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Non-linear Pulse Propagation in Structured Plasma Channels J.P. PALASTRO, T.M. ANTONSEN, A. PEARSON, W. ZHU, N. JAIN, IREAP, University of Maryland — We consider two non-linear processes in structured plasma channels: forward Raman scattering, and phase locking of radial eigenmodes. In traditional analysis, Raman scattering is an interaction between an incident light wave, scattered light wave, and plasma density fluctuation that are *linearly phase matched*. We find that the traditional analysis, including the damping due to phase mixing and the spatial localization and discreteness of modes, greatly overestimates the growth of the instability. Furthermore, we find that the presence of axial modulations reduce the growth of the Raman instability allowing for the stable guiding of long pulses. This effect is ideal for quasi-phase matched direct acceleration which relies on long pulse lengths for high energy gain [1]. The second effect we consider is *non-linear phase-locking* of radial eigenmodes which *cannot* be linearly phase matched. The eigenvalues of the radial channel modes are typically on the order of the relativistic shift to the plasma frequency. For modest vector potentials a subset of the channel modes become locked (degenerate) leading to a "super-mode" of the channel, which evolves with a single group velocity. This is an intermediate regime of guiding between channel guiding and non-linear self-guding. [1] J. P. Palastro, T. M. Antonsen, S. Morshed, A. G. York, and H. M. Milchberg, Phys. Rev. E 77, 036405 (2008).

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