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HOLMES AND LITTLE MONSTERS

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RESUMEN

Las estrellas evolucionadas calientes de baja masa (HOLMES) pueden tener mayor importancia en las galaxias que lo que generalmente se considera.

ABSTRACT

Hot low-mass evolved stars (HOLMES) may have a more important role in galaxies than generally thought.

Key Words: galaxies: active — galaxies: elliptical and lenticular, cD — galaxies: ISM — stars: AGB and post-AGB

1. PRESENT STATUS

There are several families of emission-line objects in the Universe whose source of ionization is still debated.

1.1. *LINERS and alike*

The most known is the case of LINERs (low-ionization nuclear emission regions), defined as a class by Heckman (1980) and which are found in nearly 40% of nearby galaxies (Ho 2008). The spectra of these objects are dominated by lines from low ionization states. This distinguishes them both from Seyfert galaxies and from H II regions. In addition, the line luminosities are modest. While the first explanations for the observed emission-line spectra favoured the effects of shock waves, it now seems that many of these nuclei harbour a supermassive black hole accreting at a low rate, a "little monster" as called by Eracleous et al. (2010). While this interpretation seems to hold for an important fraction of LINERs (González-Martín et al. 2009), other possibilities have to be investigated for those objects that apparently are not "little monsters". Ionization by hot low-mass evolved stars (HOLMES) is one of them. Such an explanation was already proposed by Binette et al. (1994) to account for the emission lines observed in early-type galaxies.

With the advent of the Sloan Digital Sky Survey (SDSS, York et al. 2000) which provided fiber-fed spectra of a million of galaxies, it was found that a large fraction of galaxies have spectral characteristics of LINERs (Kauffmann et al. 2003; Kewley et al. 2006). The typical redshift of those galaxies is 0.1, so that the $3''$ fibers cover regions much larger than just the nuclei. Using the spectral synthesis code STARLIGHT (Cid Fernandes et al. 2005), Stasińska et al. (2008) showed that the stellar populations of those galaxies are old, and that the Lyman continuum photons produced by these old stellar populations are able to explain the location of these "LINER galaxies" in the classical emission-line ratio diagram of Phillips, Baldwin, & Terlevich, 1981, hereafter BPT): indeed, the integrated spectra of the HOLMES in these old stellar populations are much harder than those of the massive stars that ionize pure star-forming galaxies.

Cid Fernandes et al. (2010) studied the "forgotten" population of emission-line galaxies in the SDSS, i.e. galaxies that do not appear in the BPT diagram because their [O III] λ5007 and/or Hβ lines are too weak. By introducing the W(Hα) vs. [N II]/Hα (WHAN) diagram they could classify 50% more emission-line galaxies. It turns out that a large fraction of them are LINER-like galaxies, defined by log [N II]/H$\alpha > -0.4$ and W(Hα) < 6 Å.

The question of how to distinguish "retired" galaxies, ie., galaxies that have stopped forming stars and are ionized by their old stellar population from galaxies ionized by "little monsters", or, in other words, fake from true AGN, was discussed in Cid Fernandes et al. (2011). A practical limit between these two overlapping populations of LINER-like galaxies was set to W(Hα) = 3 Å. It was corroborated by the analysis of global properties of the different spectral classes of galaxies defined in the WHAN diagram, showing similarities between galaxies hosting strong or weak AGN on the one hand, and galaxies which have stopped forming stars, i.e. "retired" and "passive" (or line-less), on the other.

1.2. *The diffuse ionized gas in late-type galaxies*

Another case where the cause of the ionization is disputed is that of the diffuse ionized gas (DIG) in spiral galaxies. As shown by Flores-Fajardo et al.

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