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HIGH-REDSHIFT OBJECTS IN DUST ENVIRONMENTS

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RESUMEN

Se da una introducción para un proyecto relacionado con el estudio de objetos a alto corrimiento al rojo (principalmente galaxias formando estrellas), que pueden albergar grandes cantidades de polvo en su interior. La entrada de telescopios más poderosos en las longitudes de onda infrarrojas y submilimétricas (e.g., ALMA, JWST), junto con modelos de síntesis de poblaciones estelares, de transferencia radiativa, y de evolución del polvo, ayudarán a desenmascarar la evolución cósmica del contenido de polvo en las galaxias.

ABSTRACT

We give an introduction for a project related to the study of high-redshift objects (mainly star forming galaxies) which may harbor large amounts of dust within them. The incoming of better and powerful telescopes in the infrared and submillimeter wavelengths (e.g., ALMA, JWST) , together with stellar population synthesis models, radiative transfer models, and dust evolution models will help to unmask the cosmic evolution of dust content in galaxies.

Key Words: cosmology: observations — dust, extinction — early universe — galaxies: evolution

1. INTRODUCTION

In the modern evolutionary model of the Universe, it is assumed that at a certain time ($z \sim 10-14$) primeval objects begin to create stars and reionize the IGM. Those objects evolved to the galaxies we know today. In this scenario there is little understanding of the cosmic evolution of dust content.

High-redshift (z) objects had been studied for many years. Between these objects we may found Radio galaxies, optically selected QSOs, X-ray detected AGNs, optically-NIR selected Lyman-break galaxies (LBG's), Lya emitters, Balmer break galaxies (BBG's), Submm galaxies, ERO's, Lensed objects, Distant Red galaxies (DRGs) and BzK selection galaxies. In this sense the high-redshift frontier has been broken since, e.g. the $z = 3.80$ Radio galaxy of Chambers et al. (1990) to the $z \sim 10$ galaxy candidates of Yan et al. (2010). These high-z candidates were selected as J125-dropouts with the Wide Field Camera 3 observations of the Hubble Ultra Deep Field. One important aspect of the highest redshift objects is the need of spectroscopic confirmation.

Lyman break galaxies (or dropouts) studies had been carried out with the aim of optical and NIR deep fields (e.g., Bouwens et al. 2004). These studies assume little amounts of dust extinction. On the other hand, submm galaxies (Blain et al. 2002), may result from a dusty galaxy population. A submm-LBG connection has been ruled out by some authors (Ho et al. 2010).

The properties of nearby (Milky Way and Magellanic Clouds) dust show large variations in UV extinction,[4] DIBs, and mid-IR PAH emission. Most known extinction curves (except SMC) show a 2175 Å UV bump. Although starbursts galaxies show no indication of this feature (see e.g., Calzetti et al. 1994) These variations are likely due to processing of dust by star formation. Conroy et al. (2010) consider a sample of disk-dominated star-forming galaxies from GALEX, SDSS and 2MASS. Based on stacking several hundred galaxies per inclination bin, these authors found a signature of the UV bump at $z < 0.05$. This may imply that dust corrections in the UV are significantly more complicated than traditionally assumed.

The properties of extragalactic dust are observationally consistent with nearby dust (Gordon, K., STScI Science Colloquia 2010). To treat dust mixed with stars (see e.g., Bruzual et al. 1988; Witt et al.

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[4]The UV spectral slope is commonly used to infer the total UV dust attenuation, which is important for calculating unobscured star formation rates.

1992) we need to take into account the fact that multiple stars are attenuated by different amounts of dust, and that dust scattered starlight may reduce the attenuation. Attenuation is dependent on both the dust grain properties and the geometry of the stars/dust.

Large amounts of dust had been claimed to be present in high-z quasars and submm galaxies (e.g., Walter 2009). The stellar winds produced by stars on the ABG phase are thought to be the main source of dust in galaxies, but they cannot produce dust on a short enough timescale (< 1 Gyr) to explain the results in the high-z galaxies. Where does the high-z dust comes from? Supernova explosions (type II) of massive stars are also a potential source, that may account for high-redshift dust (Dunne et al. 2003; Maiolino et al. 2004). Although these may don't form the $0.1 - 1$ solar masses of dust per SN required to explain the large dust content ($> 10^8$ solar masses) and rapid enrichment in high-z galaxies (Clayton, G. C., et al. 2010, STScI Science Colloquia 2010). High-z dust maybe grown mainly in the ISM. SNe and AGB stars need to provide only a fraction of the dust, i.e., the seed material.

Modelling dust is important for future observations (ALMA, JWST, ELTs, LMT, TMT 30 meters), and deep multiwavelength surveys. da Cunha et al. (2010), modelled SED's for quiescent and highly dusty galaxies at $z \sim 0$. Their model seem to reproduce the observed broad-band luminosities from objects in GALEX, SDSS, 2MASS, and IRAS. Future observations, together with stellar population synthesis models (e.g., Charlot & Bruzual 2011), radiative transfer models, dust and chemical evolution models (e.g., Calura et al. 2008; Gall et al. 2011), can help us to understand questions such as: how much dust is present in high-z galaxies and how it affects observations? How is the cosmic evolution of dust content in galaxies? What is the source of dust at high-z?

REFERENCES

Blain, A. W., Smail, I., Ivison, R. J., Kneib, J.-P., & Frayer, D. T. 2002, Phys. Rep., 369, 111
Bouwens, R. J., et al. 2004, ApJ, 616, L79
Bruzual A., G., Magris, G., & Calvet, N. 1988, ApJ, 333, 673
Calura, F., Pipino, A., & Matteucci, F. 2008, A&A, 479, 669
Calzetti, D., Kinney, A. L., & Storchi-Bergmann, T. 1994, ApJ, 429, 582
Chambers, K. C., Miley, G. K., & van Breugel, W. J. M. 1990, ApJ, 363, 21
Charlot, S., & Bruzual, G., ed. 2010, IAU Symp. 262, Stellar Populations - Planning for the Next Decade (Cambridge: Cambridge Univ. Press)
Conroy, C., Schiminovich, D., & Blanton, M. R. 2010, ApJ, 718, 184
da Cunha, E., Eminian, C., Charlot, S., & Blaizot, J. 2010, MNRAS, 403, 1894
Dunne, L., Eales, S., Ivison, R., Morgan, H., & Edmunds, M. 2003, Nature, 424, 285
Gall, C., Andersen, A. C., & Hjorth, J. 2011, A&A, 528, A13
Ho, I.-T., Wang, W.-H., Morrison, G. E., & Miller, N. A. 2010, ApJ, 722, 1051
Maiolino, R., Schneider, R., Oliva, E., Bianchi, S., Ferrara, A., Mannucci, F., Pedani, M., & Roca Sogorb, M. 2004, Nature, 431, 533
Walter, F. 2009, ASP Conf. Ser., 414, Cosmic Dust - Near and Far, ed. T. Henning, E. Grün, & J. Steinacker (San Francisco: ASP), 287
Witt, A. N., Thronson, H. A., Jr., & Capuano, J. M., Jr. 1992, ApJ, 393, 611
Yan, H.-J., Windhorst, R. A., Hathi, N. P., Cohen, S. H., Ryan, R. E., O'Connell, R. W., & McCarthy, P. J. 2010, Res. Astron. Astrophys., 10, 867