On the Possibility of Phase Measurements in Microoptical Gyro

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Abstract — The paper considers the possibility to organize the phase measurements of the rotation speed in the ring-shaped single mode passive cavity, supplied by lone power divider (directed coupler).

Index Terms — microoptical gyro, passive ring interferometer, Sagnac effect.

All published approaches to microoptical gyro design with the use of the passive ring cavity (multi-beam interferometer) — see, for instance, [1-4] — are employing the amplitude characteristics of such cavities and their splitting for determining the rotation speed. Our results indicate that one can use the phase retardation characteristics for the same purposes. Such a technique is widely used in fiber-optical gyros [5] with two beam interference, and thus the similar approaches and methods can be also used in designing the passive microoptical gyros.

Fig. 1 Principle of passive ring cavity gyro operation.

Fig. 1 illustrates the principle of such a device action. Radiation for the laser source 1 is divided by Y-shaped divider 2 to two channels. Phase modulators 3 and 4 control the frequency of each light flow. The system comprises 3 directed couplers (DC) 7, 8 and 9 and the ring-shaped cavity with diameter of several centimeters (sensitive element of gyro) 10. The light from both channels is inserted into the cavity 10 by DC 9 — one to clockwise (CW) and second to the counter-clockwise direction (CCW). The same DCs are also providing the reverse process — they are extracting the radiation from the cavity back to the waveguide, which delivers it to the photo detectors 5 and 6. The signal from both detectors comes to the control unit 11.

From the optical point of view such a cavity is very similar to the well-known Gires-Tournois interferometer [6] (the variant of Fabry-Perot interferometer with non-transparent rear mirror). In our case there is also observed the constant amplitude reflectivity, accompanied by strong dependence of phase shift of the reflected wave upon its frequency. Similarly to ordinary Sagnac interferometer, the rotation of the ring cavity results in split of its characteristics for clockwise (CW) and anti-clockwise propagating waves (see Fig.2). The value of this split is proportional to the angular velocity, producing thus the basis for its measure in a passive optical gyro.

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