Galaxy Evolution and Feedback across Different Environments
Proceedings IAU Symposium No. 359, 2020
T. Storchi-Bergmann, W. Forman, R. Overzier & R. Riffel, eds.
doi:10.1017/S1743921320004305

Feedback from ionised gas outflows in the central kpc of nearby active galaxies

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Abstract. We use integral-field spectroscopy obtained with the Gemini instrument GMOS-IFU (Gemini Multi-Object Spectrograph Integral Field Unit) to map the gas distribution, excitation and kinematics in the central kpc of 11 nearby active galaxies. We use channel maps to quantify the ionised gas masses, mass outflow rates and powers of the outflows in order to gauge the feedback effect of these outflows on the host galaxies. We compare this method with others previously used to calculate the feedback power of such outflows.

Keywords. galaxies: active; active galactic nuclei; AGN: feedback, AGN: outflows

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1. Introduction and Goals

One of the most important phenomena occurring in the center of galaxies are the feeding and feedback processes associated with Active Galactic Nuclei (AGN) that may explain how nuclear activity is connected with the evolution of the host galaxy (Madau & Dickinson 2014). In this work we quantify AGN feedback via ionised gas outflows, and show a comparison between two different methods to calculate the mass outflow rate $\dot{M}$ and outflow power P. We use data from the Gemini instrument GMOS-IFU to derive these quantities from emission-line channel maps (Fig. 1), under the assumption that ionised gas that has velocities $|\,v\,| \geqslant 300\,\mathrm{km\,s^{-1}}$ is outflowing. We use the equations below:

$$M = \frac{m_p L_{H\alpha}}{n_e j_{H\alpha}(T)}, \quad \dot{M} = M\frac{v}{R} \quad \text{and} \quad P = \frac{1}{2}\dot{M}v^2 \tag{1.1}$$

where M is the ionised gas mass, m_p is the proton mass, $L_{H\alpha}$ the $H\alpha$ luminosity, n_e the electronic density obtained from the [SII] lines ratio, and $j_{H\alpha}$ is the $H\alpha$ emissivity in $\mathrm{erg\,cm^3}\,s^{-1}$ for a typical temperature of 10^4K. $\dot{M}$ is the mass outflow rate, calculated in units of solar masses per year, v is the velocity of the channel and R is the distance of each pixel to the galaxy center. P is the outflow power, calculated in units of $\mathrm{erg}\,s^{-1}$.

2. Results

We use the hypothesis that the outflows are mapped only via the channels with velocities $|\,v\,| \geqslant 300\,\mathrm{kms^{-1}}$, with lower velocities assumed to correspond to orbits in the galaxy disk. The calculated $\dot{M}$ and P values are shown in Fig. 2, compared to previous values from the literature, showing that the points approximately follow the relation with the AGN luminosity L_{Bol} obtained by Fiore *et al.* (2017) for active galaxies with similar L_{Bol}.

Hopkins & Elvis (2010) argue that $P/L_{Bol} \geqslant 0.005$ is necessary to impact the galaxy evolution. We did not find any galaxy in our sample with $P/L_{Bol} \geqslant 0.005$, and concluded that these outflows do not have significant impact on the host galaxies.

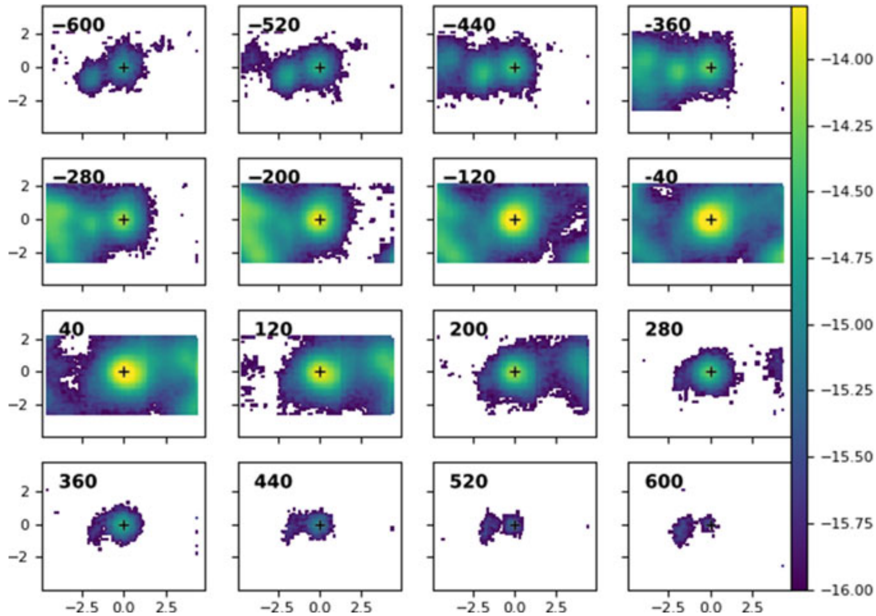

Figure 1. [OIII]λ5007Å channel maps of the inner kpc of the nearby Seyfert 1 galaxy NGC 3516. Angular units are arcseconds and the color bar gives the fluxes in logarithmic units of erg cm^{-2} s^{-1}.

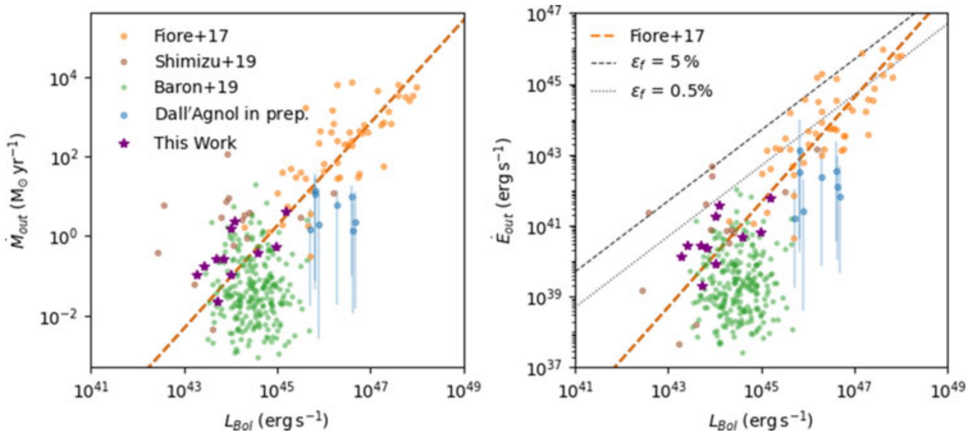

Figure 2. Our results (magenta stars) for $\dot{M}$ and P as a function of the AGN luminosity as compared with others from the literature. Adapted from Dall'Agnol *et al.* (2020).

References

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https://doi.org/10.1017/S1743921320004305 Published online by Cambridge University Press