Wolf-Rayet Phenomena in Massive Stars and Starburst Galaxies
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Two-dimensional spectroscopy of the Wolf-Rayet galaxy NGC 4861

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Abstract. We have obtained two-dimensional spectroscopy of the central $\sim 10'' \times 12''$ of the Wolf-Rayet galaxy NGC 4861. We have carried out a preliminary analysis of the data, deriving continua at different wavelengths, and emission-line intensity maps (He I λ4471, He II λ4686, Hβ, [O III]λ4959, 5007) directly from the observed spectra.

1. Introduction

The nearby galaxy NGC 4861 ($d = 17.7$ Mpc if $H_0 = 50\,km\,s^{-1}$) is a peculiar galaxy with an elongated streak morphology. Its spectrum exhibits a prominent set of Wolf-Rayet features between 4650 and 4750 Å as well as between 5700 and 5900 Å (Dinerstein & Shields 1986). In this poster, we present some preliminary results derived from two-dimensional spectroscopy ($\sim$4400–5800 Å) with optical fibers of the central $\sim 16'' \times 12''$ of NGC 4861.

2. Instrumentation, observations and data reduction

We used the INTEGRAL system at the 4.2m *William Herschel Telescope* on 1998 April 4 and 5 at the Observatorio del Roque de los Muchachos (*ORM*) on the island of La Palma. Weather conditions were fairly good, with a seeing of about $1''$. We used the standard bundle #2 which is formed by 219 optical fibers, each $0''.9$ in diameter. At the focal plane, the fibers are arranged so that they form a central rectangle and an outer ring. The central rectangle, formed by 189 fibers, covers an area of about $16'' \times 12''$ on the sky. The outer ring, with $90''$ in diameter, is formed by 30 additional fibers. This set of fibers is intended to collect the sky background. At the other end of the bundle, the fibers are aligned at the entrance of the spectrograph, forming a 'pseudo-slit'.

The spectrograph was equipped with 1200 groove mm^{-1} grating centered on 5000 Å. A Tek6 CCD-array of 1124×1124 pixels of 24 μm size was used, giving a linear dispersion of about 1.45 Å $pixel^{-1}$. With this configuration, we took three exposures of 1800 seconds each of the central region of NGC 4861. We have used the INTEGRAL software package (IRAF environment) to reduce the data, which included bias subtraction, fiber extraction, throughtput correction, wavelength calibration, and cosmic-ray rejection. We monitored the atmospheric temperature and pressure during the observing nights to correct for the effects of the differential atmospheric refraction (see Arribas *et al.* 1999 and references

therein for additional details on fiber instrumentation and 2-D spectroscopic data reduction).

3. Results

The observed nuclear spectrum clearly shows the WR emission bump extending from 4650 to 4750 Å. The He II λ4686 emission line seems to be broader than nebular emission lines in a well defined region placed $\sim 0''.5$ SW from the optical nucleus. The FWHM of the He II λ4686 emission line reaches values above $600\,\mathrm{km\,s^{-1}}$ in the spectra of this region, whereas the values for [OIII]λ5007 are lower than $100\,\mathrm{km\,s^{-1}}$. We have obtained from spectra some continuum maps at different wavelengths. The continua present an elongated morphology toward the NE, but with a secondary peak at the NW located $\sim 2''$ from the maximum. Disturbed morphologies are common in WR galaxies, which could be the result of interactions or mergers (Vacca & Conti 1992). In fact, NGC 4861 has a close companion, IC 3961. Emission maps also have been obtained from observed spectra. They clearly show two strong emission regions with the optical nucleus placed between the two peaks. Values for the [OIII]/Hβ ratio are not larger than 8 in the whole observed area, which is a typical value for photo-ionization in H II regions. The bi-polar morphology of the ionized gas maps contrasts with the structure exhibited by the old population of the galaxy. The SW maximum of the emission-line intensity maps nearly coincides with the region where the He II λ4686 emission presents broader FWHMs. The NE peak has He II λ4686 widths similar to nebular emission lines. This fact suggests that the broad features are due to a large number of WR stars in the SW region, whereas the NE emission seems to be of nebular origin.

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