JETS FROM DISCS AND DOUGHNUTS

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Various authors have suggested that there is a close connection between jets in radio galaxies and the precessing beams of SS433, and that the underlying mechanism for forming the jets is the same on both scales (Rees, 1981). We examine a possible model for generating gas jets close to the central object in either of these two cases.

Elsewhere (Allan, 1981), we have proposed that in cases where viscosity is small, accreted gas may form a doughnut around a compact object instead of the usual accretion disc. We have calculated the flow of gas off the surface of such a doughnut under the influence of the radiation from the doughnut and the gravitational attraction of the compact object, and the general result is that orbits are bent in towards the rotation axis, which causes a standing shock around the axis. The flow of gas along the axis and inside the shock is then calculated in a manner similar to the flow in an accretion column (Bondi & Hoyle, 1944).

The present situation is rather more complicated than the usual accretion column due to the fact that the velocity of the incoming gas parallel to the z (rotation) axis, $V_{//}$, and the accretion rate per unit lenght, A, are not constant, but can be represented by the formulae

$$V_{//} = V_o \left(1 - (z_o/z)^n\right)$$

$$A = A_o/\left(1 + (z/z_o)^2\right)$$

where V_o, A_o, z_o and n are constants. The equations of conservation of mass and momentum can be combined to give the equation describing the flow of gas in the jet as

$$u \frac{du}{dz} + \frac{GM}{z^2} - \frac{KL}{4\pi GMc} \left(\frac{r^2}{r^2+z^2}\right)^{3/2} \frac{z}{r} = \frac{z_c+z_o}{z+z_o} \; \frac{u\,(V_{//} - u)}{z - z_c}$$

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where u is the gas velocity, M is the mass of the compact object, L is the luminosity of the doughnut, K is the opacity and r is the orbital distance of the doughnut from the compact object. $z=z_c$ is a critical point in the flow and in fact it must be a stagnation point. Furthermore if the gas in the column is to be accelerated by the gas flowing in from outside then $z_o < z_c$. For reasonable values of z_c, the velocity increases to a limiting value of V_o, which is of order $(GM/r)^{1/2}$, which is typically c/3.

This model of gas jets may also be relevant to flow off accretion discs if most of the outflowing gas originates at the inner edge of the disc. If this is the case then this model should have some general validity in axisymmetric accretion systems and can provide a single explanation for jets in SS433 and radio galaxies.

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