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Nonlinear imaging of isoechogenic phantoms using selective phase conjugation of acoustic harmonics

Vladimir Preobrazhensky[a,b], Philippe Pernod[a] and Leonid Krutyansky[b]
[a]IEMN, UMR CNRS 8520, avenue Poincaré, BP 60069, 59652 Villeneuve d'Ascq, France
[b]WRC-GPI-RAS LEMAC, Vavilova street, 38, 119991 Moscow, Russian Federation

Selective phase conjugation of acoustic harmonics generated by an intense focused probing wave is applied for imaging of isoechogenic phantoms non detectable by the linear echography. The principle of imaging is based on the difference between the nonlinear properties of a phantom and its surrounding medium. As shown by theoretical modelling the analysis of the phase conjugate second harmonic 2ω of the probing wave provides an image contrast comparable with the relative difference between the nonlinear parameters of the phantom and its background. Second harmonic generation by the phase conjugate wave 2ω during its back propagation to the source of the probing wave provides an image contrast at the frequency 4ω even stronger than the difference of nonlinear parameters. These theoretical conclusions are confirmed by the experimental measurements carried out using 10MHz supercritical parametric phase conjugator. The objects were prepared with methanol water solutions of concentrations 20% and 60%. The solutions filling either a cavity in the agar gel or an acoustically transparent container immersed in water represented isoechogenic phantoms with weaker and stronger nonlinearities relatively to water. The contrast values of 2ω-images were measured as -14% and +10% respectively while for 4ω- images the contrast achieved -45% and +37%.