“Comparative study of three models of metrological cavities and numerical modelling of a new cavity”

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Abstract

The need for a good standard of frequencies and lengths has led scientists, since the 1980s, to take an interest in lasers, in particular gas lasers. Indeed, the variations, as a function of the frequency, of the light power emitted by gas lasers with low gain are characterized by a hollow called Lamb-dip and whose frequency is generally different from the resonance frequency of the laser. As a result, this gives rise to an asymmetrical line shape. Previous work has shown that this asymmetry has several causes and depends closely on the geometry of the laser cavity. Also, through an adequate choice of geometric parameters, it is possible to design a cavity, called "metrological cavity", for which the line shape would be symmetrical. In this case, the frequency of the Lamb-dip coincides with the resonance frequency of the laser and can therefore be a good reference for length and frequency measurements.

It is for this purpose that several models of stabilized cavities have been proposed in the literature. Unfortunately, most of these models do not take into account all the causes of asymmetry and are based on the mean field approximation and the Kogelnik matrix formalism which is valid only in linear media.

The aim of this work is to study these models, in order to highlight the limit of their validity and then, based on the theory of the disturbed Gaussian beam and numerical simulations, to propose a new model of metrological cavity which gives, a line shape which keeps its symmetry even when gain in the cavity vary, contrary to the previous models.