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Host galaxy properties of radio selected AGN

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Abstract. With the goal of investigating the link between black hole (BH) and star formation (SF) activity, we study a deep sample of radio selected star forming galaxies (SFGs) and active galactic nuclei (AGNs). Using a multi-wavelength approach we characterize their host galaxies properties (stellar masses, optical colors, and morphology). Moreover, comparing the star formation rate derived from the radio and far-infrared luminosity, we found evidences that the main contribution to the radio emission in the radio-quiet AGNs is star-formation activity in their host galaxy.

Keywords. galaxies: active – galaxies: star formation – radio continuum: galaxies

1. Disentangling the faint radio sky

Our group has conducted one of the deepest radio survey with the VLA at 1.4 GHz on the Extended Chandra Deep Field South (E-CDFS). The sample consist of 883 radio sources down to $\sim 30\mu$Jy (Miller *et al.*, 2013). Using a likelihood ratio technique, we identify their counterparts at all the other wavelength available, from the UV to the X-rays, in order to reconstruct their full SED (Bonzini *et al.*, 2012). The two main processes that contribute to the radio continuum at 1.4 GHz are the non-thermal emission from relativistic jets powered by AGNs and the synchrotron emission from supernova remnants associated with SF activity. Disentangling these two emission mechanisms is important to investigate the circumstances under which they originate and to study their connection. Indeed, the μJy sensitivity of our survey allows us to detect not only radio loud (RL) AGNs, but also a significant population of SFGs and, for the first time, a statistically significant sample of radio selected radio-quiet (RQ) AGNs (Bonzini *et al.* 2013, Padovani *et al.*, this volume). To separate these three classes of sources we consider the ratio between their mid-infrared and radio emission, their IRAC colors, and their X-ray luminosity (Bonzini *et al.*, 2013). This method is almost independent of any modelling and does not require spectroscopic follow up, making it suitable for large radio samples.

2. Host galaxy properties vs radio loudness

Comparing the properties of AGN hosts with different levels of radio loudness can give insights on the possible connection between the AGN and its host galaxy evolution. With this motivation, we derived stellar masses and rest-frame optical colors for our radio sample using a two-component (AGN+galaxy) SED fitting technique (Bongiorno *et al.* 2012). We found that the host galaxies of RQ and RL AGNs are clearly separated in two

groups; RQ AGNs are preferentially hosted in blue, young stellar population galaxies with late type morphology, while RL AGNs are mainly found in red and old galaxies. This suggests that the RQ and RL AGN activity occurs at two different evolutionary stages of the BH-host galaxy co-evolution. RQ AGN are in an early phase, when the galaxy is gas rich, is still forming stars, has a young stellar population, and the AGN is efficiently accreting. The radio activity of the AGN occurs instead at later times when the galaxy is gas poor, the accretion on the BH is inefficient, the star formation in the host decreases, and the stars get older and redder (Bonzini *et al.*, 2013).

3. Origin of radio emission in radio-quiet AGNs

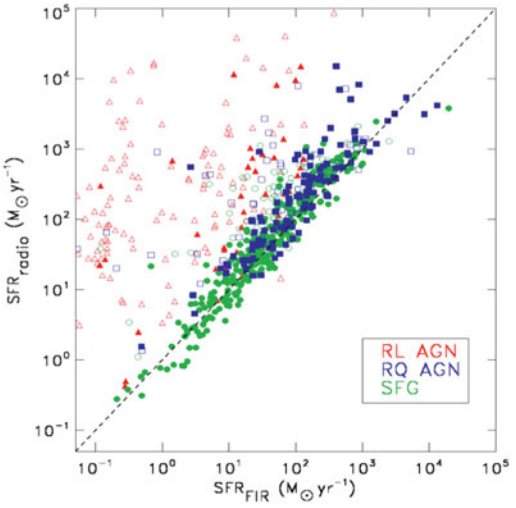

Figure 1. Comparison of the SFR derived from the radio and FIR luminosity for SFGs (green circles), RQ AGNs (blue squares) and RL AGNs (red triangles). Full symbols represents sources detected in at least one *Herschel* band, while for empty symbols the SFR_{FIR} estimate is based on the photometry up to 24 μm.

We have used our clean sample of RQ AGNs to address the long-standing issue about the origin of the radio emission in radio quiet AGNs (Bonzini *et al.* in preparation). There are essentially two scenarios that have been proposed: either they are a scaled down version of RL AGNs (e.g., Giroletti & Panessa, 2009) or their radio emission comes from the SF in their host galaxy (e.g., Padovani *et al.*, 2009). To test the latter hypothesis, we have compared the SFR derived from the far-IR emission detected by Herschel (where the contribution from the AGN is considered negligible) with the SFR derived from the radio luminosity under the assumption that all the radio emission is due to SF. As shown in Fig. 1, we found that the two SFR measurements agree within 0.2 dex over 4 orders of magnitudes for both SFG and RQ AGN. Instead, the agreement for RL AGN is poor as expected due to the contribution of relativistic jets to their radio luminosity. This strongly supports the hypothesis that the main mechanism of radio emission in RQ AGN is indeed the SF in the host galaxy rather than being associated with the accretion onto the BH. Hence, this result shows that it is possible to estimate the SFR even in the host galaxy of bright RQ AGN and QSOs directly from the radio luminosity.

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