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/S1743921320004317

Multiwavelength analysis of OH Megamaser galaxies: The case of IRAS11506-3851

Carpes P. Hekatelyne and Thaisa Storchi-Bergmann

Departamento de Astronomia, Universidade Federal do Rio Grande do Sul,
91501-970 Porto Alegre, Rio Grande do Sul, Brazil
email: hekatelyne.carpes@gmail.com

Abstract. We present Multi-Object Spectrograph (GMOS) Integral Field Unit (IFU), Hubble Space Telescope (HST) and Very Large Array (VLA) observations of the inner kpc of the OH Megamaser galaxy IRAS 11506-3851. In this work we discuss the kinematics and excitation of the gas as well as its radio emission. The HST images reveal an isolated spiral galaxy and the combination with the GMOS-IFU flux distributions allowed us to identify a partial ring of star-forming regions surrounding the nucleus with a radius of ≈500 pc. The emission-line ratios and excitation map reveal that the region inside the ring present mixed/transition excitation between those of Starbursts and Active Galactic Nuclei (AGN), while regions along the ring are excited by Starbursts. We suggest that we are probing a buried or fading AGN that could be both exciting the gas and originating an outflow.

Keywords. masers; galaxies: active; galaxies: interactions; galaxies: ULIRGs

1. Introduction

Ultra Luminous Infrared Galaxies (ULIRGs; $L \geqslant 10^{12}$ $L_{\odot}$) are known to be gas-rich galaxies undergoing strong interactions and associated with advanced mergers (Sanders & Mirabel 1996). Approximately 20% of LIRGs present masers at 1665 and 1667 MHz with luminosities of about 10^{2-4} $L_{\odot}$ (Lo 2005). These galaxies are called OH Megamaser galaxies (hereafter OHM galaxies). The OH maser emission is the result of stimulated emission, being produced by the amplification of the nuclear radio continuum by foreground molecular gas, with the inverted level populations being pumped by far infrared radiation that could be due to a Starburst or its combination with an obscured Active Galactic Nuclei (AGN) (Parra *et al.* 2005).

There is evidence that many of these OHM galaxies host an AGN that is still immersed in dense layers of dust and gas, suggesting that they could represent a key stage in galaxy evolution in which the AGN is being triggered by the accretion of matter to the central supermassive black hole (Darling & Giovanelli 2000). The investigation of the nature of OHM galaxies can provide information about the evolution of gas-rich mergers and about how the OH maser emission is related to the nature of the dominant heating source.

This study is part of an ongoing project aimed to investigate the nature of OHM galaxies using multi-wavelength analysis (Sales *et al.* 2015, 2019; Hekatelyne *et al.* 2018a,b). The main result, so far, is that the four galaxies already studied present signatures of an embedded AGN surrounded by star-forming regions. In addition, it is possible to identify signatures of gas non-circular motions that are attributed to inflows and outflows. Although we find evidence of the presence of AGNs, the number of objects is still too small for a more definitive conclusion about the nature of OHM galaxies.

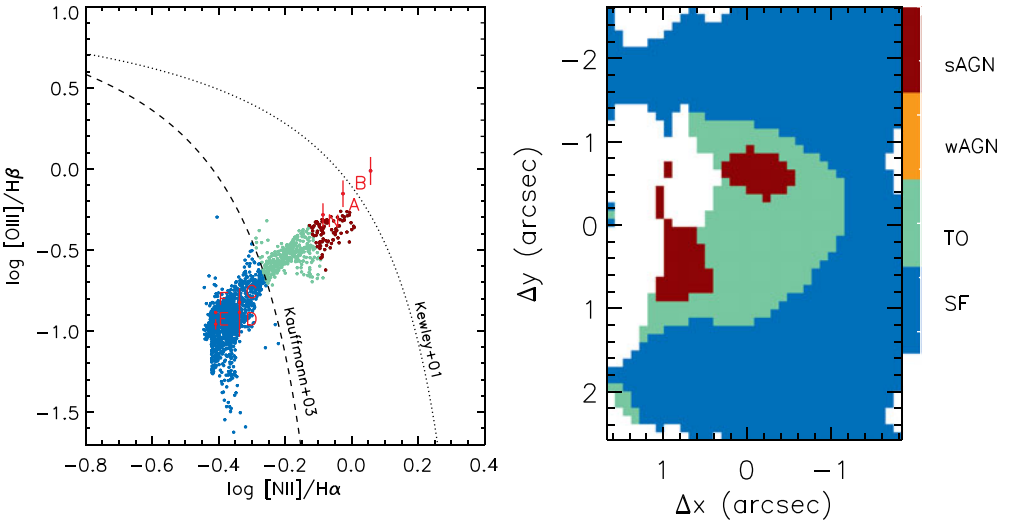

Figure 1. [O III]λ5007/H$_\beta$ versus [N II]/H$_\alpha$ diagnostic diagram (left). The dotted and dashed lines represent the Kewley and Kauffmann criteria respectively. Excitation map identifying the regions within the FoV presenting distinct excitation mechanisms: strong AGN (sAGN), weak AGN (wAGN), Transition object (TO) and star-forming (SF) (right).

2. Results

We report a multi-wavelength data analysis of IRAS 11506-3851. The GMOS-IFU observations cover the inner $720 \times 1200\,\mathrm{pc}^2$ at a spatial resolution of 193 pc and spectral resolution of 1.8 Å. Our main results are:

The HST images reveal an isolated spiral galaxy and several knots that in combination with the GMOS-IFU data can be attributed to star-forming regions in a 500 pc radius circumnuclear ring. Moreover, the VLA images reveal a steep continuum spectrum kpc-scale bipolar structure in the east-west direction, consistent with an AGN outflow.

Inside the circumnuclear ring the excitation is due to both Starburst and AGN activity (see Fig. 1). On the other hand, the excitation in the external regions (ring) it is due only to Starburst activity. Besides, the presence of radio emission indicates another source of excitation in the nuclear region. From VLA data we also conclude that the gas in the inner 240 pc is partially ionized by an embedded AGN.

We fitted and subtracted a rotating-disk model to the gas kinematics and find deviations from pure rotation within the inner 240 pc that are co-spatial to an outflow in neutral gas that was previously detected (Cazzoli *et al.* 2016). Moreover, these regions present the highest velocity dispersion and are coincident with the radio emission. We argue that the nuclear region is unveiling a new plasma bubble ejection that is pushing the surrounding gas and either shocks or escape from the AGN radiation are increasing the gas excitation in these regions.

References

Cazzoli, S., Arribas, S., Maiolino, R., *et al.* 2016, *A&A*, 590, A125
Darling, J. & Giovanelli, R. 2000, *AJ*, 119, 3003
Hekatelyne, C., Riffel, R. A., Sales, D., *et al.* 2018a, *MNRAS*, 474, 5319
Hekatelyne, C., Riffel, R. A., Sales, D., *et al.* 2018b, *MNRAS*, 479, 3966

https://doi.org/10.1017/S1743921320004317 Published online by Cambridge University Press

Lo, K. Y. 2005, *ARA&A*, 43
Parra, R., Conway, J. E., Elitzur, M., *et al.* 2005, *A&A* 443, 383
Sales, D. A., Robinson, A., Axon, D. J., *et al.* 2015, *ApJ*, 799, 25
Sales, D., Robinson, A., Riffel, R. A., *et al.* 2019, *MNRAS*, 486, 3350
Sanders & Mirabel 1996, *ARA&A*, 34, 749

https://doi.org/10.1017/S1743921320004317 Published online by Cambridge University Press