Magnetic Connection Model for Launching Relativistic Jets in Active Galactic Nuclei

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We propose an alternative model for launching relativistic jets in active galactic nuclei (AGN) from an accreting Kerr black hole (BH) by converting both the binding energy of the accreted gas and the BH rotational energy transferred form the BH to the accretion disk into energy in the jet by means of the magnetic connection between the BH and the accretion disk. The extractable spin energy of the BH may be transferred to the accretion disk through closed magnetic field lines which connect them, i.e, by magnetic connection, providing a supplementary energy source particularly for a low-accretion rate disk. Adding these two energy sources (the rest-mass energy flow in the disk and the spin energy of the BH transferred to the accretion disk), we derive the launching power of the jets. To do this we integrate the energy conservation law over the inner disk, where the frame dragging effect takes place, for both the sub-Eddington and Eddington accretion rates. We find the launching power of the jets ranges from $\sim 10^{45}$ erg s^{-1} to $\sim 10^{47}$ erg s^{-1} for a BH of 10^9 $M_\odot$. In the case of a very low accretion rate, a magnetic connection spin-down of the BH powers the jets, so that the jet-launching efficiency can reach values close to unity. That is, almost all of the power used to launch the jets is borrowed from the BH extractable rotational energy, thus the jets can still be driven even though the contribution of the rest-mass energy of the accreted flow is very low. The consequences of the proposed model for the spin evolution of the BH in AGN, as well as its relevance to the observational data, are described.