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Alfven waves and their excitations by energetic particles in fusion and space plasmas[1]

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Hydromagnetic Alfven waves are fundamental electromagnetic oscillations in magnetically confined plasmas both in laboratories and in space. The anisotropic shear Alfven wave is particularly interesting due to its near incompressibility, and its group velocity being at the Alfven speed and parallel to the confining magnetic field. In realistic plasmas, shear Alfven waves consist of both the continuous spectrum due to the radial nonuniformities, and discrete eigenmodes due to the near periodic properties along the magnetic field. Energetic particles, meanwhile, are prevalent in laboratory fusion as well as solar-terrestial space plasmas. As the typical energetic particle velocities are comparable to the Alfven velocity, they can readily resonate with the waves and excite shear Alfven waves within the continuous and/or the discrete spectra. We shall discuss how excitations can be analyzed within the theoretical framework of a generalized linear fishbone-like dispersion relation. We shall also discuss issues of nonlinear physics pertinent to both the waves and the energetic particles; emphasizing the crucial roles of equilibrium geometries and nonuniformities.

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