

MINIGRANT RSN1

Antonello Calabrò (INAF – OAR)

Title: High-redshift galaxy evolution with VANDELS

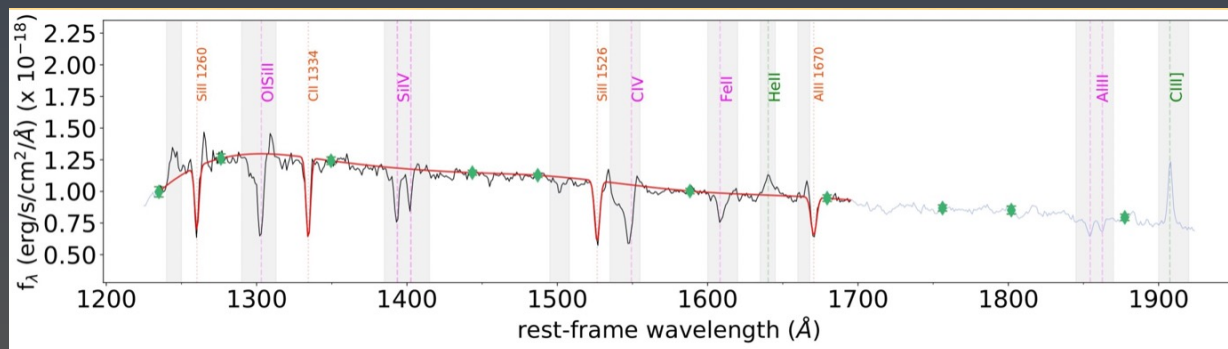
Associated INAF project ('scheda') : VANDELS: an ESO public spectroscopic survey to explore the high-z universe (P.I. L. Pentericci)

Budget requested/awarded : 7000 €

Main research topics and accomplishments

A) The kinematic properties of the ISM in high-redshift star-forming galaxies :

- Paper entitled 'Properties of the interstellar medium in star-forming galaxies at redshifts $2 \leq z \leq 5$ from the VANDELS survey' was published in A&A (volume 667, page A117) on 15 November 2022 : <https://doi.org/10.1051/0004-6361/202244364>
- Results were presented at the conference 'From galaxies to cosmology with large spectroscopic surveys' in Marseille (4-7 July 2022)

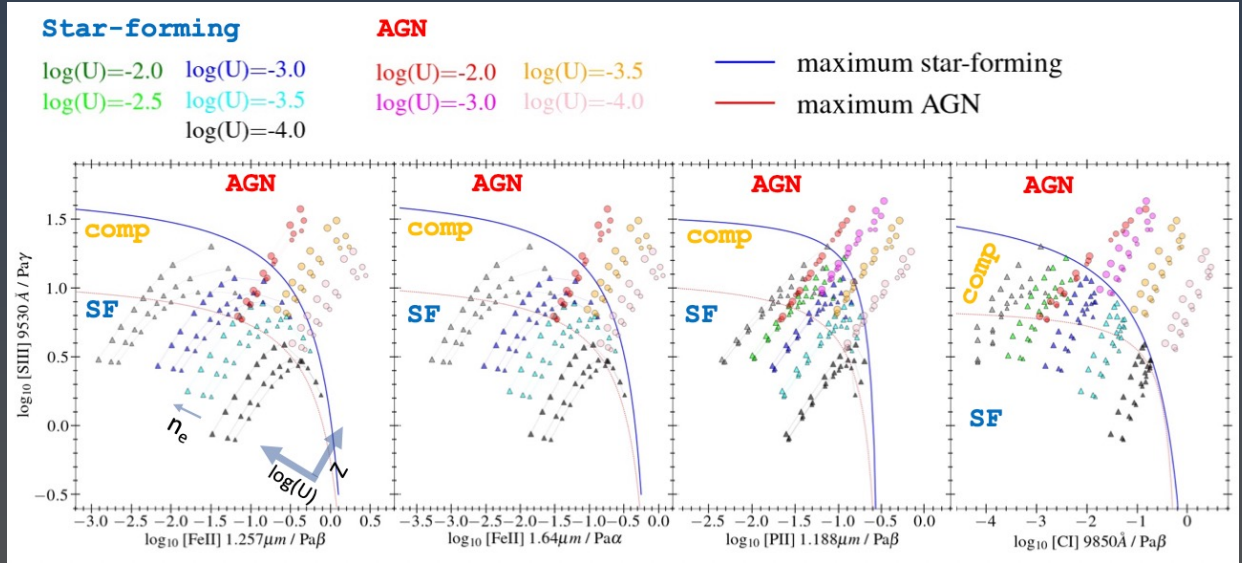


Spectral stack of 330 star-forming galaxies selected for our analysis in the VANDELS survey. The red curve highlights low-ionization, UV absorption lines that were used to measure the ISM outflow velocity in typical galaxies at redshifts $2 < z < 5$ and study its correlation with other galaxy properties.

B) The growth of black-holes and their influence on galaxy evolution :

- Paper on the mass-metallicity relation of type-2 AGNs at redshift ~ 3 from the VANDELS (+ zCOSMOS) surveys is ongoing
- Priority was given to the new data coming from JWST, in particular from the CEERS and GLASS surveys, which I am member of. With these data, a paper entitled ‘Near-infrared emission line diagnostics for AGN from the local Universe to $z \sim 3$ ’ was recently accepted for publication on A&A on 5 September 2023 (forthcoming article available at <https://doi.org/10.1051/0004-6361/202347190>). This paper leverages the unique sensitivity of JWST/NIRSpec in the near-infrared to explore new diagnostics for AGN and star-forming galaxies in the near-infrared rest-frame. This method allows to unveil a new population of dust obscured type-2 AGNs compared to those identified through standard optical based diagnostics.
- Catalog of emission line measurements (fluxes, FWHM, redshifts) for 90 emission line galaxies observed in CEERS with the M-grating mode (R=1000) is publicly available on the GitHub page: https://github.com/Anthony96/Line_measurements_nearIR

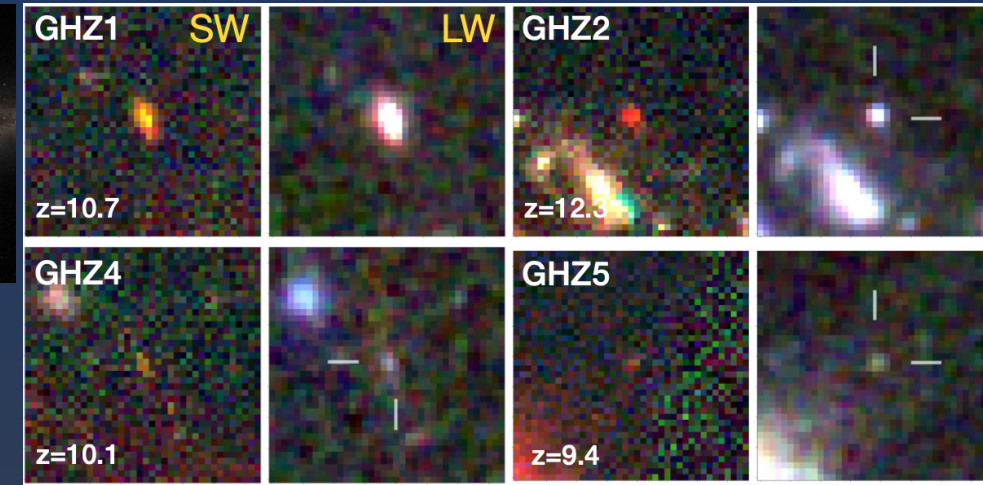
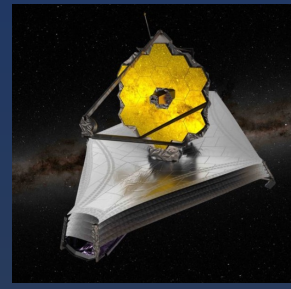
- Cloudy emission line predictions for star-forming and AGN models used in the paper are publicly available at the pages : https://github.com/Anthony96/AGN_models and https://github.com/Anthony96/star-forming_models
- The results were presented at the conference ‘The growth of galaxies in the Early Universe - VIII’ in Sexten (13-17 March 2023)



Separation of AGN and star-forming galaxies in four near-infrared rest-frame diagnostic diagrams, involving the $[SIII]9530 \text{ \AA} / Pa\gamma$ ratio vs $[FeII] / Pa\beta$, $[FeII] / Pa\alpha$, $[PII] / Pa\beta$, $[CI] / Pa\beta$.

Complementary research topics

C) The morphology of galaxies up to the reionization epoch :



- Key contribution in the study of high-redshift galaxy evolution was given in several JWST-related projects investigating the morphological properties of high redshift galaxies.
- Non parametric morphological parameters estimation from JWST-NIRCam images through the following code available for the general public: <https://github.com/Anthony96/JWSTmorph.git> . The code has been used for several papers in our collaboration: *Early Results From GLASS-JWST. XII. The Morphology of Galaxies at the Epoch of Reionization* : Treu, Calabrò et al. (2023) ApJL 942, L28 *Early Results from GLASS-JWST. XX. Unveiling a Population of "Red Excess" Galaxies in Abell2744 and in the Coeval Field* : Vulcani, Treu, Calabrò et al. (2023) ApJL 948, L15 *Early Results from GLASS-JWST. XVIII. A First Morphological Atlas of the $1 < z < 5$ Universe in the Rest-frame Optical* : Jacobs, Glazebrook, Calabrò et al. (2023) ApJL 948, L13 *Closing in on the sources of cosmic reionization: First results from the GLASS-JWST program* : Mascia, Pentericci, Calabrò et al. (2023) A&A 672, A155 ; *Assessing the rate and contribution of mergers to mass assembly using NIRCam galaxy candidates out to $z = 9$* : Dalmaso, Calabrò et al. (2023) in prep.

Minigrant expenses so far

- ~ 1k € for participation in scientific conferences

Future plans

- Finalize the paper on the mass-metallicity relation of VANDELS type-2 AGNs (**Research topic B**)
- Investigate the star-formation and ISM properties of high-redshift galaxies ($z > 5$) recently observed with JWST (**Research topic A**)
- Present the new results in forthcoming conferences in 2024 , thanks to the remaining Minigrant budget (~6k €)