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Numerical and experimental observations of azimutal shock waves

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Acoustical Vortices (AV) are acoustical beams with a phase singularity of screw type. They possess a phase with an helical structure which is winding around the axis of propagation. These twists of phase engender special properties such as the existence of an associated angular momentum and imply a coupling between the axial and transverse components of the beam. Propagation of AV of finite amplitude follows the classic rule of nonlinear acoustics. Beyond a shock formation distance, AV develop shocks, but the structure of the latters is noticeable. It will be shown by numerical simulations and experimental measurements, that the nonlinear propagation of AV gives birth to 3D shock waves: a classical shock in the direction of propagation plus an azimutal one in the transverse plane. The numerical simulation, based on an original algorithm solving the 3D Khokhlov-Zabolotskaya equation, is used to investigate the dynamic of the formation of the azimutal shock. Experimental observations made with ultrasonics in water confirm the existence of particular shock waves. Finally, a brief discussion of the potential applications will be proposed.