FROM SIMULATION TO OBSERVATION: TESTING COMPATIBILITY OF AGN OUTFLOW RATE ESTIMATES

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Active galactic nuclei (AGN) can launch powerful galactic outflows that reshape the interstellar medium and regulate star formation. However, comparing outflows in simulations and observations is difficult because key derived quantities (most notably the mass outflow rate $\dot{M}$) depend strongly on how outflowing gas is defined and how $\dot{M}$ is computed [1]. This can change inferred scaling relations and make physical interpretation unclear.

The aim of this project is to test how different outflow definitions and $\dot{M}$ calculation methods affect the relations between outflow properties and galaxy/AGN parameters, and to determine which trends remain stable across methods.

High-resolution hydrodynamical IllustrisTNG50 simulations [2] are used as the main simulation data set, and idealized GADGET-3 simulations [3] are used as controlled test cases to diagnose systematic effects. Outflowing gas is selected using kinematic criteria refined by thermodynamic phase cuts to reduce contamination from non-outflowing material. Multiple $\dot{M}$ estimators are then evaluated: Eulerian shell-based fluxes, Lagrangian crossing methods and projection-based observational analogues, while aperture, velocity threshold, time sampling and line of sight are varied. It is found that $\dot{M}$ and the resulting scaling relations with $M_{\star}$, SFR and L_{AGN} can vary strongly depending on the chosen outflow definition and measurement method, even for the same system. This motivates clearer, more consistent reporting of $\dot{M}$ calculation methods.

Overall, a more consistent basis for comparing simulations and observations is provided, and the analysis choices that most strongly affect $\dot{M}$ and the scaling relations are identified.

Acknowledgements
This research was funded by the Research Council of Lithuania (LMT), project No. S-MIP-24-100.

Keywords: active galactic nucleus (AGN), galactic outflows, mass outflow rate.

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