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Whipping IC63/IC59

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The mid-IR spectra of photodissociation regions (PDRs) are dominated by the well-known emission features at 3.3, 6.2, 7.7, 11.3, and 12.7 micron, generally attributed to polycyclic aromatic hydrocarbon molecules (PAHs). PAHs drive much of the physics and the chemistry in these PDRs, e.g. by heating the gas and as a catalyst in the formation of molecular hydrogen on their surfaces. Thus, PAHs and PDRs are intimately connected, and a complete knowledge of PDRs requires a good understanding of the properties of the PAH population and vice-versa, a complete knowledge of the PAH population requires a good understanding of the local physical conditions.

Here we present a general description of two PDRs, IC63 and IC59, from an observational standpoint in order to study the physical conditions at the UV-illuminated surfaces of these objects and their PAH properties. IC63 and IC59 are a pair of cometary-shaped nebulae in the vicinity of the star gamma Cas (also known as Tsih, "the Whip"). Both nebulae have very different optical appearances, despite the fact that both objects lie at similar projected distances from the star: IC63 shows bright rims and filaments, while IC59 looks more homogeneous and faint.

We use the available data on both nebulae taken with Spitzer, Herschel and SOFIA to study the infrared emission at the tip of both clouds, and derive the intensity of the UV radiation field, the density and the gas temperature. We find that the IR emission from polycyclic aromatic hydrocarbons (PAHs) is very similar at the tip of both nebulae. Even though it varies in intensity between the two, the derived PAH band ratios are remarkably similar. These ratios are similar to those found in the more shielded regions of other nebulae such as NGC7023 and NGC2023. Regarding the physical conditions, we obtain that while in IC63 the intensity of the UV field, G0, is a factor of ~10 higher than in IC59, the density n at the tip of IC59 is lower than in IC63 by a similar factor. For both objects we derive G0 values significantly lower than what previous works have so far assumed. Comparison with other reflection nebulae PDRs and known correlations support our claim that both IC63 and IC59 are low-UV irradiated environments. We conclude that the tips of IC63 and IC59 are about 3 and 5 times farther away from the star than their respective projected distances. The similarity of the mid-infrared emission between the two nebulae is consistent not only with both objects being overdensities within the same region around gamma Cas, but it is also consistent with the similar G0/n ratio and ionization parameters, which altogether rule the evolution of the hydrogenation and ionization level of the emitting population of PAHs. Finally, regarding the kinematics of the material in IC59, we find evidence of photo-evaporation due to the incident radiation from gamma Cas.

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Yes

Primary author: Dr ANDREWS, Heather (Leiden Observatory)

Co-authors: Prof. PEETERS, Els (University of Western Ontario & SETI Institute); Prof. TIELENS, Alexander (Leiden Observatory); Dr OKADA, Yoko (University of Cologne)

Presenter: Prof. PEETERS, Els (University of Western Ontario & SETI Institute)

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