THE UV/RADIO CORRELATION OF QUASARS AND ITS IMPLICATIONS FOR UNIFIED SCHEMES.

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1. Introduction

What causes the differences in the central engines of AGN? Are they intrinsically different or are the differences entirely due to environment and orientation? We have postulated that there is basically only one engine, consisting of a black hole and a closely coupled (even symbiotic) jet/disk system with very similar parameters in all AGN [2]. This has lead to interesting results concerning the modelling of the UV/radio correlations [4] of quasars and the difference between FR I and FR II radio galaxies [3].

2. The UV/radio correlation for quasars

If there is a closely coupled jet/disk system in AGN we would expect to find a strong correlation between accretion disk luminosity (UV bump) and radio core luminosity in quasars; and indeed correlations between optical (e.g. O[III] [5]) and radio emission have been demonstrated. We tried to improve upon those correlations by estimating the UV-bump luminosity of quasars directly from optical/UV/x-ray observations of quasars [6] *and* indirectly from emission line luminosities [1]. We combined all estimates for each source into a single estimate for the disk luminosity $L_{\rm disk}$ and plotted this vs. their VLA radio core fluxes at 5 GHz [4]. The UV/radio distribution can then be compared to a simple emission model which takes mass and energy conservation in a coupled jet/disk system into account [2]:
– We find a strong correlation between UV/bump and radio core luminosity in radio weak quasars and a similar trend in radio loud quasars. The former correlation implies that radio emission and UV-bump in *radio weak* quasars have a similar origin (central engine rather than starburst).

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– Flat-spectrum compact quasars have brighter radio cores than steep spectrum quasars at the same $L_{\rm disk}$ consistent with the former being relativistically boosted. Width of the distribution and location of the flat-spectrum cores are well modelled by randomly oriented relativistic jets with bulk Lorentzfactor $\gamma\sim6$ at $L_{\rm disk}\sim10^{46}$ erg/sec.
– The cores of radio loud quasars (with bright extended emission) are brighter than those of radio weak quasars at the same $L_{\rm disk}$. Hence, the radio-loud/radio-weak dichotomy is already established on the pc scale.
– The total jet power of radio loud quasars must be comparable to their accretion disk luminosity to explain the bright synchrotron emission from their radio cores. This indicates that the jet is produced in the innermost region of the disk where most of the energy is available. Radio loud quasars are very efficient and require that relativistic electrons are in equipartition with the magnetic field (having a minimum Lorentzfactor of $\gamma_{\rm e}\sim100$). Radio weak quasars can be modelled by basically the same jet if the available electrons are accelerated into a powerlaw starting at $\gamma_{\rm e}\sim1$.
– There is a distinct population of a few flat-spectrum quasars which have *total* radio luminosities intermediate between radio loud and radio weak quasars (flat-spectrum intermediate quasars = FIQ). Despite being dominated by a variable, flat-spectrum radio core – which usually is indicative of relativistically boosted jets – their cores are equally bright or even weaker than the cores of lobe-dominated quasars at the same $L_{\rm disk}$. If the FIQ are boosted quasars their parent population can not be the radio loud quasars as they lack the steep-spectrum lobe emission and their cores are to weak. The only possible parent population therefore are radio weak quasars. Number and offset of the FIQ in the PG sample would then both indicate bulk Lorentz factors of $\gamma\sim3-5$ in *radio weak* quasars!
– In the optically and the radio selected sample there is a void of radio loud *quasars* below a critical $L_{\rm disk}$. We identify this with the FR I/FR II break and suggest that this might be caused by a torus with power-dependent opening angle [3]. At low powers the torus closes, obscures the central engine for all aspect angles (no quasar signatures) and starts to disrupt the radio jet (causing the FR I morphology). The power-dependent torus will change the length/number statistics for quasars and radio galaxies and the jet torus interaction can modify the jet on the pc scale.

References

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