Interaction and relative role of the ion temperature gradient and trapped electron modes in reactor-relevant finite beta plasma conditions

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The two micro-instabilities of the ion temperature gradient (ITG) and trapped electron mode (TEM) are receiving a strong interest as main candidates responsible for the turbulent transport in high temperature core plasmas in tokamaks, particularly taking an increasing support from recent turbulence validation studies. Here, focusing on the reactor-relevant plasma condition, where electrons and ions are expected to have a similar temperature profile, an estimate is made on the relative role of the two modes. A local kinetic code, which takes into account the collisional and electromagnetic effects as well as the interaction between the two modes, are utilized for the linear stability comparison between the two modes. It is shown that, when we limit our consideration to the low-frequency ion-scale wavelength regime, the TEM, more explicitly the electron temperature gradient or \( \eta_e \) driven TEM, becomes sub-dominant than the ITG in most parameter range with plasma beta smaller than or near to the threshold of the kinetic ballooning mode. When we increase plasma beta from zero, a destabilization of the ITG is also observed before the stabilization by electromagnetic effect becomes effective. The asymmetric interaction between the ITG and TEM, in addition to the collisional effect, is found to play the central role in producing these results. When we consider the density gradient driven TEM, a strong interaction is also observed, with the mode being rapidly stabilized or transited to the \( \eta_e \)-driven TEM (ITG) as the electron (ion) temperature gradient increases. Finally, based on these results of the interaction and relative role of the ITG and the two types of TEM a brief discussion is presented about how the temperature and density profiles will evolve in the reactor-relevant plasma condition.