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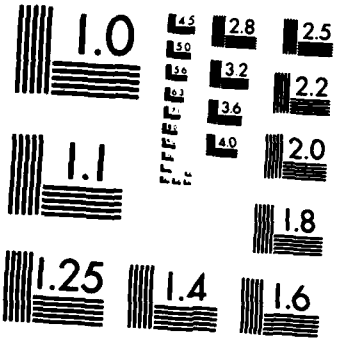

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FINAL REPORT

STATISTICAL OPTICS AND SCATTERING

Contract #N00014-80-C-0808

Principal Investigator

J.C. Dainty

1st August 1980 - 31st. July 1981

10th August 1981

THE UNIVERSITY OF ROCHESTER

COLLEGE OF ENGINEERING AND APPLIED SCIENCE

ROCHESTER, NEW YORK 14627

THE INSTITUTE OF OPTICS

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August 4, 1981

Dr. Van O. Nicolai
Physics Program
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217

Dear Dr. Nicolai:

I enclose 20 copies of my final report on contract N00014-80-C-0808 which terminates on July 31st, 1981.

I would like to add to this report the following comment: no single contract has ever had such a profound, and, I suspect, long-lasting effect on the quality of the experimental work done in my statistical optics laboratory.

I hope you will have the opportunity sometime to visit me herein Rochester.

Yours sincerely,

J.C. Dainty

J.C. Dainty
Associate Professor of Optics

JCD:maf
Enclosures

xc: Dr. W. Condell, ONR

Vincent Moreno at ONR (NYC), tell me you never received this!

1. Introduction

The purpose of this one year contract was to provide capital equipment for experiments on statistical optics and scattering. Whilst only a single publication[1] directly acknowledging ONR has resulted to date, a further four papers[2-5] are in press, or in preparation, which have indirectly benefitted from this capital expenditure. The benefits of this equipment will also be reflected in our experimental studies for the next several years.

2. Equipment Purchased and its Applications

A. Photon counting photomultiplier (EMI)

In our experiments on the measurement of the statistics of scattered light, photon counting techniques are used partly out of necessity (due to low light levels) and partly for ease of on-line data processing (see B). In particular, it can be shown that the normalized cross-correlation of photon counts equals that of the classical intensity and that the normalized factorial moments of photon counts equal the normalized moments of the intensity; these two facts enable us to estimate correlation functions and probability density functions of the intensity of scattered light from photon counting experiments. The particular photomultiplier purchased has an exceptionally low dark count (approx. 10 s^{-1} at room temperature) and is

incorporated into a dual channel photometer used for measuring the spatio-temporal statistics of laboratory[3] and stellar[4,5] speckle patterns.

B. Correlator Upgrade

The Langley-Ford digital photon correlator used for on-line data processing of photon counting signals has been upgraded by the following additions:

(i) an additional 64 analysis channels brings the total to 128,

(ii) a (custom) dual histogram feature (see below),

(iii) an analog input option.

The dual histogram option is unique to our instrument; with this, we can simultaneously measure histograms of photon counts (and hence factorial moments) in two channels. This option was central to the success of a recent experiment on the wavelength dependence of stellar scintillation[5].

C. HP85 Desktop Computer System

This system comprises an HP85 Computer with 32K words of memory, RS232 and IEEE 488 interfaces, a plotter and a printer. Its main function is to interface to the Langley-Ford correlator for on-line analysis of measured correlation functions and probability histograms. It has been used extensively in laboratory studies of the space-time dependence of "boiling" speckle[3] and was a part of the complete

system (dual photometer, correlator, HP85) used on our recent observing trip to Mauna Kea, Hawaii[4,5]. It has also been continuously used as a desktop calculator, thus relieving the load on the central computing facilities. For example, it was used in an investigation of a geometrical optics theory of focusing by random wavefronts. It will also be used in the near future to interface to a "Dektac" surface profilometer for the on-line measurement of the statistics of randomly rough surfaces.

D. Video Digitizer

As part of an investigation of the phase problem in stellar interferometry[2], we are assembling a laboratory simulation of stellar speckle interferometry. The video digitizer is part of that assembly; it enables images consisting of up to 480x512 pixels to be entered into the LSI 11/23 computer with 8 bit precision in a few seconds.

E. LSI 11/23 Computer (part cost)

A computer system, centered on an LSI 11/23 computer has been installed in the statistical optics laboratory. It comprises an LSI 11/23 central processor, 80K words memory, twin 8" flexible discs, serial, parallel and IEEE 488 interfaces, printer and CRT console; it is linked to a CAMAC crate system for the acquisition of data and

the control of instruments. This system is being used for a variety of general purpose computing as well as for experiments on the phase problem and in non-gaussian speckle.

3. Personnel

Partial salary support was provided for the Principal Investigator through a cost-sharing agreement with the University of Rochester. Although no research students were explicitly supported under this contract, the following students benefitted from the availability:

B.J. Brames	(Ph.D)
K. Creath	(M.Sc.)
B.M. Levine	(Ph.D)
K.A. O'Donnell	(Ph.D)

4. References

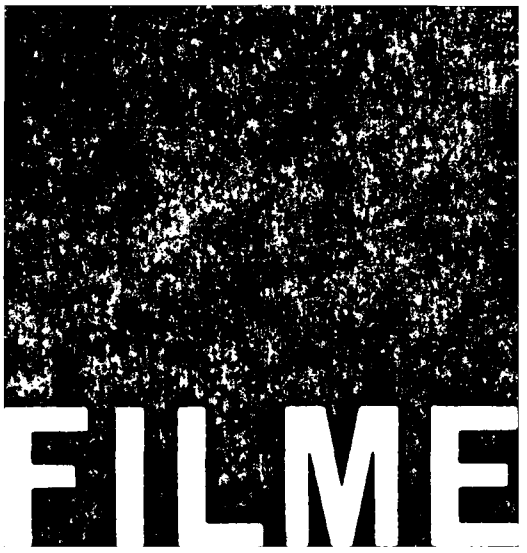
1. J.C. Dainty, "Assessment and Modeling of Image Noise", Conference Preprint, "Image Analysis, Techniques and Applications", Tucson, Arizona, January 1981.

2. B.J. Brames and J.C. Dainty, "A Method for Determining Object Intensity Distributions in Stellar Speckle Interferometry", J. Opt. Soc. Am., in press.

3. K.A. O'Donnell, "Correlations of time-varying speckle near the focal plane", submitted to J. Opt. Soc. Am.

4. K.A. O'Donnell, B.J. Brames and J.C. Dainty, "Measurements of the Temporal Statistics of Stellar Speckle Patterns at Mauna Kea, Hawaii", in preparation.

5. J.C. Dainty, B.M. Levine, B.J. Brames and K.A. O'Donnell "Measurements of the Wavelength Dependence and Other Properties of Stellar Scintillation at Mauna Kea, Hawaii", in preparation.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