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Abrupt excitation of intense geodesic acoustic mode in the LHD

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Abrupt excitation of a geodesic acoustic mode (GAM) has been observed in the Large Helical Device (LHD), when the frequency of an up-chirping energetic-particle driven GAM (EGAM) approaches twice the ordinary GAM frequency. The abruptly exited GAM has larger amplitude and a lower frequency than the initially excited EGAM. The amplitude dependence of the growth rate of the abrupt GAM indicates that the GAM is excited through nonlinear processes. The observed specific phase relation between the GAM and the EGAM indicates the coupling between the GAM and the EGAM, and cannot be explained by well-known driving mechanisms such as nonlinear coupling of turbulence [P. H. Diamond, et al.., Plasma Phys. Control. Fusion 47, R35 (2005)] or interaction between energetic particles and a GAM[G. Y. Fu, Phys. Rev. Lett. 101, 185002 (2008)]. Thus, the observed phenomenon indicate the existence of a new excitation mechanism of the GAM.
A candidate mechanism of the abrupt excitation of the GAM is proposed in [M. Lesur, et al., Phys. Rev. Lett. 116, 015003 (2016)] and [K. Itoh, et al., Plasma Phys. Reports (2016) (in press)], in which a subcritical instability of the GAM is shown to be driven by a cooperative collaboration of fluid parametric coupling and kinetic nonlinearity. The model can reproduce the observed phase relation, amplitude, and time scale of the abrupt excitation.

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