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Exploring the ionized core of the PPN CRL618 and its vicinity with ALMA

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The events that occur during the proto-planetary nebula (PPN) inter-phase are among the most stunning phenomena taking place during the evolution of solar and intermediate mass stars. PPNe comprise a dense circumstellar envelope that hide hot central stellar objects, which are frequently white dwarfs. PPNe usually display high velocity bipolar outflows that form close to the central stellar system and work their way through the ancient circumstellar envelope produced during the AGB phase. Extensive effort has been done to understand how the outflows are developed but there still are questions to be answered, mostly due to the lack of observational constraints.

One of the most paradigmatic PPN is CRL618, a C-rich PPN located at ~900pc from us with a set of bipolar outflows expanding at velocities up to ~200km/s. Its outflows are collimated by a dusty torus which makes difficult to observe the ionized core that host the stellar system and where the outflows are launched. Strong molecular emission is detected beyond the photodissociation shell that surrounds the ionized gas but this emission traces the neutral, low-velocity envelope and it is useless to describe the regions where the outflows form, for no molecule can survive inside the HII region. Nevertheless, it is possible to explore this region with the aid of recombination lines and free-free continuum emission in the mm range.

Based on high angular resolution observations (HPBW~30-50mas) of the H30alpha recombination line at ~1.3mm toward CRL618 carried out with ALMA, we have been able to resolve the ionized core of the envelope. The observed structure can be described as an elongated region along the E-W direction with a size of ~0.7”x0.4” and a perpendicular remarkable arc that connects two bright spots located to the N and S, which are separated by ~0.2”. It resembles a cylinder tilted with respect to the plane of the sky with a bright, incomplete ring-like waist lacking its back side. The ionized gas is expanding toward the E and W with projected velocities up to ~45km/s and gradients of ~250km/s/arcsec. Apparently, there are not velocity gradients along the N-S direction but the velocity dispersion is as high as ~80km/s. We are currently modeling the continuum and H30alpha emission. Moreover, lines of CO, HC3N, HC5N, c-C3H2, and SiO among others have been detected in the observed spectral windows and their emission enclose the ionized gas in the bipolar outflows and the core, also describing the dense, expanding equatorial torus. In this talk, we will present our last advances on the analysis of these very rich high angular resolution data.

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