



Micro-Optics Research & Engineering (MORE) Laboratory



Dr. Willie S. Rockward, PhD
Morehouse College

April 10, 2002

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With such software, equipment and modules, the MORE Laboratory will allow the students the flexibility to study, simulate and fabricate real-world engineering systems while concentrating on the fundamental principles of engineering, mathematics and science. Several students will complete the "hands-on" experiment modules as summer research projects. An "Open House Tour" of the MORE Laboratory was held on Wednesday, April 10, 2002.



**MICRO-OPTICS
RESEARCH AND ENGINEERING (MORE) LABORATORY**

DIRECTED BY

**DR. WILLIE ROCKWARD
ASSISTANT PROFESSOR OF PHYSICS**

OPEN HOUSE TOUR

**WEDNESDAY, APRIL 10, 2002
4 TO 7 PM**

PROGRAMME

I. INTRODUCTION ROOM 130

II. PRESENTATION & DEMONSTRATION ROOM 130

“THE MICRO OPTICS RESEARCH & ENGINEERING (MORE) LABORATORY”
DR. WILLIE S. ROCKWARD, ASSISTANT PROFESSOR OF PHYSICS

III. TOUR OF THE MORE LABORATORY

A. DIFFRACTIVE OPTICS FABRICATION & RESEARCH ROOM 111

B. PRECISION PHOTOREDUCTION DEVELOPMENT ROOM 108

IV. QUESTIONS & ANSWERS

V. REFRESHMENTS

MICRO OPTICS RESEARCH & ENGINEERING (MORE) LABORATORY

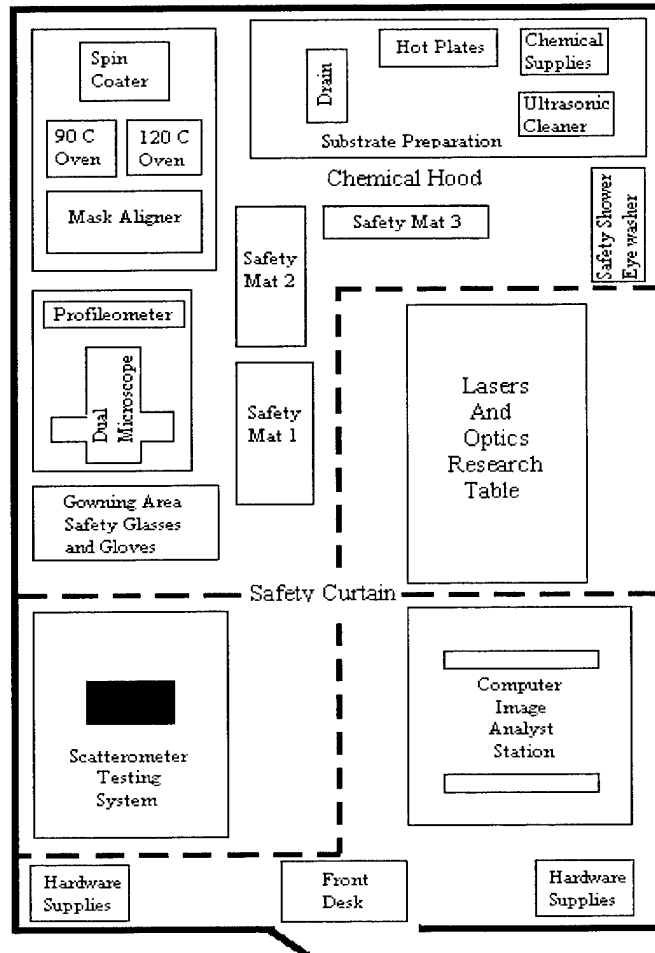
ABSTRACT

The present surge of interest in optical communication technology has led many researchers scurrying to find new and promising applications. Diffractive optics represents a new field of optics that can extend the efficiency and design of classical optics and create new optical components for electro-optic systems. As this new field has progressed, more elaborate structures and wavefronts have been generated with finer features that require a better understanding and control of intensity distribution and polarization behavior.

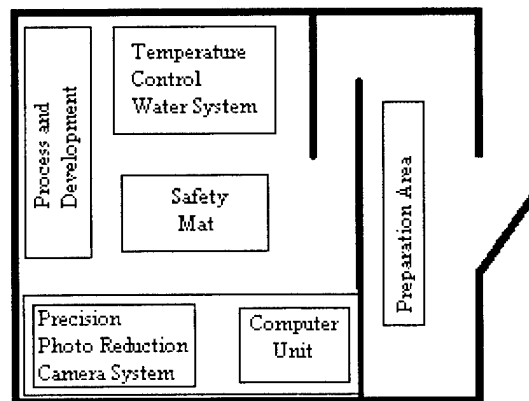
The goal of this project is to establish a state-of-the-art Micro Optics Research & Engineering (MORE) Laboratory that will dramatically improve the quality of undergraduate education in the various science, engineering and mathematics (SEM) departments at Morehouse College. This laboratory will allow students in the various SEM departments to be well-trained with the latest micro optics and engineering technology through virtual instrumentation, micro-lithography and research. With the nation's most successful dual-degree engineering program for African-American males, Morehouse College is well positioned to have a significant impact on the production of engineers of African American lineage by increasing the number (and the retention) of students in the engineering program. The MORE Laboratory will bring about a quantum leap in our effort to produce more scientists and engineers.

The MORE Laboratory consists of a virtual instrumentation and analysis software like Laboratory Virtual Instrumentation Engineering Workbench (LabVIEW), data acquisition (DAQ), microelectronics and photolithography equipment. With such software and equipment, the MORE laboratory will allow the students the flexibility to study, simulate and fabricate real-world optical engineering systems while concentrating on the fundamental principles of optics, mathematics and engineering. The associated research will focus on the modeling, fabrication and analysis of diffractive patterns by crossing binary phase gratings with scalar features. It is also intended to explore any polarization (vector) dependence that may arise as a result of generating finer features. An understanding of these effects may permit researchers to modify fabrication processes and to generate new and useful beam deflection elements.

MORE LAB: DIFFRACTIVE OPTICS FABRICATION & RESEARCH - ROOM 111



MORE LAB: PRECISION PHOTOREDUCTION DEVELOPMENT - ROOM 111



RESEARCH & EDUCATION PROJECTS

I. CROSSED PHASE ELEMENTS

- A. Investigating asymmetrical intensity distributions
- B. Passive optical switching devices
- C. Alvarez lens and higher order wavefronts

II. COLLABORATIONS

- A. Biomedical: Microphantons for the Optical Quadrature Microscope (C. DiMarzio, NSF-CenSSIS at Northeastern University, Boston, MA)
- B. Nanostructures: Modeling, Fabrication and Testing (V. Bennett, Physics, Morehouse College)
- C. Termite behavior: Optical environment response (D. Jackson, Psychology, Morehouse College)

III. EDUCATION

- A. New courses in Applied Optics (Diffractive Optics, Lasers, Photolithography, etc.)
- B. Applied Physics degree with a concentration in Applied Optics/Optical Engineering
- C. Dual Degree arrangement with majority institution that offers Optical Engineering major (Univ. of Arizona, Univ. of Central Florida-CREOL, Univ. of Rochester, etc.)

RESEARCH SPONSORS

MOREHOUSE COLLEGE

DEPARTMENT OF PHYSICS

DIVISION OF SCIENCE AND MATHEMATICS

NABRIT FACULTY RESEARCH

NASA/GEORGIA SPACE GRANT CONSORTIUM

U.S. AIR FORCE OFFICE OF SPONSORED RESEARCH

U.S. DEPARTMENT OF DEFENSE (HBCU/MI PROGRAM)

WOODROW WILSON NATIONAL FELLOWSHIP FOUNDATION

UNDERGRADUATE RESEARCH ASSISTANTS

OKERA HAWKINS

SENIOR

MATHEMATICS

- Graduating Senior and Center of Excellence Scholar
- Interested in Applied Mathematics and Engineering
- Plans to attend Graduate School in Washington DC/Maryland area

RONALD MARTIN

FRESHMAN

- Morehouse/Packard Scholar
- Interested in Applied Optics and Robotics
- 2002 Summer research intern at IBM Watson Research Center, Yorktown Heights, NY

KREGG QUARLES

JUNIOR

APPLIED PHYSICS/MECH. ENG./MATH

- Morehouse/NASA Scholar
- Interested in Robotics and Artificial Intelligence Systems
- 2002 Summer research intern at the NSF-Center for Subsurface Sensing and Imaging Systems (CenSSIS) at Northeastern University, Boston, MA

ANTHONY THOMAS

FRESHMAN

PHYSICS/MECH. ENG.

- Morehouse/Packard Scholar
- Interested in Applied Optics and Robotics
- 2002 Summer research intern at NSF-CenSSIS at Northeastern University, Boston, MA

THE ALUMNUS
MOREHOUSE COLLEGE MAGAZINE
WINTER 2002
ARTICLE
“AT THE *SPEED* OF LIGHT”

At The *Speed* of Light

Physics Professor Willie Rockward credits the gridiron with helping him see the light. Years ago, as a freshman at Grambling State University, Rockward made the famous Fighting Tiger's football squad as a wing back. During a play, he caught a short pass across the middle of the field for a potential ground-gainer. But a solidly built linebacker had something else in mind. In physics parlance, it was the law of momentum in all its gridiron glory. In locker room talk, young Rockward simply got his bell rung.

"An all-SWAC middle linebacker helped me to decide between a career in football or physics," he says. "That joker hit me so hard, I said, 'Okay, it's physics.'"

Football's loss is ultimately Morehouse College's gain—specifically, the College's emerging research program in physics, which Rockward now spearheads. Housed in the basement of Dansby Hall, inside a warren of offices and laboratories, Rockward presides over a fledgling program called the Diffractive Optics and Lasers Engineering (DOLE) Research Group. His series of experiments revolves around micro-optics fabrication, precision photo reduction, crossed phase elements and laser research. And his work is primed to yield astonishing, revolutionary results.

"Our [research] would assist in the control and distribution of light in freespace for space-to-space and space-to-earth [communications] systems," says Rockward. "Suppose you have relatives, who happen to live on Space Station No 3 or 4, but you like staying here on earth and you want to talk to them via the Internet or even voice. The crossed phase elements research could effectively switch and transmit pulses of light in

such a way that would make this communication scenario possible. Now, you are traveling with the speed of light."

Indeed, the practical applications seem limitless. He continues: "We are talking about optical communications, which is not just fiber optics. You can use it in space systems, micro-optic laser systems and even in some optical laser entertainment stuff, like light shows."

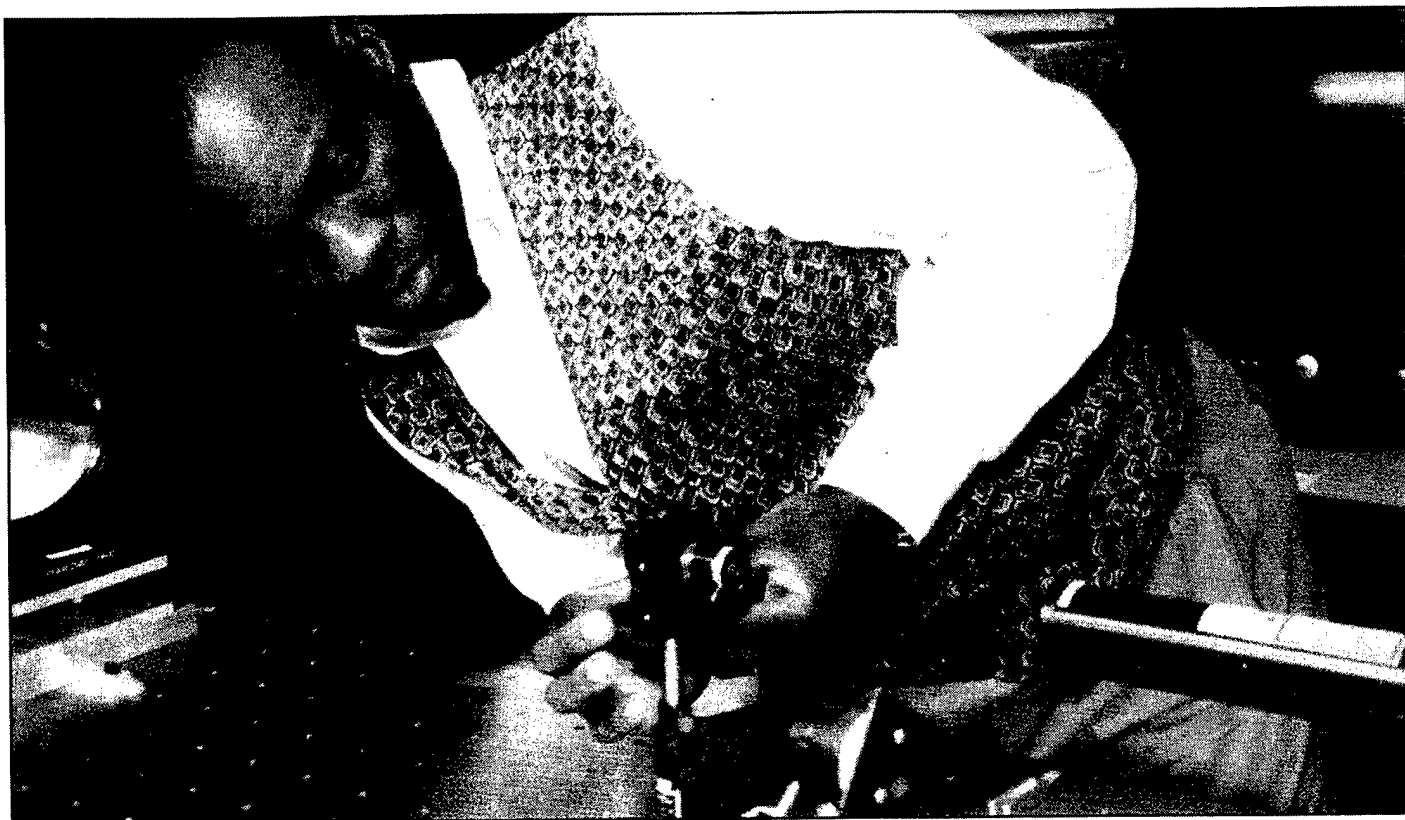
Rockward's research concentrates on harnessing the universe's primal form of energy, light beams, by redirecting them from their purest forms by switching to different phases, speeds and intensities so that they may transfer information and data.

"It is a very new way of doing something old," he says. "Yet, it will open a whole new avenue of modern applications, versus the old way we've done it."

Rockward is well suited for the challenge. With dreams of football scouts giving chase behind him, he concentrated full tilt on physics' immutable laws at Grambling, where the scientific discipline became his major. He pursued a master's degree at SUNY in Albany, New York, and completed his doctoral dissertation at the Georgia Institute of Technology (Georgia Tech), where he crystallized his research in diffractive optics. He took an assignment as a civilian scientist in a military laboratory at Eglin Air Force Base along Florida's panhandle, where he experimented with guidance systems for aerodynamic weapons like smart bombs and laser-guided missiles.

Fully dedicated to teaching and research, Rockward, 36, grew up in the bayou of Louisiana, as an all-state high school running back with a high aptitude for science. He still possesses the physique honed from hours and hours of the calisthenics of

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Dr. Rockward sets up for an experiment using a micro-optic laser.

an ex-jock. He possesses a strong, well-chiseled face. And when he talks, both his eyes and hands become instruments of communication. Today, Rockward, who joined the Morehouse faculty in early 1998, balances his time between the lectern and lab table.

"I love to teach," he says. "And with the research I am doing, it creates a unique synergy."

Rockward lives with his wife and five children near downtown Atlanta. Most Sundays, he can be found worshipping at Divine Unity Missionary Baptist Church in East Point, but not as a parishioner. Rockward is also an ordained minister and pastor.

How does a college professor and ordained minister, a man of science and a man of faith, with his spirituality reconcile his day-to-day research?

In Rockward, they find easy bearing. They are complementary, not competitive, he says. But, at first, that was not the case.

"That has always been my struggle in accepting my ministry," he says. "I come from a history of Baptist preachers. I used to believe the premise that science and religion don't mix, or science and spirituality don't mix. The Lord brought it to my attention that He is the Master Scientist. And we are just trying — as physicists — to understand what He has created. Once I got that understanding I no longer thought that science and religion were against each other, but are a continuum of each other."

Rockward is motivated even further by his role at Morehouse.

He also points to the unique educational environment that is the Morehouse experience. Perhaps, that is exemplified best in his research assistant, Kregg Quarles, a senior from Los Altos, Calif. Quarles, a McNair scholar, has been assisting Rockward in a laser optics experiment. For any undergraduate, this is a major coup.

"Being able to put actual research on my resume is something very special," says Quarles, who upon graduating will participate in the dual-degree program at Georgia Tech. "When you go to physics and engineering conferences, people ask about your research experience. Pretty much until you graduate, you really don't get the chance to do research. But now, I can say I am actually working on some meaningful research."

This is a rare opportunity for an undergrad. Usually, it is a graduate-student's exercise. But this is Morehouse, opening doors and broadening opportunities for its students, regardless of their classification. There are, in fact, a pair of freshmen—Ronald Martin and Anthony Thomas, two Packard scholars—who have recently joined Dr. Rockward's DOLE research group.

"This is something new, which I want to institutionalize at Morehouse," said Rockward. "It is a research mentoring model that allows freshmen to be acclimated to the full research process by their sophomore year, which will open major doors in graduate school. They would begin graduate programs as advanced students with extensive research skills. That is my goal, to establish a good pipeline of such students from Morehouse." *