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Selection and characterisation of Red Geysers in the MaNGA survey

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Abstract. Red Geysers are quiescent galaxies that show a bi-polar outflow, but the mechanism that produces this outflow is still unclear. Using MaNGA data, we find that Red Geysers correspond to ∼1.6% of the sample of galaxies already observed by MaNGA. About ∼16% of the Red Geysers show clear evidence of Active Galactic Nuclei, as revealed by emission-line ratios.

Keywords. galaxies: red geysers, galaxies: kinematics, galaxies: nuclei

1. Introduction

Based on the analysis of MaNGA (Mapping Nearby Galaxies at APO) data from SDSS-IV (Sloan Digital Sky Survey-IV), Cheung *et al.* (2016) revealed a new class of galaxies: the "Red Geysers". Red Geysers are quiescent galaxies and are characterised by a bipolar outflow. Cheung *et al.* (2016) showed for Akira – the prototype of this class – that this bipolar outflow is probably caused by a low-luminosity AGN (LLAGN). In addition, Roy *et al.* (2018) using MaNGA data from Data Release 13 (DR13), which are identical to the data of the DR14 (Abolfathi *et al.* 2018), and radio observations from VLA-FIRST found that most Red Geysers probably have a radio-mode AGN. Riffel *et al.* (2019) combined large scale data from MaNGA with observations from Gemini North Multi-Object Spectrograph (GMOS) Integral Field Unit (IFU) to constrain the gas and stellar kinematics of the galaxy Akira on scales of hundreds of pc and to better understand the mechanism which produces the outflow. Riffel *et al.* (2019) found that the orientation of outflow changes radially from the nuclear region to kpc scales and suggest that the outflow is produced by precession of the supermassive black hole accretion disk. In order to verify if the scenario proposed by Riffel *et al.* (2019) occurs in other Red Geysers, we have used the MaNGA data contained in SDSS-IV DR15 (Aguado *et al.* 2019) to select a sample of Red Geysers.

2. The sample and Results

Following Roy *et al.* (2018), we have defined the sample of Red Geysers in the MaNGA survey by adopting the following selection criteria: rest frame colour NUV$-r > 5$, star formation rate with $\log \mathrm{SFR}[M_\odot/\mathrm{yr}] < -2$, bi-symmetric pattern in Hα-EW maps aligned with the gas kinematic axis and misaligned with the stellar kinematic axis, velocity fields of Hα reaching values of ± 300 km/s and being at least twice as high as the values of the stellar velocity fields. To measure the orientation of the line of nodes of stellar and gas

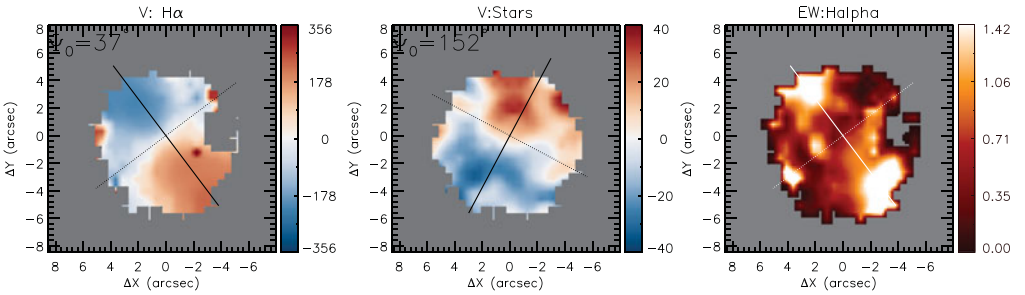

Figure 1. Kinematic structures and gas emission for galaxy MaNGA 1-523238. From left to right: Hα velocity field, stellar velocity field and Hα-EW map. The colour bars show the velocities in units of km s^{-1} and the EW values in Å. The black solid (first and second panel) and white solid (third panel) lines show the orientation of the line of nodes (Ψ_0) as measured by the kinemetry method.

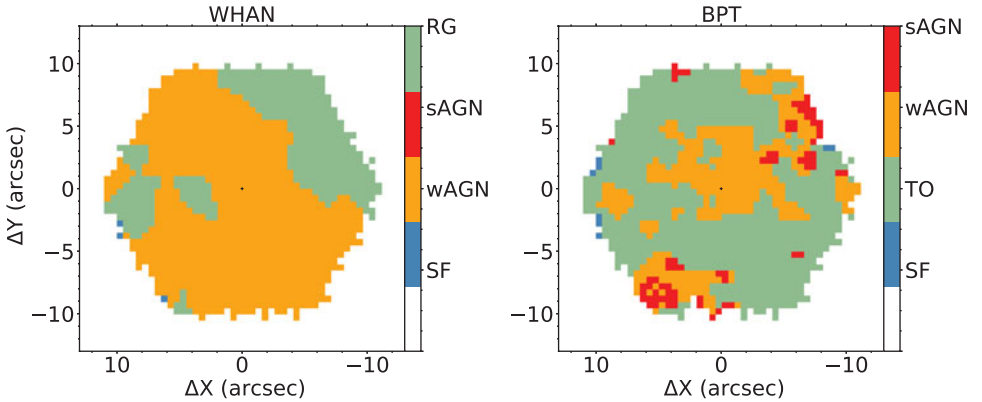

Figure 2. WHAN and BPT diagrams for galaxy MaNGA 1-217022. The following labels were used: SF or star-forming galaxies, TO (transition objects), wAGN or weak AGN (low-luminosity AGN), sAGN or strong AGN (high-luminosity AGN) and RG (retired galaxies–Hα-EW < 3 Å).

velocity fields we used the kinemetry method (Krajnović *et al.* 2006). We then added the following criteria: difference in the orientation of the line of nodes of stellar and gas velocity fields of $10° < \Delta PA < 170°$. Fig. 1 shows examples of the gas and stellar velocity fields and Hα-EW map for one target classified as a Red Geyser.

We find that ∼1.6% of the MaNGA galaxies in DR15 satisfy the selection criteria of the previous section and are thus classified by us as Red Geysers. In order to investigate if the objects of our sample present AGN activity, we constructed the BPT (Baldwin *et al.* 1981) and WHAN (Cid Fernandes *et al.* 2010) diagrams. Fig. 2 shows examples of such diagrams for MaNGA 1-217022, which present a weak AGN. We observe clear evidence of AGN (objects classified as AGN in both BPT and WHAN diagrams) in only 17 (16%) galaxies of our sample. However, the low spatial resolution of MaNGA (∼2.″5) does not allow the detection of weak AGN, whose emission may be diluted by those from circumnuclear regions. Thus, the AGN fraction determined here can be considered a lower limit. We are conducting follow-up observations with Gemini to obtain high resolution optical integral field spectroscopy for a sub-sample of Red Geysers in order to characterise the gas kinematics and excitation in the inner kpc (Ilha *et al.* in prep.).

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