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Observational Evidence Linking Interstellar UV Absorption to PAH Molecules

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Abstract & Introduction

The 2175 Å UV extinction feature was discovered in the mid-1960s, yet its physical origin remains poorly understood. One suggestion is absorption by polycyclic aromatic hydrocarbon (PAH) molecules, which is supported by theoretical molecular structure computations and by laboratory experiments. PAHs are positively detected by their 3.3, 6.2, 7.7, 8.6, 11.3, and 12.7 μm IR emission bands, which are specified by their modes of vibration. A definitive empirical link between the 2175 Å UV extinction and the IR PAH emission bands, however, is still missing. We present a new sample of hot stars that have both 2175 Å absorption and IR PAH emission. We find significant shifts of the central wavelength of the UV absorption feature, up to 2350 Å, but predominantly in stars that also have IR PAH emission. These UV shifts depend on stellar temperature in a fashion that is similar to the shifts of the 6.2 and 7.7 μm IR PAH bands, that is, the features are increasingly more redshifted as the stellar temperature decreases, but only below ∼15 kK. Above 15 kK both UV and IR features retain their nominal values. Moreover, we find a suggestive correlation between the UV and IR shifts. We hypothesize that these similar dependences of both the UV and IR features on stellar temperature hint at a common origin of the two in PAH molecules and may establish the missing link between the UV and IR observations. We further suggest that the shifts depend on molecular size, and that the critical temperature of ∼15 kK above which no shifts are observed is related to the onset of UV-driven hot-star winds and their associated shocks.

Key words: astrochemistry – dust, extinction – ISM: molecules

- 系内の early type star のスペクトルを IUE と Spitzer で取得
- 2175Å feature と 6.2μm & 7.7μm PAH features のピーク位置を測定
- 15,000 K より若い天体では feature のピークが長波長側にシフトする傾向
- 波長シフトの原因はダストサイズ分布の変化か？

Introduction

- 減光曲線の 2175 Å feature はさまざまな視線方向・銀河で検出される
- PAH のような炭素質ダストがキャリアだと考えられている
- これまで観測的に 2175 Å feature と PAH を結びつけるような証拠はなかった
- この論文では **feature のピーク位置シフトに注目**して 2175 Å = PAH 節を検証する

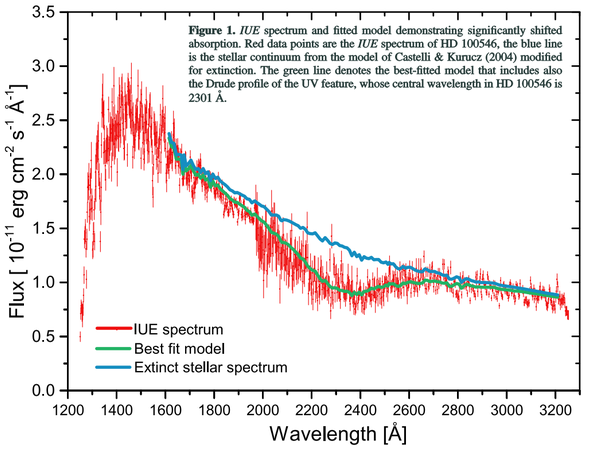
Observations

- A2-type よりも早期型の天体で IUE と Spitzer/IRS の分光データのある天体を選択
- 2175 Å feature が顕著に (EW ≧100 Å) 見えておりかつ PAH が見えている 27 天体を選択
- コントロールサンプルとして PAH の見えていない天体も 27 天体選択
- それぞれスペクトルフィッティングによって feature の強度とピーク位置を決定

Discussion

- 2175 Å, PAH ともに温度が 15,000 K よりも低い天体で系統的なピーク位置のシフトを検出
  - 2175 Å feature のピークシフトは PAH が見えている天体のほうが顕著
  - 分散は大きいがピークシフト間の相関 Figure 5. も見えている
  - 2175Å feature と PAH feature が同じ分子に起因することを示唆している (???)
- 距離と減光量の関係からおそらく 2175Å feature も PAH も星の CSM 起源
- 先行研究では 2175Å ピークシフトと C-rich な環境の関係を指摘 ⇒ 確認できず
- 波長シフトの物理的原因 ⇒ 諸説あるが今回は特定できず (サイズ分布？)
  - UV 駆動星風 (~15,000 K) の衝撃波によって大きいサイズのダストが選択的に破壊された可能性 (???)

Figure 1&2: スペクトルフィッティング



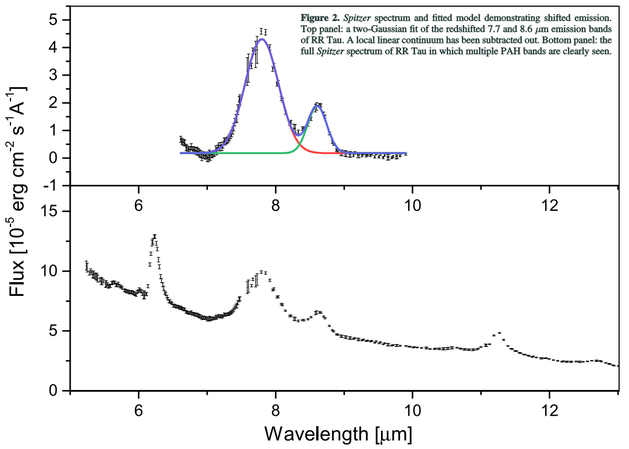
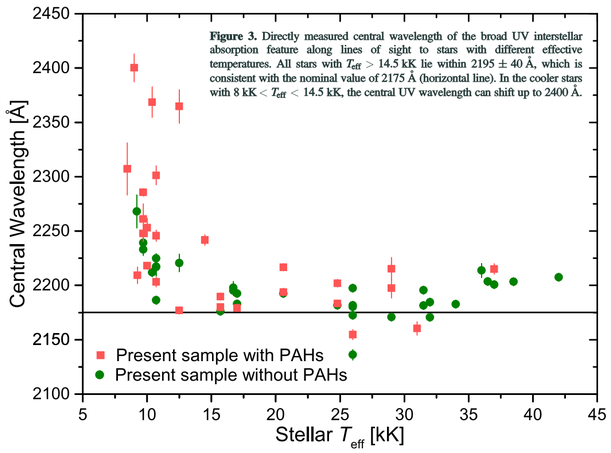


Figure 3&4: 天体の温度とピーク位置の関係



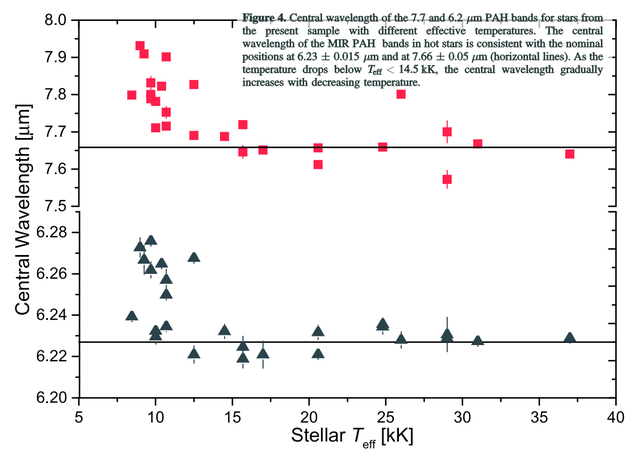


Figure 5: 2175 Å & 7.7μm PAH ピーク位置の相関