Radio-loudness of Active Galaxies and the Black Hole Evolution

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Abstract

Active galactic nuclei (AGNs) form two distinct sequences on the radio-loudness – Eddington-ratio plane. The 'upper' sequence contains radio selected AGNs, the 'lower' sequence is composed mainly of optically selected AGNs. The sequences mark the upper bounds for the radio-loudness of two distinct populations of AGNs, hosted respectively by elliptical and disk galaxies. Both sequences show the same dependence of the radio-loudness on the Eddington ratio (an increase with decreasing Eddington ratio), which suggests that another parameter in addition to the accretion rate must play a role in determining the efficiency of jet production in AGNs. We speculate that this additional parameter is the spin of the black hole, assuming that black holes in giant elliptical galaxies have (on average) much larger spins than black holes in disc galaxies. Possible evolutionary scenarios leading to such a spin dichotomy are discussed. The galaxy-morphology related radio-dichotomy breaks down at high accretion rates where the dominant fraction of luminous quasars being hosted by giant ellipticals is radio quiet. This indicates that the production of powerful jets at high accretion rates is in most cases suppressed and, in analogy to X-ray binary systems (XRB) during high and very high states, may be intermittent. Such intermittency can be caused by switches between two different accretion modes, assuming that only during one of them an outflow from the central engine is sufficiently collimated to form a relativistic jet.

1. Introduction

Already in the early 1960s it became clear that the strongest radio sources associated with disk galaxies are by about 3 orders of magnitude weaker than the strongest radio sources hosted by giant elliptical galaxies, and that the most radio luminous objects in the Universe are quasars (Matthews et al., 1964). Soon it was realized, however, that the majority of quasars is radio quiet (Sandage, 1965; Strittmatter et al., 1980). Initial optical imaging indicated that their radio-bimodality may be re-lated to the host galaxy morphology, with radio quiet quasars preferentially hosted by disk galaxies and radio-loud quasars hosted by elliptical galaxies (Malkan, 1984; Smith et al., 1986). This suggested a possible association of radio quiet-quasars with Seyfert galaxies and radio-loud quasars with radio galaxies. Such a bimodality is visualized by Xu et al. (1999) in the radio-luminosity versus [OIII]-luminosity representation.

Since radio structures in AGNs are powered by jets, the AGN radio dichotomy is most likely related to the efficiency of a jet production. According to the spin paradigm, this efficiency depends on the value of the black hole spin (Blandford & Znajek,

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1977; Blandford, 1990). In the simplest version of this paradigm the observed radio dichotomy is directly related to the cosmologically determined distribution of BH spins. Assuming that the growth of supermassive BHs is dominated by their mergers, Wilson & Colbert (1995) demonstrated that the excess of radio quiet quasars could be explained by the rarity of major galaxy mergers, resulting in a 'bottom-heavy' distribution of BH spins. This is because in such a scenario, fast rotating BHs can only be produced by mergers of two BHs with comparable masses, and this in turn implies similar masses of merging galaxies. However, as was pointed out by Moderski & Sikora (1996a), the growth of BHs in AGNs is very likely dominated by accretion processes, which are known to be able to spin up BHs very efficiently (Bardeen, 1970). Moderski & Sikora argued nevertheless that the spin paradigm could still be at work, and showed that the bottom-heavy distribution of the BH spin might be obtained provided the accretion history of most of AGNs was marked by many small-mass accretion events with randomly oriented angular momenta (see also Moderski et al., 1998). Such events, due to Bardeen-Petterson effect (Bardeen & Petterson, 1975), lead to the formation of co- and counter-rotating disks and, in consequence, to BH spins fluctuating around zero (with very small amplitudes). Since during their evolution disk galaxies have avoided major mergers (Hopkins et al., 2007), BHs in spiral-hosted AGNs had much larger chance avoiding spinning-up by massive accretion events than their cousins in giant ellipticals.

However, these simple versions of the spin paradigm were challenged, both from the observational and theoretical perspectives. Observationally, this is because: (i) luminous quasars, irrespective on their radio-loudness, were recently found to be hosted by giant ellipticals (see Floyd et al. 2004, and references therein); (ii) several independent investigations of the AGN accretion radiation efficiency using the Sołtan's type of argument (Sołtan, 1982) indicate that the majority of quasars are powered by fast rotating BHs (Yu & Tremaine, 2002; Elvis et al., 2002; Marconi et al., 2004; Wang et al., 2006) (but see Shankar et al., 2007); (iii) low luminosity AGNs (LLAGNs), including local Seyfert galaxies and LINERs, are found to have higher than previously thought radio-to-optical nuclear flux ratios, placing them rather in the category of radio loud objects (Ho & Peng, 2001; Ho, 2002). Theoretically, this is because: (iv) the Blandford-

Znajek mechanism was claimed to be not efficient enough to explain jet energetics in the most radioloud quasars (Ghosh & Abramowicz, 1997); (v) the possibility of formation of counter-rotating accretion disks in AGN systems was questioned (Natarajan & Pringle, 1998; Volonteri et al., 2005). In addition, recent investigations of the jet (radio) activity in XRBs could suggest that the accretion rate is the only parameter controlling the jet production efficiency in these systems (Gallo et al., 2003; Fender et al., 2004). As a consequence of all the above, the 'main stream' AGN models in the last years became those with a jet production related to accretion processes exclusively (Nipoti et al., 2005; Körding et al., 2006).

Does this mean that the spin paradigm is 'dead'? Not at all. As was shown and discussed by Sikora et al. (2007, hereafter SSL07) and Volonteri et al. (2007), several challenges listed above are not well justified, while other can be overcome after adopting certain modifications to the spin paradigm. In particular, King et al. (2005) demonstrated analytically and Lodato & Pringle (2006) confirmed numerically that the formation of counter rotating disks in AGNs is possible. Also, Hawley & Krolik (2006) and McKinney (2006a,b) showed (using different GR MHD simulations) that the efficiency of extraction of the BH rotational energy can be much larger than indicated by the formula derived originally by Blandford & Znajek (1977) using 1st order perturbation method and adopting the Shakura & Sunyaev (1973) disk model. Finally, SSL07 demonstrated that the host-related radio bimodality of AGNs *remains* real at *all* accretion rates. On the other hand, modifications of the spin paradigm are indeed required in order to reconcile the observed radio-bimodality of powerful (elliptical-hosted) quasars with the requirement that all BHs in quasars have large spins. Addressing this problem, SSL07 proposed that the fact that most of the elliptical-hosted quasars are radio quiet results from the suppression ("quenching") of jet production at high accretion rates. Such a suppression is in fact directly observed in the transient XRBs: the observations of micro-quasar GRS 1915-105 indicate for example that two different accretion modes may exist at high accretion rates, and that only during one of them the efficient jet production proceeds (Fender et al., 2004). In their modified version of the spin paradigm, SSL07 anticipated such a two accretion-mode scenario for the elliptical-hosted AGNs accreting at high (Edding-

ton) rates, assuming in particular that the quasar jets produced by the rotating supermassive BHs can avoid suppression only if the efficient collimation by the MHD outflows from the outer parts of the accretion disk is the case.

This article is based in its large parts on the work of SSL07, and is organized as follows. In §2, the dependence of the AGN radio-loudness on the Eddington ratio is presented; in §3, the multi-accretion-event scenarios are investigated; in §4, the challenges to the spin-paradigm are discussed and critically re-examined; and in §5 the final conclusions are listed.

2. Radio-loudness

In order to quantify the jet production efficiency in AGNs, Kellermann et al. (1989) introduced a 'radio-loudness' parameter defined as the ratio of radio (5 GHz) and optical (B-band) spectral flux densities, $\mathcal{R} = L_\nu(5\text{GHz})/L_\nu(\text{B})$. Based on the claimed bimodality of opticaly-selected PG quasars, they established $\mathcal{R} = 10$ as a borderline between the radio-loud and radio-quiet objects. The methods of estimating masses of BH in galactic nuclei developed in the 1990s (see Woo & Urry, 2002, and refs. therein) allowed to study the dependence of this radio-loudness parameter on the Eddington ratio λ, which is defined as the ratio of the bolometric accretion luminosity to the Eddington luminosity. Such a dependence was first presented by Ho (2002) for an AGN sample composed of low luminosity sources (LLAGNs: weak local Seyfert galaxies and LINERs), 'classical' Seyferts selected from the Palomar and CfA surveys, and PG quasars. He showed that the radio-loudness increases with decreasing Eddington-ratio and that, according to the Kellermann's et al. definition, practically all the LLAGNs are radio-loud. Around the same time, a trend for the increasing radio-loudness with the decreasing accretion luminosity was discovered also in the low/hard states of XRBs (Gallo et al., 2003). Following these results, Maccarone et al. (2003) constructed a 'fundamental plane' which attempts unifying the dependence of radio activity on accretion rate for all the BH (i.e., galactic and extragalactic) accretion systems.

Such studies have been extended by SSL07 by considering an AGN sample enlarged by the addition of radio selected quasars, broad line radio galaxies (BLRGs) and FR I radio galaxies. When compared with the objects considered previously
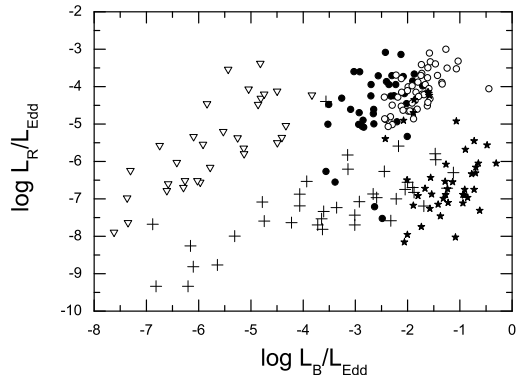

Fig. 1. Total 5 GHz luminosity vs. B-band nuclear luminosity in the Eddington units. BLRGs are marked by filled circles, radio-loud quasars by open circles, Seyfert galaxies and LINEARs by crosses, FRI radio galaxies by open triangles, and PG quasars by filled stars (from SSL07).

by Ho (2002), the newly included sources form a separate pattern (though of a similar shape) on the $\mathcal{R} - \lambda$ plane, being in particular $2-3$ orders radio louder than LLAGNs and Seyferts with comparable accretion luminosity (see Figures 1 and 2). At the first glance, one might suspect that such a two-pattern structure is a result of selection effects. However, noting that no AGN in the upper, 'radio-loud' branch is hosted by a disk galaxy, one can conclude that the two revealed upper and lower patterns represent, at least, the upper bounds for the radio-loudness of AGNs hosted by elliptical and disk galaxies, respectively. The relatively complete samples of LLAGNs and low luminosity radio galaxies analyzed by Terashima & Wilson (2003), Chiaberge et al. (2005), and Panessa et al. (2007), indicate that these are indeed the real distributions of the parameter $\mathcal{R}$ in the case of low-λ objects.

The situation changes for the high-accretion rate (high-λ) sources, represented by quasars and NLS1 galaxies. In particular, the radio-loudness distribution of quasars is very broad and 'bottom-heavy', despite that probably most of them are hosted by giant ellipticals (Floyd et al., 2004). This cannot be entirely due to selection effects. Hence, the significant differences in the jet production efficiency in these objects, as observed in Figures 1 and 2, seems not to be related to the morphologies of their hosts. We note, that a bimodal distribution (instead of a continuous one) of the radio-loudness in quasar sources was claimed by Kellermann et al. (1989),
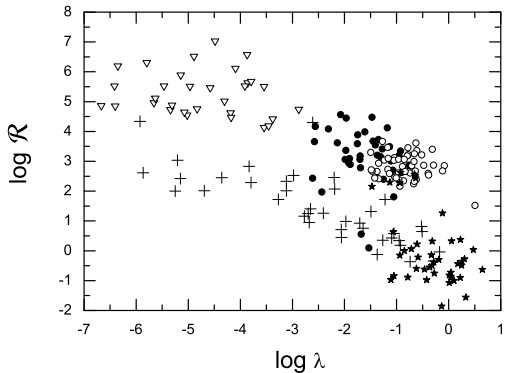
Fig. 2. Radio-loudness $\mathcal{R}$ vs. Eddington ratio λ. Different types of AGNs are denoted in the same way as in Fig. 1 (from SSL07).

Fig. 3. Radio loudness $\mathcal{R}$ vs. black hole mass $\mathcal{M}_{\mathrm{BH}}$ in the solar units. Different types of AGNs are denoted in the same way as in Fig. 1 (from SSL07).

Miller et al. (1990), and Stocke et al. (1992), although the most recent studies on this issue, based on the deep radio and optical surveys, are not very conclusive (White et al., 2000; Ivezić et al., 2002; Cirasuolo et al., 2003a,b; Laor, 2003; White et al., 2007).

At the intermediate Eddington-ratios, AGNs hosted by giant elliptical galaxies and located in the lower ('radio-quiet') sequence of Figures 1 and 2, are represented in our sample by only four objects. However, recent discoveries of many elliptical galaxies with very broad Balmer lines and very massive black holes but very weak radio emission (Strateva et al., 2003; Wu & Liu, 2004) strongly indicate that rarity of such objects in the available AGN catalogs might be due to selection effects. Hence, it is plausible that also at the intermediate accretion luminosities most of AGNs hosted by giant ellipticals are radio-quiet.

SSL07 studied also the dependence of the radio-loudness parameter on the BH mass. The results are presented in Figure 3. One can see that AGNs with the black hole masses $\mathcal{M}_{\mathrm{BH}} > 10^8 \mathcal{M}_\odot$ reach values of $\mathcal{R}$ three orders of magnitude larger than AGNs with black hole masses $< 3 \times 10^7 \mathcal{M}_\odot$. A relatively smooth transition between those two populations is caused, most likely, by the overlap between the sources hosted by disc and elliptical galaxies. The errors in the black hole mass estimations can also have a similar effect. It is then interesting to compare Figure 3 with the analogous figures restricted to high Eddington-ratio objects, and presented by Laor (2000) and McLure & Jarvis (2004). One can
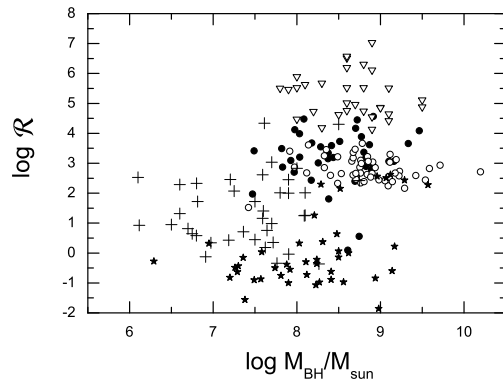
see that in all the cases there is a difference of about 3 orders of magnitude between the maximal radio-loudness of AGNs with $\mathcal{M}_{\mathrm{BH}}/\mathcal{M}_\odot > 10^8$, and those with less massive BHs. However, because in the sample studied by SSL07 the objects with very low values of the λ parameter are included as well, the boundaries of maximal radio-loudness for lower and higher mass BHs are now located at much larger values of $\mathcal{R}$. This effect is a simple consequence of the increasing radio-loudness with the decreasing Eddington-ratio. Because of this, the upper boundaries on Figure 3 are determined by low-λ objects, i.e., by Seyferts and LINERs at low BH masses, and by FR I radio galaxies at high values of $\mathcal{M}_{\mathrm{BH}}$.

Let us mention in this context the case of nearby galaxies which show marginal (if any) signatures of the central (accretion) activity, and for which precise determinations of the profiles of the stellar distribution are available. In particular, the most recent studies led to the discovery of a strong correlation between the type of the surface brightness distribution in the nuclear parts of the galaxy and its radio luminosity. Namely, the 'core-galaxies' – i.e., the ones with shallow central stellar density distributions – are much radio-louder than the power-law/cuspy galaxies (Capetti & Balmaverde, 2006, 2007). It is then interesting to note that the core-galaxies are on average much more massive than the power-law galaxies, being usually identified as giant ellipticals, while the power-law stralight profiles are common in disk galaxies or disky-ellipticals (Lauer et al., 2007; Capetti & Balmaverde, 2007).
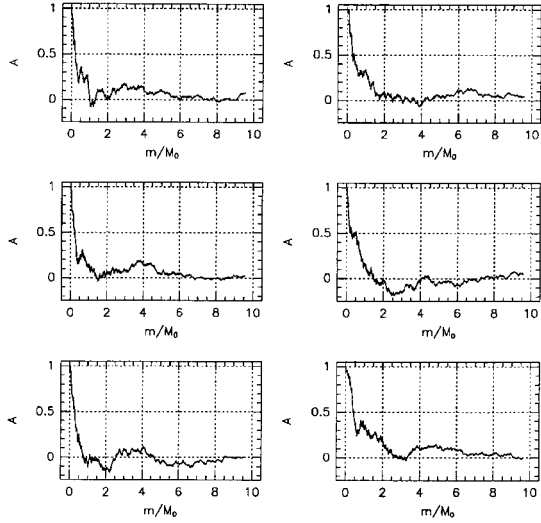
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Fig. 4. The spin evolution of a black hole for the initial spin $A_0 = 1$ and the accretion event masses $\Delta m = 0.01 \mathcal{M}_{\mathrm{BH},0}$ (from Moderski & Sikora, 1996a).

3. The spin paradigm

SSL07 investigated the possibility that the parameter responsible for the host-morphology related split of the upper radio-bounds of AGNs in the $\mathcal{R} - \lambda$ plane, as discussed above, is the spin of a central black hole, $a \equiv J/J_{\max}$, where J is the angular momentum of the black hole and $J_{\max} = G \mathcal{M}_{\mathrm{BH}}^2/c$. The conditions required for that are:

(i) BHs in disk galaxies should avoid efficient spinning-up by the accretion disks;

(ii) it should be possible to reconcile the spin paradigm with the mismatch between the spin and radio-loudness distributions of the high-λ AGNs hosted by elliptical galaxies.

As was demonstrated by Moderski & Sikora (1996a), BHs can avoid too intensive spinning-up if their evolution is composed of many small-mass accretion events with randomly oriented angular momenta. In such a case, provided that the event masses are small enough to avoid an alignment of the BH with distant portions of the accretion disk (Rees, 1978), the accretion proceeds via a comparable number of co- and counter-rotating disks. As a result, the BH spin undergoes fluctuations around the zero value with a very low amplitude, or quickly drops to small values if starting from a large one (see Figures 4 & 5).

Quantitatively, the condition to avoid the BH alignment during an accretion event of a mass m is
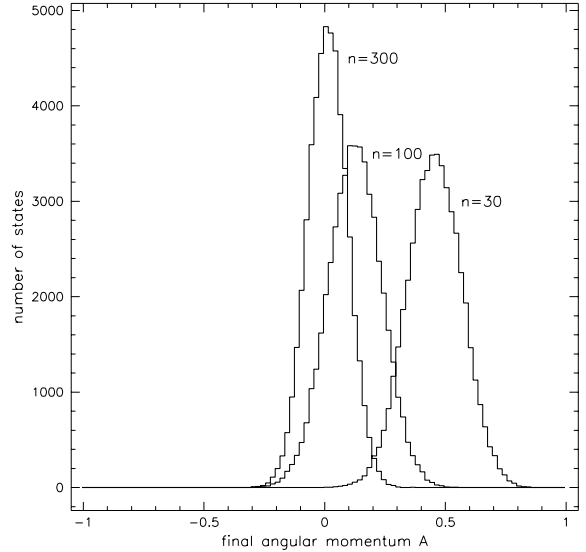

Fig. 5. Histogram of the final states of 50000 evolutionary tracks computed for $A_0 = 1$ and $\Delta m = 0.01 \mathcal{M}_{\mathrm{BH},0}$. The number of accretion events is marked on the curves (from Moderski et al., 1998).

$$m \ll m_{\mathrm{align}} \equiv \frac{a}{\sqrt{r_{\mathrm{w}}}} \, \mathcal{M}_{\mathrm{BH}} \,, \qquad (1)$$

where $r_{\mathrm{w}} \equiv R_{\mathrm{w}}/R_{\mathrm{S}}$, R_{w} is the Bardeen-Petterson warp radius, i.e. the distance at which the accretion time scale is equal to the time scale of the Lense-Thirring precession (Wilkins, 1972), and $R_{\mathrm{S}} \equiv 2G \mathcal{M}_{\mathrm{BH}}/c^2$ is the Schwarzschild radius. For the Shakura & Sunyaev (1973) disk model, for example, the warp is formed in the 'middle region of the disk', namely at

$$r_{\mathrm{w}} = 3.6 \times 10^3 \, a^{5/8} \mathcal{M}_8^{1/8} f_{\mathrm{Edd}}^{-1/4} \alpha^{-1/2} \left(\frac{\nu_1}{\nu_2} \right)^{5/8}, \quad (2)$$

where $\mathcal{M}_8 \equiv \mathcal{M}_{\mathrm{BH}}/10^8 \, \mathcal{M}_\odot$, $f_{\mathrm{Edd}} = \dot{m} \, c^2/L_{\mathrm{Edd}}$ is the accretion rate expressed in the Eddington units $L_{\mathrm{Edd}} \equiv 4\pi \, G \mathcal{M}_{\mathrm{BH}} \, m_{\mathrm{p}} c/\sigma_{\mathrm{T}}$, α is the Shakura-Sunyaev parameter, ν_1 is the viscosity related to the 'planar' shear within the disk, and ν_1 is the viscosity related to the 'vertical' shear. According to Papaloizou & Pringle (1983), $1 < \nu_2/\nu_1 < 1/(2\alpha^2)$. With this, the alignment mass reads as

$$\frac{m_{\mathrm{align}}}{\mathcal{M}_{\mathrm{BH}}} \simeq 10^{-4} \, \frac{a^{3/8} f_{\mathrm{Edd}}^{1/4}}{\mathcal{M}_8^{1/8}} \left(\frac{\alpha}{0.1} \right)^{1/2} \left(\frac{\nu_1}{\nu_2} \right)^{-5/8}. \quad (3)$$

Such an event-mass limit is severe but, on the other hand, consistent with the observations indicating very short lifetimes of individual accretion events in

Seyfert galaxies (Capetti et al., 1999; Kharb et al., 2006), and revealing random orientations of jets relative to the host galaxy axis (Kinney et al., 2000; Schmitt et al., 2001). It should be also noted that fuelling of AGNs in disk galaxies is presumably not related to the galaxy mergers, and can be provided by molecular clouds (Hopkins & Hernquist, 2006). Alternatively, low values of BH spins in such systems could be assured if the BH growth thereby is dominated by mergers with intermediate mass BHs – relics of Population III stars, or BHs formed in young stellar clusters (see Mapelli et al., 2006, and references therein).

In contrast to spiral galaxies, giant ellipticals underwent at least one major merger in the past (see, e.g., Hopkins et al., 2007). Such mergers are followed by accretion events which involve too much mass to satisfy the condition given by Equation 3. Then, regardless of whether the accretion disk was initially counter- or co-rotating, all the disks end up as co-rotating due to the alignment process. Provided that $m >> m_{\mathrm{align}}$, such disks spin-up black holes to large values of a, very likely up to even $a > 0.95$ if only $m \sim M_{\mathrm{BH}}$ (Moderski & Sikora, 1996b). This scenario is in agreement with the large average spin of BHs in quasars as inferred from the comparison between the local BH mass density and the amount of radiation produced by luminous quasars (Sołtan, 1982; Yu & Tremaine, 2002; Elvis et al., 2002; Marconi et al., 2004; Wang et al., 2006). However, since the majority of quasars is radio-quiet, the jet production in most of them should be suppressed. Such a bimodality of a jet suppression at high accretion rates can be connected with a bimodality of a jet collimation, and this, in turn, with a bimodality of the accretion states. The collimation of a central relativistic outflow can be provided by a non-relativistic MHD wind/jet produced by an accretion disk. Such a double jet structure was originally proposed by Sol et al. (1989), and was investigated further by Bogovalov & Tsinganos (2005), Gracia et al. (2005), and Beskin & Nokhrina (2006). The quasar systems with such efficiently collimated jets can be rare indeed due to the difficulties in developing the required large-scale poloidal magnetic fields in the geometrically thin accretion disks. Such fields may, however, develop stochastically, leading to an intermittent jet production (Livio et al., 2003; Mayer & Pringle, 2006). Alternatively, large-scale poloidal fields may be carried to the inner portions of the disks from larger distances by the drifting isolated patches of the accreting matter

(Spruit & Uzdensky, 2005).

4. Discussion

Recent studies of the dependence of the radio-loudness on the Eddington-ratio in AGNs and XRBs indicate that the jet-to-accretion power ratio increases with the decreasing accretion rate, and that at the high accretion rates the jet production is strongly suppressed in majority of objects (Ho, 2002; Gallo et al., 2003; Maccarone et al., 2003). In addition, the previous claims that powerful extragalactic radio sources avoid disk galaxies (Matthews et al., 1964; Xu et al., 1999) have been confirmed, and, as shown by SSL07, such a radio bimodality persists over an entire investigated range of the Eddington-ratios.

Assuming that jets are powered by rotating BHs, the galaxy-morphology related radio-bimodality can be explained if BH spins in giant ellipticals are, on average, much larger than in disk galaxies. The best and the most direct way to verify this conjecture is to measure BH spins in different types of galaxies. First attempts are already undertaken using profiles of the fluorescent iron X-ray line emitted in some AGNs by the innermost portions of the accretion disks (e.g. Laor, 1991; Beckwith & Done, 2004; Fabian, 2007). Unfortunately, the quality of the available data is too poor to disentangle the effects connected with the BH spin from the effects of a warm absorption (Reeves et al., 2004; Nandra et al., 2006; Done & Gierliński, 2006), and/or the effects of a superposition of differently shaped spectra produced in different flux states (Miller et al., 2007). We would like to point out that MCG-6-30-15, considered often to be the best evidenced case showing the fast rotating BH in a Seyfert galaxy, is hosted in fact by the E/S0 galaxy (Feruuit et al., 2000). Also, the Eddington ratio in this system is very high, $\lambda \simeq 0.4$ (McHardy et al., 2005), and so the jet production thereby is likely to be suppressed, even if MCG-6-30-15 hosts indeed the fast rotating BH.

SSL07 and Volonteri et al. (2007) investigated possible evolutionary scenarios which may lead to the galaxy-morphology related BH spin bimodality of AGNs. Assuming that the growth of supermassive BHs is dominated by the accretion, they showed that, in order to keep small BH spins in the multi-accretion event scenario (Moderski & Sikora, 1996a), the event masses must be smaller than $10^{-4} \mathcal{M}_{\odot}$. Such small-mass accretion events can

be provided by stochastically captured molecular clouds (Hopkins & Hernquist, 2006). These may form from a cold gas streaming/dropping onto the galaxy from cosmological filaments. Such an inflow is predicted to take place in galaxies with the dark matter halo masses smaller than $10^{12}\,\mathcal{M}_\odot$ (Dekel & Birnboim, 2006), and is supposed to protect the disk galaxies against destruction by the multiple minor mergers (Bournaud, Jog, & Combes, 2007).

The modified spin paradigm described above is consistent with the recent finding that the radio-loudness correlates with stellar brightness profiles in the nuclear portions of active galaxies (Capetti & Balmaverde, 2006, 2007). Namely, the inner regions of radio-loud galaxies display star deficient cores. Such cores, in turn, reside preferentially in giant ellipticals (see, e.g., Lauer et al., 2007). On the other hand, radio-quiet galaxies, including nearby low-luminosity Seyferts, display instead cuspy brightness profiles. And these are found preferentially in disk galaxies. Hence, noting that the core stellar nuclei result from merging BHs following galaxy mergers (Ebisuzaki et al., 1991; Milosavljevic & Merritt, 2001; Ravindranath et al., 2002; Volonteri et al., 2003), Balmaverde & Capetti's discovery supports our conjecture that the galaxy-morphology related spin bimodality results from the different evolutionary tracks of BHs in disk and elliptical galaxies: in the former case being dominated by randomly oriented small-mass accretion events, in the latter case by massive accretion events which follow galaxy mergers.

5. Conclusions

In summary, we conclude that:

(i) The maximal values of the radio-loudness parameter of AGNs hosted by giant elliptical galaxies are by ~ 3 orders of magnitude larger than of AGNs hosted by disc galaxies.

(ii) Both populations of spiral-hosted and elliptical-hosted AGNs show a similar dependence of the upper bounds of the radio-loudness parameter on the Eddington ratio; the radio-loudness increases with the decreasing Eddington ratio, faster at the high accretion rates, and slower at the low accretion rates.

(iii) The very large, host-morphology related difference between the radio-loudness reachable by AGNs in disc and elliptical galaxies can be explained by the scenario according to which
  – the spin of a black hole determines the jet power;
  – central black holes can reach large spins only in early type galaxies (following major mergers), and not (in a statistical sense) in spiral galaxies.

(iv) The broad, 'bottom-heavy' distribution of the radio-loudness in quasars is not related to the distribution of the BH spin; however, it is still the BH spin which mediates launching of a jet and determines the upper bound of the radio-loudness, whereas the (intermittent) suppression of a jet production can be connected with the absence of the jet collimation by an MHD wind from an accretion disk.

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