External Collaborator Request for Carlos Cunha

We request External Collabortor status for Carlos Cunha, University of Michigan. Cunha will participate in a project to estimate redshift distributions for galaxies in the SDSS III imaging. This project has already been announced as "SDSS-III Project 51: A Photometric Redshift Catalog for SDSS DR8". Cunha will participate in this **one project only**. This project was mistakenly announced before requesting collaborator status for Cunha.

While there are other projects involving photometric redshifts in the SDSS III, the techniques Cunha has developed are unique and complimentary. The "weighting" method can robustly derive redshift distributions for diverse galaxy populations (Lima et al. 2008; Cunha et al. 2009), whereas other projects focus on particular types of galaxies or estimation of a single "best redshift". The generation of full redshift distributions is particularly useful for studies such as gravitational lensing that inherently involve expectation values of physical quantities over a redshift distribution (note Cunha will not work on those projects).

Cunha already has experience working with SDSS data (see below). While this project could in principle be performed after DR8 is released, generating these redshift distributions on a shorter timescale will facilitate other studies that can begin well before the data release, such as galaxy cluster lensing or interpretation of correlation functions using photometrically selected galaxies (although note Cunha will not work on said projects).

Furthermore, we plan to release these catalogs to the public through the SDSS website along with DR8. This would be a catalog release, not part of the database. This follows the form of previous photoz releases as "value added catalogs"(SDSS 2009).

Previous Experience

Cunha has extensive experience in photometric redshift estimates, and has applied these techniques to SDSS data. Cunha and collaborators have developed, tested, and improved a number of photo-z estimators (e.g. Oyaizu et al. 2006). In Oyaizu et al. (2008a) he and collaborators tested error estimates derived from both template-fitting and training-set techniques. He developed a new photo-z error estimation technique, the nearest neighbor error estimate (NNE), which uses the error distribution of the nearest spectroscopic training-set objects (in magnitude space) to associate a photo-z error to objects for which no spectroscopic redshift is available (hereafter the photometric sample). He found that whenever a reasonable training set is available, the NNE is superior to other photo-z error estimators. As a concrete application of the above photo-z techniques, he produced a photo-z catalog for 77 million galaxies in the SDSS (Oyaizu et al. 2008b). He and collaborators applied the neural network technique to galaxy magnitudes, colors, and concentration parameters.

The estimation of photo-z's relies on using multi-band photometry to determine the location of galaxy spectral features in wavelength space. The accuracy and reliability of photo-z estimates therefore depend on the number, wavelength range, and relative positions of the filters, as well as the signal-to-noise achieved in each. Cunha developed a Markov Chain Monte Carlo code to optimize the choice and exposure times of filters for photo-z estimation and applied it to study the filter choices for DES. The results of this study have been incorporated into the specifications of the DES filters (DePoy et al. 2008).

More recently, Cunha studied the estimation of galaxy redshift distributions from photometric data. Applications such as weak lensing and baryon acoustic oscillations only require estimates of the galaxy redshift distribution, $N(z)$, not individual photo-z estimates. Since photo-z estimates can be biased it is important to develop techniques for optimal estimation of $N(z)$ on its own right, perhaps independently of photo-z's. He and collaborators developed an estimator for $N(z)$ which involves weighting galaxies in a spectroscopic training set so that the weighted distributions of colors and magnitudes match those of the photometric sample. This technique bypasses photo-z estimation to directly and more accurately estimate $N(z)$ (Lima et al. 2008; Cunha et al. 2009).

Finally, Cunha has found the weighting technique can be extended to yield estimates of the redshift probability distributions, $p(z)$'s, for each galaxy in the photometric sample (Cunha et al. 2009). Many of the biases seen in photo-z estimates arise because the photo-z estimator selects a single number to represent the full probability distribution. Working with the full $p(z)$ for each object one can get a much better estimate of the redshift distribution of the entire sample. Mandelbaum et al. (2008) demonstrated that the use of this $p(z)$ estimate yields a smaller lensing calibration bias than using individual galaxy photo-z estimates. Cunha made public a catalog of p(z)'s for about 88 million galaxies of the SDSS Data Release 7 (Cunha et al. 2009).

References

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