FR Dichotomy, Accretion Modes and Environmental Factors in the Local Universe
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ABSTRACT
Active galactic nuclei (AGN) comprise the majority of currently observed radio galaxies, and the Fanaroff-Riley (FR) categorisation provides a classification of extended AGN. The FRI objects have the highest surface brightness along the jets near the core, while FRII sources show the highest surface brightness at the lobe extremities, as well as more collimated jets. This FR dichotomy is based purely on the appearance of the radio objects, and the mechanisms differentiating the two populations are still unknown. Two main streams of models exist to explain these differences in morphology. Extrinsic models are purely based on the source environment, while morphology-intermediate density models hint at a luminosity-dependent bimodal evolution, where low-luminosity sources show no evolution while high-luminosity sources undergo positive density evolution. What differentiates FR sources? Two main streams of models exist to explain these differences in morphology: Extrinsic models, purely based on the source environment (e.g. Prestage & Peacock 1988) and intrinsic models, suggesting FRI and FRII dichotomy arises from differences in the properties of the central black hole (e.g. Ghisellini & Celotti 2001). To test these scenarios, high/low excitation classification and environmental richness factor of a sub-sample of local (z<0.3) CoNFIG extended galaxies were compiled to investigate the possible FR morphology/accretion mode/environment relations. The sub-sample contains 206 sources, including 74 FRIs and 107 FRIIs, 76% of which have available spectra, mostly from SDSS.

RESULTS

CoNFIG LOCAL SAMPLE
In previous studies of FR sources using the CoNFIG catalogue (Gendre et al. 2008, 2010), results have shown that, at comparable powers, FRI and FRII sources show strong similarities in evolution, which indicate that they very probably share a common mechanism governing the luminosity-dependent evolution. In addition, radio luminosity function (RLF) models hint at a luminosity-dependent bimodal evolution, where low-luminosity sources show no evolution while high-luminosity sources undergo positive density evolution. What differentiates FR sources? Two main streams of models exist to explain these differences in morphology: Extrinsic models, purely based on the source environment (e.g. Prestage & Peacock 1988) and intrinsic models, suggesting FRI and FRII dichotomy arises from differences in the properties of the central black hole (e.g. Ghisellini & Celotti 2001). To test these scenarios, high/low excitation classification and environmental richness factor of a sub-sample of local (z<0.3) CoNFIG extended galaxies were compiled to investigate the possible FR morphology/accretion mode/environment relations. The sub-sample contains 206 sources, including 74 FRIs and 107 FRIIs, 76% of which have available spectra, mostly from SDSS.

Cluster richness was determined using the method of Wing & Blanton (2011), in which the richness factor N_{r,i} corresponds to the number of foreground SDSS galaxies with absolute magnitudes brighter than M_{r}=-19 within a 0.01 Mpc radius of the radio source. The foreground galaxy count is obtained by measuring the total number of sources in the R=1.0 Mpc disk and subtracting a background count, measured from a shell of inner and outer radii of 0.1 and 3.0 Mpc respectively. When SDSS data were unavailable (14% of the local sample), 2MASS K- and EIS Patch-D I-band data were used. Finally, in cases where the apparent magnitude corresponding to M_{r}=-19 was fainter than the catalogue magnitude limit, a lower limit on N_{r,i} including all sources within the disk and shell was used. According to Wing & Blanton (2011), a cluster-richness of N_{r,i} ≥ 20 likely corresponds to a poor cluster, while N_{r,i} ≥ 40 corresponds to a rich cluster. We thus decided to use N_{r,i} = 30 to differentiate between poor and rich environments.

OTHER FACTORS
Several other factors might be in play, in particular properties of the host galaxies (Owen & Ledlow 1994) and polarisation (Banfield et al. 2012). We investigated both parameters by (1) including source absolute magnitudes, M_r, compiled from band data from either the SuperCosmos Sky Survey or the ESO Imaging Survey patch D and (2) retrieving polarisation data from NVSS.

HEG/LEG classification was determined here by measuring the [Oii] (λ = 4959Å and 5007Å) and [Oiii] (λ = 3727Å) lines. We then followed the definitions of Jackson & Rawlings (1997): sources with [Oii] line width < 1000 km/s and [Oii]/[Oiii] ratio > 0.1 were classified as LEG, other sources being classified as HEG. If the [Oii] line was detected, the source must then be low excitation.

For the extended local sample, we found 81 LEG (49 FRI and 32 FRII) and 58 HEG (12 FRII and 46 FRII). The 44 other sources (14 FRI and 30 FRII) do not have spectra available to determine the excitation level of the host galaxy.

The radio luminosity function was computed for both HEGs and LEGs. Sources with no HEG/LEG classification available were taken into account by including a correcting factor to each LRLFs. The resulting LRLFs are shown in Figure 1.

We see that both HEGs and LEGs cover the full range of radio luminosities studied, and broadly agrees with the work of Best & Heckman (2012), indicating that the inclusion of sources with no HEG/LEG classification was properly done.

REFERENCES:
Owen F. N. & Ledlow M. J., 1994, ASPC, 54, 319
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Figure 1: Radio luminosity function for HEGs (orange stars) and LEGs (green crossed squares) separately, using bin sizes of logP = 0.4. The LRLFs are compared to results from Best & Heckman (2012) in light and dark grey for HEGs and LEGs respectively. For more accurate comparisons, the LRLF for HEGs with SDSS counterparts (including CoNFIG sources selected by Best & Heckman 2012) are shown in black filled squares.