INTRACAVITY LASER SPECTROSCOPY

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Intracavity laser spectroscopy (ICLS) with the broadband lasers is one of the most sensitive techniques of the absorption spectral analysis. The ICLS sensitivity is fundamentally limited by laser spontaneous emission. This allows one to detect frequency-dependent losses of the order of average cavity losses divided by the number of photons in single mode. For CW broadband lasers, this quantity equals to $3 \cdot 10^{-12}$ cm^{-1}, which corresponds to the optical path of $3 \cdot 10^{11}$ cm. On the other hand, the ordinary dye laser sensitivity is limited by approximately 10^{-9} cm^{-1}, which corresponds to the effective time of "spectral memory" of a few milliseconds. We believe that this is determined by nonlinear mode interaction in the laser active media. Nonlinear interaction leads to energy transfer from more intensive modes to the neighboring modes whose intensity is reduced by the absorption. This results in the smearing of the dips in the laser emission spectrum. We performed the experimental and theoretical study of the nonlinear mode dynamics of the multimode broadband CW dye laser determined by the stimulated Brillouin scattering and the four-wave parametric mixing. The regimes of stochastic generation, dynamic chaos and regular self-oscillations have been observed. It is shown, that the influence of nonlinear interactions can be minimized by employing a unidirectional ring laser with compensated cavity dispersion. In such lasers, the stable kinetics of generation was achieved up to times of 100 milliseconds even in the case of nonselective cavity. It provides the sensitivity as high as 10^{-11} cm^{-1} and allows one to detect the absorption of a few atoms per cubic centimeter.

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