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Role of magnetic topology to form electron internal transport barrier on Heliotron J

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A role of rational surface on electron internal transport barrier (eITB) formation of the helical plasma has been investigated in Heliotron J. The experiments have been performed on the standard magnetic configuration of B_{ax} = 1.25 The plasma with eITB is produced by a centrally focused 70 GHz ECR heating (P_{inj}˜270 kW, absorption ratio is above ˜90% , N//=0.0) When bootstrap plasma current increases up to 0.7kA, a fast transitive increase of electron temperature due to an expansion of the improved confinement region has been observed. The eITB foot point moves from r/a=0.13 to r/a=0.23, and the rise time of the electron temperature is below ˜100μsec, which is shorter than the confinement time. After the fast transition at 0.7kA, the location of the eITB foot point moves to the outside of the plasma with the current increase. The current at the start of the expansion as a function of iota/2pi(0) of the vacuum magnetic field shows that the required plasma current to the expansion decreases with the decrease of the difference between 4/7 and the rotational transform values. The rotational transform profile including bootstrap current calculated by the Sugama-Nishimura moment method shows that the n/m=4/7 rational surface is produced around r/a˜0.37 at ˜1.5 kA. The timing of the n/m=4/7 rational surface formation is consistent with the timing of the transitive increase of the electron temperature. The calculation also shows the movement of the eITB also synchronizes with the movement of the rational surface. Because the 4/7 rational surface is a candidate on which the magnetic island can be formed due to the the n=4 troidal periodicity of the Heliotron J vacuum magnetic field, and other rational surfaces have no contribution to the phenomena, the results show the possibility that the formation of the rational surface can expand the region of the improved confinement, and there is a synergy effect of the eITB and the magnetic island for the expansion of the improved confinement region.

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