X-shooter Science Verification Proposal

Hunting down elusive powerful radio source

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Abstract:

Powerful radio emission has proven to be an effective tracer of the most massive galaxies to form in the early universe. These distant galaxies are identified efficiently by combining ultra-steep spectrum radio selection with deep K-band imaging, producing candidate galaxies for spectroscopy which are 2-3 mag brighter than optically-selected galaxies at the same redshift. We are currently completing an extensive project based on two large southern radio catalogues, aiming to find a significant sample of high redshift radio galaxies in the south through follow-up optical sepctroscopy. However, ∼30% of these powerful radio sources remain so far undetected in the optical and are therefore good candidates very high redshift galaxies hosting a powerful type-2 (obscured) quasar. We propose here to exploit the unique simultaneous wavelength coverage and high sensitivity of X-shooter to unveil the nature of three of these elusive objects.

Scientific Case:

Distant radio galaxies are among the largest, most luminous and most massive objects in the Universe (see eg. review by Miley & De Breuck 2008). These are proto-typical type 2 (obscured) AGNs. Theses objects have been studied for the past four decades with a strong involvment from the ESO community. Most recently, their important role in our overall understanding of galaxy formation through accretion/feedback mechanisms has been demonstrated (eg. Nesvabda et al. 2007, 2008). Despite these extensive follow-up studies, the number of known z> 2 has less than doubled in the past decade.

Over the past few years, we have developed highly efficient techniques for identifying massive high-redshift galaxies (De Breuck et al. 2004, 2006; Broderick et al. 2007a; Bryant et al. 2009a, 2009b). The key factor in distinguishing the most distant radio galaxies from the lower redshift population is the radio spectral index α (where $S_\nu \propto \nu^\alpha$) at frequencies at or below 1 GHz. The technique of steep-spectrum selection for high z radio galaxies has proven to be very successful at finding massive galaxies at redshifts $2 < z < 3.5$, the epoch when the overall star formation rate in the universe was at its peak.

In the past four years, we have been successfully building-up a sample of radio galaxies optimally accessible to the VLT ($-40 < \delta < -30$) using new radio catalogues (Broderick et al. 2007a). We have K-band identifications for >90% of our sample (Bryant et al.2009a). Optical spectroscopy with NTT and VLT has yielded so far 36 redshifts out of the 52 sources observed.

The remaining 16 sources do not show any emission line nor continuum in the Visual-red up to ∼800 nm. They are however typically relatively bright in the near-IR with K-band magnitudes between 18 and 20 (Vega). Given these K-band magnitudes, we expect to detect a red continuum and possibly bright emission lines typical of type-2 AGNs. They are therefore very good candidates for being z>6 galaxies hosting an heavily obscured AGN.

The wide wavelength range obtained in one shot coupled with the exquisite sensitivity of X-shooter make it the instrument of choice for determing the nature and redshift of the elusive counterpart of these powerful radio sources. Of particular interest for this proposal is the unique simultaneous coverage between 800 and 2500 nm. This programme essentially concentrates on the red part of the spectrum can therefore be executed in grey/bright time.

To facilitate scheduling of this project we propose a list of seven potential targets of which we would like to observe at least three as a test case for X-shooter SV.

These unique observations will provide immediate results. This project has a strong potential to break the 12 years old redshift record of 5.2 for a powerful radio galaxy. Having these data immediately public would also be a strong motivation for the radio galaxy community to analyse these spectra and propose for further X-shooter programmes.

Targets and observing mode

Target	**RA**	**DEC**	**K** mag	**Mode** (slit/IFU)	**Remarks**
NVSS J015223-333833	01 52 22.93	-33 38 36.2	K=18.0	slit	priority 1
NVSS J202518-355834	20 25 18.38	-35 58 32.3	K=18.2	slit	priority 1
NVSS J002112-321208	00 21 12.40	-32 12 10.1	K=19.1	slit	priority 1
NVSS J015418-330150	01 54 18.26	-33 01 51.0	K=19.8	slit	priority 2
NVSS J151021-364253	15 10 21.80	-36 42 54.1	K=20.1	slit	priority 2
NVSS J215009-341052	21:50:09.30	-34 10 52.4	K=19.6	slit	priority 2
NVSS J221104-35182	22 11 05.04	-35 18 20.0	K=19.0	slit	priority 2

Time Justification:

To reach a snr of about 4 to 5 per resolution element in the continuum in the H band (were NIR arm efficiency is highest) for a typical target, we need ∼3600s on target. Accounting for acqusition and readout overheads for a 4 positions nodding sequence (2 AB cycles), we estimated ∼15 min overheads. In total, 1.25 per target is needed. The total requested time is therefore 3.75h.