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Fibergyro for educational purpose

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Abstract: We describe an experiment that allows students to measure the Sagnac effect with a fibergyro linked to a rotating plate. The Sagnac signal is compared to an independant measurement that uses an optical encoder. The Sagnac law can be verified and the speed of Earth rotation can be estimated experimentally.

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1. Introduction

Fibergyros are widely used devices in aircraft industry. Our labwork experiment uses a commercial-type interferometer with all suitable integrated optics : superluminescent laser diode, integrated coupler and electro-optic modulators, 2 km monomode fiber-coil, photodiode. In a first part, with no modulation applied to the electro-optic modulators, the electric Sagnac signal delivered by the photodiode of the rotating fibergyro is transmitted to the laboratory recording station through a free space optical digital link and compared to an independant measurement that uses a classical optical encoder. Then, the Sagnac law can be precisely verified in the range $[-40 \text{ rpm}$, $+40 \text{ rpm}]$. In a second part, with modulation applied and using a lock-in amplifier, the speed of Earth rotation can be estimated with a precision limited by the fibergyro sensitivity.

2. Experiment

2.1 Set-up

Fig. 1. Fibergyro set-up.

Fig.1 shows the set-up of the fibergyro. The conditioning of the signal and the digital transmission through the dedicated optical link from the moving plate to the measurement station will be detailed in the paper.

2.2 Verification of Sagnac's law

The Sagnac signal S_g is recorded with the LabVIEW software and finally plotted versus the speed of rotation Ω measured independently. Figure 2 shows the front ends of the virtual instrument with S_g and Ω variations.

Fig. 2 . Left: Sagnac signal S_g and independently measured speed of rotation Ω versus time. Right: Sagnac's law $S_g(\Omega)$.

2.3 Speed of Earth rotation

In a second part, the extremely tiny useful signal due to the Earth rotation will be extract from noise with a lock-in amplifier and give an estimation of the speed of rotation ($\Omega \approx 1.0$ revolution per day $\pm 10\%$), the uncertainty being governed by the electrical signal to noise ratio and the residual non-reciprocity of the interferometer.