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ESO programme X-shooter observations of PN microstructures, Data Release DR1
provided by Lydia Konstantinou, submitted on 2026-10-14, published on 2026-10-14

X-SHOOTER SURVEY OF LOW-IONIZATION STRUCTURES IN PLANETARY NEBULAE: THE UNIQUE WINDOW FROM UV TO NEAR-IR.

Abstract

The spectra presented in this work were acquired using the medium-resolution spectrograph X Shooter (Program ID: 113.268E.001, PI: Akras S.). X-Shooter consists of three spectroscopic arms: UVB (300-559.5 nm), VIS (559.5-1 024 nm), and NIR (1 024-2 480 nm). Observations were carried out with spectral resolving powers of R ≈ 3600, 5000, and 4300. Both long and short exposures were acquired to provide high signal-to-noise spectra while avoiding saturation of the brightest nebular emission lines. Observations were conducted on the nights of 28-29 June (East LIS) and 6-7 July (West LIS) of 2024. In both slit positions, the emission from the LISs does not extend over the full length of the slit, so smaller extraction regions were chosen during the data reduction process. For the eastern LIS, the slit encompasses the main K1a LIS and the fainter K1b component. Separate spectra were extracted for each of these regions, dividing the slit into subregions of length ~5.2′′ (see Figure 1). For the western LIS (K4) the spectrum was extracted considering a length of 7.4′′ for the extraction region (see Figure 1). The released spectra are wavelength- and flux-calibrated and are intended for the spectroscopic study of the physical and chemical properties of the LISs of NGC 7009. Further details on the observations, data reduction, and analysis are provided in the scientific paper: https://doi.org/10.1051/0004-6361/202659454

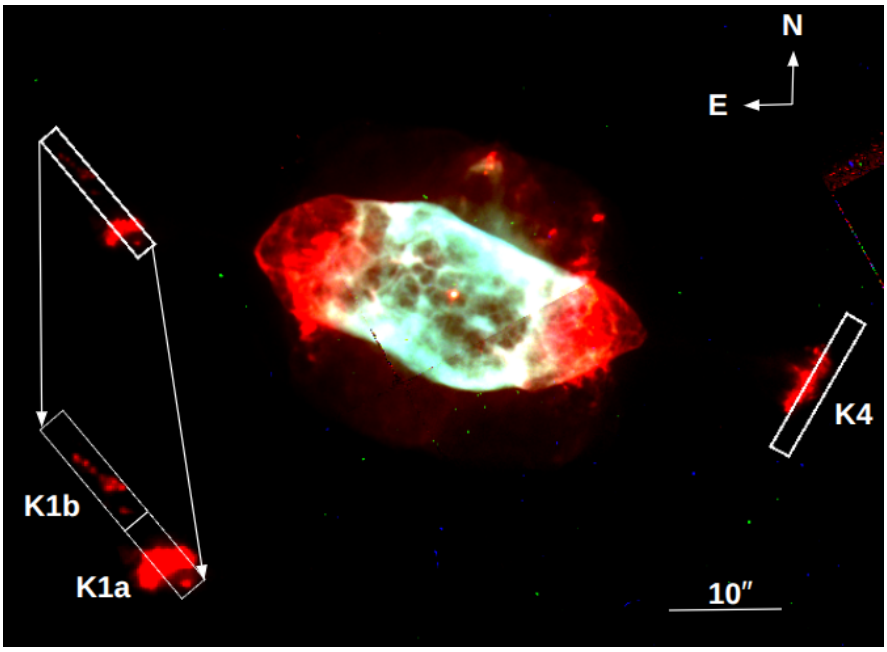


Figure 1: RGB image of NGC 7009 (R: [N II] λ6584, G: Ha, B: [O II] λ5007) from HST data. The white rectangles illustrate the position of the X-Shooter slits centered on the East and WEST LISs. The zoomed-in image of the eastern K1 LIS shows the individual regions that we chose to extract the spectra (K1a, K1b). For K4 the extracted regions is the on in which we can see [NII] emission.

Overview of Observations

Observations were carried out using slit widths of 1.6″, 1.5″, and 1.2″, for the UVB, VIS, and NIR arms respectively, providing spectral resolving powers of R ≈ 3600, 5000, and 4300. To increase the signal-to-noise ratio (S/N), the data were acquired using 2 × 2 binning in the UVB and VIS arms. Both long and short exposures were acquired to provide high S/N while avoiding saturation of the brightest nebular emission lines. Observations were conducted on the nights of 28-29 June (East LIS) and 6-7 July (West LIS) of 2024 under clear and stable conditions, with a seeing of 1.36′′ and an airmass from 1.041 to 1.105. For our observations, we used fixed sky offsets to achieve sufficient sky subtraction, with five cycles of an OSOS sequence.

Release Content

We observed NGC 7009 LISs (East LIS and West LIS) using two slits with P.A 35 and 335 degrees, respectively, and with coordinates: R.A 21:04:12.4 and DEC -11:21:42.0 for the East LIS and R.A 21:04:08.9 and DEC -11:21:56.5 for the West LIS. The X-Shooter observations cover a spectral range from 300 nm to 2400 nm separated in three spectroscopic arms: UVB. VIS and NIR. For each arm, two sets of observations were obtained: one with a total exposure time of 250 s and shorter ones (40 s for UVB and VIS, 50 s for NIR) to avoid saturation of bright emission lines. Observations were carried out with spectral resolving powers of R ≈ 3600, 5000, and 4300. The faintest emission line detected in the X-shooter spectra has a flux of approximately 0.02 relative to Hβ = 100, corresponding to a signal-to-noise ratio of approximately 3. Observations were conducted on the nights of 28-29 June (East LIS) and 6-7 July (West LIS) of 2024.

Release Notes

The data were reduced using the ESOReflex X-shooter pipeline, including wavelength and flux calibrations. For the flux calibration, we used the spectrophotometric standard stars, Feige 110 (East LIS) and EG274 (West LIS) from the ESO database, observed as part of the normal calibration plan. All data were reduced in offset mode. Sky subtraction was performed using dedicated sky exposures obtained with fixed sky offsets following an OSOS observing sequence. Rather than extracting spectra over the entire spatial extent covered by the slit (11′′), smaller extraction apertures encompassing the regions of interest were adopted. So, the East LIS the slit was divided into two subregions of length ∼5.2′′, producing individual spectra for the substructures K1a and K1b (see Figure 1). For the western LIS (K4) the spectrum was extracted considering a length of 7.4′′ (see Figure 1). Differences in slit width in the different wavelength ranges were accounted for at the final extracted spectrum: The UVB and NIR spectra were normalized to the slit width of the VIS spectrum.

Data Reduction and Calibration

The data reduction and calibration procedures are described in the Release Notes section. Corrections for flux losses and extinction/reddening have not been applied directly to the released spectra. These corrections were applied during the subsequent analysis of individual emission-line fluxes.

Data Quality

The quality of the reduced X-shooter spectra was assessed by inspecting the wavelength- and flux-calibrated spectra and the resulting emission-line measurements. The observations were obtained under clear and stable conditions, with a seeing of approximately 1.36″ and an airmass ranging from 1.041 to 1.105.

Both long and short exposures were obtained to provide sufficient sensitivity to faint emission lines while avoiding saturation of the brightest nebular lines.

Data Format

Files Types

The data release consists of reduced, wavelength- and flux-calibrated 1D X-shooter spectra extracted from different spatial regions along the two slit positions covering the East and West low-ionization structures (LISs) of NGC 7009. Rather than extracting a single spectrum over the full slit length, the slit was divided into smaller extraction regions in order to isolate the different spatial components of interest and minimize contamination from the surrounding nebular emission. Those are named as K1a and K1b (extracted from the East LIS) and K4 (extracted from the West LIS).

So the filename identifies the extracted regions name (K1a K1b and K4), the spectroscopic arm (UVB,VIS and NIR) and finally the exposure time in two different classes (short and long).
So, the fits files' names are structures as: [region name]_[spectroscopic arm]_[exposure time].fits

For instance K1a_NIR_short.fits

Acknowledgements

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