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Physics of Kinetic Alfvén Wave: History and Progresses

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In this talk, I will first review the history of the late Professor Akira Hasegawa's seminal contributions to the discovery (a half-century ago) [1], as well as the linear and nonlinear physics of kinetic Alfvén waves (KAWs) [2,3]. KAWs are shear Alfvén waves with, however, microscopic perpendicular wavelengths on the order of thermal ion radii; resulting, thus, in enhanced electron-ion decoupling. As a consequence, KAWs have significant electric field parallel to the confining magnetic field, as well as significantly enhanced and qualitatively different nonlinear wave-wave couplings. I will then discuss more recent studies of nonlinear KAW physics employing the nonlinear gyrokinetic theory and simulations [4-8]; including those in realistic tokamak fusion plasmas [9,10]. I hope to demonstrate that KAWs are not only ubiquitous in magnetized plasmas; but could also play crucial roles in the dynamics and global transports of burning fusion plasmas.

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