Blob Formation Mechanism from 3D Plasma Simulation in Scrape-off Layer Tokamak Plasmas

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Blobs play an important role in a tokamak plasma that is believed to contribute towards the anomalous and intermittent nature of plasma transport. A radially elongated streamer structure generates the plasma blob when it breaks mainly due to a differential stretching in the radial and poloidal directions. We have assumed interchange plasma turbulence in the SOL region in the presence of a finite electron temperature gradient that generates the differential stretching in the radial and poloidal directions [1,2]. Five differential equations have been solved for this purpose that consists of electron continuity, quasi-neutrality, and electron energy, parallel momentum of ion, and parallel momentum of electron equations in three-dimensional (3D) coordinate systems [3] using BOUT++ code. It is found that the electric field shears such as radial-gradient of the radial electric field, radial-gradient of the poloidal electric field, and poloidal-gradient of the poloidal electric field obtained from the differential equations play an important role. A blob is formed when these shears exceed the interchange mode growth rate within the radially elongated streamer region. We have investigated the nature of such a blob formation in the scrape-off layer (SOL) region that can be applied both in the L-mode and H-mode plasma. The role of electric field shear related to the poloidal gradient of the poloidal electric field has been investigated in detail. It is found that in H-mode without this shear sometimes it is not possible to form the blob. In L-mode, blob formation is possible even without this shear. These facts indicate a large number of blob formations in this L-mode in comparison with the H-mode.

References:

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