PAH Sizes in Nearby Galactic Sources

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Project Goals

• Using observations of nearby MIR-bright sources, we show how the average size of polycyclic aromatic hydrocarbons (PAHs) varies with respect to the FUV radiation field strength.

Astronomical MIR Spectra

 PAHs are the prime candidates for prominent MIR emission features at 3.3, 6.2, 7.7, 8.6, and 11.2 μm

• Found in wide variety of environments



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PAH Intensity Ratios

• Some PAH bands show strong correlations for many different environments



11.2/3.3 is the best tracer of PAH size

- Both are due to neutral species
- C-H modes only
- Largest wavelength range of major PAH bands maximizing sensitivity to internal temperature



Ricca + 2012

The ratio of ionized/neutral PAH emission correlates well with the ionization parameter

- 6.2, 7.7, 8.6 and the 11.0
 μm bands are typically
 stronger in ionized
 species
- The 3.3 and 11.2 μm bands are more prominent in neutral species



Galliano + 2008

We choose nearby, well-resolved MIR bright sources

SE of Orion Bar

NW PDR of NGC 7023

S PDR of NGC 2023



Credit: Bryan Goff

Credit: Adam Block

Credit: Steve Mazlin + 7







NASA/JPL-Caltech

- SOFIA: FLITECAM 3.3 μm
- Spitzer: IRAC 8 μm and IRS SH



SOFIA/USRA

Peeters + 2017

NGC 2023 Data

IRAC 8.0 FLITECAM 3.3 14:00.0 14:00.0 30.0 30.0 15:00.0 15:00.0 HD 37903 HD 37903 17:00.0 30.0 -2:16.00.0 30.0 30.0 -2:16:00.0 30.0 0 **IRS SH** 6 On SSE 1 17:00.0 30.0 30.0 . 46.0 46.0 42.0 5:41 40.0 38.0 36.0 34.0 32.0 30.0 44.0 42.0 5:41:40.0 38.0 36.0 34.0 32.0 30.0 44.0

NGC 2023 ratio maps show size and ionization increase towards star and are at minimum on PDR front



NGC 2023 radial cuts show size and ionization increase towards star



PDR Front Location

NGC 7023 Data

FLITECAM 3.3

NGC 7023 ratio maps show size and ionization increase towards star and are at minimum on PDR front 11.2/3.3 IRAC 8.0/11.2

NGC 7023 radial cuts show size and ionization increase towards star

PDR Front Location

Orion Data

Orion radial cuts do not show any clear trends in size or ionization

Derived PAH sizes in Reflection Nebulae (but not Orion) show correlation with $\rm G_0$

Source	G_{0}	Average PAH size
		minimum maximum
NGC 7023	2600	50 ± 2 65 ± 5
NGC 2023	4000	$80\pm5 140\pm30$
Orion Bar	4×10^4	$70 \pm 5 95 \pm 10$

Main Conclusions

A clear picture of the photochemical evolution of PAHs driven by the FUV field is found in the *reflection nebulae* studied

• PAH size increases upon approaching the illuminating source and is a minimum at the PDR front.

• Larger PAH size can be correlated with an increase in G₀

Based on results of Knight + Submitted

Croiset + 2016 Boersma + 2012 Rubin + 2011 Peeters + 2017 Galliano + 2008 Hony + 2001 Ricca + 2012 Tielens 2008 Stock + 2014 Geballe + 1989 Megeath +2012 Fleming + 2010 Peeters + 2004