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On the path toward a universal outflow mechanism in light of NGC 4151 and NGC 1068

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Abstract. We use near-infrared Integral Field Unit (IFU) data to analyze the galaxies NGC 4151 and NGC 1068, which have very different Eddington ratios - ∼50 times lower for NGC 4151. Together with a detailed data cube treatment methodology, we reveal remarkable similarities between both AGN, such as the detection of the walls of an "hourglass" structure for the low-velocity [Fe II] emission with the high-velocity emission within this hourglass; a molecular outflow - detected for the first time in NGC 4151; and the fragmentation of an expanding molecular bubble into bullets of ionized gas. Such observations suggest that NGC 4151 could represent a less powerful and more compact version of the outflow seen in NGC 1068, suggesting a universal feedback mechanism acting in quite different AGN.

Keywords. galaxies: active, galaxies: individual (NGC 1068, NGC 4151)

1. Context

The primary motivation of this work is to analyse the presence of an "hourglass" wall structure in NGC 1068 (May & Steiner 2017) and NGC 4151, as seen in the low-velocity [Fe II] emission of these galaxies, as well as the high-velocity emission that fills in the hourglass volume. The combination with observations having excellent seeing and our routine of data treatment has revealed a new scenario for both galaxies, which is summarized in Figs. 1 and 2.

2. Results and Conclusions

For NGC 1068, we propose that a strong secondary wind is formed in the northeast cone where the jet hits one of the H_2 molecular clouds (the primary wind comes from the accretion disc). This wind probably changes the direction of the accelerating [Si VI] emitting blobs. Furthermore, the north-south asymmetry in the ionized gas emission probably arises from this interaction. The same process likely occurs in the southwest cone, but without a molecular barrier so close to the AGN. In the northeast and southwest cones, this wind would be responsible for accelerating the narrow line region (NLR) blobs and inflating the bubble. For NGC 4151, in turn, we propose that the ionized outflow is mostly a consequence of a molecular fragmentation process, leading to the formation of bullets of gas. Furthermore, both the low- and high-velocity H_2 structures are connected

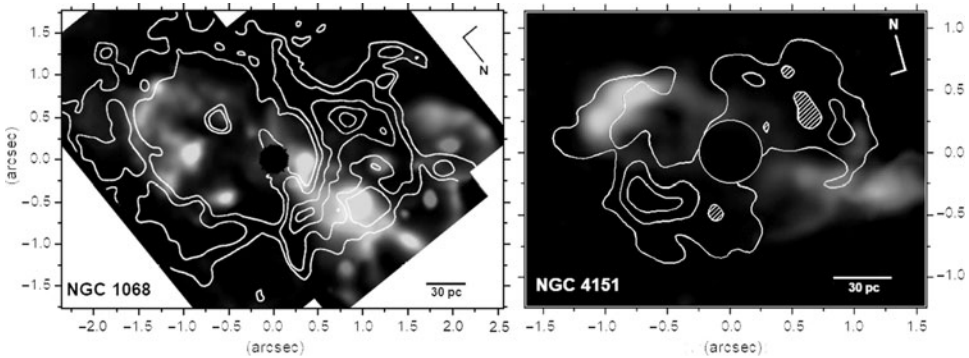

Figure 1. High-velocity [Fe II] emission and the H_2 molecular structure (contours) for NGC 1068 (left panel), and NGC 4151 (right panel).

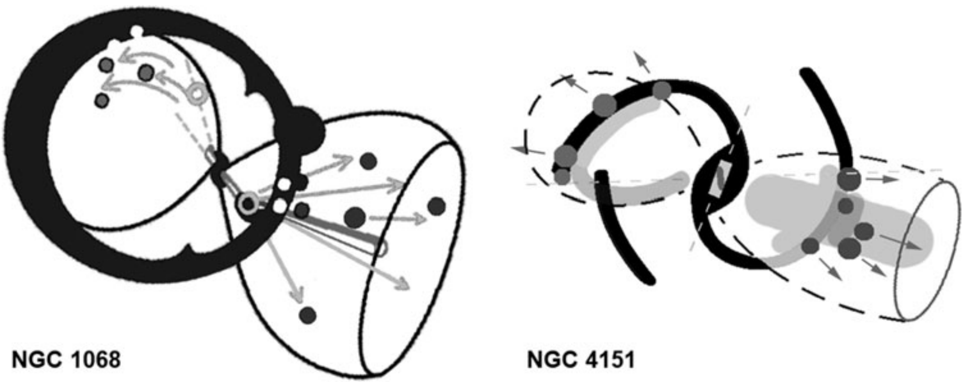

Figure 2. Left panel: a sketch of the interaction between the jet and the molecular bubble for NGC 1068. The production of the secondary wind is marked by two open circles and the arrows illustrate their directions. The molecular cavity (in black) remains intact in one side of the cone and is disrupted on the side where the blobs of gas are being blown away after the jet-cloud interaction. Right panel: sketch of the scenario proposed for the NLR of NGC 4151. The discontinuous molecular (H_2) walls are shown in black together with the dashed contours of the hourglass structure. The filled circles represent the bullets of ionized and molecular gas, with the arrows denoting their radial motion, while the light gray inside the hourglass illustrates the main regions of the high-velocity [Fe II] emission. The straight dashed lines denote the PA of the jet and the torus (central rectangle), while the accretion disc is shown inside the torus (not to scale). See a colour version of the presented panels in May & Steiner 2017 and May *et al.* 2020 (accepted).

to the [Fe II] emission inside and outside the cones. Our observations support the scenario that an expanding molecular bubble is being inflated and disrupted by the AGN and also by the jet.

References

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