Diploma thesis abstract:

Dynamics of shock waves and cavitation bubbles, stimulated by femtosecond filament in water

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In the graduate thesis the dynamics of shock waves and cavitation bubbles excited by the focused near-IR femtosecond supercritical laser pulse in water was investigated under filament formation. In the work the impact of the laser parameters, focusing geometry and medium properties on the filament characteristics and on the dynamics of filament-induced shock waves and cavitation bubbles was established. It was shown that in tight (NA>0.3) focusing of high power femtosecond laser pulse in water a superfilament (stable from pulse to pulse structure arisen from the interaction of many small-scale filaments) is fired. Each point of the superfilament becomes a center of spherical shock wave and cavitation bubble formation. On the nanosecond timescale the superposition of the spherical shock waves builds one contrast cylindrical shock wave, and the overlapped cavitation bubbles construct one cylindrical cavitation area on the microsecond timescale, which evolution significantly differs from the evolution of one isolated cavitation bubble. It leads to the jet emission directed toward the laser at the final stage of the bubble collapse. Under loose (NA<0.1) focusing there are no shock waves and, instead of uniform structure, a random distribution of cavitation bubbles spaced along the filament axis was observed. In this regime the electron density is not high enough for shock waves formation. In the intermediate focusing geometry (0.1<NA<0.3) initially formed superfilament breaks into several small-scale filaments. Optical system aberrations lead to the “hot spots” formation along the optical axis. They serve as the centers for shock wave and cavitation bubbles formation. With energy increase a filament is fired in the “hot spots”, which leads to the construction of the overlapped cavitation bubbles with different diameters and the energy exchange between the bubbles.