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Are Radio-Loud Narrow-Line Seyfert 1 Galaxies Blazar-like?

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Abstract. The similarities between blazars and radio-loud narrow-line Seyfert 1 galaxies (RLNLS1s) have received much attention. In this paper, by using the magnetized slim disk model, we calculate the jet power and disk luminosity. It is found that the jet power is only a very small fraction of the disk luminosity, <10%. This indicates that the jet orientation of RLNLS1 is close to the line-of-sight, which is similar to blazars.

Key words. Narrow-line Seyfert 1—blazar—slim disk.

1. Introduction

The current topic of interest in recent times is the similarity between blazars and RLNLS1s. It was originally proposed from the multiwavelength properties (e.g., Komossa *et al*. 2006; Yuan *et al*. 2008). More observations, such as γ-ray emission, infrared and optical variability, further support this argument (Abdo *et al*. 2009; Jiang *et al*. 2012; Paliya *et al.* 2013). Moreover, the theoretical models for the radiation of blazars have been successfully used to explain the multi-band spectra of RLNLS1s (Zhang *et al*. 2013). In this paper, we support this argument indirectly from the viewpoint of energy by theoretical calculation.

2. Model

On the one hand, it has been widely accepted that NLS1s are black holes accreting at high accretion rate, close to or even super Eddington rate, on the other hand, relativistic jets may exist in RLNLS1 (e.g., Yuan *et al*. 2008). Considering the fact that magnetic fields play an important role in powering and collimating the jet, we propose a model for RLNLS1s, in which the disk is slim and threaded by ordered large-scale magnetic field. Following Li & Cao (2009), the magnetic fields are described by two parameters, which correspond to the field strength and geometry of the field lines, and the kinetic energy of the jet is considered by another parameter. Therefore, by solving the differential equations of accretion, the jet power and disk luminosity can be calculated.

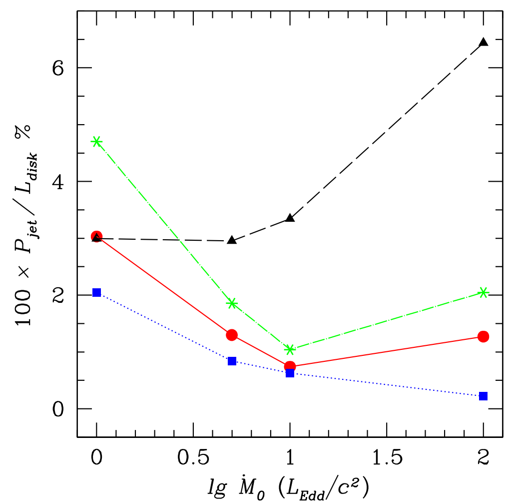

Figure 1. The ratios of the jet power to the disk luminosity at different accretion rates. The solid line shows the case with normal value of parameters, while the dashed, dashed-dotted and dotted lines correspond to the cases with stronger magnetic field, steeper distribution along the vertical direction and higher velocity of the jet.

3. Results

We assume the magnetic pressure to be 1–5% of the total pressure, and the largest Lorentz factor of the jet to be 30. Our result is shown in Fig. 1. It can be seen that the jet power is usually only a few per cent of the disk luminosity. This means the intrinsic power of the jet is much smaller than the disk. In order to explain the high radio loudness, the jet should be aligned to the Earth so that the jet power is boosted by relativistic effects. Although the disk radiation can also contribute to the jet, such a jet power cannot be greater than the disk luminosity, and thus cannot explain the high radio loudness. The spin of the central BH has not yet been included.

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