

Fusion Devices as a Life-Like System

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A life-like system is defined as an open system that requires a continuous injection of low or zero entropy power and exhausts of entropy-increased power whereby internal work is done without an increase of internal entropy or a destruction of its ordered structure

The system operates like a life where as Schrödinger says negentropy is fed to sustain its low entropy state (or ordered structure). The conspicuous example of a life-like system is the planet earth where its low entropy state that allows the life breeding on it is provided by input of negentropy solar radiation and exhaust of increased entropy via black body radiation from it. Note that injected entropy of the solar radiation is proportional to its wavelength (i.e., near ultraviolet) while exhaust of entropy from the earth is proportional the wavelength of the earth's blackbody radiation (i.e., far infrared), thus the earth receives a huge amount of negentropy power from the sun although the net power the earth receives from the universe is zero.

The detailed process of the work done in the proposed fusion system of a Tokamak like is described as the following. The injected power via RF or particle beam heats the central portion of plasma and provides a proper pressure profile: $\partial p / \partial \psi < 0$, a negentropy state (or a state that has free energy) that enables fusion reaction. The pressure profile excites various micro-instabilities even if the system is MHD stable. The micro-instability excites micro-turbulence. When the level of turbulence becomes larger than ρ_{ii}/a , (the ratio of the ion gyroradius to the device radius), the turbulence becomes hydrodynamic. The hydrodynamic turbulence produces a self-organized state owing to the dual conservation of energy and enstrophy (the squared vorticity). The self-organized state produces azimuthal zonal flow that can help maintain the desired pressure profile to sustain fusion reaction. However in order to sustain the self-organized state the condensed energy in the zonal flow needs to be taken out of the system to avoid possible disruption. This requires an exhaust system of thermal power. A possible scenario of the process is the power exhaust via kinetic

Alfven wave. Here the fusion device works as a power amplifier. This detailed process and design of the system requires a future work. A similar scenario may apply to other open devices.