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Elimination of alpha particle losses in quasi-helically symmetric stellarators[1]

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In three-dimensional equilibria non-zero bounce-averaged radial drifts may exist. Radial drifts can cause losses of both thermal and energetic particles. One possible method of eliminating drifts is through quasi-symmetry, as a perfectly quasi-symmetric surface will have no bounce-averaged radial drift. However, in realistic stellarator configurations there will always be deviations from quasi-symmetry, and these deviations will drive energetic particle losses. Previous calculations of stellarator equilibria showed that some collisionless alpha particle losses always existed even deep within the core. In this talk we demonstrate that there exist configurations with no energetic particle losses in the core plasma, and losses well below 1% within the mid-radius. The mechanism for producing these configurations was non-linear equilibrium optimization for quasi-helical symmetry and a metric developed by V.V. Nemov, Γ_c [1], that seeks to align the second adiabatic invariant, J with the flux surfaces. We demonstrate that the methodology succeeds in greatly reducing losses of particles near the trapped-passing boundary, where most losses are concentrated. [1] V.V. Nemov PoP (2008) 15, 052501

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