Propuesta de
Trabajo de introducción a la Investigación

Departamento de Astrofísica
Universidad de La Laguna

Título del trabajo:
The relationship between black-hole mass and galaxy mass for dwarf galaxies

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¿Desea que este trabajo se ofrezca a estudiantes de universidades colaboradoras? (si la respuesta es afirmativa, es deseable que este formulario se cumplimente en inglés)**:**
Si

Resumen del trabajo propuesto (máximo de 100 palabras)**:**

Most galaxies seem to harbor Super Massive Black Holes (SMBHs) in their centers. The mass of the BH scales with the mass of the host galaxy, which suggests a joint evolution of the SMBH and its galaxy. Actually, SMBH feedback on galaxy assembly seems to be essential to understand the lack of massive galaxies in the nearby universe. Using a unique set of Seyfert galaxies selected from SDSS/DR7, we propose to extend the observed relationship between SMBH mass and galaxy mass down to BHs of 10^6 solar masses, and beyond. All the required ingredients can be obtained from the existing SDSS spectra.

Medios materiales que serán puestos a disposición del alumno (datos astronómicos, acceso a medios informáticos y bibliográficos, …):

SDSS/DR7 and ASK classification of these spectra. The relevent bibliography is mostly provided in this document.

Asignaturas del Máster que el alumno deberá haber cursado (este apartado es opcional)**:**

Justificación (importancia del tema, antecedentes, etc). Máximo 1 página:

Most galaxies seem to harbor Super Massive Black Holes (SMBHs) in their centers. Accretion onto these central SMBH would be responsible for the Active Galactic Nucleus (AGN) activity of quasars, Seyfert galaxies, and LINERs. Most of these SMBHs are dormant in the local universe, such as the one present in the center of the Milky Way. However, their activity must increase with lookback time, being responsible for the rich population of quasars observed at high redshift. Our understanding of the role played by SMBH in galaxy evolution underwent a dramatic change during the last decade. From SMBH being an ingredient required to power the engine of some exotic objects, to become a key ingredient that regulates the formation of most, if not all, galaxies. Two main factors have conspired to produce this shift of paradigm. On the one hand, the current hierarchical scenario for galaxy formation overpredicts the number of local massive galaxies (e.g., Benson et al. 2003). A mechanism is needed to quench the accretion of barions onto galaxies when the accretion rate is too high, and such mechanism is automatically provided by the AGN outflows (Silk and Rees, 1998). On the other hand, observations have shown how the mass of the SMBH scales with the luminosity of the host galaxy (see the comprehensive review by Ferrarese 2006 -- this relationship is often referred to as Magorrian diagram, after Magorrian et al. 1998). This relationship is exactly what one should expect if the AGN-galaxy feedback mechanism operates. When the SMBH quenches large scale accretion, it also cuts off accretion onto itself. Therefore, it is to be expected that the SMBH grows with the full galaxy at precisely the rate at which it barely stops large scale accretion, self-regulating its growth together with that of the host galaxy.

Most of these ideas are brand new. They were not around fifteen years ago. Despite the importance of the issue and the advances in the field, there is much work to do (see Ferrarese, 2006). Among the many unknowns, the Magorrian diagram has been established only for fairly massive SMBH (> 10^6-10^7 solar masses). It is important to understand whether (and to what extent) it continues down to less massive objects, where self regulation may not be provided by SMBHs but by star formation. We have

an original way of contributing to this issue, and the work we propose represent a exporation of the pathways to go.
We have managed to classify the full spectroscopic catalog of galaxies in SDSS/DR7 (Sanchez Almeida et al. 2010). Among the 930,000 galaxies, 5000 of them seem to be Seyfert galaxies. We propose to use them to extend the Magorrian diagram to low luminosities (or low SMBH masses). In principle, all the required observables can be extracted from the available SDSS spectra. The BH mass can be inferred from the width and the flux of Hbeta, following the semi-empirical recipe by Vestergaard and Peterson (2006). In addition, the mass of the bulge of the galaxy can estimated from the width of, e.g., [OIII]5007 (Nelson and Whittle, 1996). We prefer to use the mass of the bulge as proxy for galaxy mass since it seems to provide the tightest Magorrian diagram (see, again, Ferrarese 2006). If time permits, we would also like to try with the red sequence galaxies in our classification. Only a small fraction of these galaxies present Hbeta in emission, but red galaxies are so numerous that they provide another 5000 targets.

We understand the project as a first step in a series which, eventually, will allow us to study the dependence of the Magorrian diagram on Hubble type, redshift, and environment. This exension is worth a Thesis.

Referencias:
[ ] Benson et al., 2003, ApJ, 599, 38
[ ] Ferrarese, L., 2006, in Joint Evolution of BHs and Galaxies, Colpi et al. Eds., Taylor and Francis, p. 1
[ ] Magorrian et al., 1998, AJ, 115, 2285
[ ] Nelson & Wittle, 1996, ApJ, 465, 96
[ ] Silk, J. & Norman, , 2009, ApJ, 700, 262
[ ] Silk, J, & Rees, M. J., 1998, A&A, 331, L1
[ ] Sanchez Almeida et al. 2010, ApJ, in preparation
[ ] Vestergaard & Peterson, 2006, ApJ, 641, 689

Objetivos concretos que se persiguen. Máximo media página:

To extend the relationship between SMBH mass and galaxy mass down to 10^6 solar masses, and beyond.

Plan de trabajo. Máximo media página:

1. Read the relevant literature. (1 week)

2. Write and test an IDL procedure to derive width and equivalent width of Hbeta -- probably a two component model must be adopted. Write (and test) a procedure to infer widths of [OIII]5007. (3 weeks.)
3. Apply the procedure to the spectra of SDSS classified as ASK 6 and 7. Infer the BH mass and the sigma from them. (3 weeks.)
4. Construct the Magorrian plot for these classes, and compare it to those already published. (2 weeks.)
5. If time permits, repeat the procedure with the early type galaxies with emission lines, (ASK classes 0, 1 and 2). Is the diagram cleaner?
6. Write the appropriate report (4 weeks).

We will regard the project as successful even if item 5 is not dealt with. Items 1 and 2 can be attacked simultaneously. The same happens with items 3 and 4. The writting of the report can be carried out in parallel with the development of the work.

Otros datos que se desee hace constar (lugar en que se desarrollará el trabajo, estancias previstas en otros centros, material a utilizar, etc.):