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Alpha-channeling in mirror machines[1]

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Coupling suitable electromagnetic waves in the ion cyclotron frequency range to plasmas can lead to particle ejection and cooling. This effect can be exploited for extracting energy from alpha particles to sustain the fusion reaction. First suggested for tokamaks and known as alpha-channeling [1], this technique might also improve mirror machine operation. But diffusion in mirror phase space is very different from in tokamaks; the waves are different and there are phase space loss boundaries. This talk summarizes the analytical and computational tools newly developed to study the feasibility of alpha-channeling in linear traps. We identified waves suitable for alpha-channeling in practical mirror devices by optimizing the energy extraction rate with respect to the wave parameters [2]. With the optimal regime identified, we carried out a systematic search for modes with similar parameters in mirror plasmas [3]. Modes suitable for alpha particle energy extraction are then identified in several device designs [4]. Redirection of the energy extracted from alpha particles is shown to be possible in principle by either collisional relaxation of resonant minority ions [5], or by coupling the alpha-channeling mode to the ICRH waves in the tandem mirror device plugs. As a spinoff result, in the generalized extraction problem in a network of diffusion paths, we derived a fundamental theorem [6].

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