Weakly nonlinear geometric optics for the Westervelt equation and recovery of the nonlinearity

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Abstract: We study the Westervelt equation modeling nonlinear acoustic wave propagation. In case there is no diffusion, we show that the physical nonlinear effects, predicted and observed, appear in the so-called weakly nonlinear regime: when the amplitude is of the same order as the wavelength. Then the leading transport/profile equation is of Burgers type and the tilt of the wave recovers uniquely the X-ray transform of the nonlinearity along the way, hence the nonlinearity itself. In the diffusive case, we suggest an asymptotic regime which is in line with what is expected and known in acoustics. That part is work in progress.

Ultrasound imaging is already in the nonlinear regime, creating artifacts if the model is linear. On the other hard, the nonlinearity creates higher order harmonics used by the engineers to increase the resolution and reduce strong backscattering siignals. The mathematical analysis of the implications for ultrasound imaging howver is left for future works.

The talk is based in a joint work with Nikolas Eptaminitakis.