GAS LENSING IN A HEATED ROTATING PIPE

by

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A dissertation submitted in partial fulfillment of

the requirements for the degree of

Master of Science in Applied Physics

Department of Physics

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University of Zimbabwe

May 2006

DECLARATION

This thesis is my original work and has not been submitted for examination in any other University.

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ABSTRACT

When a heated pipe is axially rotated, the dynamics of the gas inside exhibit properties reminiscent of a positive lens. These are the result of a parabolic distribution of refractive index in the pipe, which is caused by a special mixing of hot and cold gases. When a laser beam was propagated, along the pipe's axis, a focal spot was observed.

In this report, results of a numerical model are presented using the basic equations of a graded refractive index (GRIN) lens provided a tool to visualize a Gaussian beam propagating through such a lens. Experimental data are presented to demonstrate how the lensing properties depend on the rotation rate and pipe temperature. The lens is essentially a graded refractive index (GRIN) lens whose power is a result of both of these variables. The data show that, if either is increased, the power of the lens increases. An empirical formula relating focal length, temperature and rotation rate is derived.

Future research, which could not be done in time, can look at measuring aberrations generated by the gas lens, the beam quality factor and analyzing the intensity profile of its output beam. This will help understand how a laser beam can be used to take measurements of aberrations in the atmosphere.

PREFACE

The work in this thesis was carried out at the National Laser Centre (NLC) in Pretoria, South Africa on behalf of the University of Zimbabwe (UZ), from December, 2005 to April 2006. The NLC is a part of the Centre for Scientific and Industrial Research (CSIR). The visit was funded by the African Laser Centre (AFC). It is a result of the collaboration between the NLC and the UZ physics department through the efforts of Dr M Mathuthu of UZ and Dr Andrew Forbes of the NLC who both supervised this work..

ACKNOWLEDGEMENTS

The author would like to sincerely acknowledge the following people and organizations without whose assistance, co-operation and guidance, the project described in this dissertation would not have been a success:

The African Laser Center (ALC) who provided the funding for my visit to South Africa, Dr Andrew Forbes, my NLC supervisor who never gave up on me, Dr M Mathuthu, my UZ supervisor for his guidance and motivation, Dr M.M. Michaelis of the UKZN who provided the gas lens, Mr Ameeth Sharma, an engineer at the NLC who designed and constructed the opto-switch circuit used to measure the speed of rotation of the gas lens and all the other support he provided, Mr Martiens Kruger, a technician at the NLC who was mainly responsible in setting up the experiments, Bathusile Masina and Vhutshilo Nekwaliva, MPhil students doing their research at the NLC, who assisted in some of the laboratory work, Bafana Moya, of the NLC for technical assistance, numerous scientists and writers whose work provided the ideas that shaped the work within these pages, all the people who work at the National Laser Centre (NLC) who contributed to the completion of this project, my mother and family for their support and love.

DEDICATION

I dedicate this report to my loving wife, Shingi, for her devotion and support. She encouraged me to carry on when I could have given up. God bless her.

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