Proof of non-invariance of magnetic helicity in ideal plasmas and a general theory of self-organization for open and dissipative dynamical systems

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It is proved that the global magnetic helicity is not invariant, even in an ideally conducting MHD plasma, with the use of the generalized Ohm's law for a fully ionized plasmas. This proof resultantly confirms that global constraints using helicity has no power to limit the relaxation process to lead to any self-organized states in plasmas, as has been reported that all theories using helicity do never explain results of experiments and simulations in the boundary regions. A novel general theory is presented in which a variety of self-organized states in open and dissipative dynamical systems with various fluctuations can be found. This theory is based on the principle that the self-organized states must be those states for which the rate of change of global auto-correlations for multiple dynamical field quantities, which depend on multidimensional mutually independent variables, is minimized. One of the important points of this theory is that the original generalized dynamic equations are embedded in the final equivalent definition for the self-organized states, and therefore the equations deduced from the final equivalent definition include all the time evolution characteristics of the dynamical system of interest. Since states derived from the Euler-Lagrange equations with the use of variational calculus have minimal rates of change of the global auto-correlations, they are most stable and unchangeable compared with other states. We have shown three applications to solitons by the Korteweg-deVries equation with a dissipative viscosity term, to two dimensional incompressible viscous fluids with the periodic boundary condition, and to compressible resistive and viscid MHD fusion plasmas, in order to demonstrate that the new general theory of self-organization is very useful for various dynamical systems

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