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A SEARCH OF VERY HIGH REDSHIFT QSOS IN THE ALHAMBRA SURVEY WITH GTC/OSIRIS

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RESUMEN

El cartografiado ALHAMBRA ha creado una base de datos con más de 500000 objetos distribuidos en 2.5 grados e incluye información en 20+3 filtros (3500–9700 Å + *JHK*s) hasta AB∼25 a 7000 Å. Explotamos el primer catálogo interno de fotometría ALHAMBRA para seleccionar AGN de líneas anchas y quasáres. La calibración del z fotométrico con datos de la literatura proporciona excelentes resultados, con una eficiencia del 90% y una precisión en z menor al 1%. Dada la importancia de estos objetos en el universo temprano, discutimos la aplicación del método a la búsqueda de quasares a muy alto z ($z > 5$) y presentamos el espectro GTC/OSIRIS de un quasar anteriormente desconocido a $z = 5.5$ en uno de los campos de ALHAMBRA. La confirmación de dicho z valida nuestro criterio de selección y nos anima a aplicarlo a la búsqueda de objetos raros y exóticos y a la clasificación de las diferentes poblaciones galácticas y extragalácticas detectadas en ALHAMBRA.

ABSTRACT

The ALHAMBRA survey has created a photometric database of 500,000+ objects in ≈2.5 deg^2, including data in 20+3 filters (3500–9700 Å + *JHK*s), down to AB∼25 at 7000 Å. We are exploiting our first internal catalogue to select BLAGNs based on the full color information. Here we present the potential of the ALHAMBRA photometry to select broad-line AGN and QSOs. The photo-z calibration with literature data yields excellent results, with ∼90% efficiency and <1% rms redshift error. Due to their importance in the early universe, we will also discuss its application to the search of very high ($z > 5$) QSOs and present the GTC/OSIRIS spectra of a previously unknown QSO at $z = 5.5$ selected in the ALHAMBRA fields. This confirmed redshift further validates our selection criteria and encourages the application of the method to select not only rare or exotic sources but also to classify the different types of galactic and extragalactic source populations in ALHAMBRA.

Key Words: cosmology: observations — galaxies: active — galaxies: distances and redshifts — quasars: general

1. THE ALHAMBRA SURVEY

The ALHAMBRA[3] (Advanced Large, Homogeneous Area, Medium-Band Redshift Astronomical; Moles et al. 2008) survey provides a photometric dataset over 20 contiguous, equal-width, non-overlapping, medium-band optical filters (3500–9700 Å) plus the 3 standard broad-band near-IR (NIR) filters J, H and Ks obtimized to obtain high accuracy photo-z. The survey aims to understand the evolution of structures and the different extragalactic population throughout cosmic time by sampling a large enough cosmological fraction of the universe. The survey has collected its data at the 3.5 m telescope with the LAICA and OMEGA-2000 cameras at the Calar Alto observatory[4]. The full characterization, description and performance of the ALHAMBRA photometric system has been presented in the optical by Aparicio-Villegas et al. (2010) and by Cristóbal-Hornillos et al. (2009) in the NIR.

2. PHOTO-Z ACCURACY FOR BLAGN AND QSOS IN ALHAMBRA

When have used the ALHAMBRA photometry to estimate its accuracy and efficiency to derived photometric redshifts (photo-z) for the BLAGN/QSO population (Matute et al. 2001a). The public code *LePhare* provided the photo-z solutions through a χ^2 fit to a template database of normal and starbursts galaxies, type-1/2 Seyfert, QSOs and stars. Our treatment included a correction for systematics offsets between the different photometric bands and the template database, absorption by the IGM and the possibility for intrinsic reddening with different extinction laws. We find a photo-z precision better than 1% (with a 12% of outliers) when compared with a catalogue of 170 spectroscopically identified BLAGN/QSO in the ALHAMBRA fields (Figure 1). This result is similar to previously pub-

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[3]`http://alhambra.iaa.es:8080`.

[4]`http://www.caha.es`.

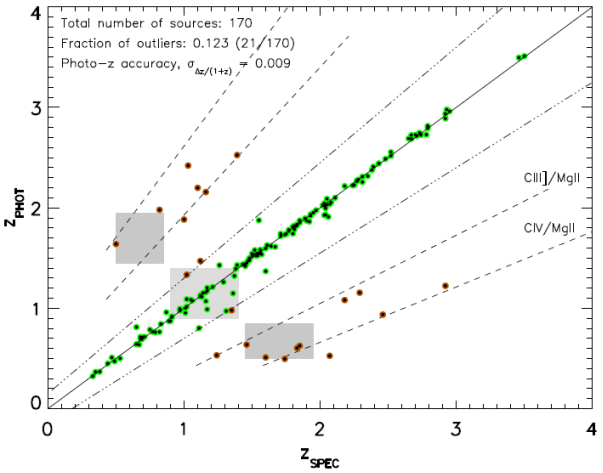

Fig. 1. Photo-z vs spectro-z for 170 QSOs in the ALHAMBRA fields. The comparison yields a very good agreement between them (<1% and 12% outliers). The continuous line gives the $z_{\rm phot} = z_{\rm spec}$ relation while the dashed line represent the boundary between good solutions (green dots) and outliers (red, indexed dots) and defined as $|\Delta z|/(1+z_{\rm spec}) > 0.15$, with $\Delta z = (z_{\rm spec} - z_{\rm phot})$. Shaded areas and dashed lines represent regions of degeneracy discussed by Matute et al. (2011a).

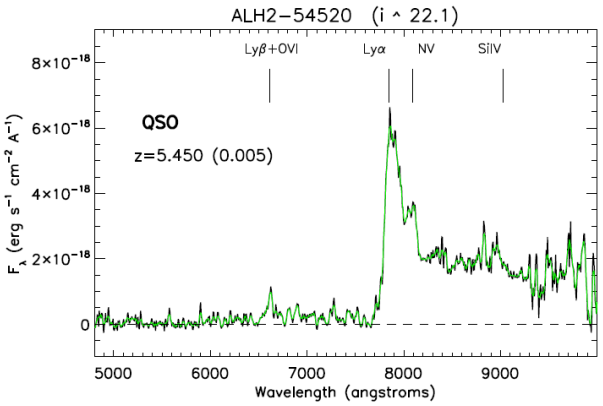

Fig. 2. OSIRIS/GTC spectra of one of the proposed high-z QSOs candidates. The source was selected from the ALHAMBRA photometric database with an estimated photo-z of 5.43. The agreement between the spectro-z (5.450±0.005) and the photo-z is remarkable. The most important emission lines for QSOs are also indicated.

lished photo-z accuracies for BLAGN/QSOs in surveys that make use of medium-band optical photometry, e.g. COSMOS (Salvato et al. 2011) and MUSYC (Cardamone et al. 2010). We have also explored the impact of NIR photometry on the quality of BLAGN/QSOs photo-z and estimated the expected number of BLAGN/QSO to be detected by the soon-to-be-launched eROSITA[5] mission (Matute et al. 2011a). This work represents the initial step for a future publication of a catalog of BLAGN/QSO selected in the ALHAMBRA fields together with the corresponding luminosity functions up to $z \sim 6$ (Matute et al. 2012, in preparation).

2.1. *High-z QSOs candidates*

High-z ($z > 5$) QSOs are important as they probe the reionization period of the universe and its physical conditions at a very early stage. These sources, with measured BH masses of 10^9 $M_\odot$ and showing emission related to dust when the universe was only 1 billion years old, provide a challenge to current models of galaxy formation, BH formation, and BH growth (e.g. Hopkins et al. 2010) and dust creation mechanisms (e.g. Wang et al. 2008). Unfortunatedly, the current number of QSOs at high-z are small and limited to those with very high luminosities. Therefore the faint end of their LF is poorly constrained at $z \sim 6$.

We have applied the methodology described in the previous section in a search for these high-z ($z > 5$) QSOs in the ALHAMBRA photometric database. A pilot program of 3 sources was selected (over 1 deg^2) to be observed by OSIRIS/GTC during period 11B. At the present time 2 sources have been completely observed and reduced. The first shows a typical QSO spectra at $z \sim 5.5$ (Figure 2) while the results for the second one are inconclusive due to a very weak contiuum and no signs of Lyα emission. We derived a space density for the detected QSO of 2×10^{-8} Mpc^{-3} mag^{-1}, a factor of 10 higher than previous estimates but more statistics is obviously needed. Nevertheless, the technique seems very promising and we intent to continue the search for these sources to fainter magnitudes with the final (and deepest) release of the ALHAMBRA catalogue.

[5] http://www.mpe.mpg.de/erosita/.

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