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Ionized gas outflows in the interacting radio galaxy 4C +29.30

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Abstract. We investigate the ionized gas excitation and kinematics in the inner $4.3 \times 6.2\,\mathrm{kpc}^2$ of the merger radio galaxy 4C +29.30. Using optical integral field spectroscopy with the Gemini North Telescope, we find signatures of gas outflows, including high blueshifts of up to ~ -650 km s^{-1} observed in a region $\sim 1''$ south of the nucleus, which also presents high velocity dispersion ($\sim$250 km s^{-1}). A possible redshifted counterpart is observed north from the nucleus. We propose that these regions correspond to a bipolar outflow possibly due to the interaction of the radio jet with the ambient gas. We estimate a total ionized gas mass outflow rate of $\dot{M}_{out} = 18.1^{+8.2}_{-5.3}$ M$_\odot$ yr^{-1} with a kinetic power of $\dot{E} = 5.8^{+7.6}_{-2.9} \times 10^{42}$ erg s^{-1}, which represents $3.9^{+5.1}_{-1.5}$% of the AGN bolometric luminosity. These values are higher than usually observed in nearby active galaxies and could imply a significant impact of the outflows on the evolution of the host galaxy.

Keywords. galaxies: individual: 4C +29.30 – galaxies: active – galaxies: nuclei – galaxies: kinematics and dynamics – galaxies: jets

1. Introduction

Active Galactic Nuclei (AGN) feedback is now thought to play a major role in galaxy evolution. In order to explain the observed scaling relationships between the mass-accreting supermassive black holes (SMBHs) and galaxy bulge properties (McConnell & Ma 2013; Kormendy & Ho 2013), AGN feedback is usually summoned (Fabian 2012). Although AGN feedback processes have been identified in recent works (Couto *et al.* 2017; Revalski *et al.* 2018), their impact must be quantified in order to determine whether or not they deliver effective power, capable of altering star formation rates and evacuating gas reservoirs (Harrison 2017; Zubovas & Bourne 2017).

In this work, we present results obtained from integral field spectroscopy observations (Gemini MultiObject Spectrograph instrument mounted on the Gemini North Telescope) of 4C +29.30, a radio galaxy with elliptical morphology at redshift z = 0.06, presenting an extended jet (up to $\sim$30 kpc from the nucleus) and moderate radio luminosity ($\sim 10^{42}$ erg s^{-1}). 4C +29.30 is possibly a merger system, displaying a characteristic dust lane passing in front of the central region in similar fashion to Centaurus A (Siemiginowska *et al.* 2012).

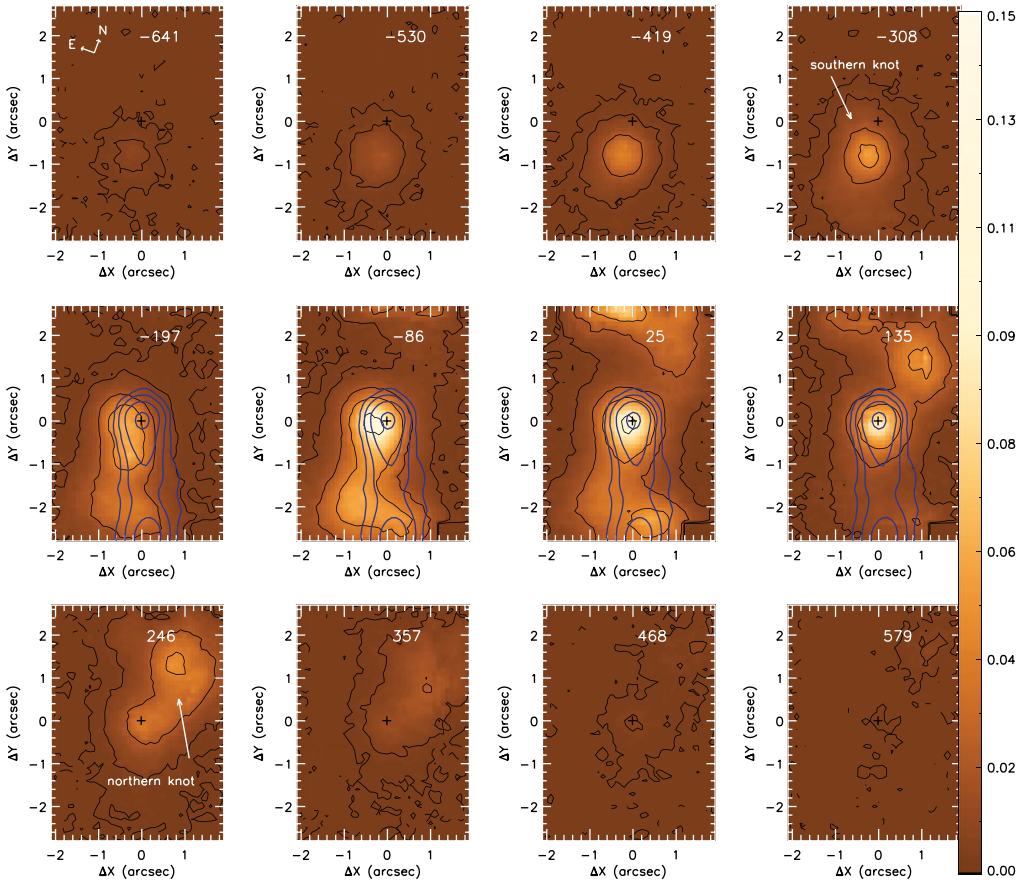

Figure 1. Channel maps along the [O III]λ5007 emission-line profile, in order of increasing velocities shown at the top of each panel in units of km s^{-1}. Flux units are 10^{-16} erg s^{-1} cm^{-2} spaxel^{-1} . The blue contours display the VLA 4.8 GHz emission from the radio jet Breugel*et al.* (1986).

2. Results and discussion

Fig. 1 shows channel maps along the [O III]λ5007 emission-line profile. High blueshifts (∼650 km s^{-1}) are observed in a region ∼1″ south of the nucleus, while a northern counterpart is observed with velocities of up to ∼580 km s^{-1}. These components also present high velocity dispersion (not shown in this proceedings, Couto et al. in preparation), with up to σ∼250 km s^{-1} in the southern region.

We interpret that these components are a bipolar outflow structure, that could be related to the interaction of the radio jet with non-symmetrical density environment, given the orientation of the outflows in relation to the jet. This is supported by the presence of the highest electron densities (∼400 cm^{-3}, also not shown here) in a region spatially correlated with the radio jet 1″ south-west from the nucleus. We estimate that the outflow mass rate is $\dot{M}_{out} = 18.1^{+8.2}_{-5.3}$ M$_\odot$ yr^{-1} and the outflow kinetic power corresponds to $3.9^{+5.1}_{-1.5}$% of 4C +29.30 AGN bolometric luminosity ($L_{\rm bol} = 1.4 \pm 0.8 \times 10^{44}$ erg s^{-1}). These values are above the trend observed by Fiore *et al.* (2017), and indicate that the outflows in 4C +29.30 are powerful and could affect the galaxy evolution.

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