Temperature and Acceleration Sensitivities of a Dual Cavity Fabry-Perot Interferometer

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Abstract

The numerical study of temperature and acceleration sensitivities of a dual cavity Fabry-Perot (FP) interferometer is carried out using finite element method. The optical cavities are formed by machining two side-by-side circular bore of 12 mm each on a monolithic block of low expansion material. One cavity will be used to generate broadband channel spectra for accurate wavelength calibration of an astronomical spectrograph. The other cavity would be utilized to monitor the long term stability of the channel spectra by optical heterodyne technique. The geometry of a dual channel FP cavity is shown in Figure 1. All relevant dimensions are shown in mm. (a) The top view showing the 10 mm thick cavity spacer with optically contacted mirror pairs on either side. Two small holes of $\phi = 2$ mm on top are provided for the venting purpose. (b) The front view showing the spacer dimensions along with two cavities of $\phi = 12$ mm each and HR mirrors with $\phi = 25{:}4$ mm each. (c) The isometric view. The cavity axis is orientated along the Z-direction and the lab vertical is along the Y-direction.

The tracking sensitivity of FP block is strongly affected by differential length changes in two cavities induced by temperature variations and mechanical noise transmitted into the experiment. We have used finite element numerical simulations to evaluate the relative drift noise of two FP cavities fabricated on a low expansion monoblock spacer. Figure 2 shows the FEM computed displacement components (nm) along the cavity axis due to gravity loading. A proposed mounting support for cavity mirrors is also worked out to suppress the relative length variations below pico-meter, thus facilitating accurate dimension tracking and generation of stable reference spectra for radial velocity Doppler measurements below 10 cm/s level.

Figures used in the abstract

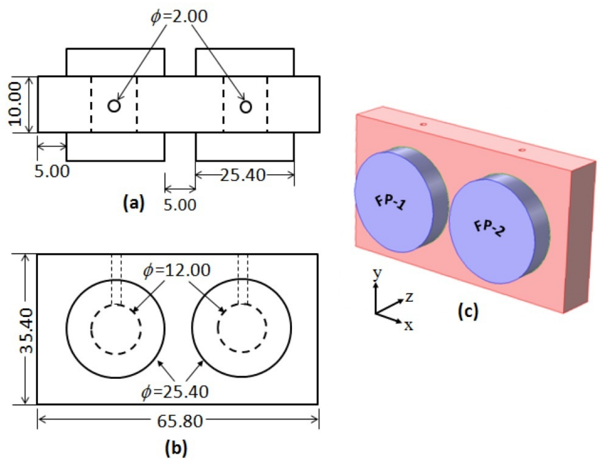

Figure 1

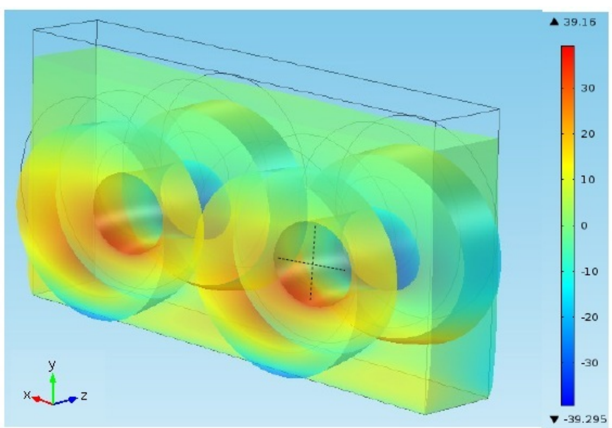

Figure 2