ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

MASTER THESIS

Evaluation of optical aberrations using Phase Diversity

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Basic Sciences

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Declaration of Authorship

I, Jordan VOIRIN, declare that this thesis titled, "Evaluation of optical aberrations using Phase Diversity" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

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Abstract

Physics
Basic Sciences

Master in Applied Physics

Evaluation of optical aberrations using Phase Diversity

by Jordan VOIRIN

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor...

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List of Abbreviations

LAH	**L**ist **A**bbreviations **H**ere
WSF	**W**hat (it) **S**tands **F**or

Physical Constants

Speed of Light $c_0 = 2.997\,924\,58 \times 10^8\,\mathrm{m\,s^{-1}}$ (exact)

List of Symbols

a	distance	m
P	power	W ($\mathrm{J\,s^{-1}}$)
ω	angular frequency	rad

For/Dedicated to/To my…

Chapter 1

Introduction

???

Chapter 2

Phase Diversity Experiment

2.1 Theoretical Background

2.2 Experimental Setup

The design of the experiment was already done by Bouxin (2017). The setup is built according to her plans and specificationsS.

The experiment is mounted on a pressurized legs optical table. The setup contains six components : a light source, an entrance pupil, an imaging system, a converging lens to focus the beam on the camera, a camera and a wavefront sensor.

2.2.1 Light source

The final application of the phase diversity will be to characterize the optical aberrations induced by the imperfect optical path to a scientific detector of a telescope. For this reason, the light source has to simulate a distant star aberration-free wavefront. A distant star wavefront is considered planar since the object distance, z, is far greater than the telescope size, r, see Fig. 2.1. The source of our experiment must then be characterized by planar wavefront.

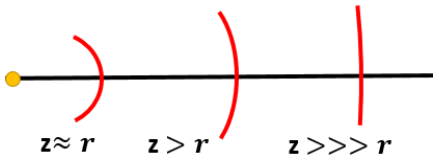


FIGURE 2.1: Wavefront curvature for different source's distances, z. r represents the characteristic size of the arc of interest.

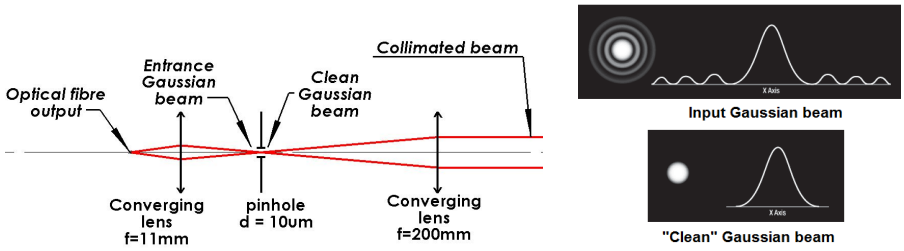
In order to obtain such a planar wavefront at the entrance pupil, the light source consist of a "pigtailed laser diode", a f=11mm converging lens, a pinhole and a f=200mm converging lens. The pigtailed laser diode, LPS-635-FC Thorlabs (2013), emits a Gaussian beam centred at 637.5 nm slightly diverging. The converging lens concentrates the beam at the center of the 10μm pinhole to filter the noise. The second converging lens collimates the beam, obtaining a collimated beam with a planar wavefront.

2.2.2 Entrance pupil

The entrance pupil of our optical system is a circular aperture of 3.2mm diameter placed after the collimating lens of the light source.

2.3 Results

This section presents the results of the phase diversity experiment, with the introduction of different sources of aberration.



(A) Source ray tracing.

(B) Beam view before and after the pinhole.

FIGURE 2.2: Source schema and pinhole effect on the beam.

2.3.1 Astigmatism

The first aberration studied in this work is the astigmatism aberration introduced by a tilted parallel plane plate (link to section). A parallel plane plate introduces astigmatism in addition to the defocus introduced by a plate perpendicular to the optical axis. The astigmatism is due to the fact that symmetric rays with respect to the optical axis have an optical path difference.

Appendix A

Frequently Asked Questions

A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

`\hypersetup{urlcolor=red}`, or
`\hypersetup{citecolor=green}`, or
`\hypersetup{allcolor=blue}`.

If you want to completely hide the links, you can use:

`\hypersetup{allcolors=.}`, or even better:
`\hypersetup{hidelinks}`.

If you want to have obvious links in the PDF but not the printed text, use:

`\hypersetup{colorlinks=false}`.

Bibliography

Bouxin, A. (2017). "Phasor diversity to measure the static aberrations of an optical system". MA thesis. HEIG-VD.

Thorlabs (2013). *Pigtailed Laser Diode, SMF*. Tech. rep. Thorlabs. URL: https://www.thorlabs.com/drawings/fabda6a9d8d9b5b7-79C310DF-0190-CACC-15060261B06DD1E8/LPS-635-FC-SpecSheet.pdf.