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Centrifugal force driven low frequency modes in spherical tokamak

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There is a longstanding issue on the physical nature of a low frequency (<50 kHz) MHD instability observed at the early phase of the discharges of a spherical tokamak (ST) - the National Spherical Torus Experiment (NSTX) (Ono et al 2000 Nucl. Fusion 40 557). This work provides evidence that low frequency modes in spherical tokamaks are often driven by the rapid plasma flow. The centrifugal force associated with toroidal plasma flow is identified as the key physics mechanism for generating this instability located in the plasma core region. Positive mode identification between toroidal modeling and experiments is achieved for the mode frequency, the mode internal structure, as well as the threshold flow value for the mode onset. The threshold flow value weakly depends on the precise value of safety factor and the mode is located around the location of sharp density gradient. More important, since the achievable rotation value on NSTX is comparable with that for future Component Test Facilities (CTF) based on ST (Peng et al Plasma Phys.Control. Fusion,47,B263), the presented results in this work are helpful for the conceptual design of ST-CTF to avoid the instability driven by fast plasma flow.

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