Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 175-176, (2026)

OPEN ACCESS https://doi.org/10.22201/ia.14052059p.2026.60.159

Unveiling the 3D geometry of nova shells with MUSE

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Keywords: *cataclysmic variables, ISM: kinematics and dynamics, novae, techniques: imaging spectroscopy*

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Nova shells are the remnants of the nova eruptions in cataclysmic variables. Understanding the physical process that shapes the geometry of these shells is necessary to fully comprehend the physical processes behind a nova eruption. Recent efforts have been made to study several nova shells using integral field spectroscopy (IFS), which allows for a complete spatio-kinematic description of the shell material. In this proceeding, we present the preliminary results of our survey of nova shells observed with IFS with an emphasis on the 3D reconstruction of the shells.

The study of nova shells using integral field spectroscopy is a recent development despite the obvious advantages it possesses. We started a project to observe several shells using the Multi-Unit Spectroscopic Explorer located at Paranal Observatory, Chile. The wavelength coverage of the instrument (470-900 nm) allows us to study the main lines observed in these shells, like Hα and [OIII]. The targets were selected based on the previous observations of Gill & O'Brien (1998), and Downes & Duerbeck (2000), in order to study the evolution of these shells during the last 20 years.

From the sample of shells, the most suitable for analysis is RR Pic, due to the combination of its age and proximity. The analysis of this shell reveals that its geometry is composed of an equatorial ring and polar filaments, which have been preserved during the last 20 years while expanding without showing signals of deceleration. The 3D reconstruction of the shell reveals that the equatorial ring possesses a radius ∼8000 au and it is surrounded by several "clouds" of material (see Celedón et al. (2024) for details on the 3D reconstruction). The overall geometry of the shell is consistent with the prolate shape expected for nova shells (Aydi et al., 2020).

More intriguing is the nova shell around the system V1425 Aql, which is composed of an inner shell traced mainly by Hα+[NII] and an asymmetric outer shell traced by [OIII] (Tappert et al., 2023). Following the methodology developed for the analysis of RR Pic, we determine the 3D geometry of the inner and outer shell of V1425 Aql, which is presented in Fig. 1, revealing that the geometry of the outer shell corresponds to an arc-like structure surrounding the inner shell.

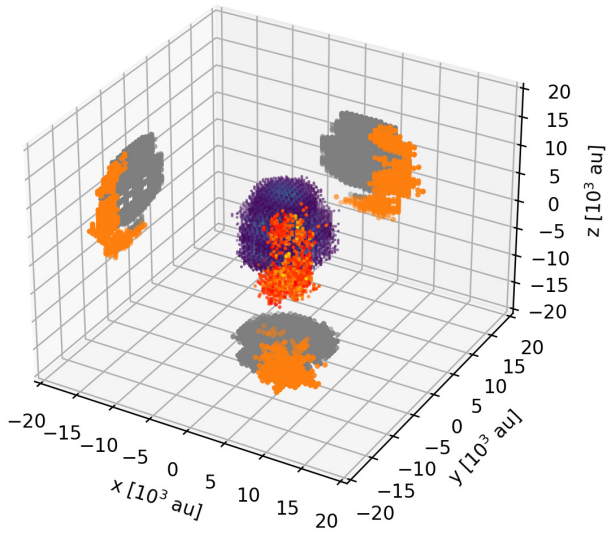

Figure 1. 3D reconstruction of the nova shell around V1425 Aql. The inner shell traced by Hα+[NII] is presented in blue colours with its projections in grey, while the outer shell traced by [OIII] is presented in red colours and its projections in orange.

Due to the strong blending between the Hα and [NII] emissions we were not able to separate the contributions of these lines individually, and so the reconstruction overestimated the actual length of the shell in the z-axis, explaining why the outer shell appears to be shifted with respect to the inner one in this axis.

The study of nova shells with MUSE opens new perspectives to understand the physical phenomena that shape these structures.

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"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

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