# JWST/NIRSpec insights into the nuclear environment of Arp 220: A detailed kinematic study

ID #228

L. Ulivi[1,2,3], M. Perna[4], I. Lamperti[4], A. Marconi[2,3], G. Cresci[2], S. Arribas[4] et al.

[1] University of Trento, Italy
[2] INAF - Osservatorio Astrofisico di Arcetri, Italy
[3] University of Florence, Italy
[4] Centro de Astrobiología (CAB), CSIC-INTA, Madrid Spain

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## INTRODUCTION

Ultraluminous infrared galaxies (ULIRGs) are among the brightest objects in the local Universe, with extreme infrared luminosity resulting from high star formation rates and/or active galactic nuclei (AGN) activity. ULIRGs are believed to represent a phase of rapid growth in massive galaxies, triggered by the merger of gas-rich galaxies. These mergers lead to the formation of multi-phase (molecular, ionized, neutral) and multi-scale (from < 0.1 to > 5 kpc) outflows. Studying these outflows in ULIRGs is essential for understanding the mechanisms and feedback processes that drive galaxy evolution.

## ARP220

Arp220 is a late-stage merging system of two compact and highly obscured nuclei located at a distance of approximately 77 Mpc. It undergoes intense star formation, with a total star formation rate of 200-250 M⊙ $yr^{-1}$. The system exhibits complex kinematics, including outflows originating from both nuclei.

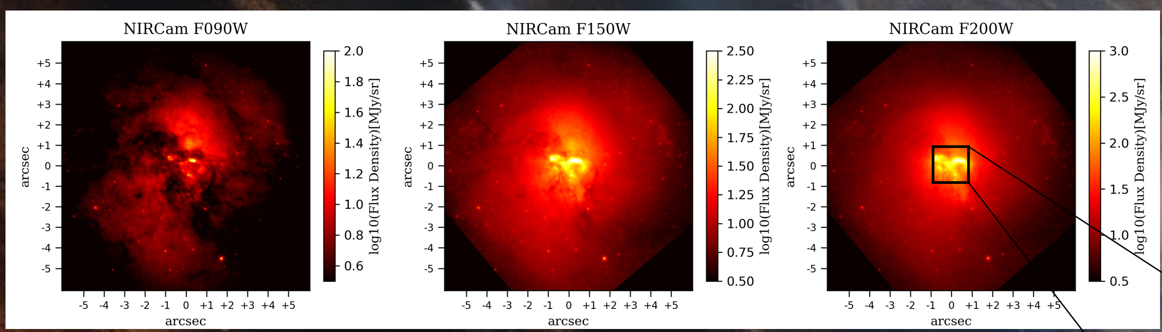


Fig.1 shows three bands of NIRCam@JWST showing high obscuration by dust in the bluest band.

Thank to NIRSpec@JWST observing in the NIR band with IFU spectroscopy, it possible to penetrate the dust and study the complex nuclear kinematics of Arp220.

## ANALYSIS

1. We modelled and subtracted the stellar continuum emission

2. We built a model for the emission lines to study the integrated properties of each transitions

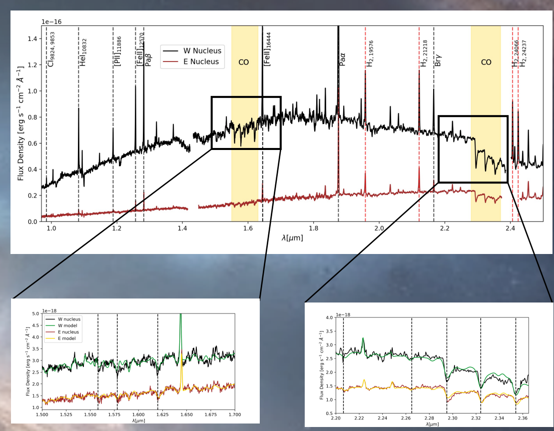


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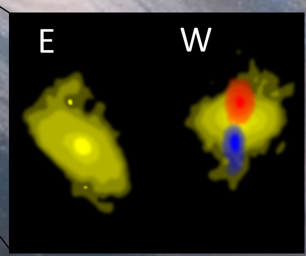
Fig. 2 shows the W and E nuclear spectra with inset on the main CO band in absorption and the model of continuum emission

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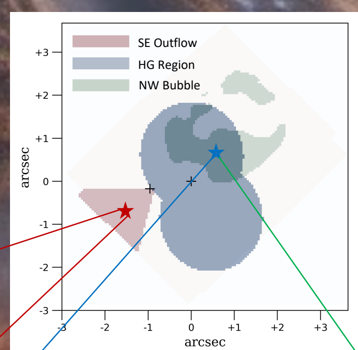
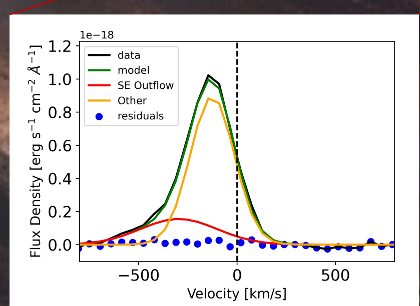
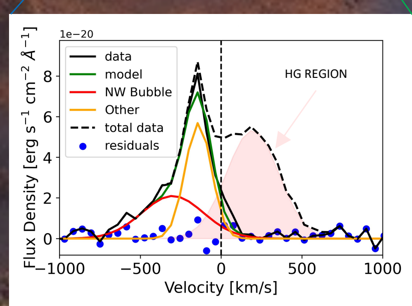
3. We decoupled the different kinematic components associated with the most prominent emission lines in the spectra. (Pa$\alpha$, $H_2$)

Fig. 3 shows the kinematic components (outflow/bubble) that we detected (upper panel) and the decomposition of the multi-peak line profiles in different Gaussian components that we attributed to these physical features

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## RESULTS

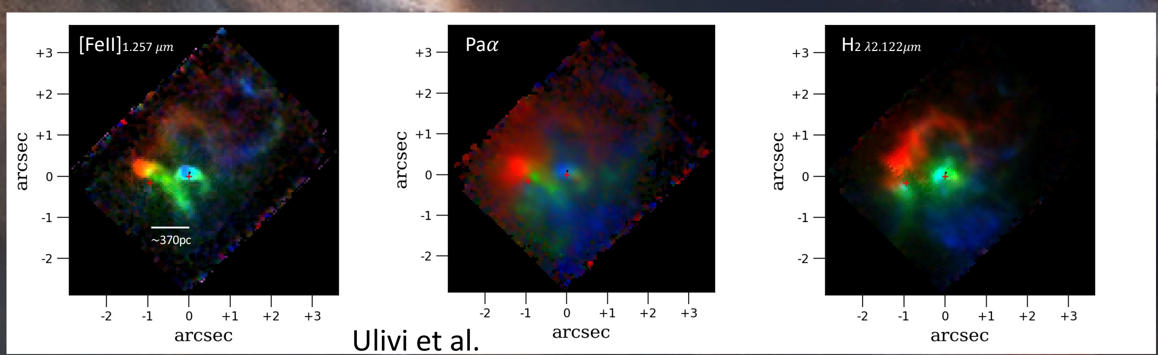


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Fig. 4 Emission line maps obtained integrating the line profile of [FeII]λ1.257 µm, Paα, and $H_2$ in red and blue-shifted high velocities (red and blue) and low velocities (<|200km/s|)

After decoupling all the components of the different outflows associated with both nuclei, we calculated the properties of the outflows (density, velocity, mass, mass outflow rate and energetics etc. ) in both the ionized gas and the molecular phase.

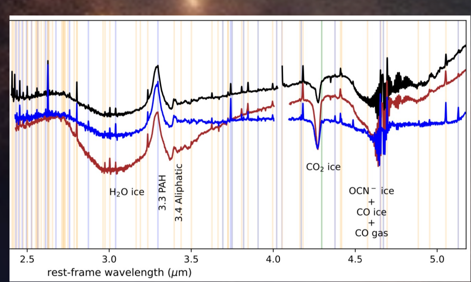
We found relatively low velocities (<~1000 km/s) , densities around $10^3$ $cm^{-3}$ and mass ~$10^{3-5}$ M⊙ .We also found that ionized and warm molecular outflowing gas contribute less than 6% to the total mass and to the total energy of the outflows; the highest contribution is given by the cold molecular gas.

We also discussed the possible origin of the outflows. The relatively low velocity and the lack of high ionization lines suggest that these outflows are mainly driven by the feedback from supernovae. We speculate that any potential AGN activity, if it exists, might be relatively weak.

We found that outflows detected at smaller scales are aligned with the larger-scale outflow observed with MUSE suggesting that the smaller-scale outflows may be related to the kpc-scale atomic outflow.

## FUTURE WORKS

Still lot of transitions and bands to analyze up to 5$\mu m$

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## STORYLINE of ARP 220

Ulivi et al. (Subm.)
Perna et al. 2024
Pereira-Santaella et al. 2021
Wheeler et al. 2020
Perna et al. 2020
Barcos-Munoz et al. 2018
Paggi et al. 2017
Varenius et al. 2016
Lockhart et al. 2015
Scoville et al. 2007
Scoville et al. 1998