FIRES at the VLT: Measuring the Rest-Frame V-Band Luminosity of Galaxies from $z \sim 3$ to Now

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Abstract.

We present early results from the Faint InfraRed Extragalactic Survey (FIRES) at the VLT, the main goal of which is to study galaxy evolution in a deep, K-band selected sample. With our NIR selection, we select galaxies based on their rest-frame optical light at all redshifts $z \lesssim 3$. Our seven band photometry, coupled with an accurate and reliable photometric redshift technique, gives us the ability to study galaxies at the same rest-frame wavelength across a large range in redshift. We present here the rest-frame V-band luminosity $L_V$ of objects in our sample as a function of redshift and demonstrate the importance of near infrared data in measuring the correct $z_{\text{phot}}$ and $L_V$.

Pre-existing optical surveys, which have been very successful in finding large spectroscopically confirmed populations of $z > 2.5$ galaxies (e.g. Steidel et al. 1996), select these galaxies by their rest-frame far ultraviolet (UV) light. This light is dominated by the most massive stars in a galaxy and these searches may not sample the population of galaxies which dominates the stellar mass at these redshifts. By looking in the near infrared (NIR), one can select galaxies at high redshift by their rest-frame optical light. The rest-frame optical is less affected by dust extinction than the rest-frame UV, and is also a better tracer of the older stars which dominate the stellar mass of a galaxy (i.e. the luminosity weighted age of a galaxy is older in the optical than in the UV).

FIRES is a program to image $\sim 30$ arcmin$^2$ of sky in $J_sHK_s$ with ISAAC at the VLT. FIRES supplements deep HST optical images of the Hubble Deep Field South (HDF-S) and the cluster MS1054-03 (van Dokkum et al. 1998) with deep, high spatial resolution VLT data. For the HDF-S, we have fully reduced the first $\sim 6$ hours (out of a total of 32 hours) of exposure time in each passband. The seeing in the combined $K_s$-band image is $\approx 0.45''$.

From the $K_s$-band image, we have generated a preliminary catalog containing 345 objects using the SExtractor software (Bertin & Arnouts 1996). Of these, 41 had sizes in the F814W WFPC2 image consistent with being point sources. In the $K_s$-band, we have determined from simulations that we are 50% complete for small sources down to $K_s(AB) \approx 24$. Therefore, we further limited our sample to those galaxies with magnitudes $K_s(AB) \leq 24$ (190 objects). After convolving final images in each filter to the same seeing, we measured the fluxes of the catalog objects in all the bandpasses using a fixed 2'' aperture.

We then measured the photometric redshift of each object using a template fitting algorithm which employs the empirical galaxy spectral templates.
We show, in both panels, the best fit template to the data at the best redshift $z_{\text{phot}}$. The top panel shows the fit with only the optical HST data, while the bottom panel shows the fit with the ground-based NIR data included. The solid squares with error bars are the actual data while the open circles are the model flux points.

The distribution of rest-frame V-band luminosities as a function of photometric redshift. We show all 190 galaxies with $z_{\text{phot}} \leq 3$ and $K_s(AB) \leq 24$. Note the large range in luminosities and the large number of intrinsically bright galaxies at $z_{\text{phot}} \gtrsim 1$.

References

Bertin, E., Arnouts, S. 1996, A&A, 117, 393
Coleman, G. D., Wu, C.-C., Weedman, D. W. 1980, ApJS, 43, 393
Madau P. 1995, ApJ, 441, 18
Steidel, C. C., Giavalisco, M., Pettini, M., Dickinson, M., Adelberger, K. L. 1996, ApJ, 462, L17
van Dokkum, P. G., Franx, M., Kelson, D. D., Illingworth, G. D. 1998, ApJ, 504, L17