RevMexAA (Serie de Conferencias), **49**, 128–128 (2017)

XV Latin American Regional IAU Meeting (Cartagena de Indias, Colombia, 3-7 October 2016)
Editors: Mario Armando Higuera Garzón & Santiago Vargas Domínguez

THE PROXY+MATCHING TECHNIQUE

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We introduce a novel technique for modeling luminosities at different wavelengths in large samples of galaxies, suitable for emission processes whose complexity requires many untested assumptions or the use of sophisticated algorithms: in the "Proxy+Matching" approach, a physical galaxy property from the model is chosen as a proxy for another property whose numerical value is unknown. Both proxy and unknown are assumed to follow a monotonic relationship, assigning that unknown to the simulated galaxies in such a way that some observational statistics for it are reproduced. By comparing the predictions for further galaxy properties with observations, a good proxy can be found. We present the prospects of this technique for probing the submillimeter and Lyman alpha emission from galaxies in a cosmological framework, using a semi-analytic model of galaxy formation and evolution.

Observing submillimeter galaxies (SMGs, Hughes et al. 1998) and Lyman-α emitters (LAEs, Cowie & Hu 1998) gives complementary views of the star formation in dusty and non-dusty environments, respectively, making them useful to test galaxy formation models. However, modeling the far infrared continuum radiation and Lyman-α emission line in a cosmological framework is still a challenge. They require a careful treatment of the dust properties, as well as of the resonant scattering experienced by Lyman-α photons. This makes a statistical study computationally expensive when modeling samples comprised by millions of galaxies.

Inspired by the abundance matching approach (Conroy et al. 2006), we propose a technique that connects current observational knowledge of a given galaxy population with galaxy formation models: the "Proxy+Matching" technique, applying it to the semi-analytic model of galaxy formation SAG (Cora 2006; Orsi et al. 2014; Gargiulo et al. 2015; Ruiz et al. 2015). For SMGs, we choose a model galaxy property as a proxy for the rest-frame submillimeter luminosity, imposing that the observed SMG number counts are reproduced. We call this approach "Count Matching" (Muñoz Arancibia et al. 2015). We find that using the product between dust mass and star formation rate as a proxy predicts distributions of redshift, stellar mass and host halo mass in good agreement with SMG observations. For LAEs, we assume that the proxy increases with the observed Lyman-α luminosity, such that the observed Lyman-α luminosity function at a given redshift is reproduced. At $z = 3.1$, we find that using the ratio between the intrinsic Lyman-α luminosity and the cold gas mass as a proxy predicts host halo masses in good agreement with LAE observations (Muñoz Arancibia et al., in preparation).

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