On the challenge of interpreting the morphology and color maps of high-z starburst galaxies with the JWST and Euclid

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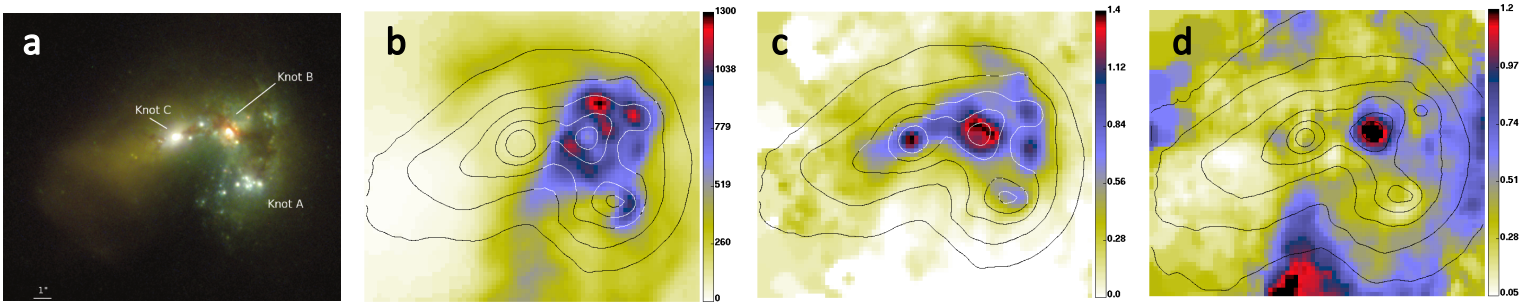
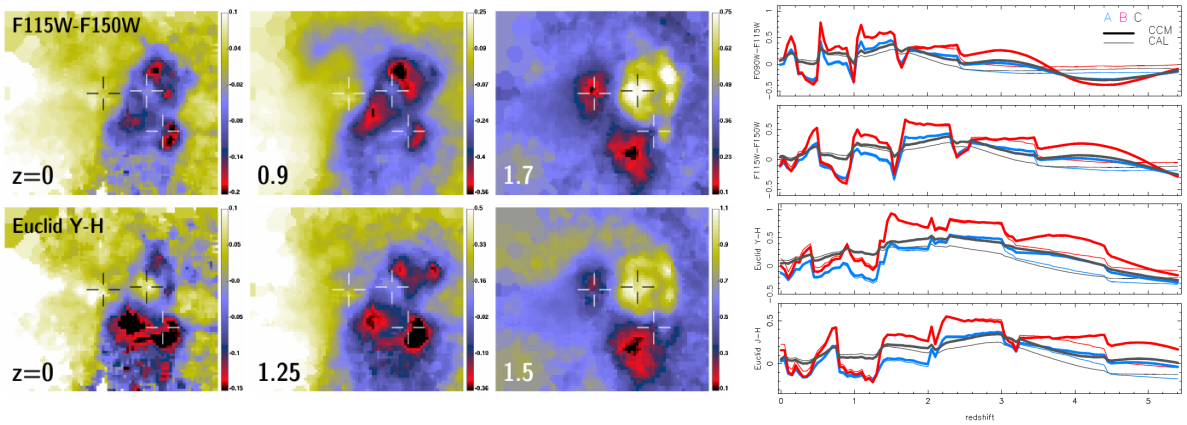
The common practice of applying a *spatially constant* "morphological" k-correction to imaging data (let alone neglecting k-corrections) leads to serious and systematic observational biases that affect the characterization of the morphology, structural properties and color patterns of high-z starburst galaxies (Papaderos & Östlin 2012 [1], Papaderos, Östlin & Breda 2023 [2]). This is due to the fact that the spectral energy distribution (SED) of these systems is spatially inhomogeneous, therefore drastically different k-corrections are required to convert observer's frame (ObsF) to rest-frame (RestF) photometric quantities in their different regions.

In this study (Papaderos & Östlin 2023 [3] for details) we examine, based on MUSE integral field spectroscopy and spectral modeling, the elements that shape the spatially varying optical SED of the nearby starburst galaxy Haro 11 - namely, stellar age gradients, strong nebular emission and its spatial decoupling from the ionizing stellar clusters, and differing extinction patterns in the stellar and nebular component both spatially and in their amount.



a: HST image of Haro 11 (from Adamo et al. 2010). The three SF regions A-C of the galaxy are indicated. The maps in panels **b**-**d** show quantities obtained from analysis of MUSE data (cf. [3]): Hα equivalent width (Å), and nebular and stellar extinction (V mag).

left: simulated color maps of Haro 11 in JWST F115W-F150W at z=0, 0.9 and 1.7 (top) and Euclid Y-H at z=0, 1.25 and 1.5 (bottom)
right: Simulated color of regions A-C vs. when assuming intrinsic extinction after Cardelli et al. (1989; CCM) and Calzetti et al. (2000; CAL).



Using the technique presented in [2] we compute simulated surface brightness and color maps of Haro 11 at $0 < z < 5.4$ in the photometric filters of the James Webb Space Telescope (JWST) and Euclid.
Our simulations show, among other things, that an optically bright yet dusty star-forming (SF) region can evade detection, while a gas-evacuated (thus, potentially Lyman continuum photon-leaking) region with weaker SF activity can dominate the optical/NIR ObsF (RestF UV) morphology of a high-z galaxy.
It is also shown that ObsF color maps are drastically affected by strong emission lines moving in and out of filter passbands, depending on z, and, if taken at face value, could lead to erroneous conclusions about the nature, evolutionary status and dust content of a distant analog of Haro 11. An additional problem in this respect arises from the uncertain prominence of the 2175 Å extinction bump that translates into appreciable (~ 0.3 mag) uncertainties in RestF color patterns of high-z starburst galaxies.

Adamo et al. 2010, MNRAS, 407, 870
Cardelli et al. 1989, ApJ, 345, 245
Calzetti et al. 2000, ApJ, 533, 682
Papaderos & Östlin 2012, A&A, 537, A126 [1]
Papaderos, Östlin & Breda 2023, A&A, 658, A74 [2]
Papaderos & Östlin 2023, A&A submitted (arxiv.org/abs/2312.13358) [3]

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