

EXCERPT FROM:

Krioshna Swamy, Dust in the Universe

2.6.2 Mass Spectra

Several mass spectrometry studies have been carried out on selected PAHs for studying chemical reactivity, photofragmentation, and formation mechanisms.

Electron attachment studies show low reaction rates. This indicates the importance of PAH ions in cloud chemistry.

PAH ion-atom reaction rates indicate rapid formation of protonated PAHs.

Fragmentation of small PAHs such as anthracene (C₁₄H₁₀) and pyrene (C₁₆H₁₀) has been studied.

Results show:

- For pyrene, the dominant fragmentation channel is dehydrogenation.
- For anthracene, the dominant fragmentation channel is loss of C₂H₂.

The same experiments also show that dehydrogenated PAHs are more stable.

This suggests that compact PAHs may be more common than non-compact species in the interstellar medium.

Laboratory studies of PAHs have improved greatly in recent years, but more work is still needed.

In particular, studies are needed on PAHs containing about 50 to 100 carbon atoms, especially their:

- physical properties
- chemical properties
- UV spectroscopy
- IR spectroscopy

These studies are difficult because such large PAHs are hard to produce in laboratories.

They are also important for understanding the size distribution of interstellar PAHs.

Theoretical studies are also needed to support experiments.

These include:

- stability

- structure
- role of chemical groups
- effect of hydrogenation
- photodissociation rates

Several theoretical studies examine PAH properties as functions of:

- molecular size
- structure
- ionization state (positive or negative ions)
- degree of hydrogenation

Calculations show that PAHs with fewer than 50 carbon atoms can be destroyed or fragmented in UV-dominated regions.

The dominant destruction channel is carbon loss through photoejection of an acetylene molecule (C₂H₂).

2.6.3 Stellar Environment

The first molecules expected to form in stellar winds are:

- naphthalene (C₁₀H₈)
- acenaphthylene (C₁₂H₈)
- acenaphthene (C₁₂H₁₀)
- pyrene (C₁₆H₁₀)

These exist in energetic environments.

To simulate such conditions, naphthalene was coated on the inside walls of a sapphire tube and exposed to plasma containing H, He, N, or O.

The resulting material in the tube had a yellow color and was called yellow residue.

Chemical analysis showed many complex species.

These products were more complex than expected from thermodynamic equilibrium models.

Large amounts of hydrogenated PAHs were produced.

These are hybrids of:

- polycyclic aromatic (sp²)
- polycyclic aliphatic (sp³)

Ultraviolet absorption spectroscopy of the plasma products showed a broad feature centered at 2175 Å.

This is similar to the feature seen in the interstellar extinction curve.

Infrared absorption spectroscopy in the C-H region (3.3 micrometers, 3000 cm⁻¹) also showed a feature similar to those observed in astronomical objects.

For example, laboratory spectra were compared with observed spectra in the proto-planetary nebula IRAS 05341+0852.

Mass spectroscopy of the yellow residue showed a complete range of PAH species, with molecular weights up to 574.

StORY: Benjamin Parzybok – “Reparador Pico”

Reparador Pico sat on a dirty child’s dollhouse and drank sweetwine made by Marzo. The wine tasted of plastic, car oil, and the smell of the dump. The tin shed around him rattled. Nails popped from the roof. This meant the trucks had arrived. The nackers were coming for new trash.

Pico finished the wine and hid the bottle in the dollhouse. He took his tool belt and tharpoon from the wall. Outside, he hit his chest with the tharpoon and said: “Aha!”

The pepenadores (dump workers) gathered at the edge of the settlement. Pico joined them, keeping distance from his parents. They used to run for new trash, but now the nackers took everything first. So they searched only old garbage.

At one end, Pico saw Mouse. Mouse wore a cowboy hat and an orange jumpsuit with one arm missing. She liked to stand out. Pico liked her. He followed her at a distance, as he always did. He kept about fifteen steps behind her. Pico sharpened his tharpoon with a stone in his pocket. The wine made him feel bold, like he could fight someone. Around him, other pepenadores waited—old people buried in layers of clothes, living like part of the dump itself.

Some dump workers were young, like Pico. Most ignored him, their faces marked with sweat and dirt. All of them watched the trucks on the horizon. They waited for the main dump area to clear of nackers. Then they slowly moved in.

Mouse went first, toward the great wall of trash. Pico followed at a distance. He was not sure what she was looking for, but he kept following anyway. He told himself she would probably send him away if she noticed.

After a while, a nacker picked up Mouse's trail. It followed her quietly, hiding among the trash. This one was different—newer, silent, with smooth joints. Pico crouched and moved behind it, staying hidden in the garbage hills.

Mouse stopped and began digging with her tharpoon. She had found something valuable. The nacker waited, watching her. Pico also waited, afraid. He thought about attacking the machine, but he was not ready.

Then Mouse pulled a car door out of the ground. It was valuable—metal, electronics, worth money. The nacker would want it. Pico tightened his grip on his tharpoon and ran toward them. He was slow, sweating, dizzy from heat and wine.

The nacker was faster. It moved on six legs across the trash, reaching forward with a mechanical arm. Pico knew he was too late—but he kept running anyway