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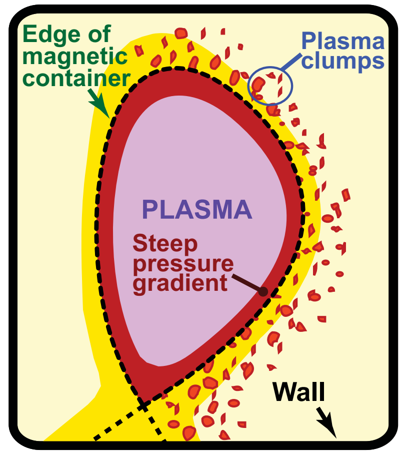
## New insight on how fusion plasmas escape from their magnetic bottle

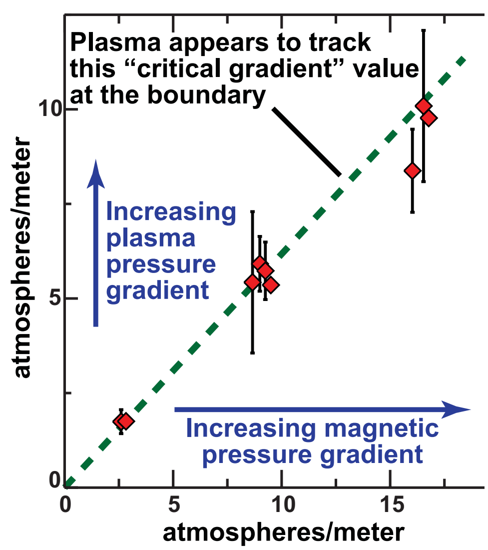
*Fusion plasmas tend to build up pressure in their boundary to a critical value, spilling material sporadically outside their magnetic container.*

ORLANDO, Florida—Fusion researchers build "magnetic bottles" to hold their plasmas for a simple reason: to keep the 100 million C plasma hot and dense by keeping it away from contact with the cold surrounding walls. Under these conditions, plasma nuclei fuse, releasing enough nuclear energy to operate a large electrical power plant. A tokamak confinement device – a torus or donut-shaped magnetic bottle – is found to be particularly effective in holding such plasmas. Nature, however, is not always accommodating; plasmas find ways to leak through their container, often damaging the surrounding walls and causing a degradation of fusion performance. For this reason, the physical mechanisms that drive losses across the boundary are an active area of research.




*Material intermittently 'peels away' in clumps from the steep pressure gradient region that forms at the boundary of magnetically confined plasmas.*

Based on experiments in a number of tokamaks, an interesting picture of the loss mechanisms is being assembled: steep pressure gradients form at the boundary of the magnetic container; plasma "clumps" intermittently peel away from this region. Once detached from the boundary, the clumps are able to freely propagate over long distances, hitting wall surfaces. Such ejections vary from small and frequent, to quasi-oscillatory, to large and infrequent – a dynamical behavior akin to avalanches, which occur when snow piles up on a mountainside. But is there an analogous "critical gradient" condition occurring in a fusion plasma? Recent experiments in the Alcator C-Mod tokamak provide a potential answer. Over a wide range of conditions, the plasma pressure gradient attains a value that appears to be limited by the *magnetic pressure* at the edge of the bottle. This behavior supports the critical-gradient hypothesis and is strong




*As the magnetic pressure is increased, plasma is able to build up a steeper pressure gradient – supporting evidence for a critical-gradient dynamic involving electromagnetic turbulence.*

evidence that electromagnetic turbulence plays the key role in regulating the plasma's leakage through the surface of the bottle.

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**Critical gradients and plasma flows in the edge plasma of Alcator C-Mod**

Invited Session BI1: Pedestal, SOL and Divertor

9:30 AM–10:00 AM, Monday, November 12, 2007
Rosen Centre Hotel - Junior Ballroom

**Further information:** *Nuclear Fusion* **45** (2005) 1658.