Equilibirum β-limits in classical stellarators and beyond

J. Loizu[1,2], S. R. Hudson[3], C. Nührenberg[2], J. Geiger[2] and P. Helander[2]

1. Swiss Plasma Center, Ecole Polytechnique Fédérale de Lausanne, Switzerland

2. Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

3. Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA

A numerical investigation is carried out in order to understand the equilibrium β-limits in classical stellarators [1]. The SPEC code [2, 3] is used in fixed-boundary in order to assess whether or not magnetic islands and stochastic field-lines can emerge at high β. Two modes of operation are considered: *fixed-current* and *fixed-iota*. Despite the fact that relaxation (magnetic reconnection) is allowed, the former is shown to maintain good flux surfaces up to the equilibrium β-limit predicted by ideal MHD, above which a separatrix forms. The latter, which has no ideal equilibrium β-limit, is shown to develop regions of magnetic islands and chaos at sufficiently high β, thereby providing a "non-ideal β-limit". We compare our results to the High-Beta-Stellarator theory of Freidberg [4] and derive a new analytical prediction for the non-ideal equilibrium β-limit above which chaos emerges. Following the same approach, we examine the effect of β and net-toroidal-current I_φ on the degradation or healing of magnetic surfaces in experimentally-relevant geometries.

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Corresponding author: J. LOIZU *joaquim.loizu@epfl.ch*