Ray and wave chaos in underwater sound channels

Sound propagation in the ocean over hundreds and thousands kilometers is possible due to the existence of a natural refractive waveguide called the underwater sound channel. There exists a factor, earlier not taken into consideration, which to a significant extent determines the structure of the wave field at long ranges, ray chaos. In the ray approximation, the underwater sound propagation can be modelled by a Hamiltonian system representing a nonlinear oscillator driven by a weak nonstationary external perturbation. A range-independent background sound speed profile plays the role of an unperturbed potential on which a range-dependent perturbation of the sound speed along the waveguide, that can be caused by internal waves, mesoscale eddies, ocean fronts or something else, is superimposed. We study main features of ray chaos in the ocean and their manifestations at finite wavelengths, so-called wave chaos, by the methods of theory of nonlinear dynamical systems, Hamiltonian classical and quantum chaos.

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