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Study of tunable resonances in laser beam divergence and beam deflection

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New, fundamental resonant properties of laser resonators are theoretically predicted and experimentally demonstrated. These resonances occur either in the time dependence of the beam width and that of beam radius of curvature of the wavefront or in the time dependent pointing and position stability of the output light beam of a laser resonator. The resonant frequency can be tuned continuously from zero to the round-trip frequency in the first case; and from zero to the half of the round-trip frequency in the second case, by for example, moving one of the mirrors of the resonator. In both cases besides a resonant frequency its complementary frequency to the round-trip frequency is also resonant, and their shifted frequencies by multiples of the round-trip frequency are also resonant. In our experimental demonstration we measured the radiofrequency noise spectrum of the output laser beam, that was partially blocked by a knife-edge. We observed increased noise at the theoretically predicted frequencies. Similar resonances are predicted either in the time dependent pulse-width and phase modulation or time jitter and the central frequency of the ultrashort light pulses of the mode-locked lasers because of the analogy between the space description of the light beams and the time-description of the light pulses.

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