Generation of Weak Magnetohydrostatic Equilibrium Under the Constraint of Field Line Topology Invariance

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It is demonstrated that a two-dimensional magnetic field configuration in magnetohydrostatic equilibrium even without any null-point can be deformed into another weak equilibrium field configuration containing tangential discontinuities either by thermodynamic change or by footpoint displacement. Two cases due to temperature variation and one case due to footpoint motion are presented. When the atmosphere embedding a quadrupolar magnetic field is uniformly heated, plasma pressure most increases at the center of underlying bipolar arcades. The consequent expansion of these arcades results in formation of a tangential discontinuity between them. If the initial equilibrium has a pressure profile in which pressure increases from the innermost flux tubes to the outer ones, cooling of the atmosphere can also lead to current sheet formation. As the pressure scale height decreases by cooling, the plasma pressure gradient force, which has held down magnetic field, gradually diminishes. The subsequent expansion of field lines creates a tangential discontinuity. If resistivity is applied in this weak equilibrium state, magnetic reconnection results in a field configuration suggested for a plausible prominence field by Malville (1979). When the field line footpoints undergo a spatially continuous shearing motion, the expanding bipolar arcades come into contact at a critical amount of shear and form a tangential discontinuity. This field configuration can be deformed to a configuration with an X-point through magnetic reconnection under resistivity.