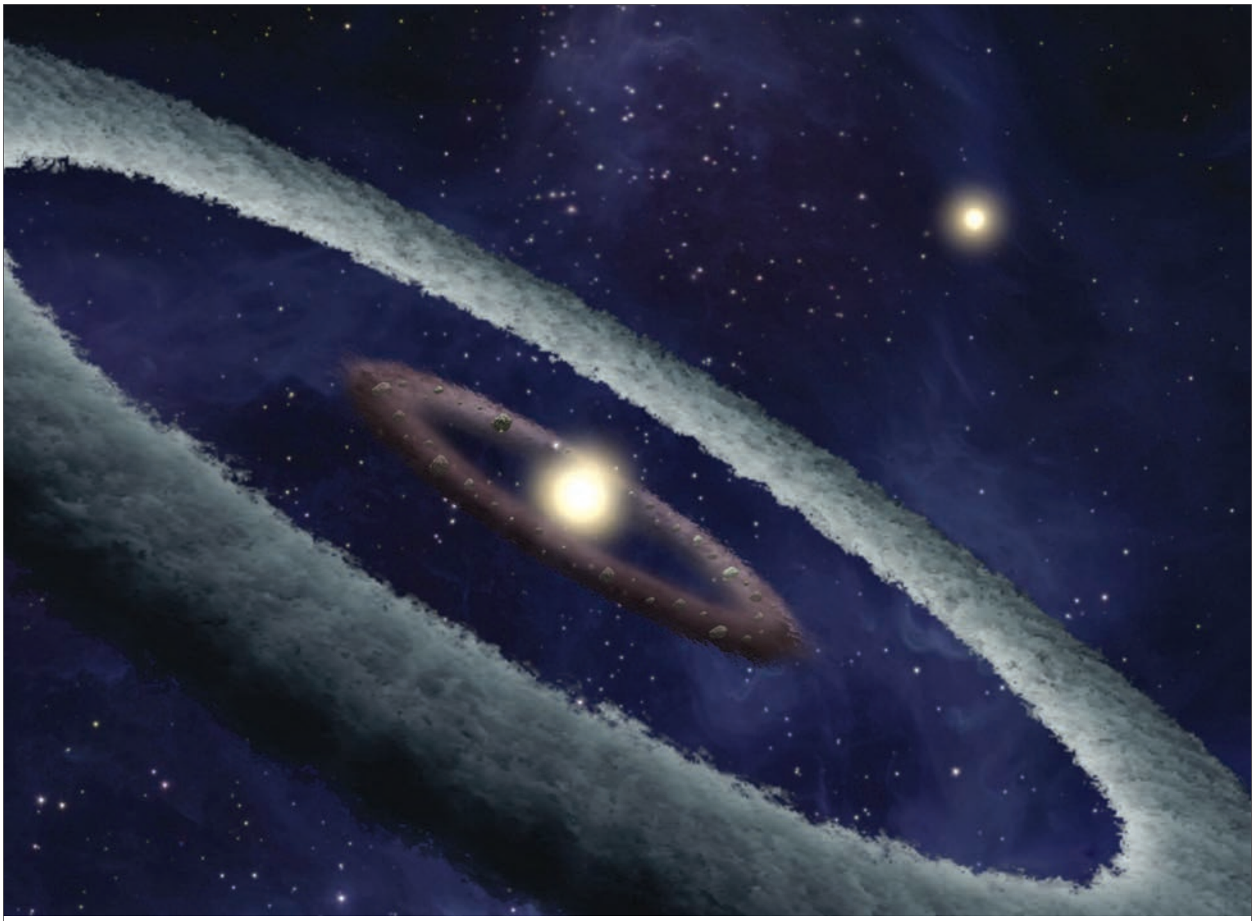

Research Journal of Physics

ISSN 1819-3463

Academic Journals Inc.

www.academicjournals.com

Research Journal of Physics 2 (1): 22-25, 2008
ISSN 1819-3463

New Setup for the Measurement of the Optical Diffracted Field

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Abstract: This study deals with the determination of the phase and the amplitude of a diffracted field. We build a simple setup in order to measure the phase of a diffracted field. This setup can be used with different direction of the incident beam.

Key words: Optical diffraction tomography, microscopy, diffracted field

INTRODUCTION

Optical Diffraction Tomography (ODT) allows a three-dimensional quantitative imaging of the absorbtivity and refractive index of a specimen (Lauer, 2002). The fields diffracted by the object are measured from a number of angles of incidence of a parallel laser beam. The object is reconstructed from this plurality of field measurements. Reconstruction uses linear Fourier transform algorithms in which case resolution is improved by a factor of 2 as compared to holography or standard microscopy (Lauer, 2002). In certain cases resolution can be further enhanced using iterative inversion algorithms (Belkebir *et al*., 2003). These algorithms used amplitude and phase data on the diffracted field in order to reconstruct the object. The most straightforward method to record both the phase and amplitude of the scattered wave is phase shifting holography. However, when successive illumination beams of different directions are used, it is not possible to control the phase of these beams. So, far Lauer successfully used phase shifting holography by an accurate compensation of the non control phase shift. But the setup of that experiment was very sophisticated.

The aim of this study is to build a non complex ODT experimental setup in order to acquire the amplitude and the phase of the diffracted field. These results could be used by iterative inversion algorithms team to validate that method.

THE SETUP

A transmission setup equipped with a Michelson interferometer is built as shown in Fig. 1. A coherent beam is generated by a polarized HeNe laser and split, by beamsplitter A into an illumination beam and a reference beam. This illumination beam is a plane wave illuminating the sample. It is phase modulated by an electro-optical phase modulator.

$$E_i = A_i \exp j(\Delta\phi + \Omega t)$$

The reference wave is a plane wave $E_{ref} = A_{ref} \exp j\,(\Delta\phi)$ superimposed to the information carrying wave by beamsplitter B. The information carrying wave is the diffracted field of the sample.

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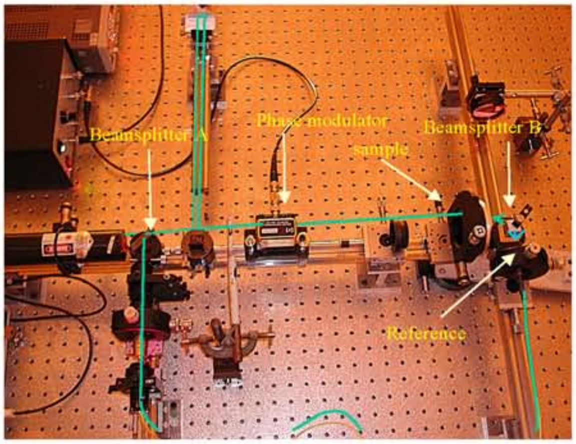

Fig. 1: Diagram of the setup

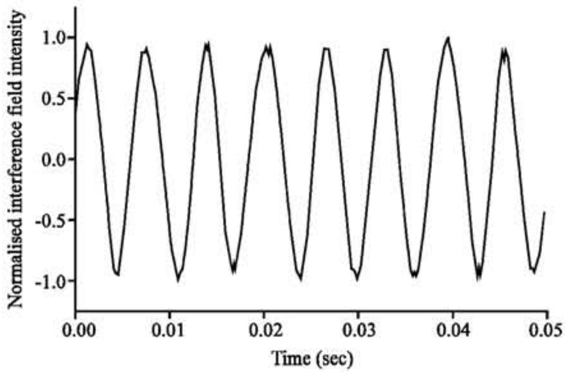

Fig. 2: Intensity I_{rd} of the interference between the diffracted field and the reference field at angle 6°

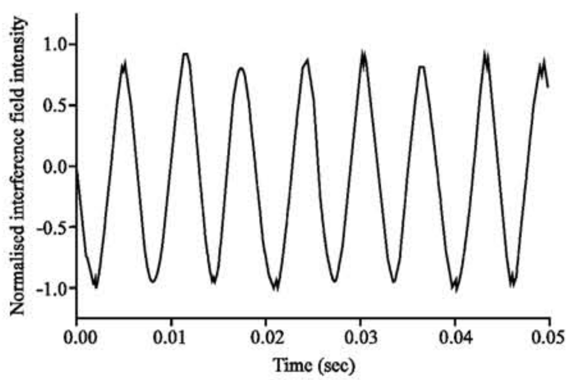

Fig. 3: Intensity I_{ri} of the interference between the non diffracted field and the reference field at angle 0°

$$E_d = A_d \exp j(\phi + \Delta\phi + \Omega t)$$

With one photodetector placed on a moving arm, the intensity I_{rd} (Fig. 2) of the interference between the diffracted field and the reference field at different angles is measured.

$$\|E_{ref} + E_d\|^2 = I_d + I_{ref} + 2(I_d I_{ref})^{1/2} \cos(\phi + \Delta\phi + \Omega t)$$

With the second photodetector, the intensity I_{ri} (Fig. 3) of the interference between the two arms of the Michelson interferometer is measured.

$$\|E_{ref} + E_i\|^2 = I_i + I_{ref} + 2(I_i I_{ref})^{1/2} \cos(\Delta\phi + \Omega t)$$

With both signals I_{rd} and I_{ri}, the phase ϕ of the diffracted field of the sample is determined.

RESULTS AND DISCUSSION

The sample is illuminated using the beam only in the normal direction. With both signals the phase ϕ of the diffracted field is determined as shown in Fig. 4.

A number of directions of the illuminating wave are used and the corresponding intensities of interference are measured. Following this the corresponding phases of the diffracted field are shown in Fig. 5.

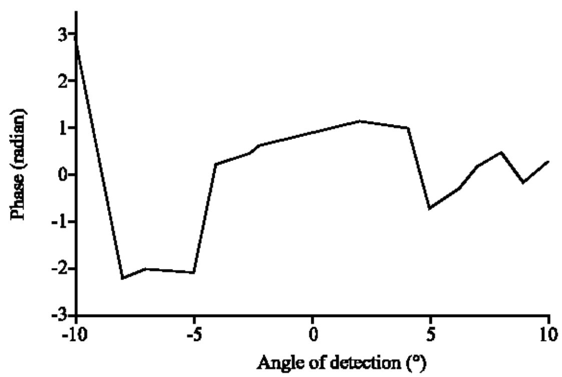

Fig. 4: Phase of the diffracted field

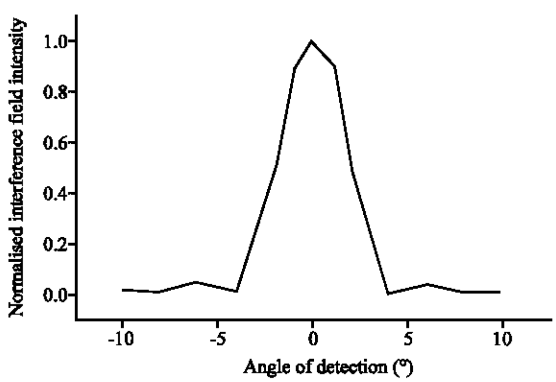

Fig. 5: Normalised intensity of the diffracted field

CONCLUSIONS

From this experiment, it can be concluded that the setup used is easy to build. It proves resistant to vibrations. Few optics element used in the setup. By acquiring the signal, it is possible to control the phase of whether illuminating beam. The measurement made and the phase obtained lead to the expected outcome that is the effectiveness of this setup.

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