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Synchronization of geodesic acoustic modes and magnetic fluctuations in tokamak plasmas

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The synchronization of geodesic acoustic modes (GAMs) and magnetic fluctuations is identified in the edge plasmas of the HL-2A tokamak. Mesoscale electric fluctuations (MSEFs) having components of a dominant GAM, and m/n= 6/2 potential fluctuations are found at the same frequency as that of the magnetic fluctuations of m/n=6/2 (m and n are poloidal and toroidal mode numbers, respectively). The temporal evolutions of the MSEFs and the magnetic fluctuations clearly show frequency entrainment and phase lock between the GAM and the m/n=6/2 magnetic fluctuations. The effects of sawteeth on the synchronization are also investigated. The results show that the synchronization can be modulated by the sawteeth. However, the sawtooth effects are not significant when the coupling between GAMs and magnetic fluctuations is strong enough. This observation indicates that GAMs and magnetic fluctuations can transfer energy through nonlinear synchronization. The nonlinear coupling analysis shows that the MSEFs couple to turbulence and low frequency zonal flows (LFZFs). This suggests that such synchronization may contribute to the LFZF formation, reduction of turbulence level, and thus confinement regime transitions. The analysis of the envelope modulation demonstrates that both the MSEFs and the LFZFs modulate the turbulence while the MSEFs are modulated by the LFZFs.