Magnetic Reconnection Experiments by Use of Merging Tokamak and Spheromak Plasmas

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Since initiation of TS-3 merging experiment (1986), a series of closed-type (toroidal) reconnection experiments TS-3, TS-4, UTST, MAST, TS-U and ST-40 have been studying a number of new reconnection physics mostly for space-, solar-, astro- and fusion plasmas. Those physics, particularly the reconnection heating physics lead us to new types of fusion plasma heating and current drive. I will focus my presentation on this recent tokamak and spheromak merging experiments both for physics and application of magnetic reconnection [1], Our findings and applications of reconnection are as follows:

1) reconnection heating by reconnection electric field and electrostatic potential:
   a) global outflow heating of ions in the downstream [1-4]
   b) local X-point and separatrix heating of electrons [1].
2) particle acceleration for high energy particle formation
3) fast reconnection mechanisms: [1]
   a) anomalous resistivity, b) plasmoid ejection and c) 3D reconnection
4) application studies of reconnection/ merging [1,2]:
   a) FRC formation by two merging spheromaks with counterhelicity
   b) high-power heating of tokamak plasmas by their axial merging.

A significant reconnection heating over 1keV was documented by the world-largest merging experiment: MAST [2] after 2D elucidation of ion and electron heating characteristics by TS-3 and TS-4 merging experiments [3]. Their detailed mechanisms have been further investigated in collaboration with particle (PIC) simulations made by Horiuchi etc. [4] and with solar/ space observations [1]. This talk reviews major progresses in those international and interdisciplinary reconnection studies for physics and applications of toroidal plasma merging and reconnection.

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