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Pfirsch-Schluter Current in and near a Magnetic Island: Singular Behavior and Symmetry Effects.[1] ALLAN REIMAN, Princeton Plasma Phys Lab, DHANUSH RADHAKRISHNAN, NYU — The current along magnetic field lines that enforces quasi- neutrality is called the "Pfirsch-Schluter current". We show that the Pfirsch-Schluter current has, in general, a logarithmic singularity at the X-line of a magnetic island separatrix if $\nabla \cdot \mathbf{j}_\perp$ is nonzero there. The singular component of the Pfirsch-Schluter current vanishes if the configuration is stellarator symmetric about a point on the X-line. (Symmetric with respect to simultaneous reflection in the poloidal and toroidal angles.) We consider, in particular, the case where $\mathbf{j}_\perp$ is determined by the MHD equilibrium force-balance equation and the pressure gradient is determined by a diffusion equation. There is a critical scale length, xc, determined by the ratio of the perpendicular and parallel diffusion coefficients, such that the pressure is not flattened on flux surfaces within a distance of order xc about the X-line. The variation of pressure on flux surfaces in that region leads to a nonzero $\nabla \cdot \mathbf{j}_\perp$ at the X-line, and a large Pfirsch-Schluter current near the X-line. This is a significant piece of physics that is absent in analytical calculations for perturbed cylindrical models having a single resonant Fourier component, and in 3D codes that have no variation in pressure within their flux surfaces.

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