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Extreme emission line galaxies in J-PLUS: studying the rarest objects of our environment to understand the first galaxies in Universe

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Extreme emission line galaxies (EELGs) constitute a population of unique systems undergoing very intense events of star formation. These objects are very rare in our immediate environment, but they are crucial for understanding the physical limits of star formation, and most importantly, the formation of the first galaxies, during the early history of the Universe. While EELGs were abundant during that epoch, their faintness prevents a detailed study of their physical properties. EELGs found at lower redshifts offer a unique opportunity to investigate the physics of that era, however a precise selection and identification of these sources is extremely challenging.

We used the third data release of the J-PLUS survey, covering 3000 deg^2 of the northern sky with 12 narrow and broadband filters, to identify over 1500 EELGs at low redshift ($z<0.35$). These galaxies were selected by a large flux difference between contiguous narrow and broadband filters, indicative of very strong emission in either the [OIII]5007 or Hα lines (which are associated with gas ionized due to young massive stars). This approach avoids biases inherent in previous studies using only broad bands, allows the identification of fainter systems than in spectroscopic surveys, and reaches a purity and completeness above 90% (Lumbreras-Calle et al. 2022). Fitting the J-PLUS photometry to stellar population models allows us to characterize the main properties of the galaxies (equivalent width of the lines, stellar mass, dust extinction, accurate photometric redshift$\cdots$).

We have performed several follow-up observational campaigns, using different telescopes on earth (INT, GTC) and in space (Hubble Space Telescope, Chandra) to study in detail the sample, and we have taken advantage of the already available large surveys (SDSS and DESI). The spectroscopic observations on a subset of J-PLUS EELG candidates have confirmed their extreme nature and enabled the study of their detailed physical properties through faint emission lines, most notably the oxygen abundance (Lumbreras-Calle et al. 2025 in prep). We find similarities between our nearby J-PLUS EELGs and JWST-detected galaxies in the early Universe, particularly in their combination of mass, oxygen abundance, and star formation rate.

The high-resolution imaging from the Hubble Space Telescope has shown very rich systems, with a complex morphology, including young bursts of star formation with different ages. On the other hand, observations with Chandra reveal a certain lack of x-ray emission in some galaxies.

The upcoming release of the fourth J-PLUS data release will allow these studies to move forward, finding even more extreme objects with its very large area (almost 5000 square degrees) paving the way for the deeper, more precise J-PAS survey.

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