

The motion thin flux tube near Kerr black hole

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In the MHD description of plasma phenomena the concept of magnetic field lines frozen into the plasma turns out to be very useful. We present here a method of introducing Lagrangian coordinates into relativistic MHD equations in general relativity, which enables a convenient mathematical formulation for the behaviour of flux tubes. With the introduction of these Lagrangian, so—called “frozen-in” coordinates, the RMHD equations reduce to a set of nonlinear 1D string equations, and the plasma may therefore be regarded as a gas of nonlinear strings corresponding to flux tubes. If such a tube/string happens to fall into a Kerr black hole, then the leading portion loses angular momentum and energy as the string breaks, and to compensate for this loss, momentum and energy has to be radiated to infinity to conserve energy and momentum for the tube. Inside the ergosphere the energy of the leading part can be negative, and the rest of the tube then extracts energy from the hole in the form of a torsional Alfvén wave. Reconnection comes into play during the next bursty phase, releasing Maxwellian stresses and producing a relativistic jet.