What can we learn about electron velocity distribution functions by Raman amplifying a probe beam off a sub-ps time scale sculpted pump wave using STUD pulses (spike trains of uneven duration and delay) in a high energy density plasma? *

Dr. Bedros Afeyan, Polymath Research Inc., Pleasanton, CA 94566

We propose pump-probe experiments on BELLA which require a preformed plasma with interesting nonlinear optical or beams or other fast features in its temporal velocity space evolution. We propose to capture those changes by amplifying them via a short pulse (100 fs - 1 ps) stream of pump pulses interacting with one or more probe pulses. The amplification of the latter when the instability is kept in the linear growth regime, can be used to extract the inverse of the slope of the velocity distribution function at the phase velocity of the beat electrostatic wave. More complicated structures such as KEEN waves, SKEENS-SRS interactions and other high frequency instabilities can also be triggered for more interesting scenarios coupling forward problems to inverse scattering with gain problems. The challenge is designing the right sequence of spikes in a train so as to infer when exponential growth occurred, when memory effects were in play and when nondestructive probing is possible. High enough rep rate experiments such as at the Hz level, make such STUD pulse deign algorithm optimization possible.
Having the right diagnostics to capture 100s of ps long records of Raman amplified light with sub-ps resolution requires time-bandwidth products of 1000 or more. This is a challenge that could spawn innovation in all areas of HEDLP and all wavelength regimes from IR to X rays. It is using a sequence of tamed nonlinear optical amplification spurts to diagnose fundamental HED states of matter in extreme conditions.

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