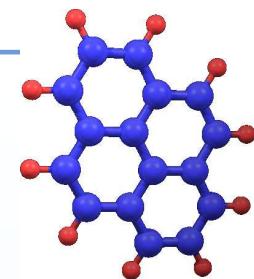


*Discovery of Blue Luminescence in the Red Rectangle:
Possible Fluorescence by Neutral Polycyclic
Hydrocarbon Molecules*

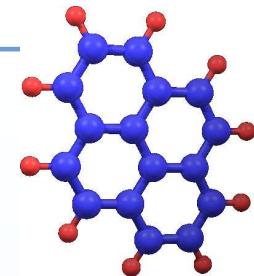
Uma P. Vijh¹, Adolf N. Witt¹ & Karl D. Gordon²

¹University of Toledo and ²University of Arizona



Outline

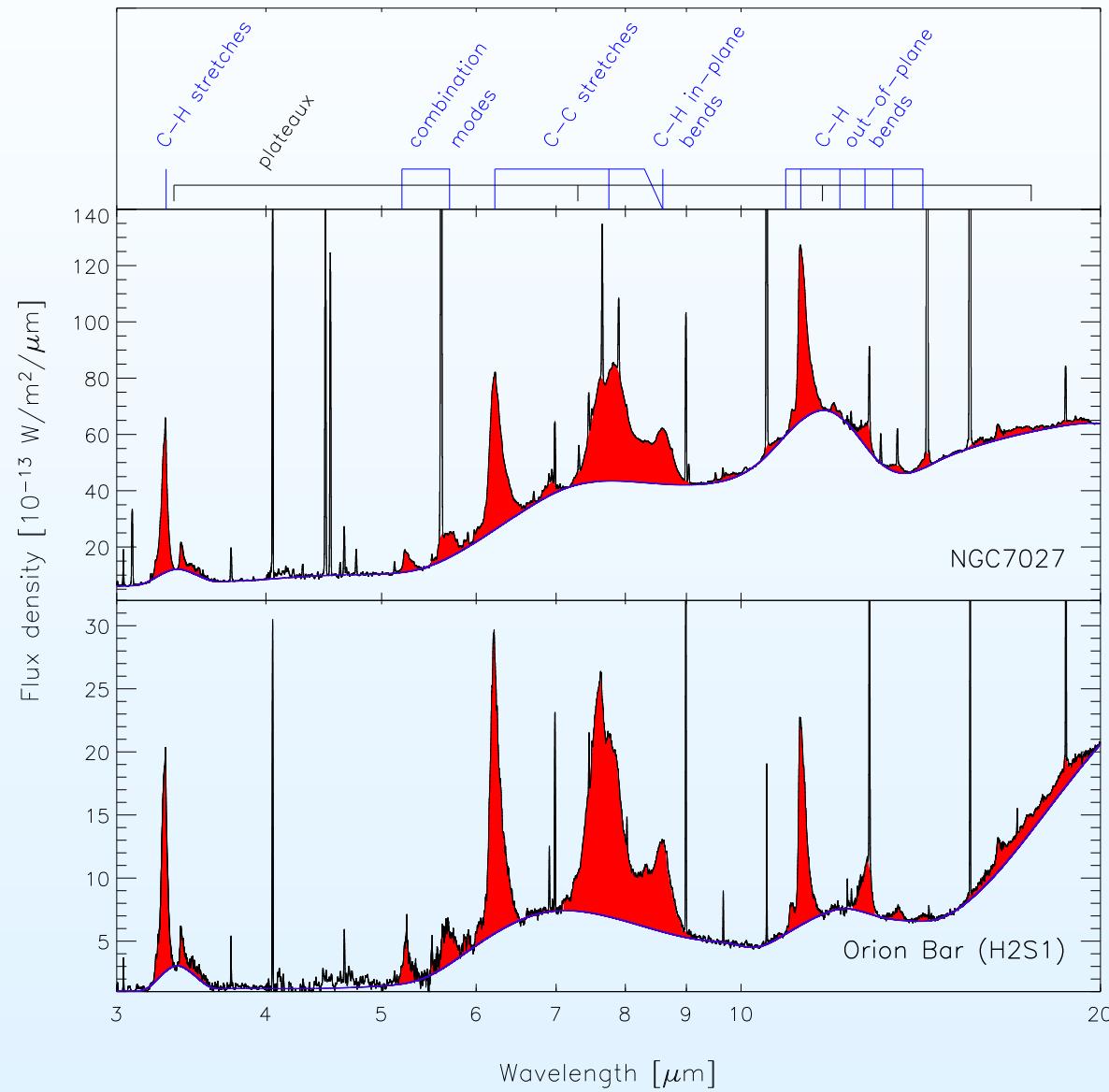
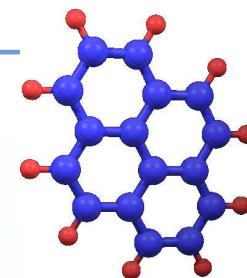
- Introduction
- Observations
- Detection of Fluorescence
- Identification of the Luminescence carrier: PAHs ?
- Conclusions

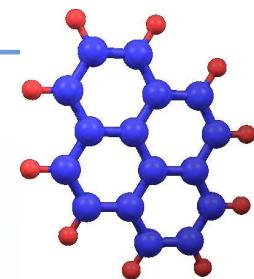


Introduction

- Polycyclic Aromatic Hydrocarbons (PAH) molecules are thought to be widely present in many interstellar and circumstellar environments in our Galaxy as well as in other galaxies.
- They are considered the likely carriers of the unidentified infra-red (UIR) band emission. fig
- No specific PAH molecule has yet been identified, as the set of mid-infra-red emission features attributed to these molecules between the wavelengths of $3.3 \mu\text{m}$ and $16.4 \mu\text{m}$ is largely insensitive to molecular sizes.

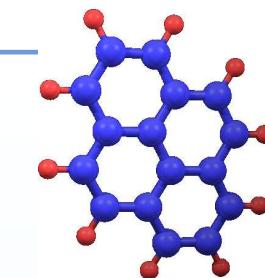
UIR Bands



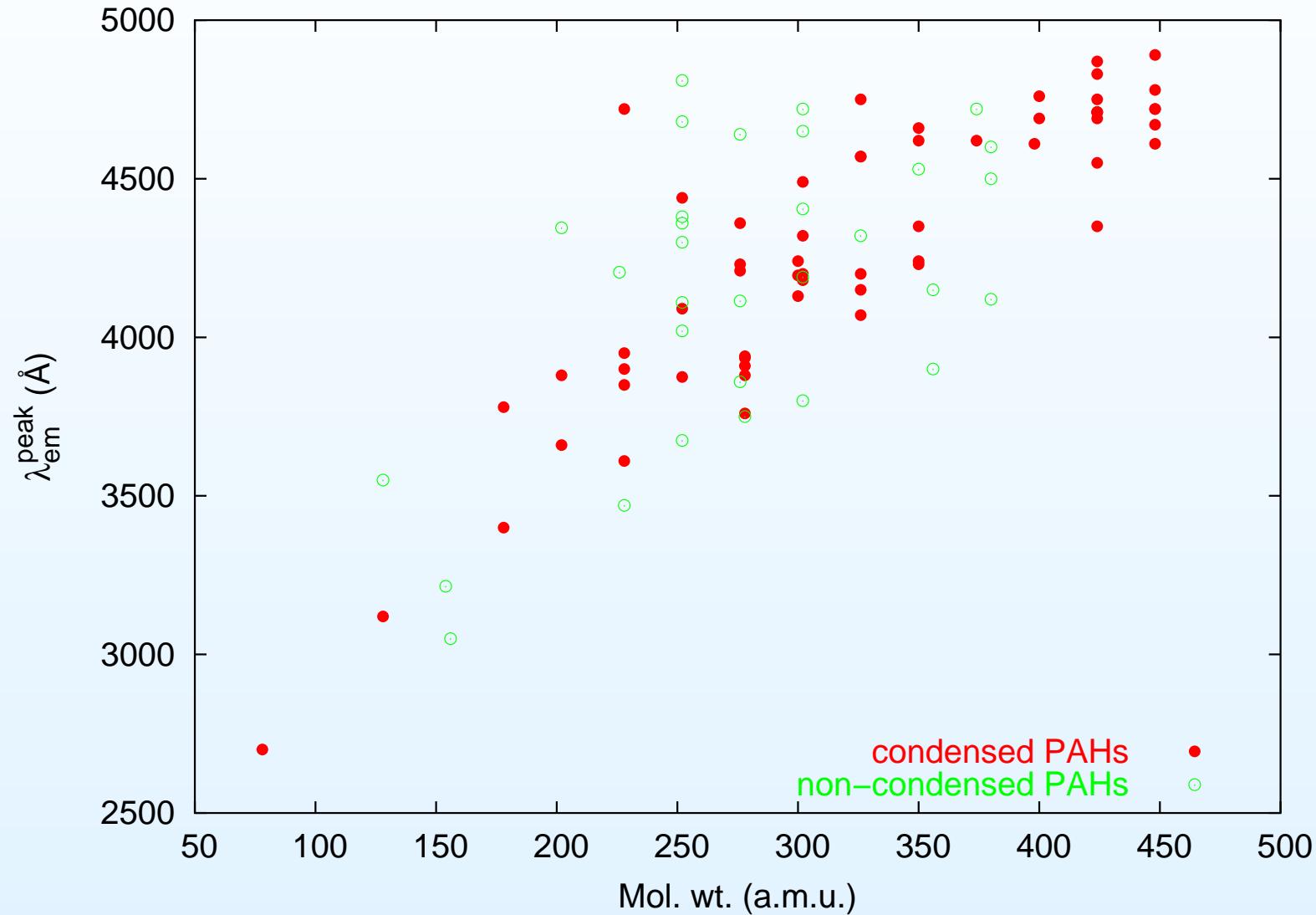


Introduction

- Near-UV/blue fluorescence of PAHs resulting from electronic downward transitions is highly size- and species-specific. [fig](#)
- Discovery of near-UV/blue luminescence in the Red Rectangle nebula, which we interpret as fluorescence from small, neutral PAH molecules with 3 - 4 aromatic rings such as anthracene ($C_{14}H_{10}$) and pyrene ($C_{16}H_{10}$).
- These are the largest molecules so far to be identified in the interstellar medium.

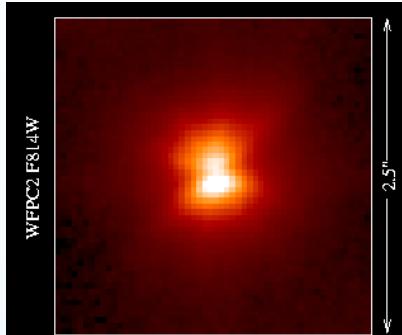
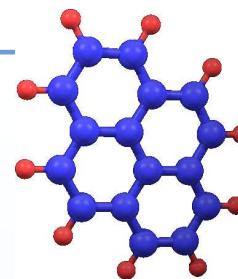


Fluorescence from PAHs

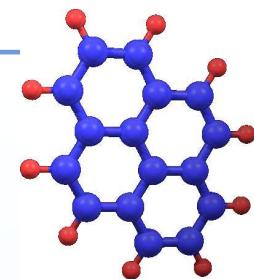


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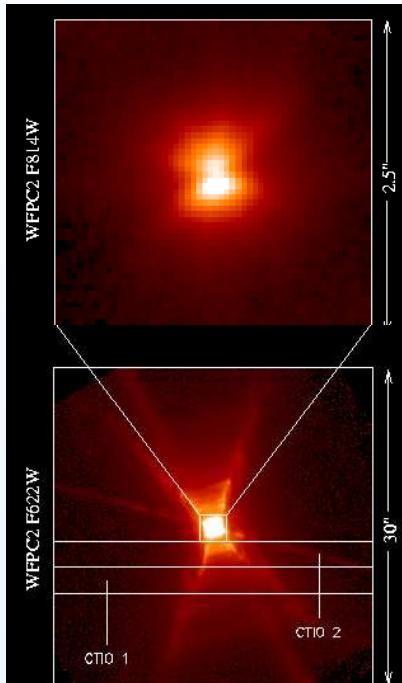
Red Rectangle



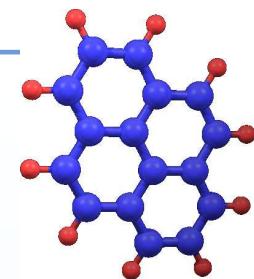
- Unique bipolar, proto-planetary, different morphologies at different wavelengths.



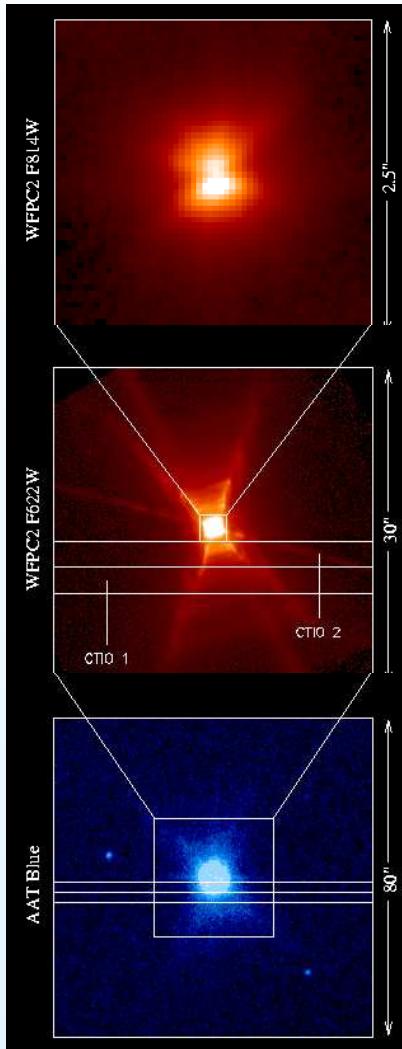
Red Rectangle



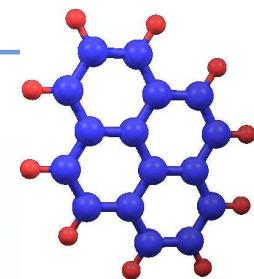
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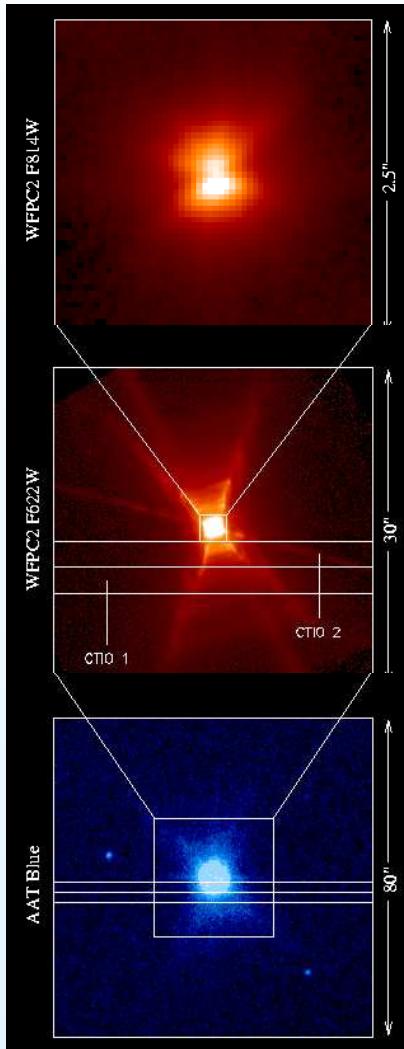
Red Rectangle



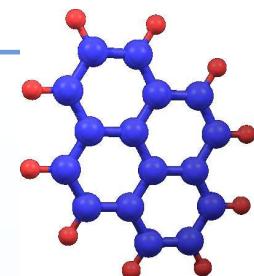
- Unique bipolar, proto-planetary, different morphologies at different wavelengths.



Red Rectangle

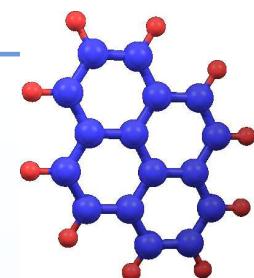


- Unique bipolar, proto-planetary, different morphologies at different wavelengths.
- Brightest known source of ERE and UIR bands.
- At a stage of active dust production.
- Low-resolution, long slit spectra obtained at CTIO 1.5 m telescope.
- 2 slit positions: 2.5" south, 5" south E-W slits (P.A. 90°).

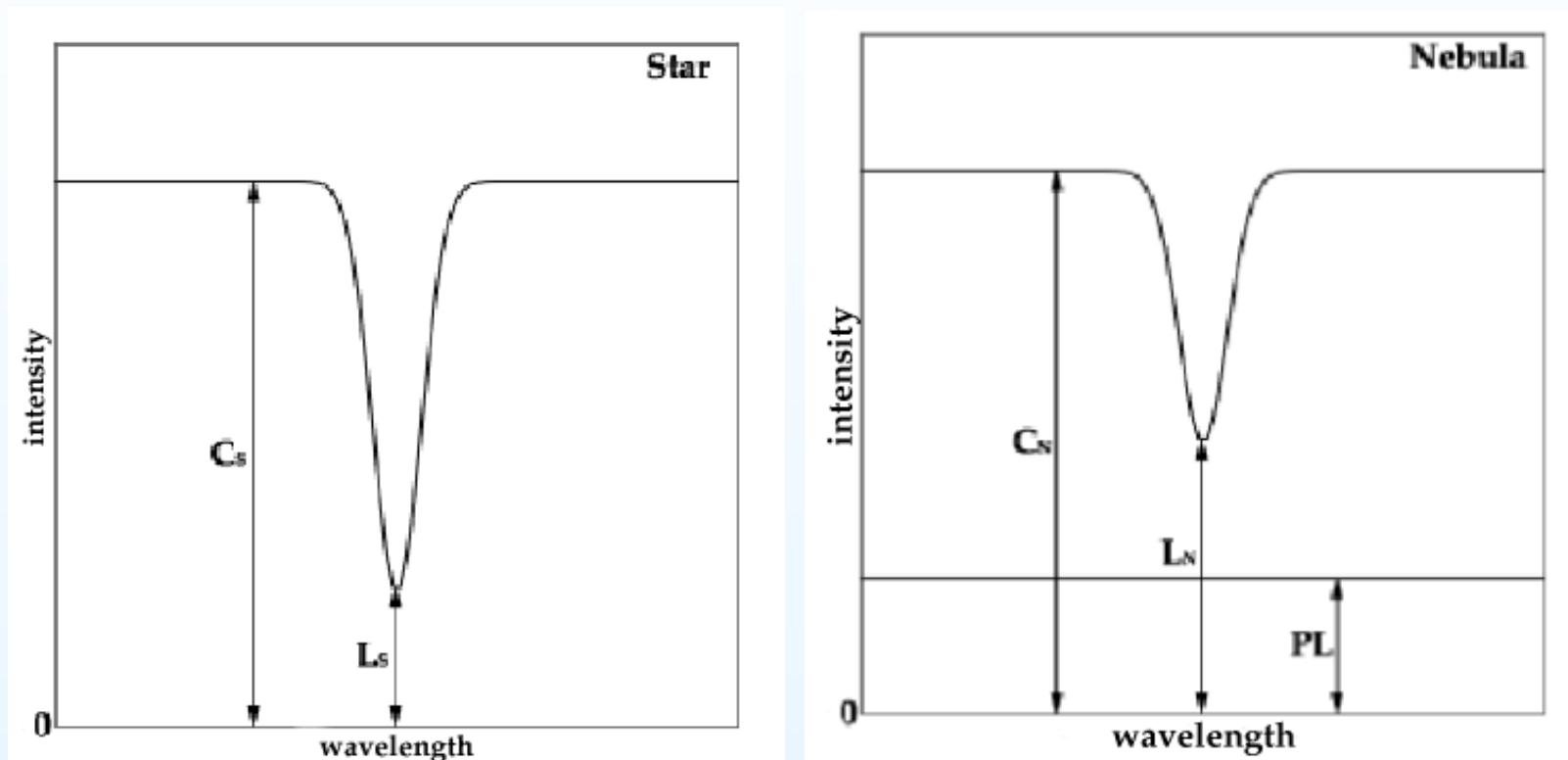


Detection and Identification of Blue Fluorescence

- Line Depth Technique. fig
- Identification:
 - Spectral match
 - Correlation with $3.3 \mu\text{m}$ emission
 - PAH ionisation discontinuity in the FUV



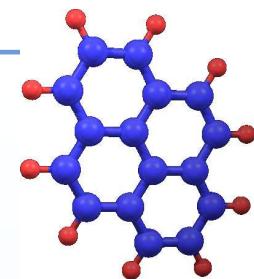
Line Depth Technique



$$R_S = \frac{C_S - L_S}{C_S}$$

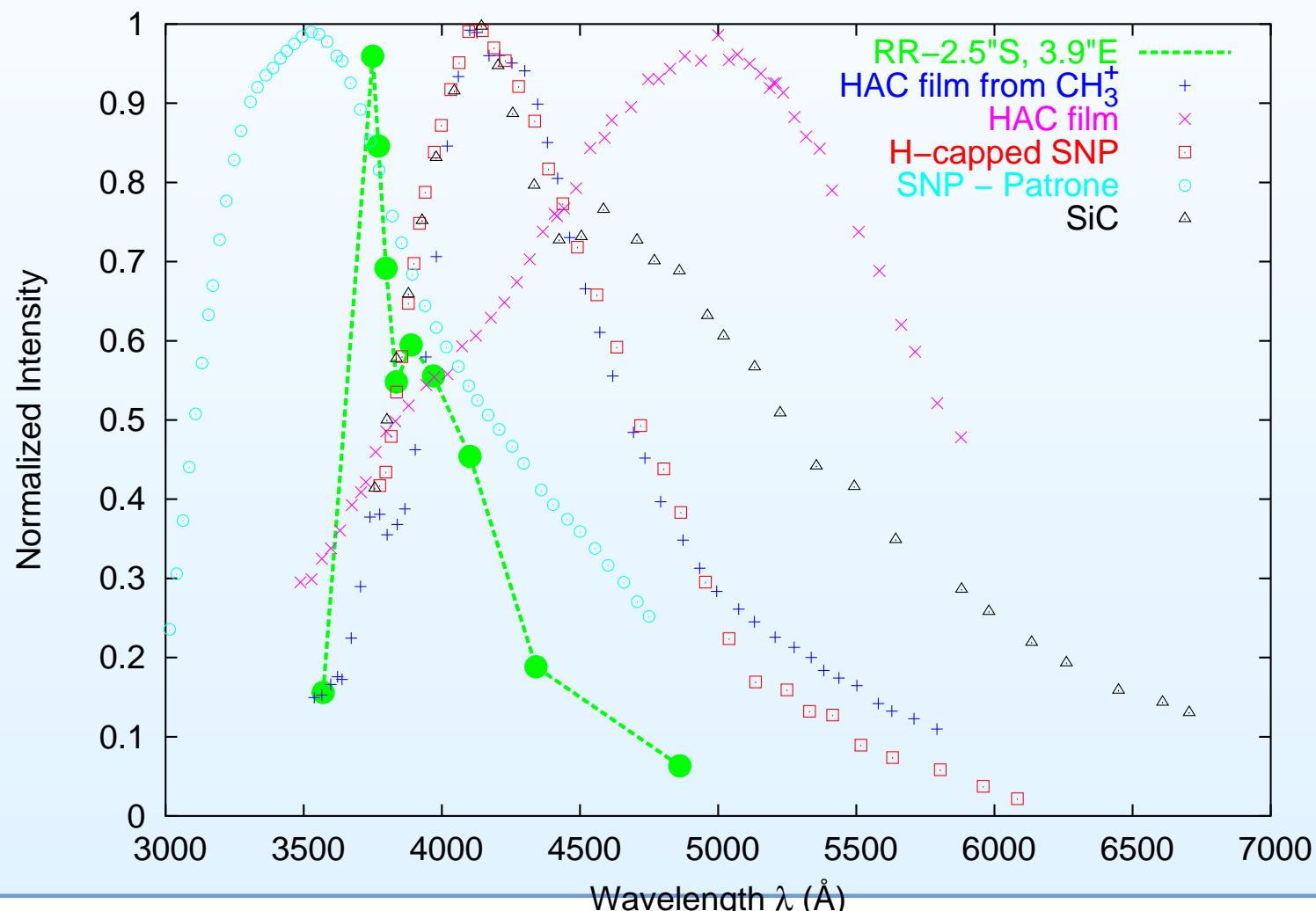
$$R_N = \frac{C_N - L_N}{C_N}$$

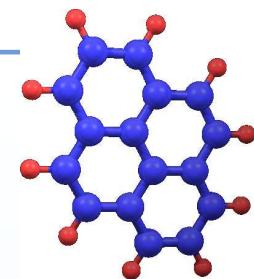
$$\frac{I_{PL}}{I_{cont}} = \frac{PL}{C_N - PL} = \frac{R_S}{R_N} - 1$$



Blue Luminescence Spectrum

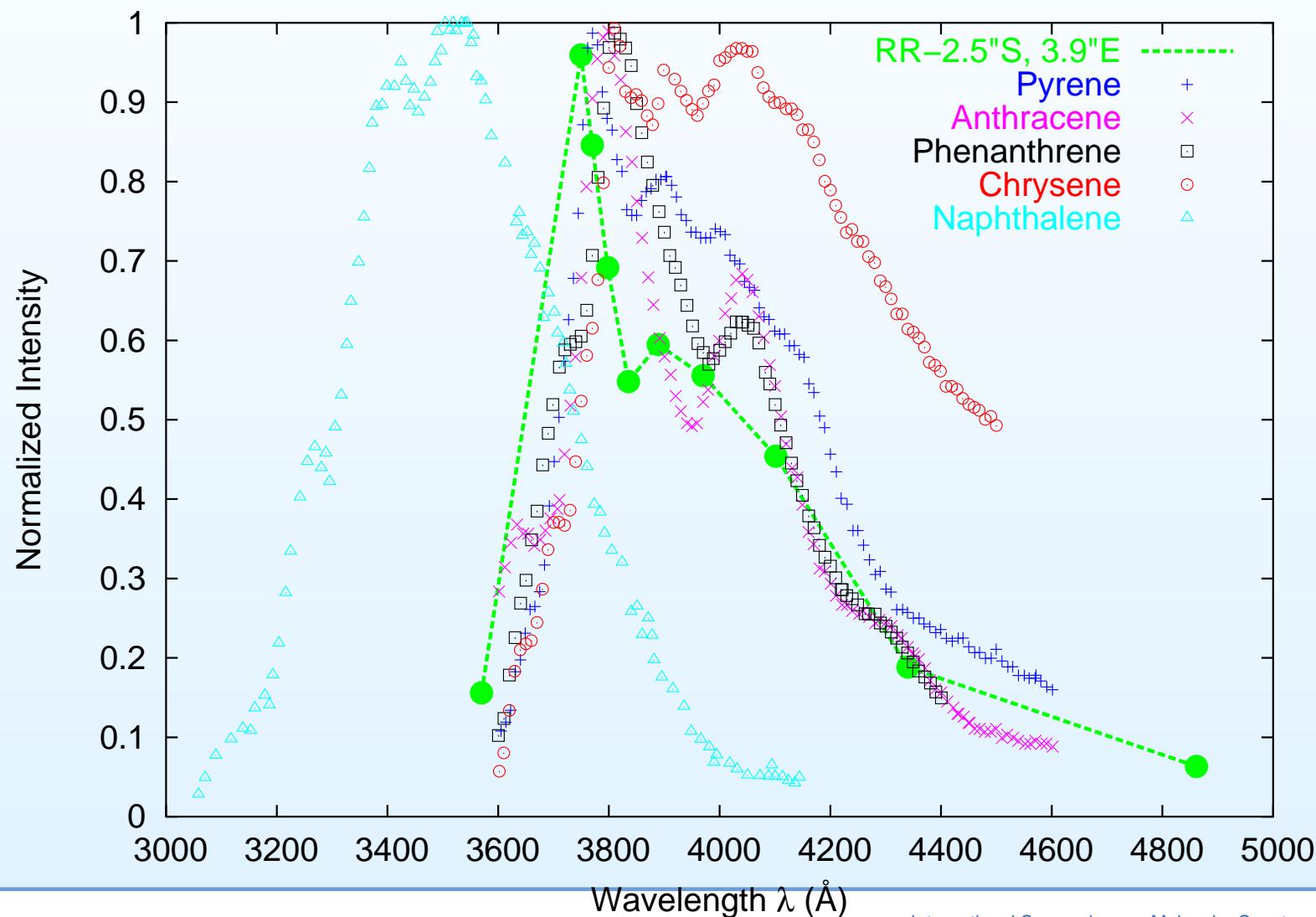
Comparison with luminescence spectra of solid-state candidates:



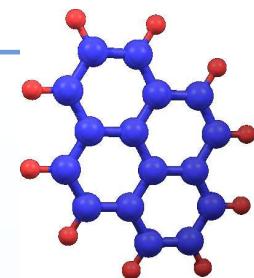


Blue Luminescence Spectrum

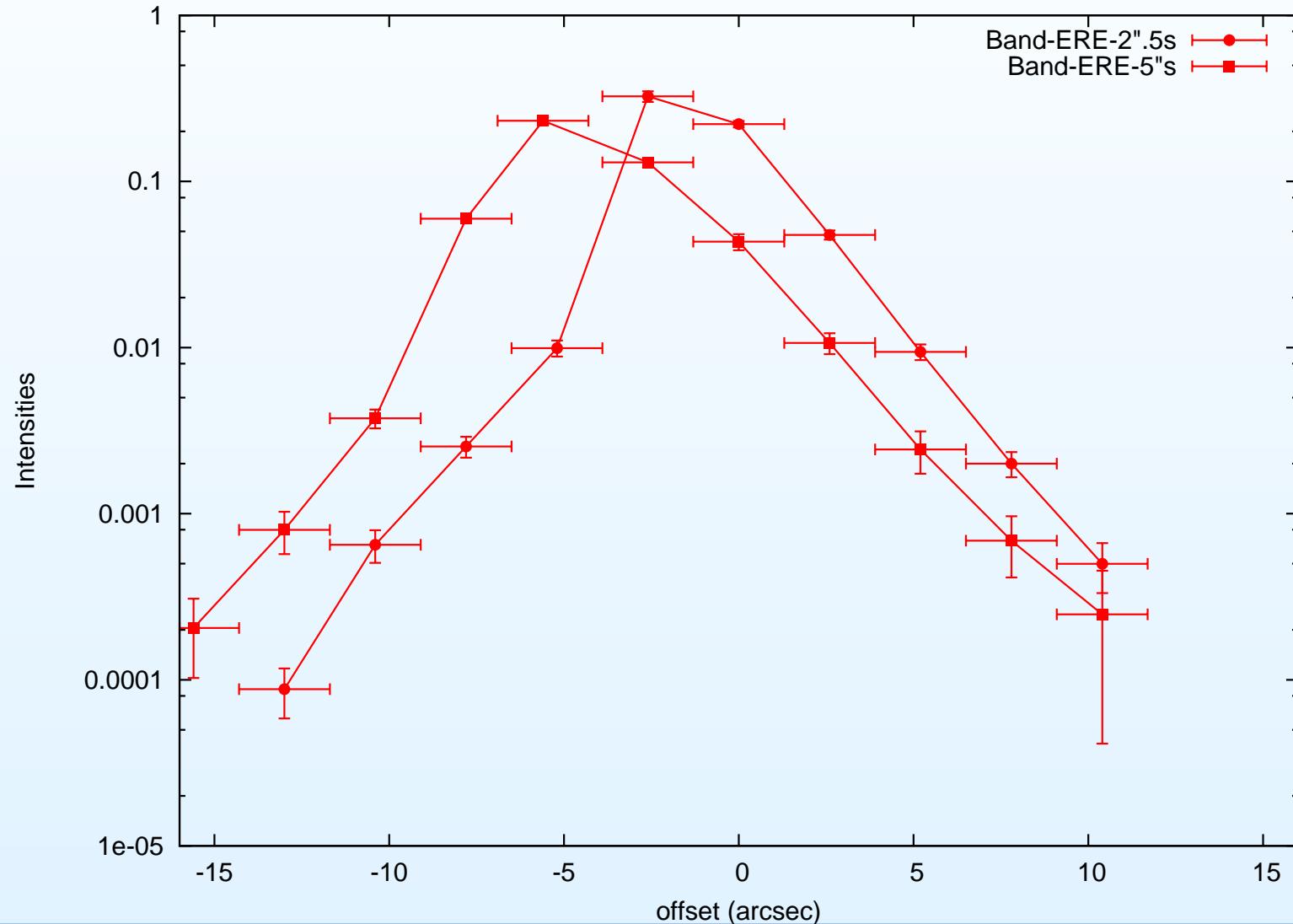
Comparison with Fluorescence spectra of small, neutral PAHs:



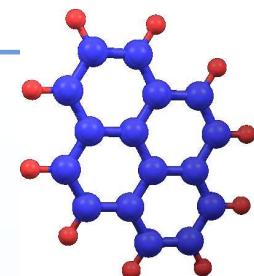
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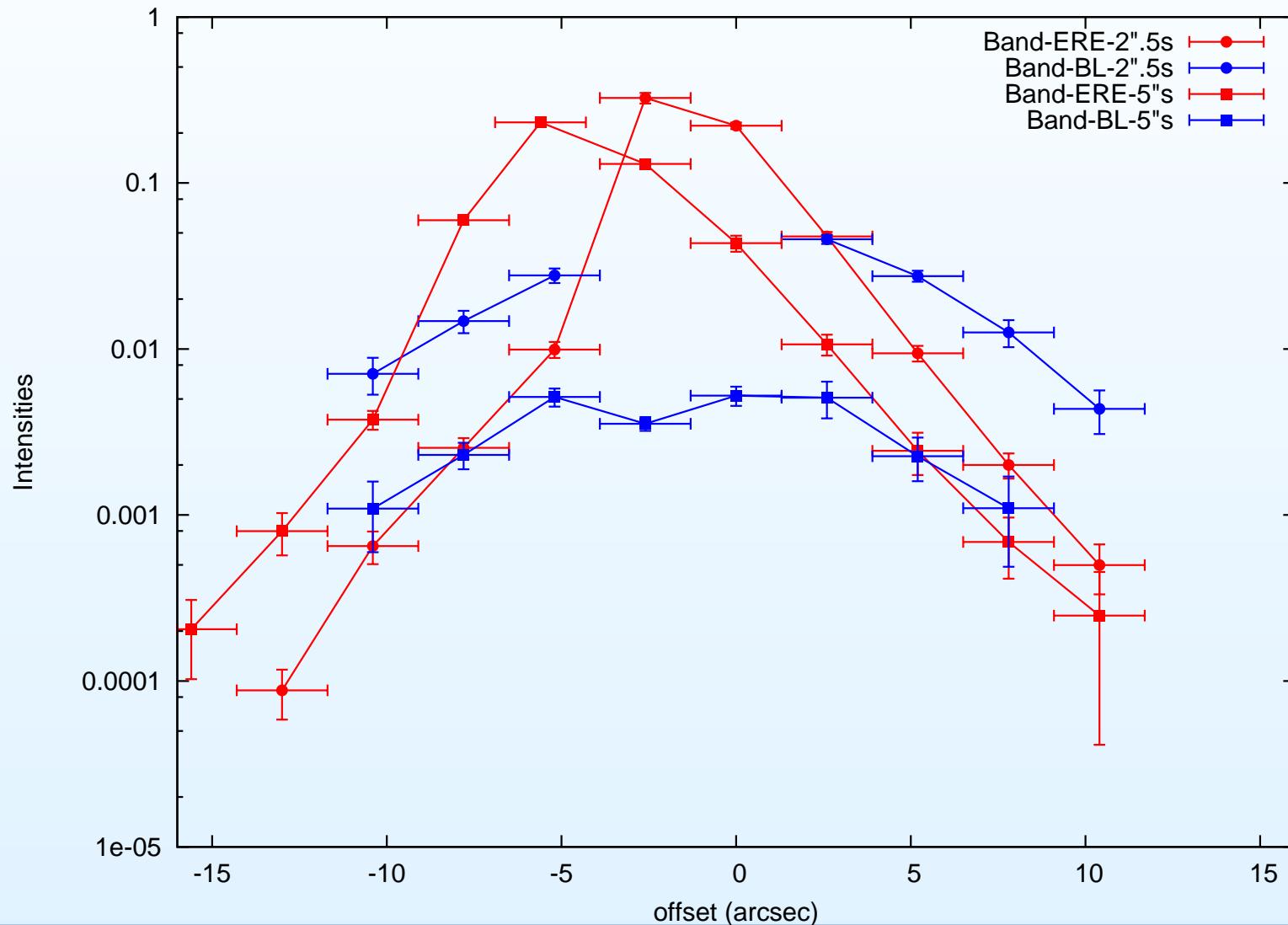
Correlation with 3.3 μ m Emission



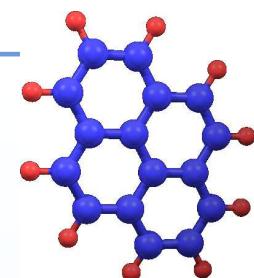
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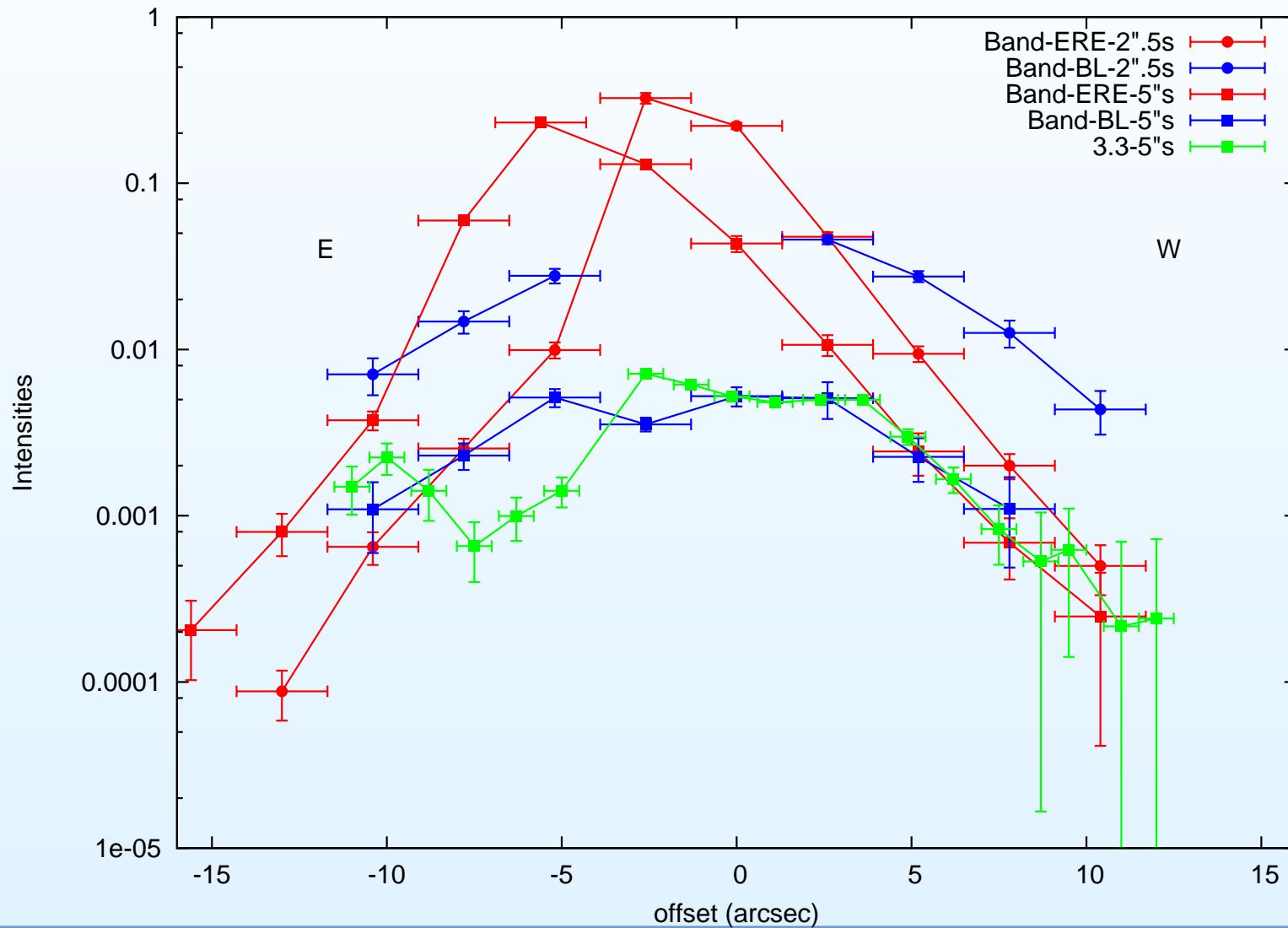
Correlation with 3.3 μ m Emission



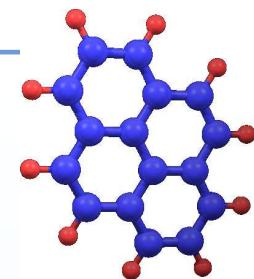
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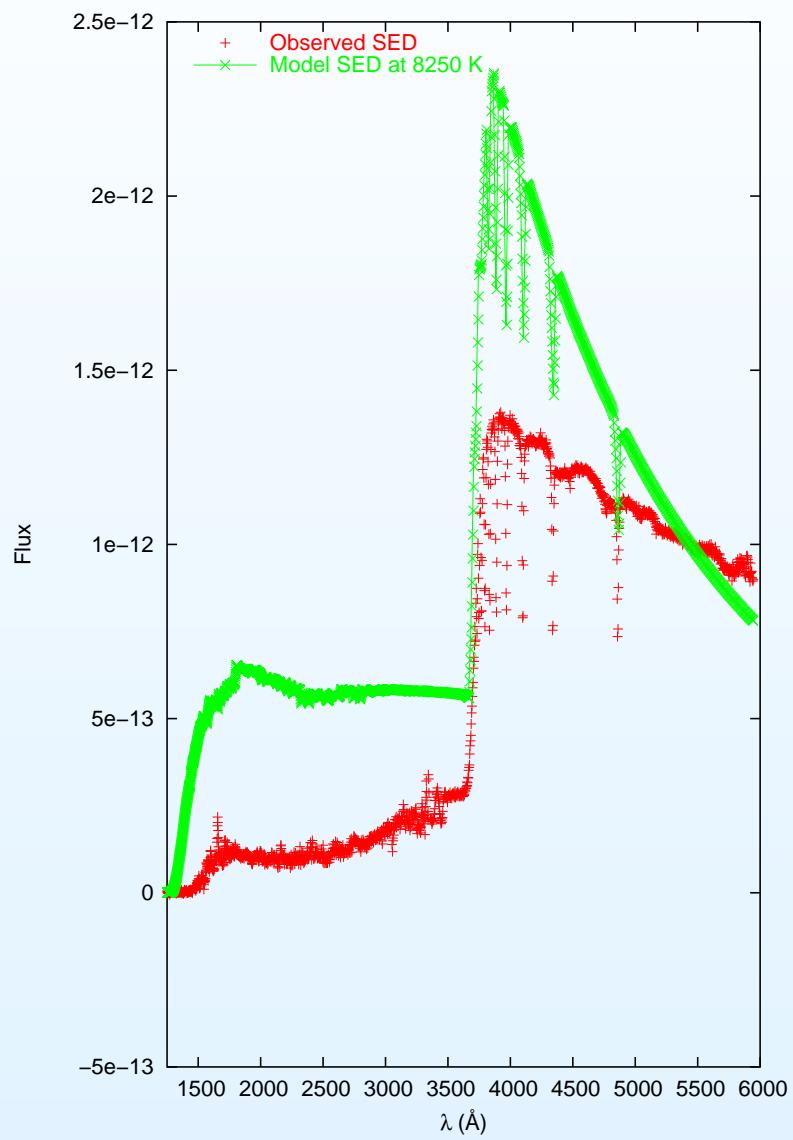
Correlation with $3.3 \mu\text{m}$ Emission



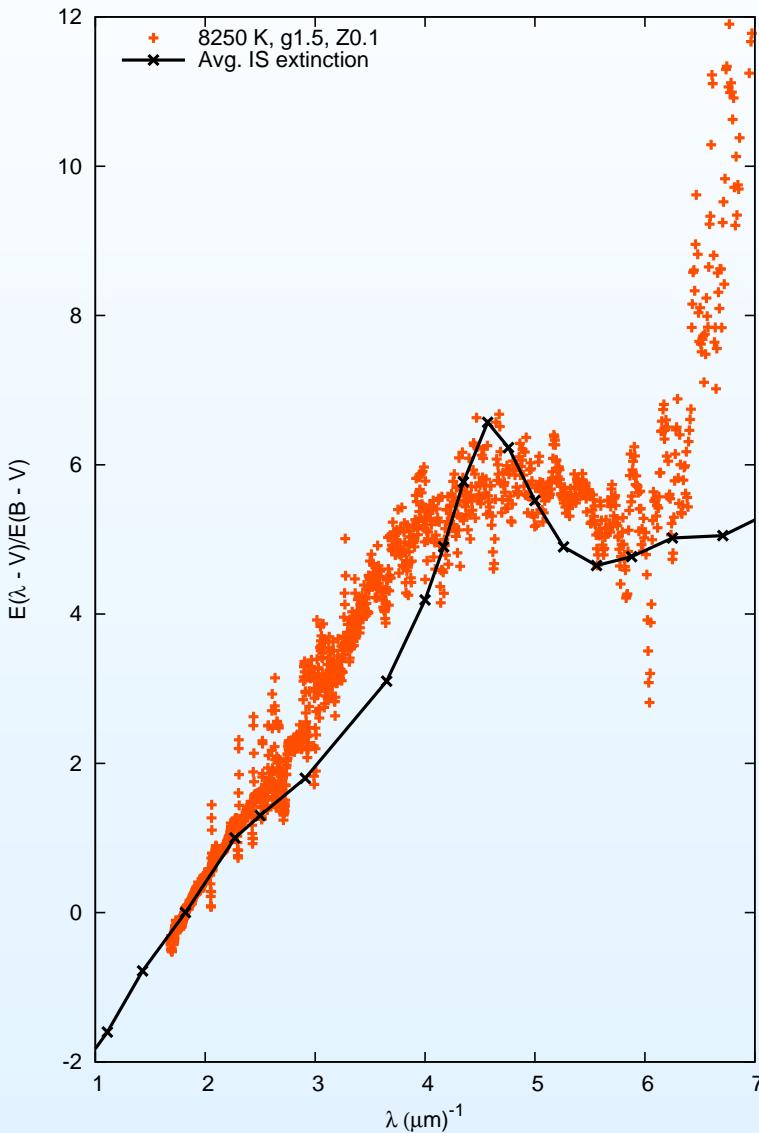
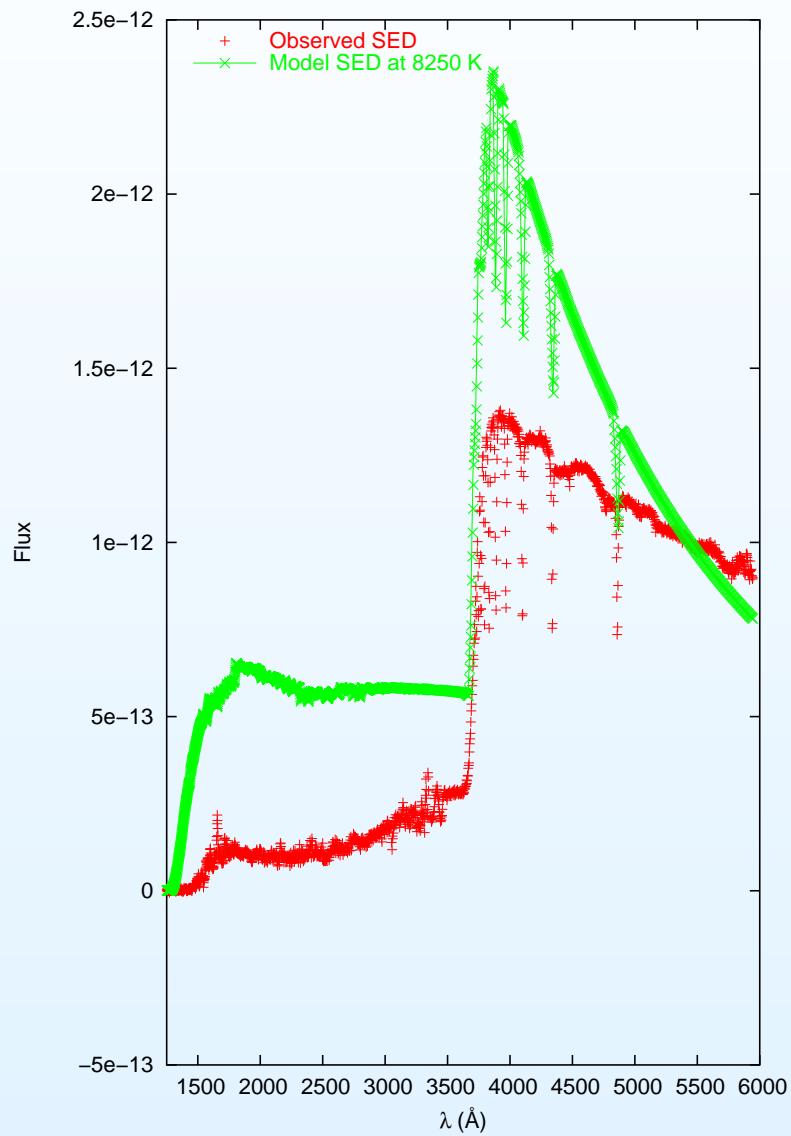
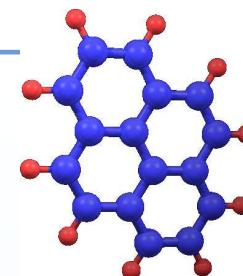
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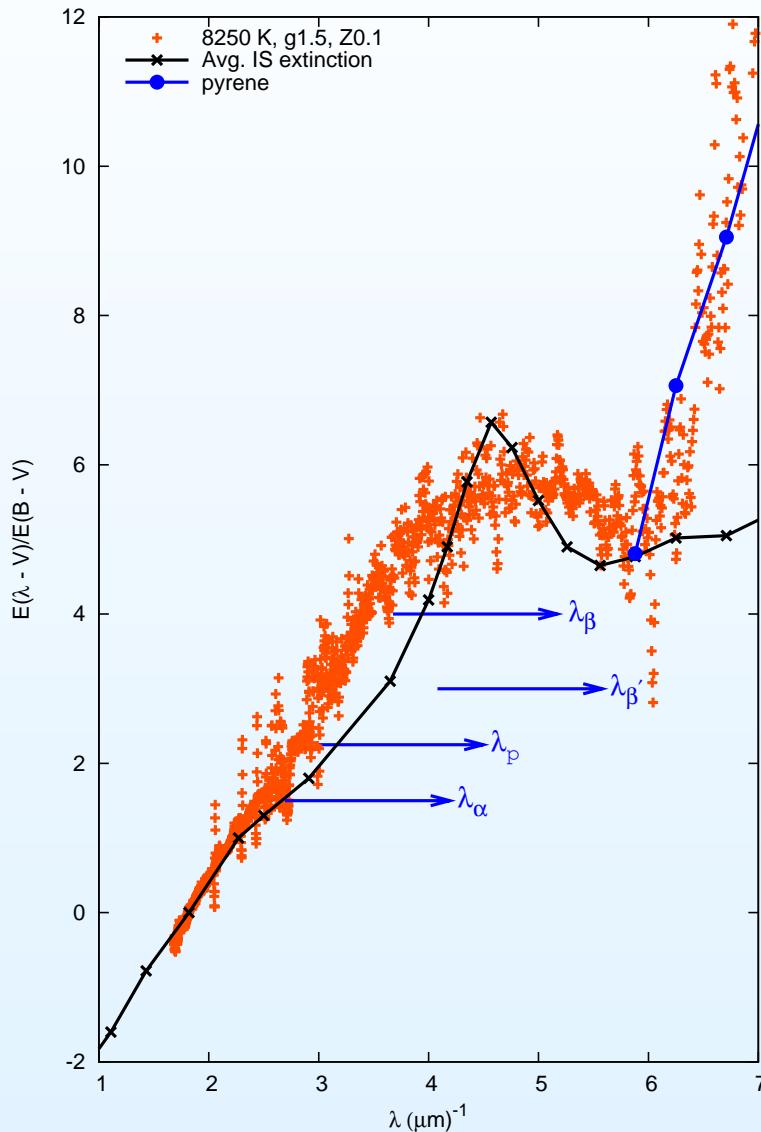
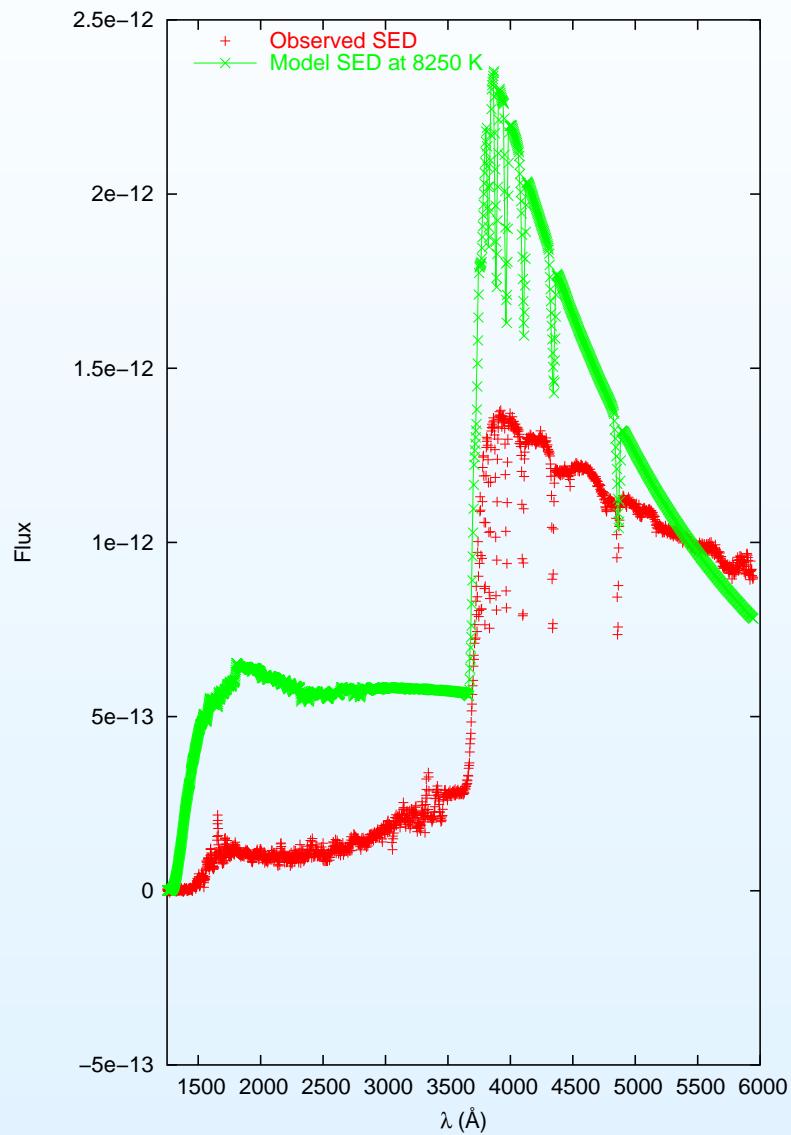
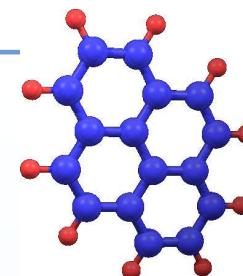
FUV Ionisation Discontinuity



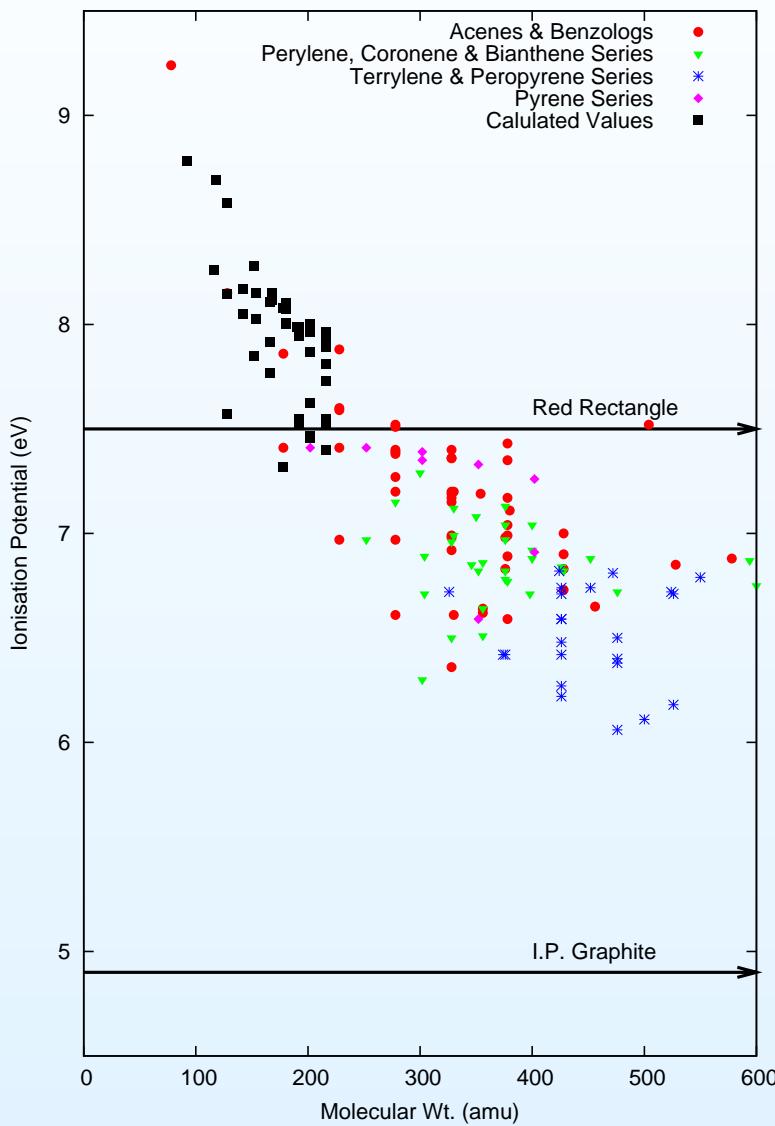
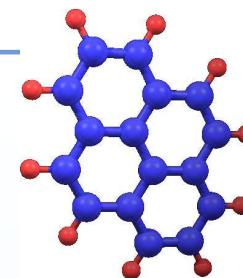
FUV Ionisation Discontinuity

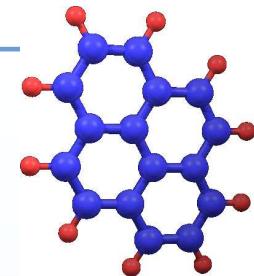


FUV Ionisation Discontinuity



PAH Ionisation Potential





Conclusions

- Discovery of a new broad blue emission (luminescence) in the Red Rectangle.
- Close spatial correlation with $3.3 \mu\text{m}$ C-H stretch emission from neutral PAHs.
- The HD44175 attenuation curve indicates the presence of electronic-band and ionisation-continuum absorption by small PAHs.
- Most likely carrier: small, 3-4 ring, neutral PAHs.
- Largest molecules so far identified in the ISM.

Vijh, U.P., Witt, A.N., & Gordon, K.D. 2004, ApJ, 606, L65

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