§19. Particle Simulation of the Potential Formation across the Magnetic Filter

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Simulation of negative ion extraction from a volume source has been done using the two-dimensional particle code[1,2]. Here, the potential formation and the particle transport across the magnetic filter is studied by the two-and-one-half dimensional (two configuration (x,y) and three volocity (v_x,v_y,v_z) spaces) electrostatic particle code. The wall at $x = 0$ is the plasma grid, while the wall at $x = L_x$ represents the vacuum chamber. Periodic boundary condition is used in the y direction. The magnetic filter at $x = 0.5L_x$, the direction of which is in the y,z plane, separates the diffused plasma region ($x < 0.5L_x$) from the source plasma region ($x > 0.5L_x$). The strength of the magnetic filter is chosen to reflect only electrons, while ions can freely move across the filter. Particles hitting the walls are absorbed there. To keep the stationary state, in the source plasma region the thermalization electrons are done as well as the injection of the particles to compensate the loss to the walls. It is found that the electron transport across the magnetic filter is the key issue to determine the potential structure. Without the anomalous transport of electrons in which $E \times B$ drifts is the dominant mechanism, the potential in the diffused plasma region is slightly higher than that of the source plasma region. Only when the anomalous transport of electrons is dominant compared with the ion flow across the magnetic filter the potential in the diffused plasma region is less than that in the source plasma region. The instability due to the density gradient across the magnetic filter generates the turbulent state with low frequency electrostatic fluctuations. Because the high energy electrons can average out the electric field with short wave lengths, these electrons diffuse less than the low energy electrons; hence the electron temperature in the diffused plasma region is about half of the source plasma region. It is also found that by raising the potential of the plasma grid the plasma potential in the diffused plasma region can be incresed without affecting the plasma potential in the source plasma region.

Figs. 1 and 2 show the case that the potential difference across the magnetic field is observed only if the direction of magnetic field is slightly tilted from z to the y direction. This results indicate that the inverse Landau damping determines the turbulent state under the magnetic filter.

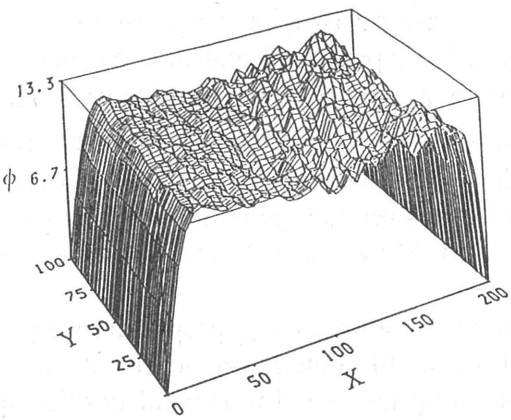

Fig. 1. Potential profile ($\theta = 0°$).

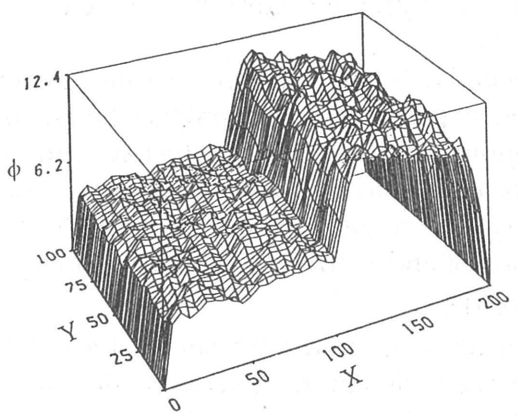

Fig. 2. Potential profile ($\theta = 2°$).

References

1) Naitou, H., Fukumasa, O., Sakachou, K. and Mutou, K., Rev. Sci. Instrum. 65 (1994) 1438.

2) Naitou, H., Fukumasa, O., Sakachou, K. and Mutou, K., Fusion Engineering and Design 26 (1995) 523.