Multilayer gas cells for compact optical frequency standards

A.Ch. Izmailov

Institute of Physics, Azerbaijan National Academy of Sciences, Javid av. 33, Baku, Az-1143, AZERBAIJAN

Email: azizm57@rambler.ru

Recently author has proposed multilayer gas cells for sub-Doppler atomic spectroscopy[1,2] (Fig.1). In such a cell, the probe light beam travels along the central axis *z* through the opening 3 of the atomic velocities selector 2 . The spatially separated pumping beam (which may be even broadband) irradiates the region 1 of the cell out of the selector. Such a cell is the compact analog of many plane-parallel atomic beams, whose divergence in the probe region is determined by the large ratio $0.5(D_1 - D_2)/\Delta l$ of a split (Fig.1).

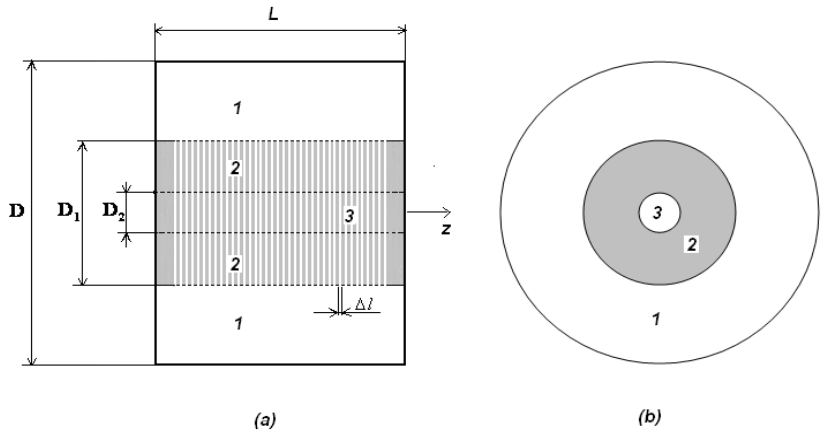

Fig.1. Scheme of the multilayer gas cell (with the diameter *D* and length *L*) in two orthogonal projections (a) and (b), which contains the velocity selector 2 for optically pumped atoms with the transparent opening 3 and a large number of plane parallel splits (with the thickness Δl) between the pumping region 1 and spatially separated probe region 3.

Possible use of given multilayer gas cells (Fig.1) as the basis for new compact optical frequency standards of high accuracy is analyzed in the present work. Thus various nontrivial sub-Doppler resonances in absorption of the probe light beam were theoretically investigated both for stationary and nonstationary broadband and monochromatic pumping radiation. Conditions were determined when the effective three-dimensional selection of slow-speed optically pumped atoms may be realized and corresponding sub-Doppler resonances were most narrow. In particular, cases of unidirectional and counter-propagating spatially separated monochromatic pumping and probe beams (with the same scanned frequency) have been considered. It was shown, that in these situations the effective width of the Doppler-free resonance in absorption of the probe beam in the multilayer cell may be less (up to the factor ≈ 1.554) than the limitary small width of the known "Lamb deep" in the saturated absorption spectroscopy for the corresponding resonant atomic transition in a usual gas cell.

---

[1] A.Ch. Izmailov, "Multilayer gas cells for sub-Doppler spectroscopy", arXiv e-prints 1208.5566 [atom-ph], August 2012.

[2] A.Ch. Izmailov, "On the possibilities of sub-Doppler atomic spectroscopy in multilayer gas cells", Optics and Spectroscopy, vol. 115, N4, p. 463-468, 2013.