THE ALHAMBRA-SURVEY

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La realidad aplaca lo imaginario como el río la bruma
Maimónides

Abstract

The ALHAMBRA-Survey is a project to image a large area, 4 □°, with 20 contiguous, equal width, medium band filters covering from 3500 Å to 9700 Å, plus the standard JHK$_s$ near-infrared bands. The photometric system in the optical was optimized to get (for a fixed amount of total observing time) the maximum number of objects with accurate SED classification and redshift and to be sensitive to relatively faint emission features in the spectrum. Thus the ALHAMBRA-Survey is expected to produce accurate enough photometric redshifts to track the cosmic evolution, i. e., the change with z of the content and properties of the Universe, a kind of *Cosmic Tomography*.

The observations will be carried out with the Calar Alto 3.5m telescope using the new wide field cameras in the optical, LAICA, and in the NIR, OMEGA-2000. We intend to reach, for a total of 100 ks integration time per pointing, the limit AB $\geq$ 25 mag (for an unresolved object, S/N=5) in all the optical filters from the bluest to 8300 Å, and from AB = 24.7 to 23.4 for the remainder. The expected limit in the NIR, for a total of 15ks exposure time per pointing, is K$_s$ = 20 mag, H = 21 mag, J = 22 mag, at S/N=10.

The deep, homogeneous and contiguous spectral coverage will result in several hundred thousand objects with accurate SED identification and z-values. This accuracy will allow us to study, among others, the large scale structure evolution with z, the identification of clusters of galaxies (with membership assessment for a fraction of the galaxies), the identification of families of objects, and other detailed studies, without the need for any further follow-up. Indeed, it will provide exciting targets for 10m class telescopes, the GTC in particular. Given its area and spectral coverage and its depth, apart from those main goals, the ALHAMBRA-Survey will also produce valuable data for galactic studies.

1 Introduction: Global scientific aim and opportunity

One of the main topics in Cosmology is **Cosmic Evolution**. The central issue is to disentangle genuine cosmic evolution from physical variance at a given redshift and the details of the metric, what has been a permanent challenge for Physical Cosmology. To approach the question of Cosmic Evolution meaningfully it is therefore necessary to sample large physical volumes even at low redshifts, to capture not only representative average properties but also their variance.

From an observational point of view this implies a combination of wide area and depth, with a continuous spectral coverage to avoid having complex selection functions depending on z and on the nature of the objects. The quest for precision implies a good enough spectral resolution and photometric accuracy as well. Up to now, the largest surveys were photometric, ensuring a complete spectral coverage with broad-band filters. The resulting precision in z obtained via photometric redshift techniques (~ 0.1 in $\Delta z/(1+z)$, at best) and in Spectral Energy Distribution (SED) determination are correspondingly rough. Moreover, large area surveys like the SDSS are correspondingly shallow, whereas deeper surveys have sampled the distant and/or faint Universe in rather small areas. At the other extreme in spectral resolution, spectroscopic surveys cannot go as deep as the photometric surveys, reaching only $I \approx 24$ with the use of large telescopes. The covered fields are necessarily small and cannot cope with the complex variety of objects in the Universe.

Obviously the spectrophotometric surveys will always run behind the photometric ones. Thus, the problem at any given moment is to find the optimal filter combination to produce the deepest and more accurate possible photometric survey. The first proposal to use intermediate band filters to cover the optical range, as a compromise between resolution field and depth, was that of Hickson et al (1994). Later, the project CADIS was defined and carried on with the 2.2m telescope in Calar Alto, using a combination of broad and narrow band filters. Its primary goal was to find emission line galaxies, even if it was exploited in many other fields (see the CADIS web page at http://www.mpia.de/GALAXIES/CADIS/welcome.html). Later, on the experience gained by CADIS, the project COMBO-17 was defined for the MPIA 2.2m telescope in La Silla. It also uses a combination of broad (UBVRI) and narrow band filters to find accurate z-values and SEDs for tens of thousand objects (see http://www.mpia.de/COMBO/ for all the details).

From the existing experience, we have designed a project to get the optimum compromise between large area and depth, good spectral resolution and coverage, to produce the optimum output in terms of redshift accuracy. This is the **A**dvanced **L**arge **H**omogeneous **A**rea **M**edium **B**and **R**edshift **A**stronomical, **ALHAMBRA**-Survey, a photometric survey primarily intended for cosmic evolution studies. As we explain in the following, we intend to use specifically designed intermediate band filters to continuously cover the optical spectral range, plus the standard J, H, K_s NIR filters. The filter system in the optical has been purposely designed to produce accurate enough redshift and SED for hundreds thousand objects. Aiming at capturing the cosmic variance at even relatively low z-values, we also decided to cover a large area to very faint limits. We propose to cover a large-area with 20 contiguous, equal width, medium band optical filters from 3500 Å to 9700 Å, plus the three standard broad band, JHK_s, in the NIR. Thus, the ALHAMBRA-Survey is placed halfway in between the traditional imaging and spectroscopic surveys.

It will make possible the study of many different astronomical problems in a self-contained way. By design, the ALHAMBRA-Survey will provide precise ($\Delta z < 0.015(1+z)$) photometric redshifts and SED classification for $\geq 300,000$ galaxies and AGNs, allowing for any kind of analysis regarding populations, structures and evolution. Thanks to the unbiased nature of this survey (i.e. neither designed to detect a given class of objects nor to be precise in fixed windows only), important problems other than Cosmic

Evolution can be addressed. These include the study of stellar populations in the galactic halo, the search for very cold stars and blue stragglers, and the possible detection of debris from galactic satellites in the Milky Way halo. Moreover, the large surveyed area and the ability to finely discriminate between different spectral energy distributions will permit the serendipitous detection of objects that could be classified as *exotic* or *rare*. This broad category includes very high redshift galaxies (≈ 2500 objects at $z > 5$, with $\Delta z < 0.01$, expected from scaled HDF observations) and QSOs.

The main strategic goal of the ALHAMBRA-Survey is to provide the community with a set of data appropriate for the systematic study of Cosmic Evolution. The hypothesis of homogeneity and isotropy implies the existence of maximally symmetric subspaces and the existence of a 1-to-1 relation between redshift and time. This is a model-independent prediction, prior to any consideration about the value of the cosmological parameters. Precisely, we intend to materialize a *foliation of the space-time*, producing narrow slices in the z-direction whereas the spatial sections are large enough to be cosmologically representative, what could be called *Cosmic Tomography*.

This is a very demanding project indeed. The opportunity to undertake it was prompted by the new possibilities open to the Spanish community in the Calar Alto Observatory, now shared on equal basis by Germany and Spain. The Calar Alto telescopes, in particular the 3.5m, equipped with the new instruments OMEGA-2000 and LAICA, are specially well suited for such a work.

Indeed, a project like the ALHAMBRA-survey requires to be allocated an important fraction of the observing time if it is going to be accomplished in a reasonable period of time. Therefore the support of a large fraction of the Spanish astronomical community was requested and eventually obtained, and our survey was finally allocated Guaranteed Spanish Time.

2 The project implementation

The idea to use photometric information to determine the redshift of faint sources was first proposed by Baum (1962), and later re-launched by Loh & Spillar (1986) and Koo (1986) as a *poor person* machine to get redshifts. Later, as we said before, Hickson et al (1994) discussed the possibility to continuously cover the whole optical spectral range with medium band filters. No discussion was done however in this work on the number and kind of filters to optimize the output.

Taking together the constraints in coverage, resolution and depth imposed by our scientific goals we have designed a system that optimizes the output in terms of number of objects with accurate enough z and SED. The ALHAMBRA-Survey is a multi-narrowband survey with complete spectral coverage in the optical range. We have defined the filter system to have a complete, homogeneous spectral coverage in the optical domain, and added the NIR standard filters to complement the information about the detected objects and to improve the z and SED determination, in the case of relatively large photometric errors (see below) or for particular classes of objects. It has also been adapted to the instrumental capabilities available now in Calar Alto.

2.1 The ALHAMBRA-Survey optical filter system

The project was designed having in mind all the subtleties of the techniques to get photometric redshifts, to be able to use them in the most advantageous way (see Wolf, Meisenheimer and Röser, 2000, for an analysis of systems including broad and narrow band filters). Our goal was to optimize the number and width of the of filters to get, for a fixed total amount of observing time, accurate SED and z determination for the largest possible number of objects, and to be sensitive to relatively faint emission lines. Given the

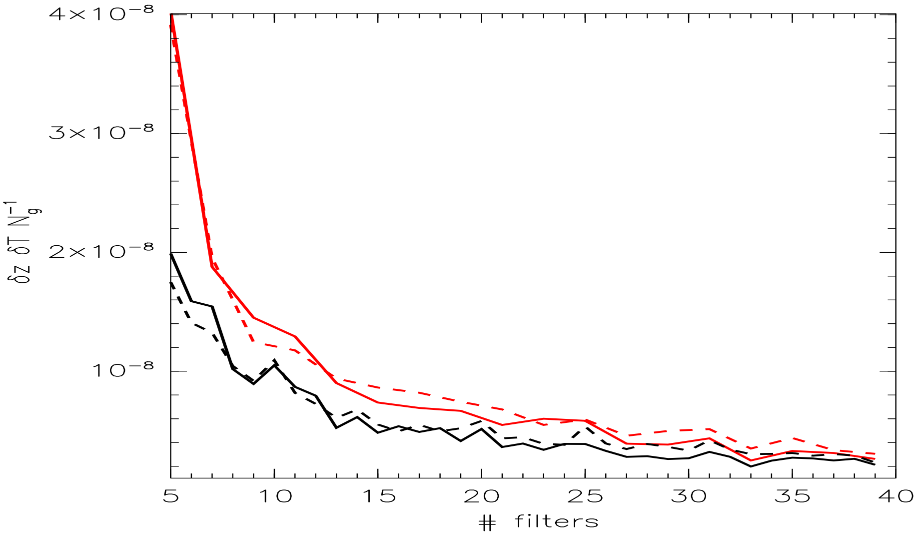

Figure 1: Product of the normalized rms in photometric redshift by the rms in spectral type, divided by the number of objects with $Odds = 1$. The continuous lines are for constant width filters without (black) and with (red) overlap. The dashed lines are for logarithmic width filters, without (black) and with (red) overlap.

performance of the instruments to be used, the total exposure time in the optical domain was fixed to 100 ksec. Since we will use the standard filters in the NIR, we concentrate in the following on the characterization of the optical filter set.

We have analyzed four filter sets: constant or logarithmic ($\Delta\lambda \propto (1+\lambda)$) width, with either minimal or 50% overlap. In all cases the filters continuously cover the whole optical interval from 3500 Å to 9700 Å, with almost square transmission. To test the efficiency of the different systems we generated a mock catalogue of 13,000 galaxies upon the magnitude, redshift and spectral type distribution of the galaxies in the Hubble Deep Field (Fernández-Soto *et al*, 1999). Since the accuracy of the input photometric redshifts is $\approx 0.06(1+z)$, we perturbed them by a similar, randomly distributed amount to produce a more realistic redshift distribution. We then generated magnitudes in each of the filter systems above with realistic photometric noise added with the estimated performance of the site + 3.5m telescope + LAICA cameras. The exposure times were distributed among the different filters trying to reach constant S/N per filter, but with two constraints: the minimal exposure time per filter is, for practical reasons, at least $2,500$s, and we do not expose more than twice this time in a homogeneous exposure distribution, to avoid spending all our time on the less efficient filter/detector combinations.

The photometric redshifts were calculated using the BPZ software (Benítez 2000, with the templates as in Benítez et al. 2004). The main result of the simulations is illustrated in Figure 1, where it appears that the minimally overlapping filter systems, either of constant or logarithmic width, are the best performer for any fixed number of filters. We also find that the improvement in the number-weighted precision of the survey is slow after $n_f = 15$ filters. Therefore, from that point of view, the conclusion would be to use 15 minimally overlapping filters, of 410 Å if they were of constant width, to cover the whole spectral range.

As we said before, our second requirement was the possibility to detect relatively faint emission lines. Indeed, having logarithmic filters would produce a modulation of the detection capabilities depending on the actual width of each of the individual filters. Therefore, this second criterium points directly to a system of constant width filters.

To figure out what EW values would be worth to detect, we notice that the median value of the EW of the Hβ line in HII galaxies amounts to 35 Å, whereas 85% of the same galaxies have EW([OII]) $\geq$ 35 Å (Terlevich et al 1991). Therefore, detecting lines with observed EW $\approx$ 35 Å or stronger would allow to find a substantial fraction of this, or other similar, family of galaxies.

Now, an emission line of equivalent width EW in one of the filters would be detected at the n-σ level provided that

$$EW \geq n\sqrt{2}\sigma \times W_F$$

where W_F is the filter width and σ the error in each of the measured magnitudes. Detection at the 3σ level for photometric errors of 0.03 mag would then imply $EW \geq 0.127W_F$. It is clear that to detect a substantial fraction of the emission line objects similar to HII-galaxies the filters should be narrower than the 410 Å wide filters resulting from the previous simulations. To detect a line with EW = 35 Å, S/N = 30, at the 3σ level, filters $\approx$ 300 Å wide are needed.

Taking all these aspects together, the ALHAMBRA optical photometric system was eventually designed to include 20 contiguous, medium-band, FWHM = 310 Å, square-like shaped filters with minimal overlapping in λ, covering the complete optical range from 3500 to 9700 Å. With this configuration it is possible not only to accurately determine the SED and z even for faint objects, but also to detect rather faint emission lines. In particular, with this configuration, for an appropriate continuum level, the Hβ line of a typical HII-like galaxy could be detected till $z \approx 1$ for rest frame EW values over 20 Å (i. e., for more than half the whole population), whereas the [OII] line would be detectable till $z \approx 1.6$, with rest frame EW of over 14 Å(i. e., for almost the whole population). We also notice that a galaxy like IZw18 could be detected till z = 0.1

In the Figure 2 we have plotted the transmission curves of the filters as offered by BARR, together with the quantum efficiency of the detectors and the final response of the system. In spite of some difficulties encountered all along the process with BARR, the filters are presently in an advanced phase of production, and 2 of them have actually been already shipped.

The survey will also include NIR deep observations through the standard broad band filters, JHK$_s$. The gain in z-determination accuracy when this information is added will be presented below.

3 Field selection

3.1 The total covered area

It is well known that astronomical objects are clustered on the sky on different scales. The clustering signature contains a wealth of information about the structure formation process. A survey wanting to describe and understand the clustering needs to probe as many scales as possible, until the homogeneity scale is reached. In particular, searching contiguous areas is important to cover smoothly the smallest scales where the signal is stronger and to obtain an optimally-shaped window function.

Measuring a population of a certain volume density is a Poissonian process with an associated variance. One would obtain different densities of the same population when measuring in different places. The variance in those measures is dictated by the volume density of the population under study, the volume searched and the clustering of the population. In order to beat down this sample (or cosmic) variance one needs to sample independent volumes. So there should be a balance between probing contiguous area and independent areas. On the technical side, the geometry of LAICA, the 3.5m Calar Alto

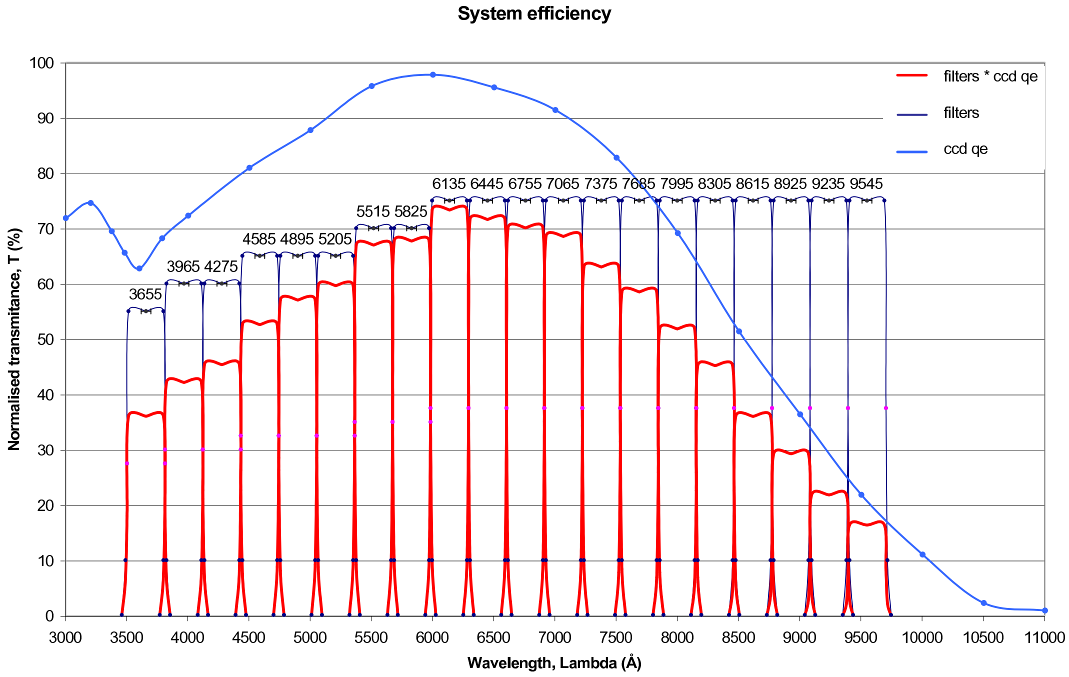

Figure 2: Calculated transmission curves of the ALHAMBRA-system taking into account the atmospheric transmission and the CCDs quantum efficiency, for the minimum filter transmission guaranteed by the manufacturer

telescope instrument with which the ALHAMBRA survey is devised to be carried out in the optical, imposes a minimum contiguous area patch of 1° × 0.25°.

The relative error in any counting statistical measure will scale as

$$\sqrt{\frac{N_{st}}{N_f \; \Delta \; z}}$$

where N_{st} is the number of spectral types that need to be resolved, N_f is the number of fields and $\Delta \; z$ the redshift interval to be resolved. Assuming the SDSS local luminosity function with a plausible evolutionary parameterizations that yields a redshift distribution similar to the one obtained from the HDF at our magnitude limit, we estimate that we will get relative errors of

$$\sim 0.015\sqrt{\frac{N_{st}}{N_f \; (\Delta \; z/0.1)}}$$

at redshift $z \sim 0.3$ where the SDSS starts to be unable to sample the galaxy population due to its relatively bright flux limit. At other redshifts the expected relative errors are

$$\sim 0.010\sqrt{\frac{N_{st}}{N_f \; (\Delta \; z/0.1)}}, \text{at} \quad z \sim 0.8 - 1$$

$$\sim 0.010\sqrt{\frac{N_{st}}{N_f \; (\Delta \; z/0.1)}}, \text{at} \quad z \sim 1.5$$

$$\sim 0.020\sqrt{\frac{N_{st}}{N_f\ (\Delta\ z/0.1)}},\text{at}\ \ z \sim 2.0$$

Therefore, if we decide that we want relative errors no larger than 2% at $z \sim 2.0$ with a redshift resolution of $\Delta\ z = 0.1$ and resolving 8 spectral types, we would need 8 $\square^{\circ}$. At any other lower redshifts our relative errors will be lower.

Given the previous arguments we defined our survey aiming at covering a total of 8 square degrees. Taking into account the maximum observing time per semester that we could obtain and the weather and seeing conditions in Calar Alto, we found that at least 5-6 years would be needed to complete the observations. We considered that this is too long a time to complete a project involving important efforts by many people, and that planning for 3-4 years would be more reasonable. Therefore, without renouncing at completing the 8 fields, we have defined an observing strategy aiming at completing first two strips, $1^{\circ}\times0.25^{\circ}$ each, in each of the 8 selected fields, to ensure a large enough covered area and a good sampling to cope with the cosmic variance.

3.2 The selected fields

To select the fields to be covered we have taken into account evident criteria like low extinction, no (or few) known bright sources, high galactic latitude, and, very important for future work, significant overlap with other surveys and/or other wavelengths. The selected fields are listed in the Table 1 below.

4 Global expectations

4.1 Sensitivity considerations. Instrument performances. Calibration Strategy

Taking into account the average extinction in Calar Alto and the performance of the telescope and cameras, we have calculated the exposure time per filter to reach the proposed limit. The results are plotted in Figure 3. They were calculated for AM = 1.3, FWHM = 1.2". The average exposure time per filter amounts to 5000s, for the reasons discussed before. In the bluest filters the exposure time is fixed by the need to get a minimum number, actually 5, of exposures to correct for cosmic and transitory artifacts. In the reddest filters the exposure time is limited to fit within the total exposure time allowed for a given pointing.

In the NIR the available information on the Omega-2000 performances allowed us to estimate that we will be able to reach $K_s = 20$, H = 21, J = 22 in 5000s per filter and pointing. A preliminary examination of the data collected during the August/2004 run indicates that we could be not far form that limit.

To determine the extinction coefficients we intend to take advantage of the accumulated experience on determining and modeling the extinction in Calar Alto. Indeed, as shown by Hopp & Fernández (2002) it is not necessary to obtain the extinction for all the 20 ALHAMBRA filters. A significantly smaller number of filters would be enough to determine the input parameters of the models shown to adequately fit the atmospheric extinction at Calar Alto in the whole optical domain covered by our survey. This question will be settled empirically, but our guess is that 5 filters, adequately chosen, would suffice to catch the extinction curve.

The photometric calibration is demanding since we are in fact defining a new photometric system, that needs defining the reference fluxes and magnitudes for some set of standard stars covering a wide colour range. The core of the ALHAMBRA network of standard stars (ANSS) is a set of stars with accurate spectrophotometric calibration.

Table 1: The ALHAMBRA-Survey Selected Fields

Field name	RA(J2000)	DEC(J2000)	100 μm	E(B-V)	l	b
ALHAMBRA-1	00 29 46.0	+05 25 28	0.72	0.017	113	-57
ALHAMBRA-2	01 30 16.0	+04 15 40	0.80	0.022	140	-57
ALHAMBRA-3/SDSS	09 16 20	+46 02 20		0.015	174	+44
ALHAMBRA-4/COSMOS	10 00 28.6	+02 12 21	0.90	0.018	236	+42
ALHAMBRA-5/HDF-N	12 35 00.0	+61 57 00	0.60	0.011	125	+55
ALHAMBRA-6/GROTH	14 16 38.0	+52 25 05	0.35	0.007	95	+60
ALHAMBRA-7/ELAIS-N1	16 12 10.0	+54 30 00	0.27	0.005	84	+45
ALHAMBRA-8/SDSS	23 45 50.0	+15 34 50	1.17	0.027	99	-44

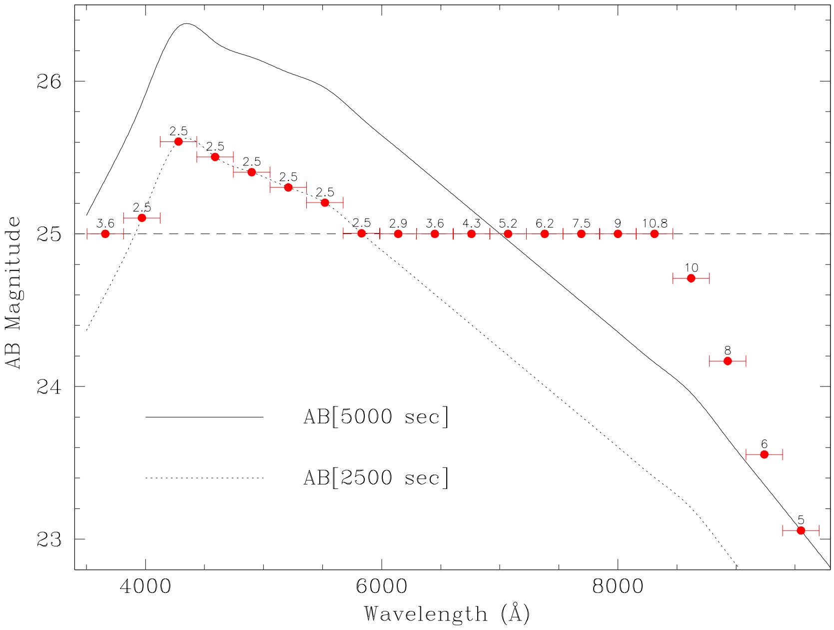

Figure 3: Total exposure time per filter in ksec. For the bluest filters the time is fixed by logistic considerations rather than for accuracy reasons

We will use this set as primary calibrators at the telescope and to define the secondary calibrators, chosen to be stars in the target fields.

The magnitudes will be defined from the catalogue fluxes by:

$$m = -2.5\log\frac{\int_{\mathrm{F}} \mathrm{f}(\lambda)\mathrm{S}_{\mathrm{F}}(\lambda)\mathrm{d}\lambda}{\int_{\mathrm{F}} \mathrm{S}_{\mathrm{F}}(\lambda)\mathrm{d}\lambda} + \mathrm{Cte}$$

This is the usual way to calibrate narrow-band images when the photometric system is not previously defined, as for line filters. The SDSS Consortium has also adopted that strategy to define their own photometric system (Fukugita *et al*, 1996; Smith *et al*, 2002). We will set the ANSS on the AB system,

$$AB_\nu = -2.5 log f_\nu - 48.574$$

where f_ν is the flux per unit frequency from an object in erg s^{-1} cm^{-2} Hz^{-1}

The primary standard stars have been selected form the lists by Oke & Gunn (1983), Oke (1990), Massey & Gronwall (1990) and Stone (1996), together with the 4 fundamental calibrators adopted by the HST.

For practical reasons, but also to control the accuracy and homogeneity of the photometric calibration, we have considered to define secondary standards in every subfield corresponding to a CCD in the LAICA imager, about 15.4'x15.4' each. The plan is to select 3-5 stars in each field and to obtain accurate, calibrated absolute spectrophotometry of all of them. The observations will be carried out with the 1.5m OSN telescope with the ALBIREO spectrograph. These secondary standards will be observed under photometric conditions and the extinction and calibration will be secured by observing primary standards.

The NIR observations will be done in the standard system J,H,K$_s$. The procedure is also the usual one, with observations of standard stars to determine the night extinction and the zero points of the system. In principle the 2MASS magnitudes of the stars in each field can be used as secondary calibrators when they are accurate enough for our purposes. Otherwise we will re-observe this stars with other systems to define a precise network of secondary, local calibrators, referred to the same primary set.

4.2 The number of objects with accurate SED and z determination

In Figure 4 it can be seen that we can obtain highly accurate, $Odds = 1, \Delta z/(1+z) \approx 0.015$ redshifts for $\approx$ 90% of galaxies with $I_{AB} < 23.5$, a total over 300,000. If we relax the selection criteria to $Odds > 0.99$, we would then reach 90% completeness at $I_{AB} = 24$, with a photo-z accuracy of $\Delta z/(1+z) \approx 0.03$ (more than 500,000 galaxies). The results have been obtained for the simulations described before. Let us point out that this is a minimum since we intend to analyze the implementation and to use new and more detailed and specific templates than those used in the simulations, that could improve the quality of the fittings and the final results.

Indeed, the final result critically depends on the photometric errors and the adequacy of the templates. To test the first aspect we have built a mock catalogue of 5×10^5 galaxies, with z between 0 and 1.5, from the sets of templates given by Kinney (E, S0, SA, Sc), Bica (Starburst), Calzetti (Starburst) and a QSO. White noise with different amplitudes was added to the objects in order to calibrate the effect of photometric errors. Then, the redshift of each target was determined using best fitting criteria by the initial templates. The results are shown in Figure 5, where we plot the errors resulting in z as a function of the input photometric error (error bars were obtained by bootstrap) in magnitudes.

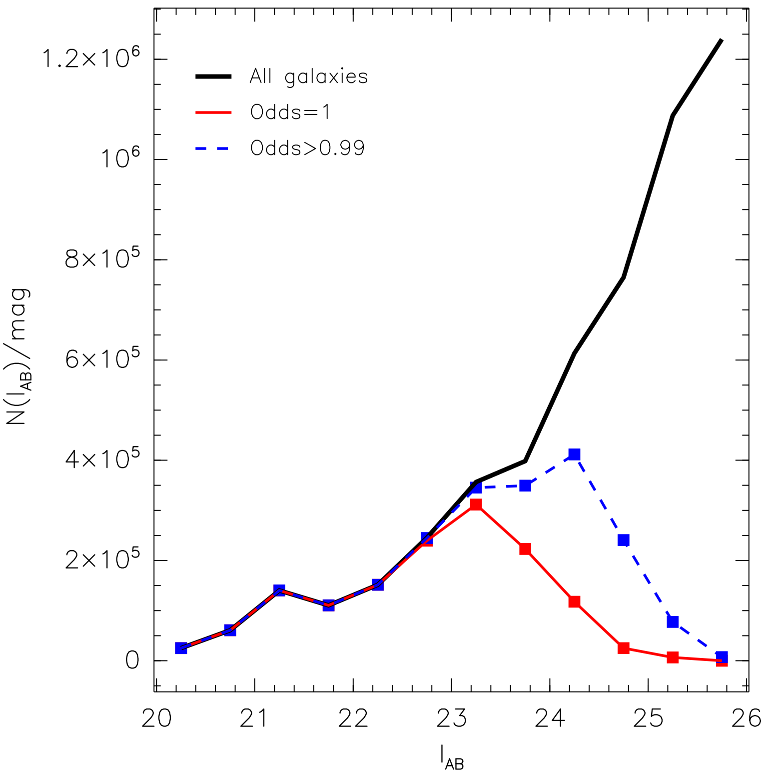

Figure 4: Number of galaxies with $Odds > 0.99$ and $Odds = 1$ as a function of magnitude

Inclusion of the NIR information can significantly improve the z determination in some cases. In particular, as has been pointed out by many authors using photometric redshift techniques in deep surveys, the use of NIR filters can help break the degeneracy between low-redshift ($z \approx 0.5$) and high-redshift ($z \approx 3$) galaxies. The reason behind this degeneracy is the confusion between the Balmer and Lyman breaks, which are the most salient features of the respective spectral energy distributions. In absence of any infrared information, it is not possible to tell the slope of the rest-frame red end of the spectrum, the range that can in fact tell the difference between both families of objects.

Figure 6 explicitly shows this effect. Each panel shows the theoretical degeneracies between the different spectral types and redshifts (all redshift axes range from $z = 0$ to $z = 8$). It can be seen how (for a typical case) the presence of NIR data eliminates most of the degeneracies between low and high redshift, and sharply separates the elliptical, Sab, and Scd galaxies from the rest and from each other, leaving only some residual degeneracy between the three bluest types. Of course, we should never forget that the infrared information also adds greatly to the information content of the survey, via the more direct relation existing between the galactic mass and the infrared luminosity.

Finally, we show in Figure 7 the efficiency of the proposed survey as a function of redshift. As expected we can see than the efficiency of the photo-z is low in the $1.5 < z < 3.$ interval, but otherwise is rather homogeneous. Note that most high-z objects will have good redshift measurements.

5 The first observing run

Last August we had the first ALHAMBRA observing run, with OMEGA-2000. Despite the problems encountered with the telescope control system, then in the process of being

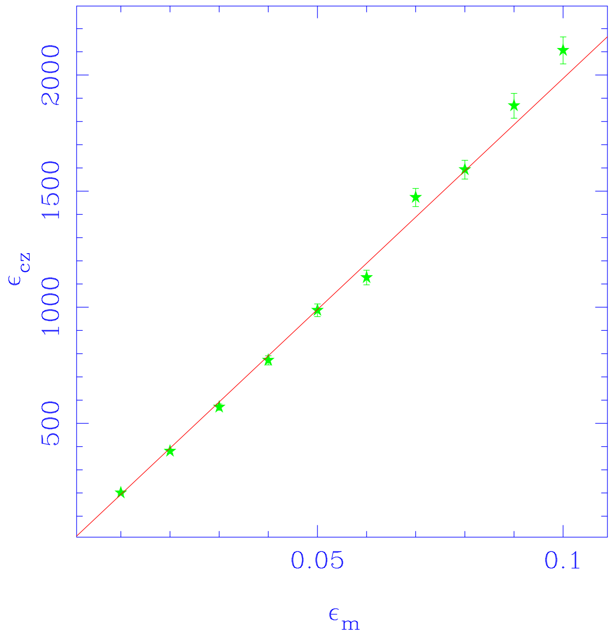

Figure 5: The errors in the redshift determination as a function of the input photometric errors

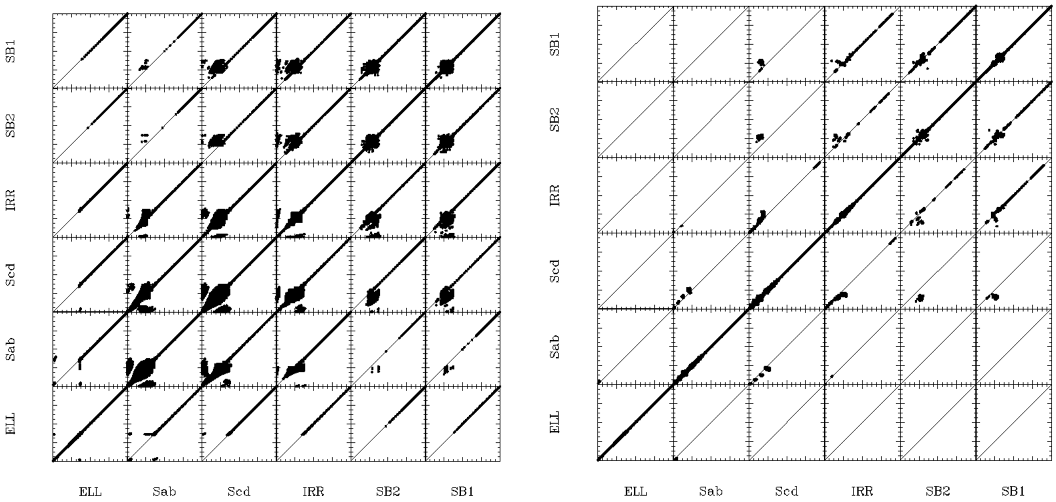

Figure 6: Theoretical degeneracies in type and redshift expected for galaxies in the ALHAMBRA survey measured to an accuracy of 0.2 magnitudes in all filters. The left panel shows the case where no infrared information is available, and the right panel corresponds to the case where infrared information is included. Each of the 6×6 subpanels corresponds to a z_1 vs z_2 diagram with redshifts ranging from 0 to 8.

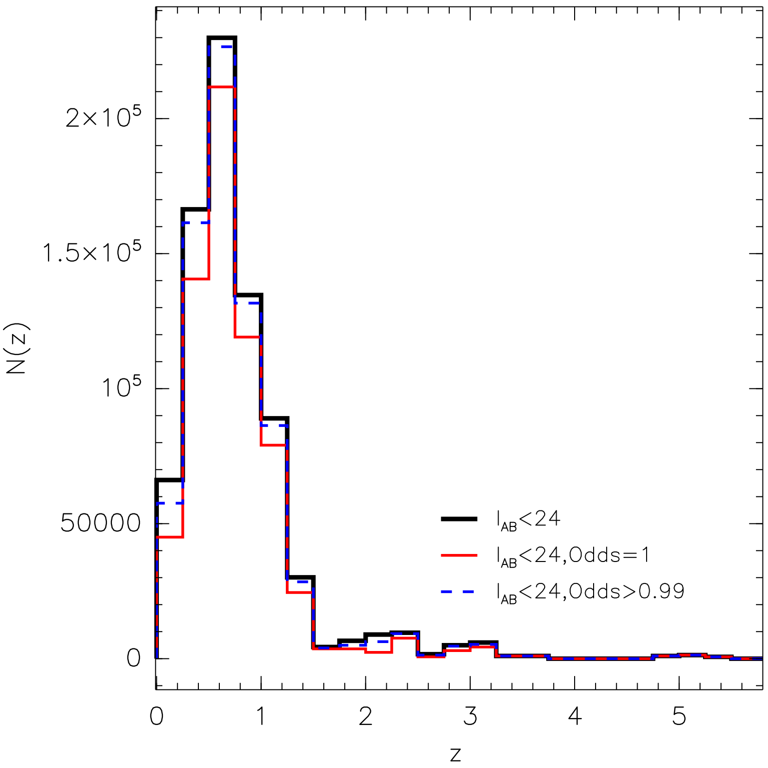

Figure 7: Number of galaxies with $I_{AB} < 24$, $Odds > 0.99$ and $Odds = 1$ as a function of redshift

overhauled, and the fact that we were the first visitor users of the camera, we could obtain high quality data in J,H,K$_s$ for the equivalent of 2/3 square degrees. The data are not yet fully processed as we are developing a whole pipeline to handle all the data flux we expect. We experienced observing conditions that yielded a wide range of FWHM in the resulting images. Eighty-five percent of the on-source integration time met our requirement of image quality of FWHM $\leq$ 1.4". With the observed standard stars we estimate zero points for the system that are slightly better than those measured with ISPI, a similar instrument mounted at the Blanco 4m telescope at CTIO. Just comparing the count level in one of the Ks images we obtained with the magnitudes of stars in common with 2MASS in the field, we estimate that we reach a magnitude limit(preliminary value, without correction for extinction) of ~ 19.8 at 5σ. This is somewhat less deep than expected but we cannot make any clear statement before the data are fully reduced and calibrated.

6 Final Considerations and Conclusions

The ALHAMBRA survey aims at filling a yet empty niche in astronomical surveys, halfway between relatively shallow, wide-area spectroscopic surveys, and deep, narrow-area photometric surveys. We intend to observe a large area (a minimum of 4 □°) divided in eight separate sub-fields using a specially designed set of 20 mid-band, minimally overlapping filters covering the whole visible range from 3700 Å to 9700 Å, plus the standard JHK_s near infrared filters.

The survey has been designed having in mind the use of photometric redshift techniques as the basic analysis tool. We have carried on detailed simulations based on available deep catalogues, and estimate that we can measure high-quality redshifts and accurate spectral types for more than 300,000 galaxies with $\Delta z/(1+z) \approx 0.015$, and for more than half a million galaxies down to $I_{AB} \approx 24$, with redshift accuracy $\Delta z/(1+z) \approx 0.03$. Approximately 2000 of these galaxies will be at $z > 5$.

The main objective of our survey is the study of cosmological evolution, under the many facets it can offer. We will study the evolution of the large scale structure, the evolution of the populations of different cosmic objects, and the processes leading to galaxy formation, evolution, and differentiation. The unbiased nature of the survey will also allow for the study of many different kinds of objects, ranging from emission-line galaxies to the diverse types of AGNs, and stars in our own Galaxy.

At the present stage of the project we have started the data collection, with the first run having taken place in August 2004, and next runs happening in December 2004, February, and May 2005. The Core Team, constituted by the authors of the present article, has already designed the data analysis routines, and the first version of the data analysis pipeline will be operative by mid 2005. We intend to complete the survey data acquisition after six semesters (approximately July 2007) and offer the survey products to the community two years after the acquisition of the last data.

The project involves the effort of many astronomers. The Core Team members have the charge of the implementation, observations, data reduction and analysis till producing the final Catalogue. It is backed by the Extended Team, made by 51 astronomers form essentially all the institutions in Spain and some others, that help in defining specific tasks or implementations. They have access to the data on equal foot as the CT members and will play a fundamental role to extract the maximum scientific output from the ALHAMBRA-Survey.

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