High Energy Radiation From Jets and Accretion Disks Near Rapidly Rotating Black Holes

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Abstract

X-ray binary (XRB) systems exhibit powerful relativistic jets, routinely detected as radio emission, although
their contribution to the high-energy (X-ray and γ-ray) radiation is less certain. We use a general-
relativistic radiative transport code to study emission from magnetically arrested accretion flows in the
context of the low/hard state in XRBs. We find the following signatures of jet emission (i) a significant
γ-ray peak above $\sim$ 10ˆ22 Hz, (ii) a break in the optical/UV band where the spectrum changes from
disk to jet dominated, and (iii) a low-frequency synchrotron peak . 10ˆ14 Hz indicates that a significant
fraction of any observed X-ray emission originates in the jet. We also investigate the dependence of the
high-energy radiation on black hole spin. We find that the X-ray power depends strongly on spin and
inclination angle. Surprisingly, this does not follow the Blandford-Znajek scaling P $\sim$ aˆ2 , but instead
can be understood as a redshift effect. In particular, photons received by observers perpendicular to
the spin axis suffer little net redshift until very close to the horizon. For rapidly rotating black holes,
such observers see deeper into the hot, dense, highly-magnetized inner disk region. While the X-ray
emission is dominated by the near horizon region, the near-infrared radiation originates at larger radii.
Therefore, the ratio of X-ray to near-infrared power is an observational signature of black hole spin.

Keywords: accretion disks, black hole physics, jets, radiative transfer, relativistic processes

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