Reconnection Startup and Heating of High-Beta Spherical Tokamaks (STs) in TS-3 and 4 Merging Experiments

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Recent merging and reconnection heating experiments of TS-3/4 have developed a new efficient startup of high-beta ST using current swing of external or internal coils[1]. In Type-A merging, two STs were formed by the current swing of two or four internal coils and were merged together. High power heating of reconnection transformed the low-beta merging STs into a high-beta ST within a short reconnection time[1]. Application of ECH enables us to form the two STs not only by the internal coils but also by external field coils, possibly explaining recent non-OH startup of JT-60[2]. We also studied another Type-B merging where an oblate FRC was initially formed by two merging spheromaks with opposing toroidal field Bt and was transformed into an ultra-high-beta ST by applying external Bt[1]. Ballooning stability analyses confirmed formations of the first-stable STs by Type-A merging and the second-stable STs by Type-B merging. The unstable STs in both merging formations revealed the ballooning stability window consistent with measured high-n instabilities. We also found normalized betas of the produced STs as large as 6-17 for comparison with the Troyon scaling and a promising B-scaling of the reconnection heating energy.

[1] Y. Ono et al., Phys. Plasmas **7**, 1863 (2000).
[2] Y. Takase, private communication.