Mapping PAH sizes in NGC 7023 with SOFIA

By Bavo Croiset
Supervisors: A.G.G.M. Tielens, O. Berné, A. Candian
Overview

- Introduction
- NGC 7023
- Instruments
- Images
- PAH size emission model

Croiset et al., 2016, A&A, 590, A26
PAH emission

- Polycyclic Aromatic Hydrocarbon

![Graph showing PAH emission spectrum](image)

Tielens (2008)
PAH emission

“$11.2/3.3$ $\mu$m proportional to PAH size”

- Absorption UV
- Vibrational emission

- Typical vibrational modes:
  - C-H $3.3$ $\mu$m, neutral (stretch)
  - C-H $8.6$ $\mu$m, ionized (in plane bending)
  - C-H $11.2$ $\mu$m, (out of plane bending)

Leger, d’Hendecourt, Defourneau (1989)
Photo Dissociation Region

Cloud of dust and gas

Star

FUV radiation field

C+, O, H

C+, O, H₂

CO, H₂, O

PAH emission

Aᵥ=0.01  Aᵥ=0.1  Aᵥ=3

Gas temperature $T'(K)$

Tielens & Hollenbach (1985)
Photo Dissociation Region

unstable VSG evaporate → compact PAH at PDR surface → PAH broken down

Andrews et al., (2015)
NGC 7023 (Iris nebula)

- Reflection Nebula
- Distance: 320 pc
- Herbig Be Star system

Hubble NGC 7023 North PDR (1995)
NGC 7023 (Iris nebula)

“H$_2$ 2.12 µm traces the PDR surface”

Hubble NGC 7023 (1995) & CFHT 2.12 µm
Instruments

**NASA SOFIA**
- FLITECAM: 3.3 µm
- FORCAST: 11.2 µm

**NASA SPITZER**
- IRAC 8.0 µm

**CFHT**
- MIDAS: 2.12 µm

**NASA HST**
- NICMOS: ERE
Instruments

AKARI, Pilleri et al., 2015
Images

North PDR

South PDR
Images

PAH

Very Small Grains
PAH emission-size model

Extinction
Crossection PAH
Photon energy emitted

Avg. photon energy absorbed by the PAH

• NASA Ames PAH IR spectral database
• Spectra of 27 different PAHs

“Avg. photon energy emitted → Dust extinction
→ absorbed by PAH → PAH spectra → 11.2/3.3 μm”
PAH emission-size model

“Avg. photon energy emitted → Dust extinction → absorbed by PAH → PAH spectra → 11.2/3.3 µm”
PAH emission-size model

Croiset et al., 2016
PAH emission-size model

Intensity Ratio (11.2/3.3) vs. Number of Carbon atoms

11.2 / 3.3 μm
PAH emission-size model

![Graph showing PAH emission size model](image-url)

- Normalized intensity
- Distance to star ("")
- 11.2/3.3 Ratio

Key points:
- ~70 C
- ~50 C

SOFIA Tele-Talk 14-9-2016
Summary

• The PDR surface is well traced by the 11.2/3.3 ratio and H₂
• A factor of ~2 in size variation
• unstable VSG evaporate → compact PAH at PDR surface → smallest PAH broken down → Avg. size increases in the cavity

Croiset et al., 2016, A&A, 590, A26
Future work

• Observe more objects with SOFIA

• Laboratory work to examine the 11.2/3.3 μm

• Model the effect PAH size in PDR models

• JWST

Croiset et al., 2016, A&A, 590, A26
Images

FLITECAM 3.3 | IRAC 8.0 | FORCAST 11.2

68°10'30" | 00" | 00"
09'30" | 00 | 00"
09'00" | 00 | 00"
08'30" | 00 | 00"

21h01m40s 35s 30s 25s 21h01m40s 35s 30s 25s 21h01m40s 35s 30s 25s
RA (J2000) RA (J2000) RA (J2000)

SOFIA Spitzer IRAC SOFIA

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