Topic A	Requested: ☒ Oral ☐ Poster	Panel suggestion: ☐ Oral ☐ Poster

MHD-Driven SOL Pressure and Flows*

M.J. Schaffer, J.A. Boedo,† N.H. Brooks, R.C. Isler,‡ R.A. Moyer†

General Atomics, P.O. Box 856908, San Diego, California 92186-9784, USA

MHD theory applied to open tokamak scrape-off layer (SOL) magnetic lines demands a large poloidal pressure gradient in the upstream plasma during divertor detachment, due to blockage of the Pfirsch–Schlüter (P–S) electric current.[1] Thus, the usual approximation of nearly uniform pressure on a SOL surface is invalid, and the gradient drives parallel flows at Mach ~1 that might significantly alter energy transport to the detached divertor plasmas. This theory is compared against experiment in this paper.

Pfirsch–Schlüter current arises in toroidal plasmas to satisfy $\nabla \cdot J = 0$. When the SOL P–S current passes freely through conducting divertor targets, $\nabla \cdot J = 0$ is satisfied by conventional SOL equilibria with pressure gradients concentrated just in front of the targets. Target–mounted Langmuir probes detect this current.[2] However, the measured target current disappears as detachment is approached.[1,2] Then, $\nabla \cdot J = 0$ is satisfied completely within the SOL, which requires at least one zone of cross–B current and a corresponding poloidal pressure gradient in the upstream SOL.[1] The pressure gradient drives additional parallel flow, convecting energy and particles. The expected pressure differential at conventional tokamak aspect ratios of R/a ~ 3 is about 2:1, and the parallel speed effect is of order Mach ~ 1. Even larger effects are predicted for lower aspect ratio tokamaks.

Experimental data were taken during lower–single–null divertor operation in the DIII–D tokamak. The two–dimensional (r, z) distribution of n_e, T_e and p_e is measured by both Thomson scattering and moveable Langmuir probe diagnostics. T_i is measured by Doppler broadening of various visible spectral lines along multiple viewing chords. Parallel velocity is measured by Doppler shifts and also by a moveable Mach probe. Preliminary data indeed show high p_e in the divertor X–point region relative to p_e upstream on the same magnetic surface, in qualitative agreement with the theory. The X–point overpressures occur on open SOL surfaces, but not on private flux surfaces. Overpressures have been observed during both Ohmic and ELMing H–mode operation. More complete data are being taken and will be presented.

---

*Work supported by U.S. Department of Energy under Contract Nos. DE-AC03-89ER51114, DE-AC05-96OR22464, and Grant No. DE-FG03-95ER54294.

†University of California, San Diego.
‡Oak Ridge National Laboratory.

[1] M.J. Schaffer, submitted to Comments on Plasma Phys. and Controlled Fusion (1997).
[2] M.J. Schaffer *et al*., Nucl. Fusion **37** (1997) 83.