Stabilisation, on the basis of narrow optical resonances, of the frequency of a laser continuously generating ultrashort pulses

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The progress in continuous generation of ultrashort-pulse radiation opens up new opportunities for the stabilization of laser frequencies. Phase locking of all the frequency components in a spectrum makes it possible to construct a frequency standard operating in a wide frequency range. In the stabilization of the frequency of ultrashort laser pulses, each of the N frequency components of the spectrum has a stable frequency. The mode spacing is also stable, i.e. in essence there are N reference frequencies covering an extensive range. Since the positions of all the spectral components of a pulse are determined solely by the cavity length, it is necessary to have a stable cavity length to achieve stabilization of these components. This problem is analogous to that of the stabilization of a single-frequency laser, which makes it possible to employ the existing technology and well-developed methods. One of the ways of doing this involves phase locking of one of the components to a single-frequency stable laser [1, 2].

Another possibility, proposed in this work, is to employ narrow optical resonances as reference points for the stabilization of the frequency of a laser continuously generating ultrashort pulses. As an example, we have considered a two-photon absorption resonance in a gas [3].

We have considered a system for the stabilization of the frequency of a Ti: sapphire laser continuously generating ultrashort pulses. The possibility of efficient pulsed-laser frequency conversion to the second and fourth harmonics because of the high pulse power makes it possible to employ this laser in frequency stabilization on the basis of a two-photon absorption resonance as a result of the 1S- 2S transition in the hydrogen atom (243 nm).

Various nonlinear resonances may be used as reference points for frequency stabilisation. The ultrashort pulse regime does not impose fundamental limitations on the employment of a particular method: the saturated-absorption method, the two- photon absorption method, the separate optical fields method, the method of cooled ions in a trap, etc. may be used.

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[2] T. Udem, J. Reichert, T.W. Hansch, M. Kourogi, *Opt. Lett.* **23**, 1387, 1998.
[3] E.V. Baklanov, V.P. Chebotayev, *Appl. Phys.* **12**, 97, 1977.