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Raman scattering instability in laser-plasma interaction: a personal reminiscence and recent work of trapped electrons effects on Raman backscattering reflectivity and electron acceleration

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Raman scattering of laser in plasmas as a parametric instability in laser-plasma interaction has been shown to be an important mechanism for laser fusion, laser electron accelerator and laser amplifications. I will give a brief personal reminiscence the physics development of Raman scattering ,with emphasis on different natures of absolute and convective instability, from early theoretical work in 1972 [1,2,3],to computer simulations [4,5] to the key experimental observations in the following decades [6,7,8] to present – day status [9,10,11]. Good reviews can be found in [12,13].

I will present recent work on the phase space dynamics of trapped electrons in the plasma wave excited in the Raman back-scattering and its role in the coupling of two important areas of nonlinear plasma physics: wave- particle interaction [nonlinear Landau damping or growth] to three-wave interaction [parametric instability] . In particular, I will discuss the trapped electron effects on the nonlinear development of Raman backscattering in laser plasma interaction from a convective instability to absolute instability [14] to explain the experimentally observed "inflation" or chaos of Raman reflectivity: a sudden jump of reflection coefficient by several orders of magnitudes with a small change of pump laser power [15]. As a consequence of this chaotic process, resonant electrons can be accelerated not only to energies an order of magnitude higher than electron thermal energy, but also high beam quality with narrow energy spread near the phase velocity of plasma wave [16]. I suggest the mechanism for the generation of these nearly mono-energetic electrons by absolutely unstable Raman backscattering as resonant electrons surfing on the breaking plasma wave. Its potential for electron acceleration and laser amplification will be discussed.

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