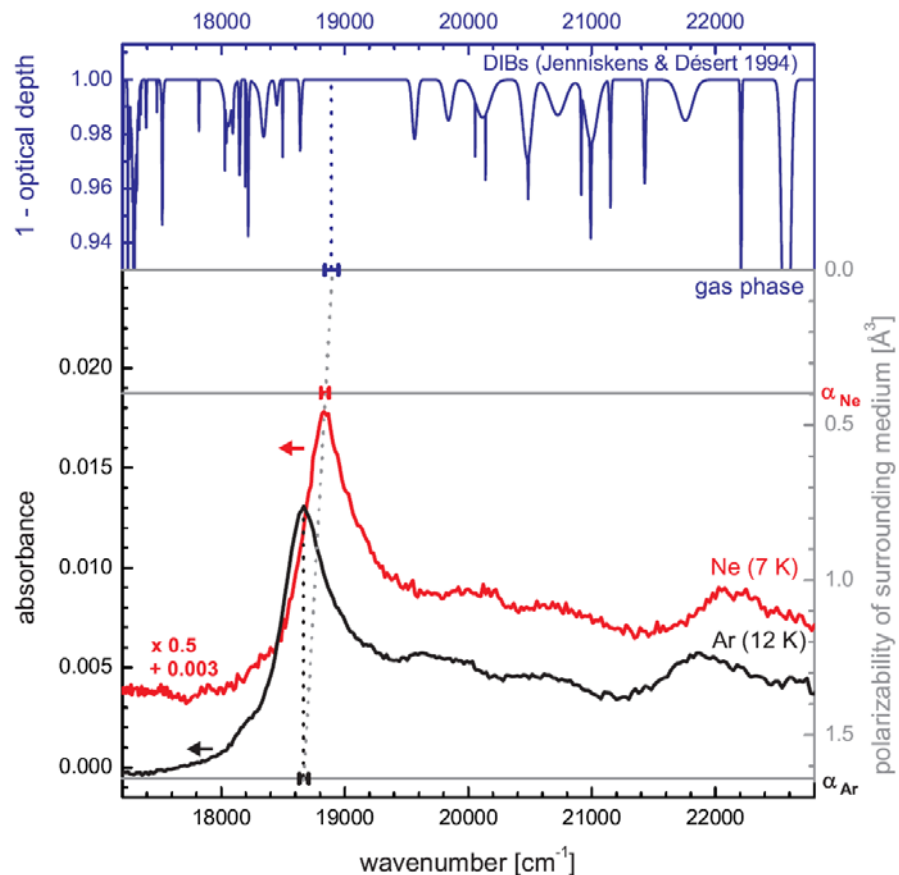
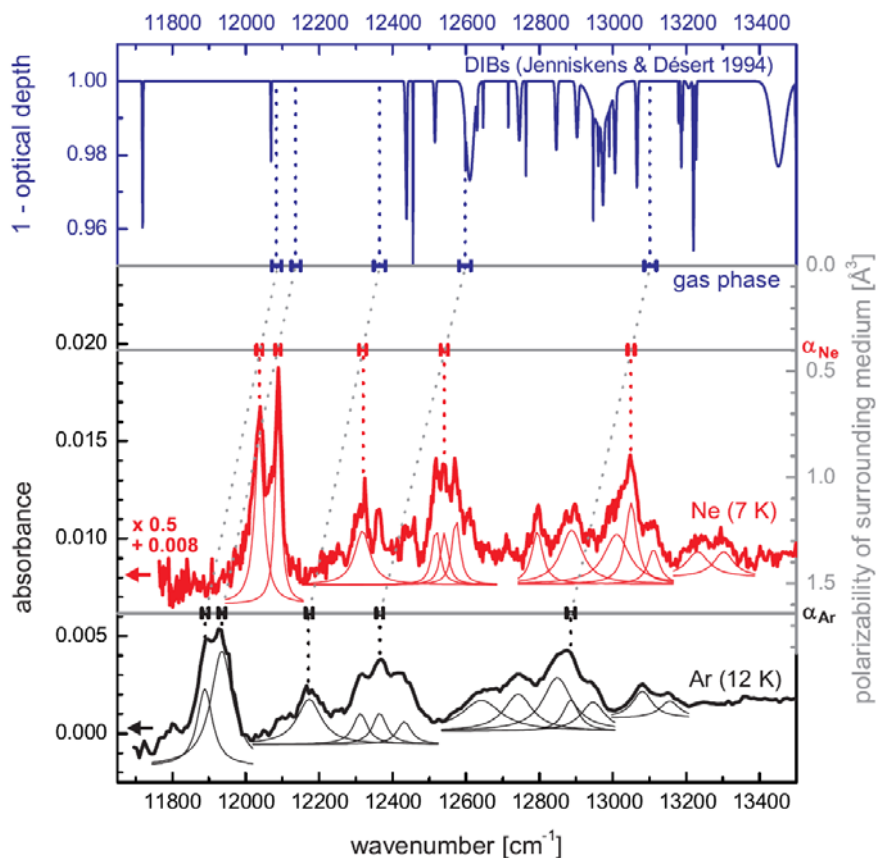
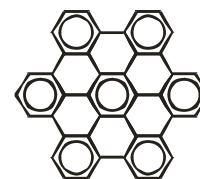
Comparison of specific PAHs in neutral and ionized form



Ionized HBC ($C_{42}H_{18}$) and the DIBs

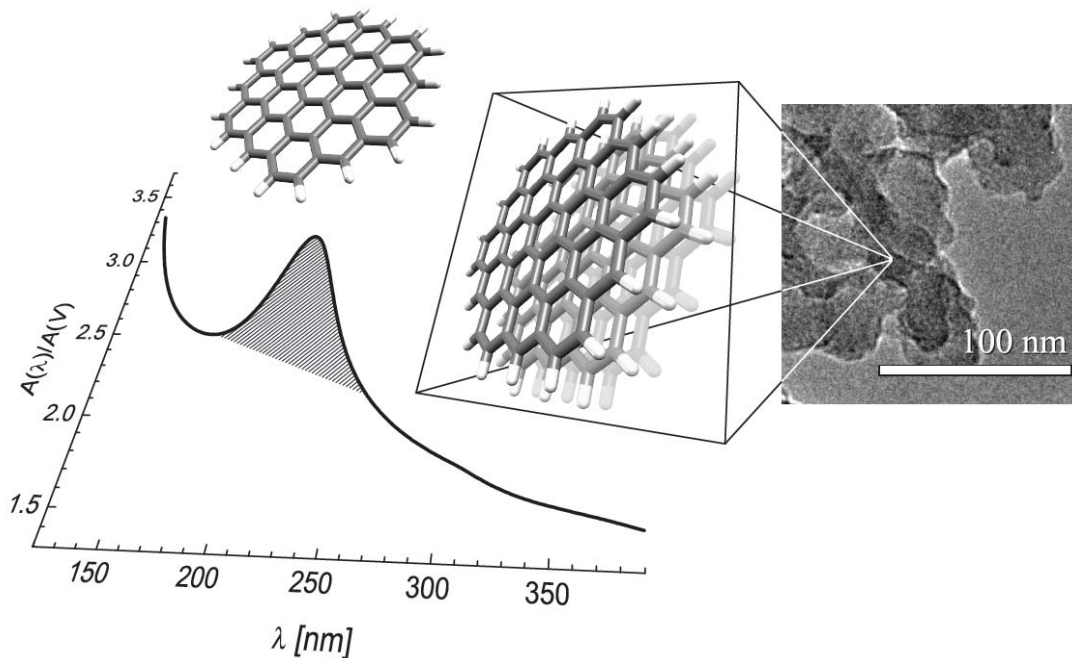
- “all-benzenoid” PAH HBC → high stability (higher abundance than other similarly-sized PAHs?)

[T. P. Troy & T. W. Schmidt, MNRAS 371 (2006) L41]



Summary

- The interstellar UV bump can arise from π - π^* resonances of small aromatic islands (~ 50 C atoms) as they are present, e.g., in the PAHs that are responsible for the aromatic IR emission bands.



- No absorption band specific for a certain PAH (measured so far) has been detected in the ISM. “Normal” PAHs are probably not responsible for the DIBs.

Papers related to this talk

- M. Steglich, C. Jäger, G. Rouillé, F. Huisken, H. Mutschke, Th. Henning, ApJ **712** (2010) L16
“Electronic spectroscopy of medium-sized polycyclic aromatic hydrocarbons: Implications for the carriers of the 2175 Å UV bump”
(arXiv: 1002.3529)
- R. Gredel, Y. Carpentier, G. Rouillé, M. Steglich, F. Huisken, Th. Henning, A&A **530** (2011) A26
“Abundances of PAHs in the ISM: Confronting observations with experimental results”
(arXiv: 1102.3775)
- M. Steglich, J. Bouwman, F. Huisken, Th. Henning, ApJ **742** (2011) 2
“Can neutral and ionized polycyclic aromatic hydrocarbons be carriers of the ultraviolet extinction bump and the diffuse interstellar bands?”
(arXiv: 1108.2972)
- M. Steglich, Y. Carpentier, C. Jäger, F. Huisken, Th. Henning, *in preparation for A&A*
“On the smoothness of the interstellar extinction curve in the UV: Comparison with recent laboratory measurements of PAH mixtures”

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