Non-thermal Fusion Burning Processes, Relevant Collective Modes and Gained Perspectives*

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In fusion burning plasmas meaningful and accessible regimes can be identified by considering the self organization processes and the new modes, or new forms of known modes, that can emerge. Resonant mode-particle interactions that involve reacting nuclei can lead to reactivities that are different from those evaluated for strictly Maxwellian distributions and allow for effective burn conditions of different kinds of reacting plasmas. A relevant analysis refers to a DT axisymmetric toroidal plasma and to the excitation of ballooning modes [1] of the form [2] $\hat{n} = \tilde{n}(r,\theta)\exp\{-i\omega t + im^0\theta - in^0\varphi\}$, where φ is the toroidal angle and $\tilde{n}(r,\theta)$ is a periodic function of θ, with $\tilde{n}(r,\theta=\pi)=0$, that is radially localized. These modes [3] are shown to be ballooning along the magnetic field and treated as superpositions of waves, referred to as ``multispecies cyclotron frequency waves'' [3], with the same frequency but propagating along the field with different phase velocities [4]. The relevant mode-particle interactions are found [4] to modify the height and the longitudinal width of the mode amplitude and constitute a direct (linear) process to transfer energy [4] from the produced α-particles to the reacting nuclei without the inefficiencies of nonlinear processes. The possibility to influence the characteristics of these modes by an external RF source is considered. An interpretation of relevant experimental observations [5] is given that is connected to the onset of appropriate ballooning modes.
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