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Low-frequency acoustoelasticity in glass beads saturated with water using a nonlinear wave-coupling technique

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To study "non-classical" acoustical nonlinearities in cracked materials, we developed a nonlinear (NL) wave coupling technique. Propagation velocity and amplitude of short high-frequency (HF, 600 kHz) bursts are modulated as result of nonlinear interaction with a low-frequency (LF, 3 kHz) wave. Time Of Flight Modulation (TOFM) is indeed related to both elasticity and density variations. Because high acoustic nonlinearities in glass beads have been reported, we applied our technique to glass beads with different diameters (hundreds micrometers). A small container is filled up with glass beads saturated with water and placed below the LF source. The large HF to LF ratio (200) and the small sample size (6 cm) compared to the LF wavelength in water (50 cm) allow: 1) to measure instantaneous Time Of Flight Modulation (TOFM) and attenuation as functions of the instantaneous LF pressure, 2) to consider the LF pressure field a quasi-static hydrostatic variation of the ambient pressure in the medium. The LF pressure amplitude in water is approximately 10 kPa. Different TOFM and NL attenuation behaviors in tension and in compression, as well as different hysteresis patterns, are observed. The influence of the LF pressure amplitude is discussed.