7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov., 2023 at Port Messe Nagoya

Experimental Verifications of Parker's Effect and Applications in Fusion

Martin Storey[1], Kooper de Lacy[1], Jesse Schelfhout[2], David Pfefferlé[2], L. R. Owen Storey[1]
[1] Meranti Research Laboratories
[2] School of Physics, Mathematics and Computing, University of Western Australia
e-mail (speaker): mstorey@meranti-research.net

In the late 1960s, Parker studied an idealised model of the flow of the solar wind around Earth's magnetic field, focussing on the plane where the flow is parallel to the field lines. He discovered that, in the thin boundary layer between the plasma and the field, a secondary magnetic field would arise, stronger than the primary field in the ratio of the flow speed to the ion thermal speed. This effect causes the boundary layer to become unstable under certain circumstances [1]. In 1979, Storey and Cairo suggested that Parker's Effect may have applications to fusion. Specifically, they showed that if the flowing plasma was confined by the magnetic field rather than the inverse, then the effect would reinforce the confinement [2]. This effect has never been observed experimentally or in simulation, mainly because it has not been sought.

In this poster, several experiments designed to confirm the reality of Parker's Effect and to investigate the stability of the equilibrium of the boundary layer will be presented, together with latest results. They are mainly computer simulations (Figure 1), and some laboratory experiments.

Two concepts for possible devices exploiting this effect, provisionally named the Plasma Storage Ring (PSR) and the Plasma Storage Tube (PST), will also be presented, for comments and criticism.

The PSR would resemble superficially prior reactor concepts such as tokamaks; however, it would be fundamentally different because based on a new type of z-pinch, wherein the bulk of the confined plasma isotropic and all the confining magnetic field is concentrated in a thin static boundary layer, resulting in a more energetically efficient and more stable confinement (Figure 2). The PSR would also resemble the "moving picket fence" proposed by James Tuck [3], with the difference that the multipolar magnetic field lining the walls of the plasma chamber would be stationary and the plasma moving.

The PST would resemble the Gas Dynamic Trap developed at Novosibirsk in Russia [4]. This device has axial symmetry. Again, the main difference is that the bulk of the confined plasma would be isotropic.

References

[1] E.N. Parker. "Dynamical properties of the magnetosphere" In *Physics of the Magnetosphere: Based upon the Proceedings of the Conference Held at Boston College June 19–28, 1967*. Springer Netherlands, 1968.

[2] L.R.O. Storey and L. Cairo. "Kinetic theory of the boundary layer between a flowing isotropic plasma and a magnetic field." *Magnetospheric Boundary Layers* 148 (1979)

[3] J.L. Tuck, "Picket Fence." USAEC Report WASH-184 (1954): 77.

[4] A. Ivanov and V. Prikhodkho. "Gas-dynamic trap: an overview of the concept and experimental results", *Plasma Phys. Control. Fusion* **55** (2013) 063001

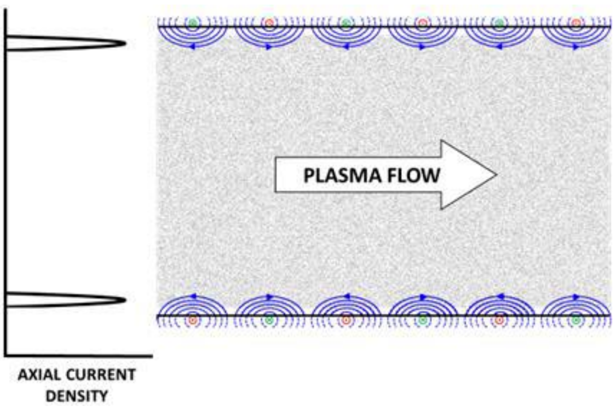

Figure 1. Simple system to evaluate the suggested method of plasma confinement.

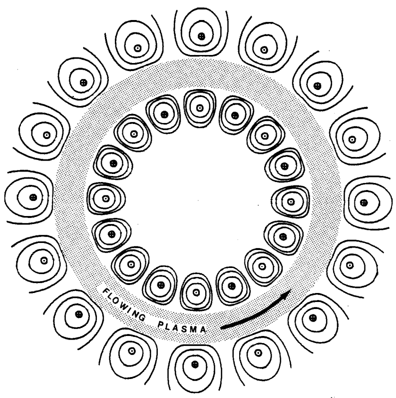

Figure 2. Schema of Plasma Storage Ring concept.