Towards an ALHAMBRA quasar catalogue

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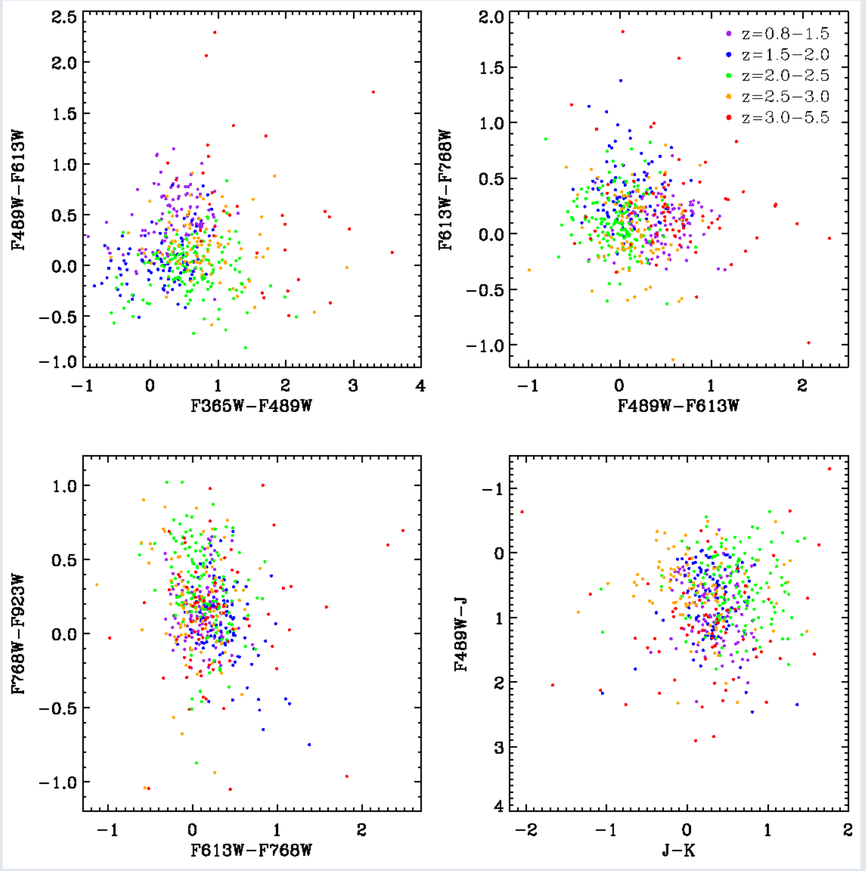
The ALHAMBRA survey

The ALHAMBRA (Advance Large Homogeneous Area Medium Band Redshift Astronomical) survey (Moles et al. 2008) has observed an effective area of 2.79 deg^2 using 20 contiguous filters in the optical range and three filters (J, H and Ks) in the infrared range. The depth of the images ($\mathbf{I \sim 24.5AB}$), the entire coverage of the optical range and the width of the filters ($\sim \mathbf{300Å}$) that is enough to observe broad emission lines makes this survey an unprecendent machine to discover new broad emission line quasars and to compute their accurate photometric redshifts.

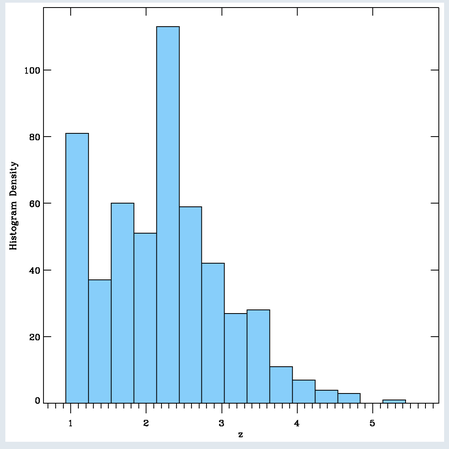
Steps towards a quasar catalogue

- **Identify the quasar candidates**. We used the publicly available template fitting code LePhare (Arnouts et al. 1999; Ilbert et al. 2006). The code matches the photometry of each source to a library of templates displaced in z, classifying the object and providing the best-fit photo-z based on a simple χ^2 fitting method.
- **Calibrate the code**. We used a sample of spectroscopically confirmed quasars in the ALHAMBRA fields to test the capability of the code in identifying quasars and calculating their photo-z. We chose the set of the templates, extinction laws, luminosity priors... which increased the accuracy of the photo-z.
- **Remove the misidentifications**. We shifted four broad emission lines common to a large fraction of quasars (MgIIλ2799, CIII]λ1909, CIVλ1549 and Ly$\alpha\lambda$1216) to the wavelenght that corresponds to the photo-z derived by LePhare and then we searched if there were a substantial increment of the flux in the optical filters where the lines should be located. We only applied the code to objects with z larger than 0.8 to allocate almost two emission lines in the optical range.
- **Perform a visual inspection**. Finally we did a visual classification of the remaining $\sim$3000 candidates to remove objects that we had misclassified due to the degeneracy in the position of the emission lines. We also eliminated the objects with a small signal-to-noise where the emission lines could been spurious.

Starting from a total of 438356 sources in all the ALHAMBRA fields, after applying all the steps above we ended up with a total of 524 quasar candidates.



ALHAMBRA color-color diagrams for the 524 identified quasars. We selected the ALHAMBRA filters (F365W, F489W, F613W, F768W and F923W) that better correspond to the SDSS bands (u, g, r, i, z). The points are color-coded as function of their redshifts.



Redshift distribution for the 524 identified quasars.

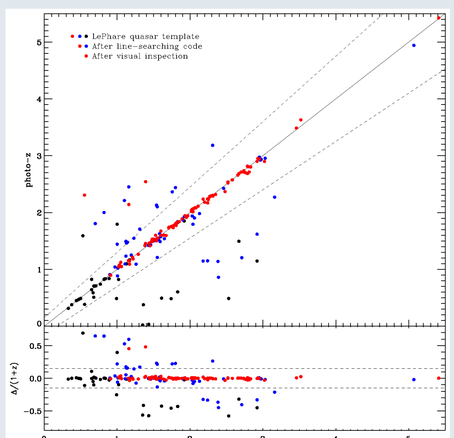


Photo-z vs. spec-z for the QSS. The dashed-lines correspond to $\mathbf{\Delta z = 0.15(1 + z_{spec})}$.

Photometric redshift accuracy

To obtain the level of galaxy contamination and the accuracy of the photo-z we did a crossmatch between spectroscopically identified objects in another surveys and the ALHAMBRA sources. We found 205 quasars from Matute et al. (2012, 2013), Pâris et al. (2013) and Civano et al. (2012) and 1058 galaxies from the zCOSMOS 10k-bright spectroscopic sample (Lilly et al. 2009). To characterize the accuracy of the photo-z, we used the normalized median absolute deviation (NMAD)

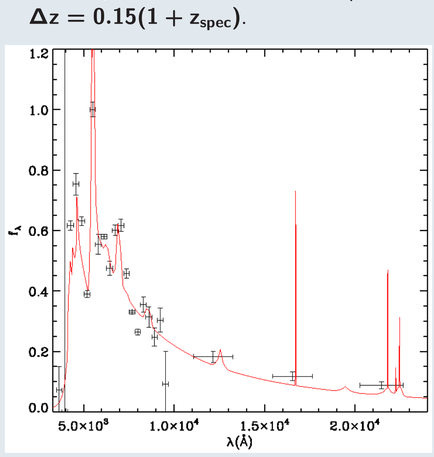
$$\sigma_{\mathbf{NMAD}} = \mathbf{1.48 \cdot median}\left(\frac{|\mathbf{z_{photo} - z_{spec}}|}{\mathbf{(1 + z_{spec})}}\right)$$

and the number of objets with a photo-z significantly different to their spectro-z (outliers η)

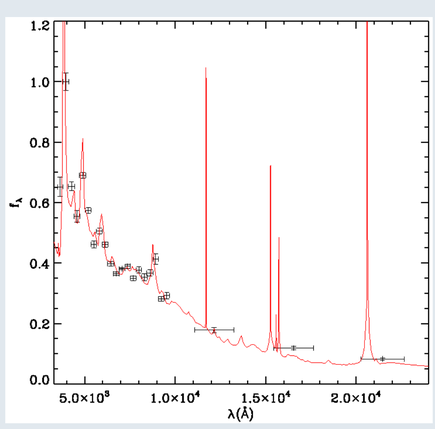
$$|\mathbf{z_{photo} - z_{spec}}| > \mathbf{0.15(1 + z_{spec})}.$$

We followed the same approach to identify the ALHAMBRA quasars with the quasar spectroscopic sample (QSS) and the galaxy spectroscopic sample (GSS).

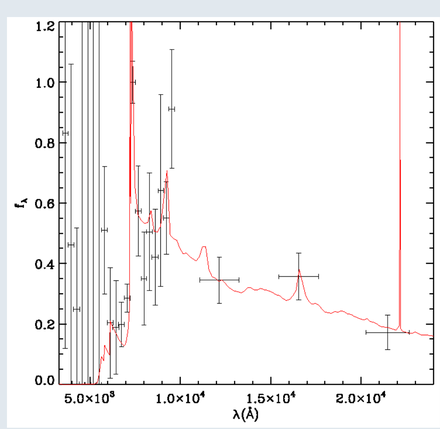
	LePhare quasar template	After line-searching code	After visual inspection
QSS (205 sources)	N=191 σ_{NMAD}=0.015 η=36	N=151 σ_{NMAD}=0.014 η=24	N=96 σ_{NMAD}=0.010 and η=3
GSS (1058 sources)	N=331	N=1	N=0



Example of a quasar with spec-z 3.48 and photo-z 3.49. The flux of the three figures is normalized for visual purpouses.



Example of a quasar with spec-z 1.16 and photo-z 2.14. The solution provided by LePhare seems to be in a very good agreement with the ALHAMBRA photometry.



Example of a source with spec-z 5.07 and photo-z 4.94. This object was rejected after a visual classification because we do not expect significant emission in the first three filters.

References

Arnouts, S., et al. 1999, MNRAS, 310, 540; Civano, F., et al. 2012, ApJS, 201, 30; Ilbert, O., et al. 2006, A&A, 457, 841; Lilly, S. J., et al. 2009, ApJS, 184, 218; Matute, I., et al. 2012, A&A 542, A20; Matute, I., et al. 2013, A&A, 557,A78; Moles, M., et al. 2008, AJ, 136, 1325; Pâris, I., et al. 2014, A&A, 563, A54.

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