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Steep gradients in plasma confined at convex-concave magnetic field lines

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The formation of large stable plasma gradients, e.g. in form of internal transport barriers, being of a strong both practical and fundamental interest. Normally the larger the gradient the larger the transport, and any deviation due to collective plasma behavior is of great interest.

We have predicted theoretically that there is a strong stabilizing action against convective (flute-interchange) perturbations when plasma is confined by magnetic field of alternating-sign curvature –i.e. with convex–concave field lines [Tsventoukh 2014 Nucl. Fusion 54 022004]. The calculations that have been done for simple combinations of axisymmetric mirrors and cusps according to the kinetic stability criterion, give strongly centrally peaked stable plasma pressure profiles instead of shallow ones.

We have performed an experimental investigation of the plasma confinement at magnetic confinement device of the alternating-sign curvature [Tsventoukh et al 2015 Nucl. Fusion 55 062001].
For the experimental research of this effect, a compact magnetic confinement device has been modified by adding of the external current coil to fulfil the field-line curvature requirements. The critical convectively-stable plasma pressure profiles calculation in this experimental geometry and the probe measurements of the spatial plasma distribution in the new magnetic configuration of alternating-sign curvature have been performed.
The experimental results give some support for a conclusion that there is an increase in the ion saturation current at the region near the minimum of the specific volume min ∫dl/B. This region corresponds to the average minimum in the second adiabatic invariant, and the kinetic description predicts the stable pressure profile peaking here due to reduction of charge separation by particle drift in alternating-sign curvature.

For further experimental investigations, a stationary microwave device has been used. A mirror geometry has been created by axisymmetric coils, Langmuir and magnetic probes have been used for the measurements.
For the theory developing the effects of a finite plasma beta has been analyzed in axisymmetric equilibrium, and plasma particle kinetics effect on the plasma transport.

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