

The African American Presence in Physics



Editor: Ronald E. Mickens

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A compilation of materials related to an exhibit prepared by the National Society of Black Physicists as part of its contribution to the American Physical Society's Centennial Celebration.

Editor
Ronald E. Mickens
Historian, The National Society of Black Physicists

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Foreword

The National Society of Black Physicists (NSBP) was founded in 1977 by a group of physicists, primarily at Historically Black Colleges and Universities. During the late 1960s and early 1970s, this group became increasingly interested in enhancing and enriching teaching and research activities at those institutions. The group felt that a central organization concerned with the continued presence of black physicists in society would be the best vehicle for accomplishing their goals. The NSBP has as its purpose the promotion of the professional well being of its members within the scientific community and society at large. The Society develops and supports efforts to increase both the numbers and opportunities for African Americans in physics; enhance the awareness of African American contributions to physics research, science policy and management; and provide a non-partisan platform for major issues of scientific and cultural significance to its members. Membership is open to all who affirm the goals of the NSBP. The Society holds an annual meeting, and publishes a newsletter and the proceedings of its annual meeting.

Formed in 1899, the American Physical Society (APS) has dedicated itself to the advancement and diffusion of the knowledge of physics. This knowledge had been a critical ingredient of the major advances of the twentieth century. The APS is the major membership organization for physicists in the United States and a significant force in physics internationally. Over 40,000 scientists worldwide belong to the non-profit scientific and educational Society whose members include the physics leadership in academia, industry, and government laboratories. Membership in APS is open to all those with an interest in and love for physics. APS publishes the leading international scientific journals, organizes major scientific meetings, and provides strong outreach programs in physics education and in international and public affairs.

The American Physical Society celebrates its 100th Anniversary in conjunction with the 1999 Centennial Meeting, March 20-26 in Atlanta, Georgia. Centennial activities begin on Saturday, March 20, with a Nobel Luncheon. This is to be followed by the opening of the Nobel Discoveries Exhibit describing how 100 years of Nobel Prize works and allied fields have improved people's lives. An APS historical exhibit, especially designed to celebrate the Centennial, will tell the story of the birth and growth of the Society, its journals and 100 years of physics, and will also include the Centennial Time-Line Wall Chart, which marks a century of milestones in physics. The official opening of the Centennial Meeting will be a plenary session on March 21, followed by the beginning of the scientific program.

As part of its contribution to the APS Centennial Celebration, the National Society of Black Physicists has produced an exhibit, *The African American Presence in Physics*. This exhibit highlights some of the African Americans who have made both original and significant contributions to the physics of the 20th century in research, science administration and policy formulation and the training of students. The exhibit consists of six panels, each 1.2 meters by 2.3 meters, and provides photographs, summaries of scientific work and brief biographical information on thirty-eight African

American physicists. A tri-fold brochure accompanies the exhibit and serves as both a carry-away souvenir and historical reference source for viewers.

This document is a compilation of materials related to both the NSBP's exhibit and the general themes of the APS Centennial Celebration. The three essays in Part I are based on presentations given at the XXIV Day of Scientific Lectures and 22nd Annual Meeting of the NSBP held March 19-22, 1999, in Atlanta, Georgia. The first essay, "Can History Predict the Future?" is written by Professor Kenneth R. Manning, an eminent historian of science, who is at the Massachusetts Institute of Technology. In the second essay, "The National Society of Black Physicists : Reflections on Its Beginning," James C. Davenport, Professor of physics at Virginia State University, reviews the reasons for the creation of the NSBP, the people significantly involved in its formation and early leadership, and discusses the impact the organization has had on the perception of African Americans within the general physics community. In the last essay, "Where There's a Way There's a Will," Harry Morrison, Professor of physics at the University of California – Berkeley, gives personal reminiscences of his graduate experience at the Catholic University of America.

Part II consists of two articles by Ronald E. Mickens, Professor of Physics at Clark Atlanta University. The first discusses the professional careers of Edward A. Bouchet, the first African American to obtain the doctorate in any subject from an American university, and Elmer S. Imes, a physicist who made fundamental experimental contributions to the spectroscopy of diatomic molecules. The second article is on the scientific and professional activities of Hubert Mack Thaxton. While a fascinating personality and a contributor of important work to several areas of both engineering and scientific research/development, he is unknown to essentially all to the African American scientific community.

Part III gives summaries and photographs of all the individuals featured on the NSBP's display. The final item is a brief listing of books and articles that give historical and recent sources on the lives, contributions and careers of African Americans to science.

Ronald E. Mickens
Atlanta, Georgia
March 1999

Part I

Can History Predict the Future?

by

Kenneth R. Manning
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Few scientists of any color have made breakthrough discoveries. The world cannot expect to produce a Newton or an Einstein more than once every few centuries. But science, as much as it may be based on the fundamental discoveries of one or two great minds, is developed through the day-to-day activities of hundreds of hardworking, most of the time little known men and women. African Americans in this group have a far lower profile than whites. Their achievements have been underplayed, neglected, or totally ignored.

African Americans have made important contributions to science since the eighteenth century, beginning with the work of Benjamin Banneker, an astronomer, architect, mathematician, and engineer who, among other things, helped plan the layout of the city of Washington, DC, in 1790. The activity of African Americans in the fields of invention and technology increased in the nineteenth century, with inventors like Lewis Latimer and Norbert Rillieux, among others, receiving hundreds of patents. Late in the century, 1876 to be exact, the first black Ph.D. in science, Edward Bouchet, received his Ph.D. in physics from Yale University. He was the first black to receive a Ph.D. from an American university and one of the first recipients of any color to earn that degree. Unfortunately, his career did not include research in the sciences; instead, he became and remained a high-school teacher of science. Professional opportunities in science were not open to him, though he had worked beside some of America's top physicists, including the eminent Josiah Williard Gibbs at Yale. His was nonetheless an important accomplishment, a landmark of sorts, though we are unable to discern the full extent of his influence on other blacks who subsequently took up careers in science.

It is not really until the turn of the twentieth century that a handful of blacks began to enter the scientific fields. Among these people come to mind Charles Henry Turner, George Washington Carver, Ernest Everett Just, St. Elmo Brady, Samuel Imes, and a little later, Percy Lavon Julian, Charles Richard Drew, and Julian Lewis. This cohort represents the first group of black scientists who received Ph.D.s from major white universities, pursued science at the research level, and, with the exception of Carver, published in the leading scientific journals of the day. Their professional lives unfolded mainly at black colleges, universities, and other institutions. The only exception, Julian Lewis, a pathologist at the University of Chicago, was able to secure a post at a white university prior to the Second World War.

A few blacks did engage in research at white laboratories and other institutions, such as the Marine Biological Laboratory at Woods Hole, Massachusetts. E. E. Just and Charles Henry Turner are two examples. When they took part in research activities at these laboratories, they often were confronted by the prevailing racial attitudes of the time. Ernest Everett Just's experience at the Marine Biological Laboratory in Woods Hole is a good example, where he and his family were subjected to a hostile environment and racial slurs both in a scientific and non-scientific context. For the most part, however, the careers of African-American scientists were grounded in a black institutional context that rarely had sufficient financial wherewithal to provide essential facilities and meet the other demands of research science.

After World War II, a few white universities began to open up opportunities for blacks on their faculty as well as for blacks seeking graduate training within the departments. Still, the major problems facing blacks pursuing careers in science lingered: lack of access to a high-quality elementary and high-school science preparation, weak undergraduate curricula in black colleges and exclusion from certain opportunities at white colleges, the high cost of graduate training, and outright discrimination in the professional sphere. As an example of the last point, professional meetings of national scientific groups such as the American Association for the Advancement of Science were still being held as late as the mid-1950s in segregated cities like Atlanta and New Orleans, where black scientists who wanted to attend would not be given accommodations at the conference hotels.

Although science purports to be objective and supposedly has imbedded in it a kind of democratic core, scientists are not science, they are not the thing itself -- they are people who live in the world with other people and have many of the same social views and behavior patterns of society at large. Their institutions are hardly any different than institutions of other professions. The pursuit of a scientific education conforms to the structure of that for any other kind of education. A segregated educational system has had the same effect, if not greater, on science in this country with regard to blacks as it has had on other provinces of learning. Even though the 1954 *Brown vs. The Board of Education* landmark decision was intended to eliminate segregation in education, we know that in many parts of the country segregation persisted. Not until the 1964 Civil Rights Bill was a minor milestone in the direction of eliminating segregation achieved. Then, opportunities for African Americans opened up at both the undergraduate and graduate levels at many white colleges and universities, and as a result, careers in the field of science became a firmer reality for many African-American students. Even so, the dual educational structure was so deeply imbedded in the society that many aspects of the segregated system carried over into so-called integrated situations.

Throughout the history of science two striking constants for scientific success have been early education and mentorship. In looking at the lives of black scientists like Charles Drew, Benjamin Banneker, Margaret Lawrence, David Blackwell, and Walter Massey, to name a few, we see the importance of nurturing family, early schooling, and scientific role models. Such optimum conditions are still not common. While integration

of schools has supposedly opened up roots of access, in many circumstances a disguised form of segregation has emerged known as "tracking" -- a system which assigns students to courses within a school system by ability groups. Since it is deeply ingrained in American culture and society that African Americans have inferior minds in general and inferior ones for logical deduction and analysis in particular, it is little wonder that black students end up where they do. When minority students are "tracked," they are often steered away by counselors and teachers, not all white, from the rigorous scientific and mathematical courses requisite for future training in science. The system is more insidious and often more destructive than an openly segregated one.

If we wish to talk about the future and the need to increase the number of blacks in science, then we must address the issues of early education. Indeed, we must focus on the education of blacks all along the educational pipeline, from pre-school through post-graduate work. Science as a discipline is cumulative and training in science often proceeds along well-established lines and routes. It is not easy to overcome a sidestep along the way. So, counseling and mentorship are crucial in steering and encouraging black students to fulfil their goals in this direction. One common aspect of the lives of many black scientists is the thoroughness of their education from beginning to end, and the decisive way they have seized and taken full advantage of every opportunity.

When we talk about African-Americans in science, too frequently we focus on the benefits and gains for the race as a whole and rarely do we take into account the personal sacrifices of the individual. Throughout history, case after case reveal that blacks choosing science as a profession do so at tremendous personal cost. Inevitably a career in science for an African American has required a level of interaction with the white professional community, in a way that a career in medicine, for example, might not. This interaction involves struggle, conflict, tension -- experiences that can both generate creativity and take their toll psychologically and otherwise. We need to address this issue of personal cost and sacrifice, and try to understand it as a challenge -- though not an unmanageable one -- for African Americans joining the professional ranks of science.

I have been working for the last eight years on a project, "Quality Education for Minorities," which is currently based in Washington, DC, and which has as its main goal an increase in the number of black and other minorities in the field of science over the next decade. The project is comprehensive and attempts to deal with the problems of the underrepresentation of blacks and other minorities from a systemic perspective. It seeks to restructure some fundamental aspects of education of blacks in both urban and rural settings.

As we enter the twenty-first century, if this country is to maintain its status as a world power, it will clearly need the talents and resources of all of its citizens, including -- perhaps especially -- those of African Americans. The low percentages of black Ph.D.s in the fields of science and engineering that we now see (around 3%) must increase significantly. Over the last decade, the percentage of African Americans entering the scientific profession has not increased much. The goal of increasing the numbers of producing African-American men and women on the cutting edge of scientific research, can be attained by determination on the part of African Americans to continue the struggle for excellence that we have inherited from people like Imes, Just, Julian, Roger Arliner Young, Ruth Lloyd, Jewel Plummer Cobb, Shirley Jackson, George Langford, and Ronald Mickens. By looking at the

careers of these men and women in African-American history, we can draw inspiration to shape a future of scientific opportunity and achievement for the present generation and for generations yet to come.

The National Society of Black Physicists: Reflections on Its Beginning

By

James C. Davenport
Department of Physics
Virginia State University
Petersburg, VA 23806

Abstract

The National Society of Black Physicists was established on April 28, 1977. The Society was established to develop and support efforts to increase the number and level of participation of blacks in physics. Several activities led to the formulation of the Society. A chronological review of these events and the physicists identified with them is presented.

I wish to express my deep gratitude for the honor of having been invited to speak on the topic, "The National Society of Black Physicists: Reflections on its Beginning" on the occasion of the XXVI Annual Day of Scientific Lectures, the 1999 Annual Meeting of the National Society of Black Physicists (NSBP), and the Centennial Celebration of the American Physical Society. I would like to believe that this invitation is based on my association with the founding of the NSBP, rather than my scholarship in the areas of documentation or writing historical perspectives.

Historically, it is interesting to note that some of the founding members of the National Society of Black Physicists were also instrumental in forming and serving as officers of The American Physical Society's (APS) Committee on Minorities. The APS Committee on Minorities was established by Council action on April 23, 1972. The organizational meeting was held on May 26, 1972. The following African-American physicists served as committee members: Howard Foster (Alabama A&M University), Warren E. Henry (Howard University), Ronald Mickens (Fisk University), Harry Morrison (University of California at Berkeley), and James Young (Massachusetts Institute of Technology). Due to the urgency of the problems that the committee planned to address, Professor Henry, chairman of the committee, took leave from his teaching responsibilities for the summer of 1972 and devoted full time to the work of the American Physical Society's Committee on Minorities in Physics. Ex-officio members of the committee included Phillip M. Morse (Massachusetts Institute of Technology), President of the American Physical Society; W.W. Havens, Jr. (Columbia University), Executive Secretary of the American Physical Society; and J.A. Burton (Bell Telephone Laboratories), Treasurer of the American Physical Society.² Therefore, we celebrate our history in an atmosphere that recognizes the importance of both of these organizations to the scientific and technological welfare of the nation.

The city of Atlanta has special significance in the history of the Society of Black Physicists. The idea of forming a Society was a topic of much discussion at a Day of Scientific Lectures which was held at Morehouse College in 1976. Also, two important activities were held in 1970 and 1975 at Morehouse College, which focused on concerns dealing with minority participation in physics that would later influence the goals of the Society. These activities were: The May 1970 Atlanta conference on *Physics in the Black Colleges*;³ and the May 27-31, 1975 Workshop on the *Pre-Graduate Preparation of Minority Students in Physics*.⁴ The 1970 Atlanta Conference was dedicated to the following physicists: Herman Branson, Frank Coleman, Halson V. Eagleson, Donald Edwards, Warren H. Henry, and Julius H. Taylor. Another important conference which focused on issues that would later be addressed by the NSBP was the *Minority Physics Conference* held at Fermi National Accelerator Laboratory, November 7-8, 1974.

I accepted the invitation to speak secure in the knowledge that there were numerous documents that featured a brief or comprehensive account of the history of the NSBP. The most notable among these documents are: (1) *The Genesis of the National Society of Black Physicists*, by Ronald E. Mickens, Distinguished Fuller E. Calloway Professor of Physics at Clark Atlanta University, Atlanta, Georgia, from which I made extensive use, and a *Brief History of the National Society of Black Physicists* prepared by Dr. Sekazi Mtingwa at North Carolina A&T State University. In this time that has been allotted me, I shall review with you some of the events and activities that led to the establishment of the National Society of Black Physicists. I shall also speak briefly about some of the people who were involved in these activities.

The decade of the '70s was a period in which numerous organizations were established to address the lack of participation of minorities in science and strategies for addressing this deficiency. As mentioned earlier, the APS established a Committee on Minorities in 1972, and the American Association for the Advancement of Science Office of Opportunities in Science was established in 1973 to promote increased participation in science by women and people of minority races and ethnic groups,⁵ and of course the NSBP. Several other discipline-specific organizations in the sciences which dealt with the lack of participation in science by women and minorities were also established.

Perhaps the most significant event that would later lead to the establishment of the NSBP took place on the Fisk University campus in Nashville, Tennessee on December 9, 1972. This event was the result of informal discussion between Ronald Mickens and James Young on the need and importance of honoring senior physicists in the black college community who had mentored several generations of students who went on to achieve doctorates in physics. These discussions began as early as 1968 at the Center for Theoretical Physics at Massachusetts Institute of Technology (MIT) where Mickens was a National Science Foundation Postdoctoral Fellow and Young was on leave from Los Alamos National Laboratory, soon to become Professor of Physics at MIT. Mickens later joined the physics faculty at Fisk. In early 1972, Mickens and Young decided to organize

a gathering to honor three senior black physicists. Those individuals were Halson V. Eagleson (Howard University), Donald Edwards (North Carolina A&T College), and John M. Hunter (Virginia State College). These individuals were well known in the black college community, were considered excellent teachers, and had trained large numbers of students who earned advanced degrees in physics. Fisk University, which had a long and impressive tradition in both physics education and research, was selected as the site for hosting the gathering. Also, the prime organizer and planner for the event, Ronald Mickens, was on the Fisk University faculty.⁶

Joseph J. Johnson, III (Southern University) and Harry Morrison (on leave at Howard University from the University of California-Berkeley) were invited by Mickens and Young to serve on what was referred to as an Awards Committee.⁶

A roster of blacks in physics compiled by Howard Foster (over a period of several years) made it easy for the Awards Committee to contact potential attendees. After considerable planning, the First National Physics Award Ceremony and Dinner was held on December 9, 1972. In recognition of their distinguished service and outstanding contribution to society, each honoree was presented a plaque and a certified check for \$250.00.⁶ This impressive ceremony was attended by more than 50 African-American physicists.

It is significant to note that Eagleson and Hunter were awarded Distinguished Service Citations by the American Association of Physics Teachers (AAPT) on February 4, 1974, in Chicago, Illinois. The AAPT awarded seven citations in 1974 and two of the recipients were African-American physicists who were honored at The First Annual Award Ceremony and Dinner in 1972.⁷

The accomplishments of Eagleson, Edwards, and Hunter are impressive and inspiring and worthy of mentioning here. I shall begin with John McNeile Hunter, whom I replaced at Virginia State University. Born in Woodville, Texas, he did as much as any single individual in America to add physics to the curriculum of black students and to add black students to the professional rosters of physics. He received the S.B. in EE from MIT and an M.S. and Ph.D. in Physics from Cornell University. Hunter was the third black physicist to receive the Ph.D in the United States.⁸ While coming to Virginia State University in 1925 as a teacher of electrical wiring and operator of the power plant, by the time of his retirement in 1958, Hunter had served as professor of Physics and chairperson of the department, Director of the Division of Graduate Studies and Research, and Dean of the College. For several years he performed these administrative duties simultaneously. At the time of his retirement he had taught more than 4,000 students. Sixty-five of these students were physics majors. In 1973, ten of his students had received doctorates in physics. Hunter's success as a teacher, mentor, and role model is reflected in the accomplishments of his students. For example, his first student to earn a bachelor of science degree in physics was Charles Townes. The degree was awarded in 1935. Townes earned a Ph.D. in physics from Pennsylvania State University. He later attended medical school and received an M.D. degree.

Another one of Hunter's students, Herman Branson, who received his bachelor of science degree in 1936, earned a Ph.D. in physics three years later (1939) at the University of Cincinnati. Two of Hunter's students, Rutherford Adkins and Herman Branson, became college presidents. James Herman Stith, also one of Hunter's students, was the first African-American to be awarded tenure at the United States Military Academy at West Point. Stith is also the first African-American to serve as president of the AAPT. Currently, he serves as the

Director of Physics Programs at the American Institute of Physics and is also the President of the National Society of Black Physicists.

Halsen V. Eagleson's teaching career goes back to 1927, when he joined Morehouse College after graduation from Indiana University. Over the next thirteen years, he brought sound physics training to Morehouse and Clark College students, gave scientific leadership to those institutions, and completed both the master's and doctoral degrees at Indiana University. Eagleson was the fourth African-American to receive a doctorate in physics in the United States.⁸ Moving to the faculty of Howard University in 1947, he continued a leadership role in undergraduate education, while also training graduate students and carrying out research in acoustics. Additionally, he served in the Visiting Scientists Program of the American Institute of Physics and contributed to National Science Foundation (NSF) Summer Institutes at ten different southern institutions. In the early seventies, Eagleson served as President of the National Institute of Science. At that time, this organization was the largest black scientific organization in the country. I was indeed fortunate to have had Halsen Eagleson as one of my teachers and mentors.

Donald Edwards received his doctorate from the University of Pittsburgh in X-Ray Crystallography. Edwards was the founding chair of the department of physics at North Carolina A&T State University.⁹ Edward's dedication and commitment to the education of black students in the field of physics and the other sciences is indeed impressive. Several of his students earned Ph.D.'s in physics. Ronald McNair, whose name is familiar to all and who died on the space shuttle, Challenger, was one of Edwards' students who earned a degree in physics at A&T, as well as a doctorate in physics from Massachusetts Institute of Technology.

These individuals were pioneers who had to create their own roles - often laboring under inadequate working conditions and lacking basic equipment. Nevertheless, they were consistently productive in the roles they created. These brave souls had to follow a different path from their counterparts in the majority institutions, and they channeled their energies into sharing their zest and enthusiasm for learning with their students - serving as role models and mentors - providing leadership and guidance - as well as building self-esteem and instilling in their students the knowledge that the world was their oyster and that they were capable of reaching the highest heights. As Robert Browning said, "Ah but a man's reach exceeds his grasp, or what's a Heaven for?"

They shaped and carefully molded these young men and women and prepared them for success. They exemplified the true meaning of success -- not in what they acquired -- but in what they gave. These are men who succeeded, not because they were destined to, but

because they were determined to. Therefore, they richly deserved the honor and recognition that they were given at the First National Physics Award Ceremony and Dinner at Fisk University in 1972. Incidentally, in 1973, Eagleson, Edwards, and Hunter were credited with having taught over 90% of the black physicists in this country.

The Second National Physics Award Ceremony was held at Howard University on May 1, 1975. The planning committee for this ceremony consisted of Anna Coble, Arthur Thorpe, and Ronald Mckens. The committee decided that the Awards Dinner concept would be expanded and would be preceded by a full day of formal scientific

lectures. The speakers who presented lectures on this occasion were: Walter Massey, William Jackson, William Lester, Ernest Coleman, James Young, and Warren Henry. The three physicists who were honored were: Herman Branson, Warren Henry, and James Lawson. Following the format of the First Award Ceremony, each of the honorees was presented a plaque and a certified check for \$250.00.⁶

On April 1, 1976, a Day of Scientific Lectures and Seminars, which was organized by Carl Spight and Ronald Mckens, was held at Morehouse College. Representatives from Morgan State University, who were in attendance, volunteered to host a similar program on their campus in 1977.⁶

In addition to the scientific lectures, much discussion took place on the possibility of establishing a national black physics organization. Some of the individuals who made significant contributions, in the period 1976-77, to the plans for creating the proposed organization were: James Davenport, Warren Henry, Walter Massey, Harry Morrison, Carl Spight, and James Young.

The Society was inaugurated on April 28, 1977, at Morgan State University, Baltimore, Maryland, with interim structures and officers. Walter Massey served as president of the Society and James Davenport served as treasurer. A general statement of purpose was also formulated at this meeting - the purpose being to promote the professional well being of black physicists within the scientific community and within society at large, and to develop and support efforts to increase the opportunities for, and numbers of, blacks in physics. It was made clear at the April 28, 1977 meeting that the Society would not conflict with either the goals or the mission of the APS or the AAPT, or any of the other mainstream professional organizations, nor was it established to supplement any of them.⁶

The Fifth Annual Day of Scientific Lectures and the first business meeting of the Society of Black Physicists was held on March 31, 1978 at Morehouse College, Atlanta, Georgia. The Society elected its first full-time officers. They were: Carl Spight (Morehouse College) president, Walter Massey (Brown University) treasurer, and James Davenport (Virginia State College) executive member.

The executive committee consisted of the three elected officers and was assigned several short-term activities. Included among them were the drafting of a formal statement of purpose and Bylaws of the Society; establishing liaisons with the Minorities Committee of the AAPT and APS; initiating a Society "newsletter"; continuing the Annual Day of Scientific Lectures and Dinner; and continuing the compilation of the roster of black physicists under the direct supervision of Ronald Mickens.⁶

Over the years, questions have arisen regarding the numbering of the Society's annual meetings and the Day of Scientific Lectures. According to Mickens, it was believed by some members of the Society that having an organization with a history would strengthen its case for securing funds to support its projects. Therefore, the First Awards Ceremony and Dinner held at Fisk University in 1973 is referred to as the First Day of Scientific Lectures and the ceremony at Howard, the Second Day of Scientific Lectures. Following this numbering scheme, the meetings at Morehouse (1976), Morgan (1977) and Morehouse (1978), would be the third, fourth, and fifth Day of Scientific Lectures. The second meeting of the Society of Black Physicists was held at Knoxville College on April 26-27, 1979, along with the Sixth Annual Day of Scientific Lectures.⁶

Also according to Mickens, the original name of the organization was the Society of Black Physicists. The name was later changed to the National Society of Black Physicists. This change was made to reflect the Society's stated interest in becoming involved with other national organizations with similar goals and objectives.

The history of the Society is rich and inspiring. As a Society we are obligated to keep it updated and disseminated so that it can be used to accomplish the following:

- help fill the information gap that exists regarding the contributions of African-American scientists in America;
- inspire minority students to pursue careers in science;
- help young scientists and students understand the past and develop a vision for the future; and
- promote historical consciousness and awareness of the accomplishments and contributions of African-American scientists.

Ronald E. Mickens, Distinguished Fuller E. Calloway Professor at Clark Atlanta University, has written his own excellent chronology of the formation of the NSBP, based on his personal records/documents and the first two newsletters of the Society of Black Physicists. Through this organization, we have formed an alliance that has made our existence and that of our predecessors viable. We now have a PRESENCE and a VOICE - and we are obligated to use it if we are to accomplish our goals. A goal is a dream with a deadline, and the history of the Physics Departments at which the scholars we honored in 1973 toiled, is still unchronicled. It is largely an oral history. Who will write the complete history? When will it be written? What is the status of the vision we had in the 1970s? Are our accomplishments congruent with our expectations and dreams of those of our predecessors? WHERE DO WE GO FROM HERE?

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Where There's a Way There's a Will

By

Harry L. Morrison
Professor of Physics
University of California, Berkeley
Berkeley, California 94720

It is difficult to recall the enormous extent of racial segregation that pervaded Washington, D.C. and its surroundings during the '40s and '50s. I was a product of a totally segregated school system, having been sent from Virginia to division 10-13 of the Washington high school system. This was the collection of black high schools in the District of Columbia. The white high schools were grouped in division 1-9. New school equipment and books were introduced in division 1-9 and after degradation through use were filtered down into the black system. It was one of the perverse ironies of this system that as a consequence of the total racial discrimination in employment, our teachers in 10-13 were clearly the best in the city, having no option but to teach at the high school level. Their preparation included graduate work at many of the country's finest universities. The standards they imposed on the high school student body were at the highest level. The opportunity for comparable college education was vastly restricted.

I learned about the Catholic University of America (CUA) from a high school classmate. He told me over lunch that CUA was the only predominately white university south of the Mason-Dixon Line that was integrated. This evidently was the case throughout this century. Students of color in the D.C. area were denied admission to colleges and universities such as Georgetown, George Washington, American, Maryland, Johns Hopkins and Virginia. I was a resident of Virginia and acquainted with the state practice of paying black students to leave and pursue college elsewhere. We were not welcome in Charlottesville.

Out of curiosity, I visited the CUA campus in the spring of the year I graduated from high school. I had never seen an integrated environment before. Inadvertently, on that Saturday morning, I bumped into my high school homeroom teacher. He was there looking into the summer school offerings. Learning that I had no plans for college, Mr. Laurence T. Burwell obtained application forms from the university on the spot. He filled them out as he questioned me and then ordered me to sign them. A month later, I learned that I had been admitted to the freshman class. I shall forever be in his debt.

The period between WWII and Korea was a turning point in the science departments at CUA. Strong students were coming to the university under the G.I. Bill. The surrounding government laboratories were expanding quality research programs. Mutual interactions were developing between these institutions. This attracted into the D.C. area a number of scientists who had fled Europe during the '20s and '30s. Among

these were Edward Teller, George Gamov of George Washington University and Karl F. Herzfeld of Catholic University.

Physics at CUA was personified by Karl Herzfeld. During the period after WWII, Herzfeld was a professor of theoretical physics at the University of Munich. There, he taught courses and seminars in statistical physics and atomic physics. Together with Arnold Sommerfeld, the program theoretical physics was constituted. It was during this period that a young graduate student distinguished himself in theoretical physics and particularly in the atomic physics seminars that were given by Herzfeld. In addition Herzfeld served on his oral examination committee. This student was Werner Heisenberg. Heisenberg's father was also a professor at Munich in the field of Greek philology and classics.

Herzfeld was among the initial group of physicists to apply the new quantum theory to problems in molecular and chemical physics. Leaving Europe in 1896, Herzfeld was offered the chairmanship of the physics department at Johns Hopkins University. There, he collaborated with F.D. Rice of the chemistry department on reaction rates theory. Herzfeld was largely responsible for the establishment of theoretical physics research at Johns Hopkins. One of Herzfeld's graduate students was John A. Wheeler who worked in the quantum theory of the absorption and scattering of light by helium.

After having built up the exceptional programs in physics and chemistry at Johns Hopkins, in about 1936, Herzfeld and Rice were prevailed upon on religious grounds to come to Catholic University and chair respectively the physics and chemistry departments. This was clearly the beginning of physics at CUA. In the absence of a physics building and the normal facilities, the physics department was essentially Herzfeld.

The '50s marked the evolution of the physics at CUA into a more traditional structure. The department was given its building. As a student in chemistry, I witnessed the involvement of black students in their development. Seeking to modernize the offerings of his program, Herzfeld recruited new faculty in order to enter developing fields such as nuclear, condensed matter, theoretical and experimental particle physics. These faculty included Theodore Litovitz, Virginia Griffing, Joseph Brennan, Paul Meijer and Clyde Cowan.

The first black physics student that I met during this period was Joseph Sanders, who was a product of the D.C. public schools and USC. It was through him that I, an undergraduate, began to take an interest in physics as well as chemistry. Well ahead of Saunders in the graduate program was Rutherford H. Atkins. Atkins was a student in theoretical nuclear physics with research under Joseph Brennan. As a research advisor, Brennan accepted only the very best students. William T. Pinkston was a research student of Brennan's during this period.

Atkins completed his dissertation before the physics department got its building and had conducted research in the basement of the chemistry department. He was a great inspiration to the few of us who studied physics and chemistry. He received his Ph.D. degree at the 1955 graduation where I received the B.A. degree. Many years were to pass before I met him in 1972 at that program held at Fisk University. He was Vice President of Fisk then. The term "role model" is inadequate to characterize his influence on those of us at CUA who knew of him during our years together there.

Just as Atkins had come to Catholic University from Virginia seeking graduate training, a flow of black students had come up principally from the South to do graduate work. They were attracted to CUA by the long-standing policy of integration of all its programs. Among these students were those able in chemistry, physics, mathematics and biology. Following Atkins were Pauline Piper, William Jackson, Mylous O'Dell, Roland Higgs, Thurman Spriggs, Howard Foster, Will Hoyt, William Lester, Harriette Gilliam, Arnold Jones, Reba Galloway, George Ferguson and me, Harry Morrison. These were students whose graduate work began during the second half of the '50s at CUA.

In subsequent years, the Catholic University has continued to contribute to the intellectual diversity of our nation.

The History of the National Conference of Black Physics Students

Cynthia R. McIntyre
Co-Founder
MS 3F3
Department of Physics and Astronomy
George Mason University
Fairfax, VA 22030

During the first half of the 1980s, the low number of Black scientists in physics was being discussed between two Black students at Brandeis University studying physics at the undergraduate level. These two students, Cynthia R. McIntyre and Claude Poux, only had knowledge of approximately five Black physicists. They knew that a professional organization for Black Physicists existed, the National Society of Black Physicists, but were unsure of the size of the membership. They posited where would they find the largest number of Black physicists were employed. They concluded that given the number of Historically Black Colleges and Universities (HBCUs) and the probable number of these HBCUs with physics degree programs and/or providing service to other science and engineering areas, the HBCUs probably had predominately Black faculty members in the physics departments.

The conversations progressed and questions concerning why the Black presence in the field are not obvious were discussed. They began to talk about how the small numbers of Black physicists could be increased. McIntyre suggested that one potential model, the National Society of Black Engineers (NSBE), which has been successful in increasing the number of Black engineers, could possibly work. Instead of focusing on attaining BS degrees and then on to work, the focus for physics would be to encourage Black undergraduate physics majors to continue in physics. They both agreed that the NSBE model is the most promising and should be done.

During 1985-1986, Poux (Harvard) and McIntyre (MIT) began to discuss again the NSBE model. Poux took the initiative to begin planning and implementing the first meeting exclusively focused on Black students in physics. The initiative started with six Black graduate students at MIT and Poux from Harvard. The initial meeting was held at MIT in 1986.

Planning intensified to the point where funding was the only barrier to implementing the plan. It was unknown to the graduate students planning the meeting whether MIT's physics department would endorse and support the Conference. MIT's role in the execution of the National Conference of Black Physics Students (NCBPS) was very important for the fledgling activity. The graduate students began to plot strategy for acquiring the needed MIT endorsement and support if the physics department was not forthcoming. The physics grad student decided that if necessary we would go to the Dean of Science, Dean Gene Brown, and ask for support. If the Dean was not enthusiastic, they decided, they would go to the Provost, Dr. John Deutsch, to obtain support.

An appointment was made with the Head of the Department of Physics at MIT, Professor Jerome Friedman, to present the case for authorization and support. The graduate students were stunned when Professor Friedman immediately agreed to support and gave a strong sanction for the meeting. He was so enthusiastic that he provided his staff to help implement the meeting and called the Dean of Science immediately asking for his financial support. Ms. Catherine Ormond, Administrative Officer of the Department of Physics, was critical to financially managing and administering the National Conference of Black Physics Students.

Up to this point, Claude Poux of Harvard had been in charge of planning and implementing the Conference. However, as developments continued and the level of commitment from MIT students increased, the physics department at MIT began to explore who among the MIT students would be willing to lead the NCBPS initiative. This request from MIT was not totally unexpected. Discussions went forward with the senior Black graduate students in physics. Several were close to completing doctoral studies and opted not to lead the activity. Cynthia McIntyre had recently been admitted to doctoral candidacy and agreed to lead the effort.

The first meeting of the NCBPS was held in February 1987 at MIT. Thirty-two students primarily from the New England region and one from the University of California, Los Angeles, Ronald Williams, attended the first meeting. The first keynote speaker was Professor Steven McGuire, Department of Physics, Alabama A & M University.

The second meeting of NCBPS was held at MIT in February 1988. Sixty-four students attended the meeting and two students, one from UCLA and one from Stanford University, Timothy L. Childs, provided the West Coast representation at the meeting. The second keynote speaker was Professor Walter Massey, V.P. for Research, University of Chicago and AAAS President.

Subsequent meetings were held at

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|---------------------------------------|------|
| Howard University | 1989 |
| Southern University | 1990 |
| Hampton University | 1991 |
| Stanford University | 1992 |
| Michigan State University | 1993 |
| Georgia Institute of Technology | 1994 |
| American Physical Society | 1995 |
| Fisk University | 1996 |
| Massachusetts Institute of Technology | 1997 |
| University of Kentucky, Lexington | 1998 |
| University of California, Berkeley | 1999 |

The largest number of attendants to NCBPS, ~320, occurred at the 1994 meeting at Georgia Tech. Prior and subsequent to this meeting, the number of students attending NCBPS has ranged between 100 and 220. The majority of undergraduate students attending NCBPS are from HBCUs. In 1990 and 1998, NCBPS was held concurrently with the National Society of Black Physicists at Southern University and University of Kentucky, respectively.

Over the existence of NCBPS, several institutions have seen revitalization of the number of Black graduate students into their physics departments. These institutions are Georgia Institute of Technology, Michigan State University, and MIT. These universities and others have recruited at NCBPS meetings and along with other recruiting methods have achieved a steady state for the number of Black students enrolled in their physics graduate programs.

Most recently, several of the NCBPS graduate students, after taking their Ph.D.s in physics, have joined the professorate at Fisk University, Howard University and Florida A & M University.

Part II

Bouchet and Imes: First Black Physicists

By

Ronald E. Mickens
Callaway Professor
Clark Atlanta University
Atlanta, Georgia 30314

I. Introduction

Perhaps the first black scientist of North America was Benjamin Banneker (1731 – 1806). His contributions to invention, mathematics/astronomy and publishing are well documented.¹ In a real sense, he might be considered the first black physicist. He clearly was, by the standards of his time, an “American Scientist” whose ultimate greatness was limited by the situation created by the color of his skin.

It took more than a century, after the work of Banneker, to produce the first black with a doctorate degree in the United States of America.^{2,3} This person was Edward Bouchet (1852-1918). He obtained his Ph.D. from Yale University in 1876 with an experimental dissertation: “Measuring Refractive Indices.”

The second black to earn the doctorate in physics was Elmer Imes (1883-1941). His research activities were in pioneering efforts in the new area of infra-red spectroscopy.

In this essay, I shall briefly present some of the experiences and contributions of these “first black physicists.”

Before proceeding with the discussion, I should acknowledge that there were others, during the period 1876-1918 who attempted to initiate careers in physics/mathematics. For a number of reasons they failed in their quest to become scientists. One was Kelly Miller (1863-1939) who obtained a B.A. degree from Howard University in 1886. He entered Johns Hopkins University in 1887, studying mathematics, physics and astronomy.⁴ At the university, his sponsor and advisor was Simon Newcomb. After essentially a year of studies, he decided, because of the climate of the country regarding “Negroes,” his best contribution would be in the areas of civil rights. He returned to Howard University and became a nationally syndicated columnist. He was also a very active member of the American Negro Academy.⁵

A second person was Robert Tecumtha Browne (c. 1870 –1935) who lived most of his life in New York City. He was an author, translator and (c. 1919) President, Brooklyn Negro Library Association. Just after the first experimental confirmation of Einstein's general theory of relativity, Browne published a book,⁶ *The Mystery of Space*. The book is a wide-ranging discussion on the "metaphysics of space." At the 24th Annual Meeting of the American Negro Academy (held in December 1920), he delivered a paper on "Einstein's Theory of Relativity."

A return to the 19th century will allow a better understanding of the general set of attitudes facing "Negroes" during this period. Selected passages from the recent book⁷ of Livingstone on Nathaniel Southgate Shaler is illustrative of the views of many Americans during this time. (Shaler was "... one of the great men among the intellectual forebears of American geography." He was born in 1841 and died in 1906. During the last forty-some years of his life, he was a professor at Harvard University.)

...Shaler concluded that the whole Teutonic branch of the Aryan race was particularly equipped... to benefit from the qualities of the New World ... America, in short, was only suitable for the Teutons ...

...Shaler believed that the black race constituted a distinct human species, 'a lower variety of man'...

... black progress was conditional on the imitation of a superior culture ...¹⁰

From Bruce's *The Launching of Modern American Science 1846-1876*,¹¹ we learn that

The inborn proclivity, the temperament, the awakening,
And the rationale were not enough to ensure a career in science.

Opportunity and means were also essential. Yet American society in the antebellum era denied that opportunity to millions of its members, whatever their talents and yearnings, on the irrational grounds of race and sex.

Enslavement absolutely barred most American blacks from science. Among the free black minority, most were excluded from public schools and almost all from higher education – by then more important to a scientific career than it had been for the eighteenth century black mathematician and astronomer Benjamin Banneker. Even if a black had somehow acquired a sound scientific education, race prejudice – not only among Southerners but also northerners such as Henry, Bache, Peirce and Agassiz – would surely have blocked him or her from a career or even a hearing in

science. A few blacks managed to break away from slavery and rise above slavery and rise above prejudice, but the extraordinary gifted among them, like Frederick Douglass, quite rightly gave themselves to the growing fight against slavery. So no black American in that era made a name for himself in science.

With all that said, blacks tried and did achieve education. Why was this thought to be so important? Essentially, the following passage provides the answers to the question:

All of the clergy ... whether connected with black or predominantly white churches, possessed a strong, religiously grounded belief in the role of educated black leadership as the essential force in the struggle of black Americans for social justice.¹²

II. Edward A. Bouchet¹³

Bouchet was born on September 15, 1852 at 42 Bradley Street in New Haven, Connecticut, to William and Susan Bouchet.

His mother, a native of Connecticut, was the daughter of Asher and Jane Drake Cooley. She was born in Westport on October 1, 1817. Her death occurred in New Haven on February 11, 1920. William Francis Bouchet was born (?) in New Haven in 1817 and died there in 1885. William and Susan had four children of which Edward Bouchet was the youngest, and only son.

Edward A. Bouchet entered the Artisan Street Colored School for his primary education. From there he completed his secondary education at the Hopkins Grammar School (which still exists). In September 1870, Bouchet began his college work at Yale. For the freshman year, he achieved a grade point average of 3.36; his highest grade of 3.52 in mathematics. His college days were spent in the study of English, French, German, Greek, Latin, Logic and Rhetoric, along with courses in the sciences: astronomy, mechanics, physics and mathematics.

Bouchet graduated from Yale College in June 1874 with a class rank of six and summa cum laude. That September, he enrolled in the graduate program. The graduate work was finished in two years and his dissertation on "Measuring Refractive Indices" was accepted as the final requirement for receiving the Ph.D. in physics in 1876. It is of interest to note that he took experimental physics "under Professor A. W. Wright, Yale '59, calculus with Professor H.A. Newton, Yale '50, and chemistry and mineralogy in the Sheffield Scientific School under Professors Allen, Yale '61 S. and Brush, Yale '52 S."

Because of his outstanding undergraduate academic performance, Bouchet was selected for Phi Beta Kappa. However, the actual induction service did not take place until 1876. Thus, Bouchet became not only the first black American to obtain a doctorate in any area, but, also the first to be inducted into Phi Beta Kappa.

Three months after obtaining his doctorate in physics, Bouchet accepted a position teaching physics and chemistry at the Institute for Colored Youth in Philadelphia. He stayed at this position for twenty-six years, leaving for Sumner High School, St. Louis, Mo., as a teacher of physics and mathematics. After one year he left:

... From November, 1903, until May, 1904, I was business manager for the Provident Hospital, a private institution located in St. Louis, Mo. From May 1904, until March 1905, I was United States Inspector of Customs at the Louisiana Purchase exposition in St. Louis, stationed in Ceylon Court. This appointment was obtained through the good offices of the Honorable Charles F. Joy and other St. Louis friends. In October, 1906, I became director of Academics and the St. Paul Normal and Industrial School, located in Lawrenceville, Va., where I remained until June, 1908, and in September, 1908, I accepted the position of principal of the Lincoln High School at Gallipolis, Ohio.¹³

Bouchet stayed in Gallipolis of four or five years, when arteriosclerosis forced him to resign his position and return to New Haven for rest. In (c.) 1914, he went to Bishop College, Marshall, Texas, but was again forced to return to New Haven for health reasons in 1916. He died there on October 28, 1918.

Bouchet was never “allowed” to engage in research! His life was devoted to teaching and doing good works. On his fifteenth Yale College reunion, he wrote for the class book that¹³

“There is every prospect that teaching will be my life-work.”

Ten years later, for his twenty-fifth reunion, he wrote:

I have endeavored to discharge my duty as a teacher to those coming under my care, and have aimed to be a good citizen, and to exemplify in my life the mottoes of our Alma Mater.

The following are the impressions of one of Bouchet’s former students when he was principal/teacher at Lincoln High School:

... I recall hearing my parents and other members of the black community discuss some of the outstanding characteristics of Dr. Bouchet as follows – that he was a fine Christian gentleman, a consummate scholar, one who seemed very knowledgeable in all areas and yet was extremely modest and a person who set a wonderful example of politeness and graciousness for the community.

At the time Dr. Bouchet was in Gallipolis I was in the elementary grades. When I reached the seventh and eighth grades Dr. Bouchet selected me as the student pianist for the school ... Dr. Bouchet was often in charge of the music for these classes and it was here that I learned how extensive and vital his musical knowledge and leadership were.

I am ... of the opinion that Dr. Bouchet's selection of me to play for the high school music classes while I was still in elementary school pupil was perhaps one of the contributing facts which caused me to continue my education and achieve the Ph.D. in Higher Education.

Certainly it is impossible to assess the far reaching influence of Dr. Bouchet upon the hundreds of persons whose lives he touched.

Bouchet's official Yale University obituary ends with the statements:¹³

Bouchet came among us at the beginning of freshman year with the prestige of having been valedictorian of his class at Hopkins Grammar School and from the beginning to end of the course was one of our high stand men. He was one of the few among us entitled to wear the Phi Beta Kappa Key ... He reflected great credit on his people and demonstrated by his own career their capacity to accomplish worthy things in intellectual fields. In all his association, both in college and in later life, he showed himself the thorough gentleman. The memory of his quiet scholarly life will one remain as an influence for good among the members of his race and many others who were privileged to know him.

Finally, in the preface to a 1979 report on The Status of Black Graduate and Professional Students (at Yale University), Curtis Patton, Professor of Epidemiology at Yale stated:

Preeminent, humane, undaunted by enormous odds, untouched by self pity, Yale and a young man named Bouchet found their resources and goals compatible more than a century ago. History was made. But no tradition was started.

We may never know the specifics of Bouchet's suppression. We have no documents that give clues to his thoughts on his career. We only know that he lived during a period that can only be called terrible for Black people. His challenges must have been magnificent.

II. Elmer S. Imes

The Imes family had strong roots in south-central Pennsylvania. Even in the latter part of the nineteenth century there were "free black ancestry running back several generation. They were rugged farming folk..."¹⁵

Elmer Imes' parents, Benjamin Albert Imes and Elizabeth Wallace, met and married in 1880 at Oberlin, Ohio. Benjamin graduated from Oberlin College in 1877 and two years later obtained his divinity degree from Oberlin Seminary.

In Memphis, Tennessee, on 12 October 1883, Elmer was born. Two other brothers soon followed: Albert Lovejoy and William Lloyd. The latter brother became a prominent theologian and had a very distinguished career.¹⁵

Elmer married Nella Larsen. Their marriage produced no children and they eventually divorced. (As an aside, it should be indicated that Larsen was a rather gifted novelist, having published two books¹⁶ and a number of articles. She was also the first black female creative writer to win a Guggenheim fellowship. This was in 1930.)

Elmer Imes finished Fisk University with a B.A. degree in 1903. For the next nine years he taught physics and mathematics at the Albany Normal Institute (Alabama). In 1913, Imes returned to Fisk, where he completed the requirements for the M.A. degree; he also served as an instructor. In 1915, with his new graduate degree, he enrolled in the Ph.D. physics program at the University of Michigan.

At Michigan, Imes began research under the guidance of Professor Harrison M. Randall.¹⁷

...Returning to Ann Arbor (from Professor Friedrich Paschen's laboratory), he (Randall) continued his work in infrared spectroscopy; meanwhile, he and his students – most notably, E.S. Imes – began to design and construct spectrometers of higher and higher resolving power. In 1919, Randall and Imes published a signal work that opened an entirely new field of research: the study of molecular structure through the use of high resolution infrared spectroscopy. Their work revealed for the first time the detailed spectra of simple-molecule gases, leading to important verification of the emerging quantum theory and providing, for the first time, an accurate measurement of the distances between atoms and a molecule.¹⁸

Imes' dissertation research was published in the *Astrophysical Journal* in 1919.¹⁹ The joint Randall and Imes paper appeared in 1920 in *Physical Review*.²⁰ A brief, but excellent review of Imes' work is given in the book by Ruark and Urey.²¹ The fundamental significance of Imes' research was clearly stated by Professor Earle Plyler:²²

Up until the work of Imes, there was doubt about the universal applicability of the quantum theory to radiation in all parts of the electromagnetic spectrum. Some held that it was useful only for atomic spectra (electronic spectra): some held that it was applicable for all electromagnetic radiation.

Imes' high resolution work on HCl, HBr and HF was the first clear cut experimental verification of the latter hypothesis, namely, that the rotational

energy levels of molecules are quantized as well as the vibrational and electronic levels.

Thus, Imes' work formed a turning point in the scientific thinking, making it clear the quantum theory was not just a novelty, useful in limited fields of physics, but of widespread and general application.

Portions of a letter from Youra Qualls to R.E. Mickens provide an interesting insight into how Imes was viewed by the general (physics) scientific community:²³

I worked for Dr. Imes as secretary in either my junior or my senior year in college ... At the time Dr. Imes was writing a history of physics ... One of the delightful tasks I assumed ... was going through foreign science journals to note reference to the work of 'Imes of the U.S.A.' My French and German were elementary by his standards, but I was able to keep up with this chore reasonable well. I mention it only to say that Dr. Imes was, I believe, far better known abroad than he was in his own country.

To pursue the last sentence ... I will recall an incident occurring several years after my graduation. I was teaching at Langston University ... in the year that Dr. Charles S. Johnson became Fisk's president. On my way to Fisk for the inauguration, I met a Dr. Nielson, Dean of the Graduate School of Science at the University of Oklahoma. ... As Dr. Nielson and I talked, Dr. Imes' name came into the conversation. He told me that had become familiar with the work of "Imes of the U.S.A." during his student days in Denmark but he had never known that Imes was a Negro...

After receiving his Ph.D. from the University of Michigan in 1918, Imes spent the next eleven years working in industry: first at the Burrows Magnetic Equipment Corporation as a research physicist (1918-1926) and then as a research engineer at the Edward A. Everett Company (1926-1929). Both companies were located in New York City.

In 1929 Imes returned to Fisk University as Chair and Professor of Physics. He remained in that position until his death in 1941.²⁴

Imes was very successful as both a teacher and researcher at Fisk. His enthusiasm and energy were contagious. Thus, in 1949, when Fisk started offering graduate degrees in several academic subjects, Imes' research field became one of the most fruitful of these specialties. Since 1949 the Fisk University Molecular Spectroscopy Research laboratory has offered the facilities for training Fisk graduate students at a level such that their research in infrared and Raman spectroscopy, done in collaboration with Fisk faculty, has resulted in the publication in the scientific literature of a steady stream of research papers, now numbering in the hundreds.²⁴

The Fisk University research facility has drawn collaborators, research assistants, students and faculty from all parts of the United States as well as a number of foreign countries, including England, France, Argentina, Brazil, Italy, India and Yugoslavia. Persons who have taken leadership in directing these research programs include, in addition to Dr. Imes, Dr. James R. Lawson, Fisk 1935, Dr. Marie-Louis Josien, the laboratory's director 1949-1953 (now retired as Professor of Chemistry at the University of Paris, France), Dr. Nelson Fuson, the laboratory's director from 1953 to 1968, and Dr. Enrique Silberman, director of the laboratory since 1968.

Since the founding of the Fisk University Molecular Spectroscopy Research Laboratory in 1949, over three thousand scientists have been trained in the various one-week long intensive short courses in infrared and Raman spectroscopy and several other related scientific disciplines.

III. A Final Comment

The lives of Bouchet and Imes stand in stark contrast to each other. While both had the Ph.D., one would lead primarily the life of a master teacher and quiet scholar, the other that of a first-rate researcher. However, both were successful: Bouchet by inspiring hundreds of students to believe in themselves and succeed within the context of the "American Dream." Imes through his fundamental research, the several students who themselves obtained their own doctorates in physics, and the continuation of his work by means of the Fisk University Spectroscopy Research Laboratory.

Imes had a "public" life. His stormy marriage, his social life at Fisk, and the fact that he had "research" students meant that "interesting" stories /myths exist about him.

Bouchet was a loner. No letter or paper of his is known to exist. All of his notebooks, writings and scrapbooks are gone. There are no extant Bouchets who can trace their origins back directly to Edward A. Bouchet, for he never married and, as far as is known, his sister's children had no children themselves. His homes in New Haven have been destroyed and his burial place is unknown.

Yet, Bouchet's memory lives on to haunt us with the possibilities of what can be accomplished by individuals of principle who also love and seek knowledge.

Acknowledgment

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25. Private Communication from Professor Nelson Fuson of Fisk University.

Hubert Mack Thaxton

By

Ronald E. Mickens

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Hubert Mack Thaxton (March 20, 1909- Jan. 3, 1974), mathematician, physicist and engineer was born in Lynchburg, Virginia, the son of Henry Thaxton and Sarah Jamison. Thaxton obtained his first two degrees at Howard University, the B.S. in mathematics, physics, and chemistry in 1931 and the M.S. in mathematics and physics in 1933. He entered the graduate program at the University of Wisconsin and received the M.A. degree in mathematics in 1936. He then switched to physics and took his Ph.D. in 1939 under the noted theoretical nuclear physicist Gregory Breit. In 1941 he married Lydia Richardson of Greensboro, North Carolina; they have two daughters.

After receiving the doctorate, Thaxton found himself in the same situation as other black scientists: employment opportunities were severely limited. He chose to go to the North Carolina Agricultural and Technology College, a state institution for black students in Greensboro, North Carolina. Thaxton was appointed chair and professor of the physics department. After a verbal altercation with the college's president, in the summer of 1944 he moved to Delaware State College in Dover, Delaware, as professor and chair of the mathematics department. After two years there he moved again, becoming professor and chair of mathematics at Walter Hervev College in New York; he remained in this position for about two years. During this period (1939-1947) Thaxton published a number of papers on the theoretical understanding of proton-proton scattering. One paper, "Proton Scattering" (*Physica* 7 [1940]: 122-24), was written with the noted mathematical physicist Arthur Eddington of Cambridge University.

Between 1947 and 1971, Thaxton held a series of jobs in industry. With each successive position he assumed greater managerial responsibility and scientific leadership. These positions were at the Solar Manufacturing Company, New Jersey (1947-1949), research and development of electrical and electronic products; Sperry Gyroscope, Great Neck, Long Island, New York (1949-1950), project engineer in charge of radar systems and radio and TV antenna systems; Sylvania Electric Company, Bayside, Long Island, New York (1950-1952), chief engineer in charge of research and development of color television receivers and transmitters; Balco Research Corporation, Newark, New Jersey (1952-1956), chief engineer in charge of research and development of high-temperature

electrical and electronic components; Astron Corporation, East Newark, New Jersey (1956–1960), chief engineer in charge of research and development of semiconductors and devices; Curtis-Wright Corporation, Paterson, New Jersey (1960–1961), project engineer for the design of special purpose jet aircraft; Engelhard-Hanovia, Newark, New Jersey (1961–1963), chief engineer in charge of the development and manufacture of gaseous discharge lamps and quartz products, and Kollsman Instrument Company, Elmshurst, New York (1963–1971); director of the digital computer facility. Much of his research and development work was classified; however, Thaxton continued to publish in scientific journals, including *Physical Review*, *Physica*, *Journal of Applied Physics* and *Journal of the Acoustical Society of America*.

Throughout his career, Thaxton worked with a number of mathematicians and scientists of international renown, including the Nobel Prize winners Hans Bethe, Don Kerst, Edward Lawrence, and Eugene Wigner. He participated regularly in a number of scientific organizations, notably the American Physical Society, American Mathematical Society, and American Association for the Advancement of Science. Thaxton was very active in a variety of community clubs and organizations, particularly those concerned with the education of black youth. He was president of the Harlem Engineering Corporation, Three R Schools Incorporated, and the Harlem Political Club and was director of the Sloan Foundation Computer-Space Science Center in Harlem, New York.

Thaxton was considered a scientist of great talent. Although few public documents exist that give explicitly the views of his colleagues on his scientific work, it is clear from the range of positions he held and from his many publications that he was held in high regard.

Thaxton maintained a long, but tenuous relationship with the City College of New York. He taught mathematics in the evening session, beginning in 1946. In 1971 he was appointed a full-time member of the mathematics department faculty; however, his application for tenure was later denied and a protracted legal battle ensued. Despite winning two court battles ordering the CCNY faculty to give him tenure, he died deeply disappointed in New York City.

Part III

Researchers

While all the physicists featured here have done meaningful research, these have made their primary contribution through study, investigation and exploration of the physical universe. Their work has added significantly to the body of scientific knowledge available to those who have come and will come after them.

Edward A. Bouchet
1852-1918



An eminent scholar and teacher, Edward Bouchet was the first black student to receive a Ph.D. from an American university. Yale University awarded the degree in 1876. The title of his dissertation was "Measuring Refractive Indices." Bouchet, in fact, was the first black graduate of Yale, where he also received his undergraduate degree and another first: He was the first black elected to Phi Beta Kappa. Bouchet was recruited to the Institute for Colored Youth in Philadelphia to establish a high quality science program there. He was associated with the Institute for 26 years, during which he lectured extensively in the community. Many of his students went on to assume productive positions in business and professional life. While he was in Philadelphia, Bouchet was an active member of The Franklin Institute, a foundation chartered in 1824 to promote the mechanical arts.

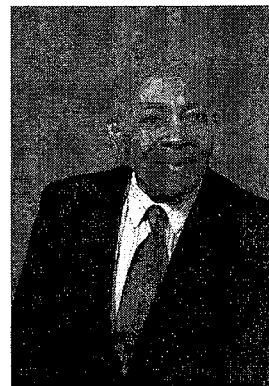
Elmer S. Imes
1883-1941



Elmer Imes made enormous contributions to the world of physics through his teaching, but it is his research for which he is best known. As he pursued a doctorate degree at the University of Michigan, Imes investigated the infrared spectrum of several diatomic molecules: HCl , HBr and HF . The doctorate dissertation he published based on this work had a major impact on molecular physics. In the two decades after the work was published it was cited intensively in research papers and reviews on the rotational-vibrational spectra of diatomic molecules. Discussions of his work and his precision spectrum of HCl would soon be incorporated into the standard textbooks on modern physics. Imes' experimental results also provided the first spectroscopic evidence for the existence of nuclear isotopics.

For a 10-year period, starting in 1918, Dr. Imes lived in and around New York City, where he worked as an engineer and applied physicist. His work resulted in four patents, each in the general area of measuring the properties of magnetic materials and the construction of instruments to conduct such tests. From 1930, until his death in 1941, Dr. Imes chaired the physics department at Fisk University, the institution that had awarded him his bachelor's degree in 1903.

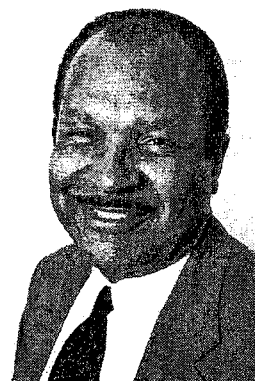
Warren E. Henry
1909 –



Warren Henry worked nearly seven decades in the field of magnetism and superconductivity. His scientific work has received both national and international recognition. Dr. Henry's early background, education, research training and teaching were highly important in preparing him to work on magnetic problems. His demonstration of the proof of non-interacting paramagnetic ions is a significant contribution and is included in many textbooks. Students often are first introduced to Dr. Henry's work in courses on solid state physics or material science, where his research is quoted extensively.

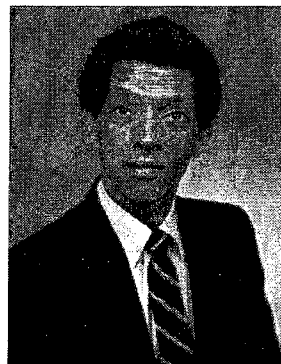
Of equal importance is his contribution as a teacher, mentor and inspiration to students for more than half a century. His distinguished and diverse career includes three years as principal of Escambia County Training School in Alabama, teaching physics at Morehouse College and Spelman College, research as a member of the MIT Radiation Laboratory, research at the U. S. Naval Research Laboratory and a position at Lockheed Missiles and Space Co. A graduate of Tuskegee Institute, Dr. Henry holds a master's degree from Atlanta University and a Ph.D. from the University of Chicago. He has done postdoctoral work at the Massachusetts Institute of Technology, the University of Chicago, the University of Maryland and Catholic University of America.

William A. Lester
1937-



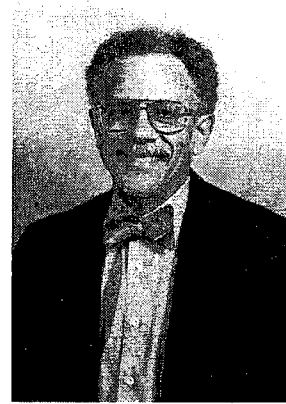
William Lester's distinguished career includes work at the IBM Research Laboratory in San Jose, California, where among other positions, he was manager of the Molecular Interactions Group. As director of the National Resource for Computation in Chemistry, he organized and directed the nation's first unified effort in chemistry. His focus there was on improving efforts of computational chemists by making available information on new methodologies, development of computational algorithms and related software, as well as research in chemistry that uses computational methods.

Since 1981, Dr. Lester has been associated with the University of California at Berkeley, where he is now a chemistry professor. He also is a Senior Fellow for Science and Engineering and Assistant to the Director for Human Resources Development. Dr. Lester's research interests include electronic structure and collision dynamics of molecular systems. His research is theoretical/computational and is characterized by the development of accurate theory and computation. His early work on the use of correlated gaussian basis functions for the calculation of properties of atomic and molecular systems continues to be cited. He brought similar attention to high accuracy to molecular collision processes – both for interaction potentials and scattering cross sections and rates. In addition to the computation of single potential energy surfaces, he was a pioneer in applying accurate computational approaches to coupling matrix elements for atom-molecule collisions. He was one of the first researchers to solve the nuclear Schroedinger equation for cross sections and rate constants for atom-molecule energy transfer using a full quantum treatment. More recently, his research has returned to molecular electronic structure. He is a major developer of the quantum Monte Carlo method for the calculation of energies and other properties of molecular systems.



George R. Carruthers
1939 -

George Carruthers is a senior astrophysicist and head of the ultraviolet measurements group of the space science division, Naval Research Laboratory. There his research specialties include ultraviolet space astronomy and ultraviolet measurements of earth and planetary atmospheres. Among the scientific results obtained from his space flight investigations was the first detection of interstellar molecular hydrogen (1970). He was principal investigator for the Far Ultraviolet Camera/Spectrograph experiment on the Apollo 16 mission (1972), the Far Ultraviolet Cameras experiment on space shuttle mission STS -39 (1991), and the Far Ultraviolet Imaging Spectrograph investigation on STS-63 (1995). Dr. Carruthers has also been active in education and public outreach activities, as a member of the National Society of Black Physicists, the National Technical Association and other organizations. He was technical editor and contributing author of the book, *Careers in Science and Technology* (NASA EP-298, September 1993).



Warren M. Washington
1936-

Warren Washington became one of the first developers of atmospheric computer models in the early 1960s at the National Center for Atmospheric Research in Boulder, Colorado. These computer models use the fundamental laws of physics such as the conservation of mass, momentum and energy. Because these equations are so complex, it is nearly impossible to solve them without a large computer system. In later years, Dr. Washington worked with others to incorporate ocean and sea ice physics as part of a climate model. Such models now involve atmospheric, ocean, sea ice, surface hydrology, and vegetation components. They require massively large computers taking thousands of hours of computer time to simulate a century experiment. Because of concerns about climate change with regard to increased atmospheric greenhouse gases, these models are being used to simulate future changes brought on by man to the earth's environment.

Dr. Washington's book *An Introduction to Three-Dimensional Climate Modeling*, co-authored with Claire Parkinson of NASA, is a standard reference on climate modeling. From 1978 to 1984, he served on the President's National Advisory Committee on Oceans and Atmosphere. In 1995, he was appointed by President Clinton to a six-year term on the National Science Board, which helps oversee the National Science Foundation and advises the Executive Branch and Congress on science-related matters. In 1997, he was awarded the Department of Energy Biological and Environmental Research Program Exceptional Service Award for Atmospheric Sciences in the development and application of advanced coupled atmospheric-ocean general circulation models to study the impacts of anthropogenic activities on future climates.

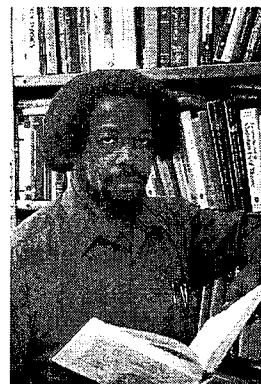
Anthony M. Johnson
1954-



Anthony Johnson is chairperson and distinguished professor in the department of physics at New Jersey Institute of Technology. After receiving his Ph.D. from City College of New York City, Dr. Johnson spent 14 years conducting research at AT&T Bell Laboratories in Holmdel, New Jersey. His research has been in the general area of ultrafast optics and optoelectronics – generation of picosecond and femtosecond optical sources, ultrashort pulse propagation in optical fibers, nonlinear optics, ultrahigh-speed optoelectronic devices and measurement techniques, the physics of ultrafast electronic transport and spectroscopy in crystalline, polycrystalline, and amorphous semiconductors, cw and ultrafast photorefractive effects in semiconductors, optical and optoelectronic properties of III-V and II-VI semiconductor multiple quantum wells, high-speed lightwave systems, and ultrashort pulse generation in semiconductor diode lasers.

He has to his credit nearly 60 refereed publications, two book chapters and four U.S. patents. Dr. Johnson is recipient of the 1996 Edward A. Bouchet Award of the American Physical Society. In 1995 he assumed his current position as Editor-in-Chief of *Optics Letters* after six and a half years as the Ultrafast Optical Phenomena Topical Editor of *Optics Letters*. He served as the 1990 Program co-Chair, 1992 Conference co-chair and 1996 Steering Committee Chair of the Conference on Lasers and Electro-Optics (CLEO '90, '92, '96). Dr. Johnson is a Fellow (1991) member of the Board of Directors (93-96) and Board of Editors (96-98) of the Optical Society of America (OSA); a Charter fellow (1992) and Chair of the Nominations and Screening Committee (92-98) of the National Society of Black Physicists; a Senior Member (1989), member of the board of governors (93-95), and Chair, 1996 William Streifer Scientific Achievement Award Committee of the IEEE Lasers and Electro-Optics Society; a Fellow (1996) of the American Association for the Advancement of Science (AAAS) and of the American Physical Society.

Sylvester James Gates
1950 -



Sylvester Gates' study of the mathematical laws that govern hypothetical forms of energy and matter have paved the way for 21st century exploration of the universe at tiny scales never previously accessible. New forms called "superpartners" may be observed for the first time in the laboratory. Models with superpartners are said to possess the property of "supersymmetry." While at Harvard, Dr. Gates and a collaborator gave the first mathematically rigorous formulation of supergravity theory, and extension of Albert Einstein's "general relativity." He co-authored a book, *Superspace*, that provided the only advanced treatment of supersymmetry for more than a decade. In the 1980s, Dr. Gates worked on structures called "superstrings" and "heterotic-strings," and showed how a 1930s physics concept called "isotopic charge space" applied in four dimensions. Starting in 1996, he formulated a model by introducing superpartners (called "pionini") for the nuclear force. If experiments verify his work, it will predict the existence of a new constant of nature that he named "gamma-ess." Dr. Gates holds two bachelor's degrees and a Ph.D. from the Massachusetts Institute of Technology (MIT). He did post graduate study as a Junior Fellow of the Harvard Society of Fellows and at California Institute of Technology. He has been a faculty member at MIT and is currently John S. Toll Professor of Physics at the University of Maryland.

Administrators

Much scientific advancement has been possible only through large institutions that have the resources to support elaborate, often expensive, projects over long periods of time. These scientists devoted most of their careers to establishing, managing and extending physics programs within universities, government and private laboratories and other such institutions.

Herman R. Branson
1914-1995



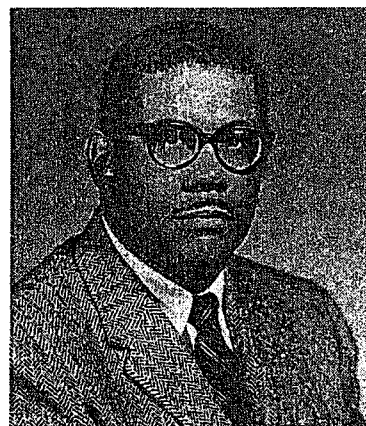
Herman R. Branson was a prolific researcher and writer as well as a prominent college administrator, who produced more than 100 research and other articles on physics, biophysics, black American colleges, and science education. Dr. Branson's most significant accomplishments include co-discovery of the alpha helix, an integral equation treatment of biological systems, physical-chemical studies of sickled red blood cells, electron impact studies on small organic molecules, the introduction of information theory in the study of biological molecules, and the use of radioactive and stable isotopes in transport studies in biology. He wrote extensively on sickled anemic red blood cells. Dr. Branson attended the University of Pittsburgh, and held a Bachelor of Science degree from Virginia State University and a Ph.D. from the University of Cincinnati. He was a member of the Board of Trustees of the Carver Research Foundation at Tuskegee University; a Faculty-Fellow, National Science Foundation, at the University of Hamburg (Germany) and the French Atomic Energy Commission (Saclay); a member of the Council and Chairman of the Finance Committee of the Biophysical Society; and a Commissioner of the Commission on College Physics. During his varied career, Dr. Branson was president of Central State University in Ohio and of Lincoln University in Pennsylvania, chairman of the physics department at Howard University and was elected to the Institute of Medicine.

Robert A. Ellis, Jr.
1924 - 1989



From 1956 until his death in 1989 Robert Ellis was head of experimental projects at the Princeton Plasma Physics Laboratory. He was regarded as a pioneer in modern experimental plasma physics. After receiving his master's degree from Yale, he taught at Tennessee State A. & I. University from which he took a leave of absence to complete his Ph.D. at the University of Iowa. He returned to Tennessee State as a full professor. Taking advantage of a unique opportunity to participate in the new field of plasma physics, Dr. Ellis went to Princeton in 1956 to join Project Matterhorn, a small group working on controlled fusion. He became a key member of the team studying the magnetic confinement and heating of plasmas in stellarators. The project's published papers on the B-1 and B-3 devices were the first to document ohmic heating, anomalous transport across the magnetic field, radio frequency plasma heating at the lower-hybrid frequency, and nonlinear cyclotron harmonic interactions. From 1972 to 1976 Dr. Ellis was group leader for the Adiabatic Toroidal Compressor tokamak at Princeton. He was a member of the Department of Energy's Compact Toroid Coordination Committee. In 1988, he was appointed head of experimental projects at the Princeton Plasma Physics Laboratory, putting him in charge of all non-TFTR experimental work.

James R. Lawson
1915-1996



Following the death of his mentor, Elmer Imes, James Lawson returned to Fisk University, where he had been the first student to receive a degree in physics. Dr. Lawson, who was awarded a Ph.D. from the University of Michigan in 1939, was named chairman of Fisk's physics department in 1942. There he immediately began work to develop a research program in infrared spectroscopy. With the help of former colleagues in the Michigan physics department's instrumental shop, he ordered an infrared spectrophotometer like one like one the department was having built for its own use. By 1948, when the instrument was shipped to Fisk, Lawson had recruited five Fisk physics majors, then seniors, to stay on to do their master's theses in infrared spectroscopy on the new instrument. That was the beginning of the Fisk Infrared Research Laboratory.

In 1950, Lawson, along with Nelson Fuson, began the Fisk Infrared Spectroscopy Institute, which sponsored week-long courses. Also, Fisk graduate students began reading scientific papers at meetings of the American Physical Society and the American Chemical Society, thereby effectively integrating those groups. Dr. Lawson taught at Tennessee State University from 1955 to 1957, when he returned to Fisk. He was named vice president of Fisk in 1966 and president in 1967. In 1975 he left Fisk and went to Washington, D.C. to serve as special assistant to the director of the office of university programs for the Energy Research and Development Administration (forerunner to the Department of Energy) and later as head of NASA's University Affairs Office.

Walter S. McAfee
1914-1995



During World War II, Walter McAfee was a member of the U.S. Army Signal Corp Engineering Laboratories in Belmar, New Jersey. There he distinguished himself in the field of electromagnetism and radar. He was a member of the Project Diana team that was responsible for the first lunar radar echo experiments, performed in 1946. After the war, he continued his education at Cornell University, where he was awarded a Ph.D. in 1949, placing him among the few African Americans at the time to hold a doctorate in theoretical physics. His thesis was on meson production in nuclear collisions. Dr. McAfee returned to the Signal laboratories as part of the nucleonics branch, which was responsible for the development of radiological instrumentation and nuclear weapons diagnostics. His 42 years in government service include time as director of a NATO study on surveillance and target acquisition and the period from 1978 through 1985, when Dr. McAfee served as scientific adviser at the Fort Monmouth U.S. Army Research and Development Command.

Shirley A. Jackson
1946-



Shirley A. Jackson was named chairman of the Nuclear Regulatory Commission in 1995. In this position she is responsible for conducting the administrative, organizational, long-range planning, budgetary and certain personnel functions of the agency. She has ultimate authority over all NRC functions pertaining to emergencies involving NRC licensees. Dr. Jackson is a graduate of the Massachusetts Institute of Technology, where she received both her undergraduate degree and her Ph.D. From 1976 until 1991, she conducted physics research (theoretical, solid state and quantum, and optical) at AT&T Bell Laboratories. Her research principally focused on condensed matter theory – in particular, transition metal dichalcogenides; the electronic and optical properties of semi-magnetic semiconductor strained-layer super lattices.

In 1986, Dr. Jackson was elected a Fellow of the American Physical Society. In 1991, she joined Rutgers University as a professor of physics, and was elected a Fellow of the American Academy of Arts and Sciences. She is the first African-American woman to receive a Ph.D. from MIT, and the first to chair the Nuclear Regulatory Commission. She was inducted into the National Women's Hall of Fame in 1998.

Homer A. Neal
1942-



Homer Neal's principal research area is experimental high-energy physics. He has conducted particle interaction studies in hadron-hadron and electron-positron collisions at laboratories in the United States and abroad. His research group is part of the DZERO collaboration that recently announced the discovery of the top quark. Within that collaboration, he and his group had particular responsibility for designing, implementing, and analyzing data from the Intercryostat Detector. His technical research expertise includes the design of particle detectors, high-speed electronics, image pattern recognition algorithms, event reconstruction and data analysis, and large scale database systems. Dr. Neal is currently director of the ATLAS Project and professor of physics at the University of Michigan. He was vice president for research from 1993 until 1997. In that position he oversaw research programs, policies and infrastructure.

Prior to serving as interim president of the University of Michigan, July 1996 – January 1997, he was chair of the physics department, 1987-1993. Dr. Neal is a Regent of the Smithsonian Institution, and is the Oak Ridge National Laboratory Advisory Board. He is also a member of the MIT Visiting Committee on Sponsored Research, a Fellow of the American Physical Society and a member of the Board of Trustees of the Center for Strategic and International Studies. He has served on the Board of Trustees of the Argonne National Laboratory and the Fermi National Accelerator Laboratory. As a member of the National Science Board, the oversight body for the National Science Foundation, he chaired the committee that produced in 1986 the Board's first comprehensive report on undergraduate science, mathematics and engineering education. He has also served as Chairman of the Physics Advisory Committee of the National Science Foundation. He has delivered testimony on numerous occasions to Congress on matters ranging from the funding of National Laboratories to the state of undergraduate science education.

Walter E. Massey
1938-



Walter E. Massey's contributions to physics have been in three areas: fundamental physics, physics and science education, and public policy. His areas of research have been in the theory of many-body systems with emphasis on quantum liquids and solids, most notably liquid helium 3 and 4 at very low temperatures. Using a correlated basic function approach, he calculated the ground state properties of helium 4, starting with an assumed two-body potential. This method of calculation (in conjunction with C. W. Woo) was later applied to the calculation of low-temperature properties of helium 3. With modifications in the correlated basic function approach, bulk properties of solid helium 3 and 4 were also calculated. The calculations compared favorably with experimental results and led to methods to be used in calculating both ground state and excited state properties of mixtures of helium 3 and helium 4. Dr. Massey's most important work (with H. Maris) was the explanation of the anomalous dispersion of sound in helium 4 at low temperatures. Using a liquid structure function calculated by Dr. Massey, he and Dr. Maris showed how the three-phonon decay process, thought to be unallowed by conservative principles, could, in fact, take place and explain the attenuation of sound in liquid helium 4.

In science education, Dr. Massey originated and led the Inner-City Teachers of Science Program at Brown University in the mid-1970s. This program was designed to attract and educate students to teach science in inner-city schools. As director of Argonne National Laboratory and as director of the National Science Foundation, Dr. Massey was instrumental in developing and generating support for physics and science education programs, relating universities and colleges to schools, and for promoting and enhancing technology transfer from laboratories and universities to the private sector. While at the University of Chicago, he was the founding chairman of the Arch Development Corporation, which was responsible for starting new technology businesses based on research done at Argonne National Laboratory and the University of Chicago. Dr. Massey was a member of the President's Council of Advisors on Science and Technology, 1990-1992. He served as president of the American Association for the Advancement of Science from 1988 to 1989 and was the organization's chairman from 1989 through 1990.

Hattie Carwell
1948-



Hattie Carwell's 25-year career as a health physicist has led to the development of new radiation safety policies at the U.S. Department of Energy facilities in California. She continues to be a leader in the development of a streamline approach to integrating safety systems into research, especially in the areas of high energy and nuclear physics. Carwell has authored numerous papers on the subject. Between 1980 and 1985, she was a key participant and group leader in the development of nuclear safeguards for the International Atomic Energy Agency. She was involved in the development of approaches to handling special nuclear materials at such bulk handling facilities as nuclear fuel fabrication and enrichment facilities in Europe. Carwell's book *Blacks in Science: Astrophysicist to Zoologist* and her booklet *In Pursuit of Excellence* document the physics achievements of African Americans. She continues to conduct studies in this area.

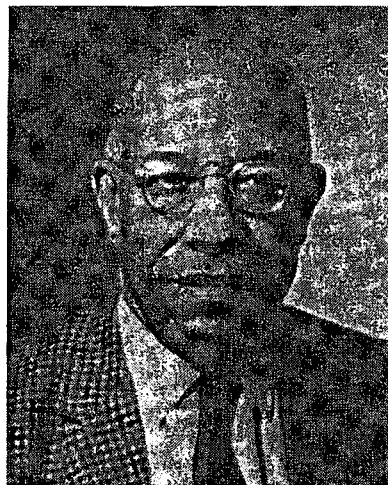
Educators and Mentors

All successful scientists recall teachers who instructed them, encouraged them and inspired them. Year after year, in the classrooms of these dedicated educators the spark is lit that fires new careers in science. Here are but a few of those educators and mentors.

Where Many African American Scientists Came From

Through much of the nation's history the overwhelming majority of black scholars and scientists received their basic education in the institutions now formally designated Historically Black Colleges and Universities. As late as the 1960s, few majority institutions of higher learning admitted more than a small number of black students to their undergraduate programs. Thus, Historically Black Colleges and Universities were charged with the basic preparation of black students who were interested in careers in the sciences. Even today, these institutions play a major role in educating black undergraduates in the sciences and other fields. Among these are Fisk University, Howard University, Virginia State university, Hampton University, Morehouse College and Alabama A&M University.

Halston V. Eagleson
1903-1992



Halston Eagleson began a long and illustrious teaching career in 1927 when he joined the faculty at Morehouse College. For a period of about 13 years, he taught at Morehouse and at adjacent Clark College as he pursued his own graduate work at the University of Indiana, where he earned his Ph.D. Dr. Eagleson joined Howard University in 1947 and taught there until his death. At Howard he taught undergraduate and graduate students and carried out research in acoustics. His introductory physics course at Howard was legendary for generations of students.

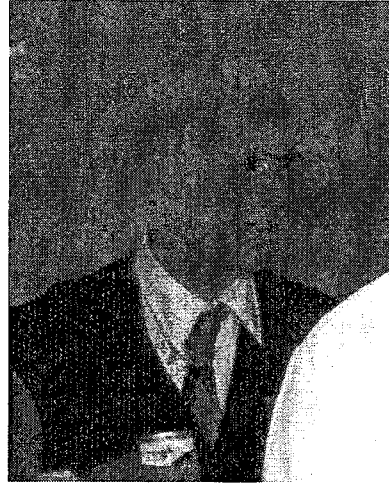
He served in the American Institute of Physics' Visiting Scientists Program and contributed to National Science Foundation Summer Institutes at 10 Southern institutions. In recognition of his lifetime of service to the cause of better education for black students and equal professional opportunities for all students, the American Association of Physics Teachers in 1974 presented Dr. Eagleson a Distinguished Service Citation.

Donald A. Edwards
1905-



Donald A. Edwards is a pioneer in physics education whose major contribution is the establishment of a physics curriculum at North Carolina A & T State University that exceeded national standards. Students completing this course of study have become a part of a new generation of physics teachers and researchers. Among the most prominent was the late astronaut, Dr. Ronald McNair. Dr. Edwards was also one of the first three persons to receive an American Physical Society citation recognizing his contributions to the black physics community. Dr. Edwards holds an undergraduate degree from Talladega College, a master's from the University of Chicago and a Ph.D. from the University of Pittsburgh.

John M. Hunter
1901-1979



John Hunter left his mark on the world of physics through the thousands of students he taught and influenced. Numbered among his students are many physicists, engineers, teachers and a university president. An AAPT Distinguished Service Citation presented to him in 1974 noted that Dr. Hunter did “as much as any single individual in America to add physics to the curriculum of black students and to add black students to the professional rosters of physics.”

Most of Dr. Hunter’s career was spent at Virginia State College, where in 1925 he became a teacher of electrical wiring and operator of the power plant. During his 43 years there he served as Professor of Physics, Director of the Division of Graduate Studies and Research and Dean of the College. While teaching at Virginia State he earned a Ph.D. from Cornell University in 1937. In addition to his work with students at Virginia State, Dr. Hunter did much to help shape the university during his years as part of the faculty. Dr. Hunter was among the first three to be named National Physics Fellows by the Community of Black Physicists.

James C. Davenport
1938 –



James C. Davenport's principal contribution to physics has been in the field of education. With a goal of guiding more students through the attainment of a degree in physics, Dr. Davenport has strongly emphasized teaching and mentoring during his career at Virginia State University. Under his leadership, the research component of Virginia State's physics department has flourished. Dr. Davenport believes that most students who drop out of science programs do so in their freshman year. Thus, he has chosen to teach first courses for physics majors since 1967. From that vantagepoint he is able to structure an environment that nurtures self-confidence, while maintaining rigorous and challenging academic standards. The results have been gratifying, as many of his students have established outstanding academic and professional careers.

He also has excelled in research and has been a vital part of research conducted at the university for NASA, including work in both medium-energy physics and muon spin rotation studies of condensed matter. He also served as co-principal investigator on a program studying radiation damage in solar-cell materials, also with support from NASA. Professor Davenport has an undergraduate degree from Tuskegee Institute and holds a master's degree and a Ph.D. from Howard University.

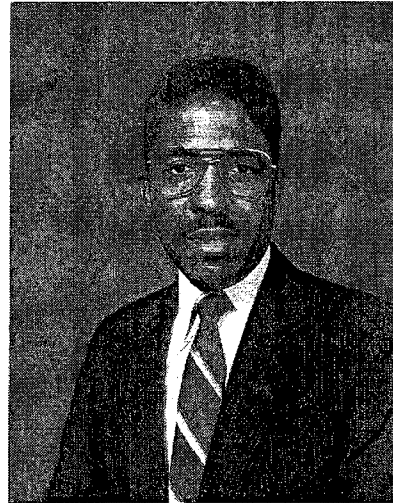
Julius H. Taylor
1914-



Among Julius Taylor's extraordinary accomplishments is the spearheading the establishment of the physics department at Morgan State University. During his tenure at Morgan State Dr. Taylor sent many students on to successful graduate careers, including 13 who earned Ph.D. degrees and many others who earned master's degrees. He is best known for having educated many public School teachers in physics and other sciences, both at Morgan State and in many National Science Foundation-sponsored institutes.

His service to teaching organizations also has been distinguished. He has been a member of the Science Council of the Maryland Academy of Sciences for more than 20 years and has served as its chairman. He has been active with the American Association of Physics Teachers and was awarded their Distinguished Service Citation in recognition of his work as one of Maryland's most outstanding physics teachers. Dr. Taylor's writings have appeared in such publications as *Physics Today*, *the American Journal of Physics*, *Bulletin of the American Physical Society* and *The Physics Teacher*. He has 25 articles in *Grolier's International Encyclopedia*.

James H. Stith
1941-

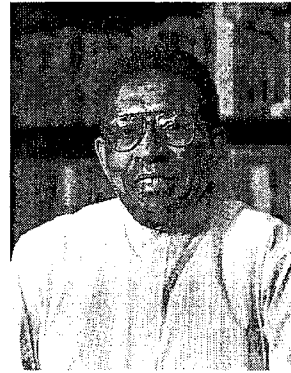


A physics education researcher, James Stith has over his career focused on evaluation, curriculum development and teacher enhancement. He serves on numerous national and international advisory boards. His recent work with the National Research Council has resulted in science standards (K-12) for the nation. The standards document establishes for the first time national guidelines by which exemplary teaching, effective assessment and student knowledge may be measured. He has conducted workshops in Canada, Ghana and Venezuela as well as in the United States. A retired colonel, Dr. Stith spent 21 years on the faculty at West Point, where he was the first African American to receive tenure.

He also has been professor of physics at Ohio State University, visiting associate professor at the U.S. Air Force Academy, visiting professor at the University of Washington and visiting scientist at Lawrence Livermore National Laboratory. While on the faculty at West Point, Dr. Stith developed techniques for writing multiple versions of examinations in a manner that ensured reasonable consistency in difficulty, validity and reliability. He also was a primary designer of the academy's physics department faculty development program and its Faculty Development Plan. He is currently Director of Physics Programs at the American Institute of Physics.

Other Colleagues

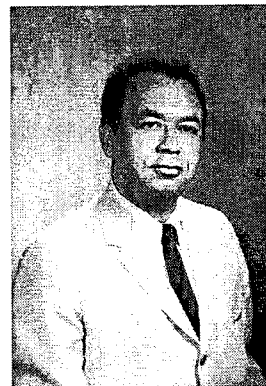
Many of the physicists featured here have made significant contributions to several areas of physics research, scientific administration, and education. This section recognizes others in our community who have had a major impact on the national and international science communities.



Clayton W. Bates, Jr.
1942 -

Clayton Bates developed an x-ray image intensifier tube for use in diagnostic radiology that today is state-of-the art and is in use in hospitals and medical centers throughout the world. The development of this equipment in 1967 while he was working for Varian Associates in Palo Alto won him the Varian Sabbatical Award. At Stanford University from 1972 to 1994, Dr. Bates and graduate students did pioneering work on the optical and electronic properties of photoelectronically active surfaces leading to a fundamental understanding of the relationship between the microstructure and properties of the first such surface to be used in practical systems, the S-1 photocathode, which had been discovered in 1927. One of the early researchers in the area of optical and electronic properties of nanophase metal-semiconductor composite systems, Dr. Bates and his students developed a useful theory for determining the optical behavior of a large number of such systems. In 1997, he established at Howard University the first interdisciplinary graduate program in materials science and engineering at a historically black institution of higher learning.

Robert H. Bragg
1919-



Robert Bragg's major contributions have been in the areas of materials characterization using x-ray diffraction and small angle x-ray scattering, and their use as a tool in studying thermally activated processes in materials. Early in his career, he developed methods of quantitative x-ray diffraction analysis of compounds, e.g., $\text{Ca}(\text{OH})_2$ and $\text{Mg}(\text{OH})_2$ in hydrous silicates.

Dr. Bragg originated the now standard practice of using the data as self calibrating in the quantitative determination of preferred orientation in polycrystalline aggregates, and his work provides clear guidance in the analysis of the diffraction patterns of materials of high transparency to x-rays, e.g. Be, B, and C. His novel studies of the coarsening of the microstructure of glassy carbon using small angle x-ray scattering have provided the accepted value for the activation energy for a-direction vacancy migration in graphite.

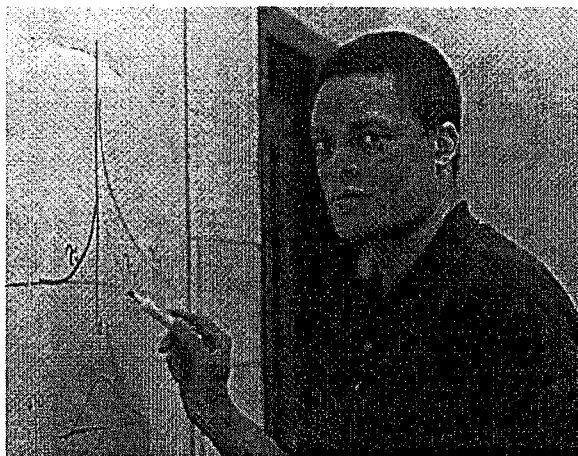
Perhaps his most important work is the recent demonstration that all apparently unordered carbon materials are mixtures of metastable carbon self-interstitial compounds, and his first principles derivation of the equations governing the phase transformations at high temperatures as these materials are converted to graphite.

Roscoe Giles
1949-



After earning a doctorate in particle theory at Stanford in 1975, Roscoe Giles joined the Center for Theoretical Physics at the Massachusetts Institute of Technology. He became an assistant professor of physics at MIT, and remained a research associate there after taking a position at nearby Boston University. Initially interested in theoretical particle physics, Dr. Giles later became more interested in computational physics and computational science. He noted that the crossover was prompted by lattice theory. He was intrigued with how the language of lattice gauge theory and the ideas of solid-state physics – looking at phase transitions and thermodynamic properties – were strongly intermeshed. The first large parallel computer at Boston University enabled him to create computer software to develop “a very high-level language to describe the interactions of the low-level processor and to control it.” Dr. Giles was part of the team that brought Boston University’s Center for Computational Science into being and acquired the CM-2 computer as a university-wide resource. The Center helps researchers use computer applications to address scientific problems.

Larry Gladney
1957-



Larry Gladney's research career has focused on the study of weak interactions of heavy quarks. Starting with his first measurements, at e^+e^- machines, of charmed meson lifetimes in 1983, Dr. Gladney came to the University of Pennsylvania as a postdoctoral student in 1985, and moved on to the CDF experiment to begin studies of bottom hadrons. In 1990, he contributed to the development of the first hardware trigger for finding hadronic decays of the tau lepton at a hadron collider. Later, he had an important role in the first direct observation of exclusive B meson decays in the hadron collider environment. He is now Associate Professor in the Department of Physics and Astronomy at the University of Pennsylvania.

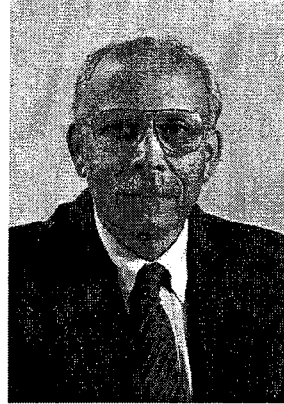
Dr. Gladney also is part of the B-bar collaborations working at the Stanford Linear Accelerator Center B factory. This facility seeks to understand the nature of CP-violation through intensive study of neutral B meson decays and thereby provide crucial tests of Standard Model predictions as well as research for physics beyond the Standard Model. Given the very real prospect of significant competition for discoveries in CP-violation around the year 2000, rapid analysis of data soon after physics turn-on will be essential. Dr. Gladney has directed the effort in which the University of Pennsylvania has played a major role in developing the object-oriented (OO) framework for the B-bar trigger simulation, Level 3 trigger, and offline reconstruction software efforts. The move toward modern software design tools and methods is a crucial part of the collaboration's plan to ensure that the B-bar reconstruction and analysis system will be robust, flexible and delivered on time. The same technology will prove vital to the software engineering efforts needed by many of the major high-energy experimental programs in the near future, hence these efforts are likely to have a physics impact that stretches well beyond the topic of CP-violations.

Wendell T. Hill
1952 –



Over the course of his career, Wendell T. Hill produced more than 125 papers and conference abstracts, reporting on work ranging from laser spectroscopy of atoms and molecules to the development of new spectroscopic instrumentation and techniques. His most recent efforts include the manipulation of quantum states of atoms and molecules with ultra-short (~ 100 fs), super intense lasers (with effective electric fields in excess of 5 GV/cm) and confining atoms to small volumes (few tens of microns) with laser cooling and trapping techniques. Dr. Hill has organized symposia for the American Physical Society (APS) and the Optical Society of America (OSA) and has served on several conference program committees. He has served on the both the executive committee of the Division of Laser Science and the Committee on Minorities for the APS, and has chaired the Optical Physics Technical Group for OSA and the Committee on Atomic Molecular and Optical Science for the National Academy of Science. Dr. Hill is a graduate of the University of California, Irvine, and holds a Ph.D. from Stanford University.

H. Ralph Lewis
1931-



Now a professor of physics at Dartmouth College, Ralph Lewis has had a diverse career that includes a 35-year association with the Los Alamos National Laboratory that continues to the present. Dr. Lewis' doctoral thesis at the University of Illinois combined experimental research in nuclear physics and superconductivity. After receiving his Ph.D., Dr. Lewis spent two years doing research in theoretical nuclear physics at the Institute for Theoretical Physics at the University of Heidelberg. He then spent three years at Princeton University where he concentrated on experimental work in nuclear spectroscopy. In 1963, he changed his research field to plasma physics and joined the controlled-thermonuclear-fusion project at the Los Alamos National Laboratory, where he emphasized the theory of collisionless plasmas. Dr. Lewis' major research contributions have been in the study of explicitly time-dependent invariants of time-dependent Hamiltonian systems, description of solutions of the initial-value problem for the small-signal response of collisionless plasmas, use of Hamilton's variational principle to generate algorithms for the numerical simulation of the equations of collisionless plasmas and other Hamiltonian systems, and the application of time-dependent operator invariants in the description of quantum systems.

Cynthia R. McIntyre
1960-



Dr. Cynthia McIntyre is a theoretical physicist whose work has concentrated in the area of condensed matter. Her research focus is on the electronic and optical properties of semiconductor heterostructures. Her current research studies electron-phonon interactions in low dimensional semiconductors. A graduate of the University of Texas, with a master's degree from Brandeis University, Dr. McIntyre was awarded a Ph.D. from the Massachusetts Institute of Technology. She has done postdoctoral research at the University of California, San Diego, and at the Electronics Science and Technology Division of the Naval Research Laboratory in Washington, D.C. She was recently elected to the governing board of the council of the American Physical Society. Dr. McIntyre co-founded the National Conference of Black Physics Students (NCBPS) in 1996, while she was a graduate student at MIT. The objective of the NCBPS is to increase the number of black students receiving Ph.D. degrees in physics.

Ronald McNair
1950-1986



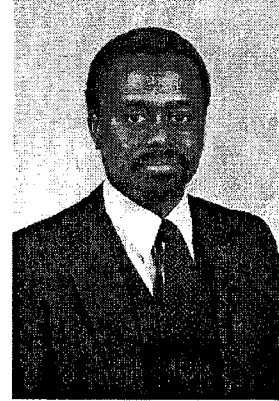
Soon after receiving his Ph.D. from the Massachusetts Institute of Technology, Ronald McNair went to work at Hughes Research Laboratories near Los Angeles. He was working there on a worldwide satellite communication program when he applied for NASA's prestigious astronaut program. A man of diverse interests, Dr. McNair in addition to his scientific work played the saxophone and held a black belt in karate. He was chosen from some 10,000 applicants for a program that would conduct a number of space research experiments in a near zero-gravity environment. During Dr. McNair's first flight aboard the *Challenger* in 1984, the space shuttle orbited earth 27 times over an eight-day period. As the craft orbited, Dr. McNair sampled the very thin gasses that surrounded it. He and other crewmembers also tested a new type of solar cell that collected sunlight and converted it to electricity and a crane-like mechanical arm designed to retrieve objects in space. His second *Challenger* mission in 1986 was to photograph Haley's comet as it reached its once-every-76-years proximity to earth. Less than two minutes after launch, the *Challenger* exploded and McNair and his fellow crew members perished.

Harry L. Morrison
1932-



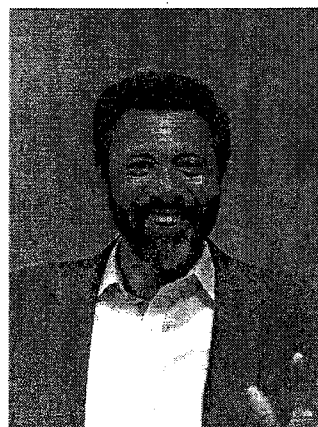
Professor emeritus in physics at the University of California at Berkeley, Harry Morrison has done research in quantum liquid theory and in the foundations of quantum statistical physics. He has studied the phenomenon of superfluidity in interacting Bose systems. This work is concerned with the spectrum of elementary excitations which provide the basis for the thermodynamic properties of quantum liquids. In addition, he and his colleagues found theorems that govern the macroscopic quantization of superfluid flow. Dr. Morrison is now investigating the topological structure of two dimensional quantum liquids and the question of broken symmetries. He and others have also developed a microscopic theory of the genesis of the vortex component of the excitation spectrum of two-dimensional Bose systems. In 1961, he was called to active military service as a 1st Lieutenant at the U.S. Air Force Academy, where he became Assistant Professor of Physics. He later joined the Lawrence Livermore National Laboratory as a theoretical physicist. He joined the Physics Department at the University of California at Berkeley in 1972. Dr. Morrison holds both a B.A. and a Ph.D. from Catholic University of America. The National Research Council awarded him a postdoctoral fellowship, which he spent at the National Bureau of Standards.

Sekazi K. Mtingwa
1949-



Sekazi Mtingwa has made major theoretical and experimental contributions to a variety of fields, including accelerator, nuclear and plasma physics. He and James Bjorken developed intrabeam scattering theory, one of the most important limitations on the performance of accelerators. Dr. Mtingwa played an important role in the design and construction of magnet and stochastic cooling accelerator systems used in the discovery of the top quark at Fermilab. Magnets guide and focus accelerator particles, and cooling systems convert poor quality beams into high quality ones. Dr. Mtingwa was scientific supervisor to the staff who assembled the stochastic cooling systems. He also was in charge of prototype testing, quality assurance, and installation of the devices into the accelerator tunnel. Dr. Mtingwa and Mark Strikmen have advocated using lasers and the next generation of electron linear colliders to produce sufficient quantities of B mesons to clarify understanding of nuclear theory and the universe. He holds Bachelor of Science degrees in both physics and mathematics from the Massachusetts Institute of Technology as well as master's and Ph.D. degrees in physics from Princeton University. He is currently the J. Ernest Wilkins, Jr., Distinguished Professor of Physics at Morgan State University.

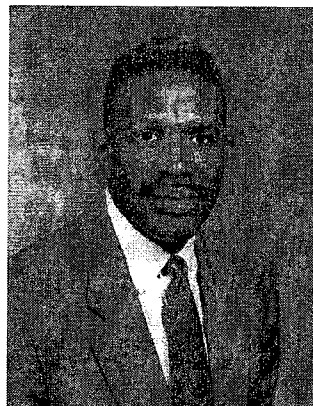
Kennedy J. Reed
1944-



Kennedy Reed's research has been in theoretical studies of atomic processes in high temperature plasmas. These plasmas are produced in experiments related to nuclear fusion energy. This research also had applications in astrophysics, as high temperature plasmas are found in the sun and other stars. The atomic processes Dr. Reed has studied fall into two categories. One involves collisions between ions and atoms. In some of these collisions, electrons can be transferred between collision partners. A particularly interesting type of collision involves the transfer of inner-shell vacancies from one partner to another. The other category includes processes involving electron collisions with highly charged ions. Most of Dr. Reed's recent research involves complex calculations of indirect contributions to electron impact excitation and ionization of highly charged ions.

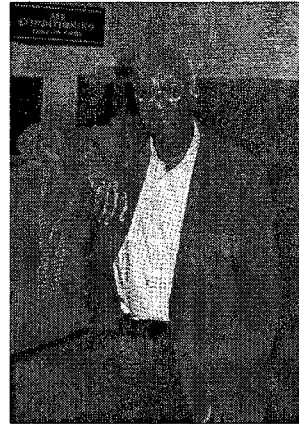
He also carried out important studies on relativistic effects in electron-ion collisions and on the polarization of radiation emitted following electron impact excitation of highly charged ions. In addition to his research, Dr. Reed has worked extensively with national programs designed to promote education and participation of minorities in the physical sciences. He has been active in international scientific affairs, especially in linking African scientists and institutions with American scientists and institutions.

Steven L. Richardson
1953-



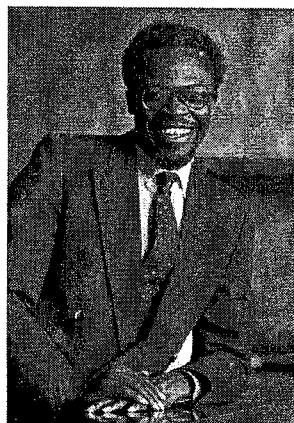
Steven Richardson's research involves the use of high-end UNIX workstations and supercomputers, such as the CRAY T3D and the IBM SP-2, to calculate the properties of materials and molecules using *ab initio* or first-principles quantum mechanics. His research has both verified experimental properties and predicted novel phenomena for problems in a variety of fields, including condensed matter physics, materials science and atmospheric chemistry. Dr. Richardson has been a visiting professor at Iowa State University, Bradley University, the *Instituto Superior Tecnico* in Lisbon, Portugal; Emory University and the Naval Research Laboratory. He has presented many seminars and colloquia at universities and research institutions in the United States, Europe and Asia and is at present a Distinguished *Sigma Xi* National Lecturer. Dr. Richardson is professor of electrical engineering and former associate director of the Materials Science Research Center of Excellence at Howard University.

Carl A. Rouse
1926-



Carl Rouse was the first to solve the Saha equation exactly for a mixture of a number of elements at a given temperature and density for use in equation of state (EOS) calculations (1961). He modified the Saha equation with a density-dependent function that extended the use of the Saha equation to higher (non-nuclear) densities in EOS calculations to equal and/or improve upon the results from the EOS, based on the Thomas-Fermi-Dirac model of the atom. The Rouse EOS is also equal to or more accurate than other much later and current EOS programs using different approaches. With the Rouse EOS, in 1962 he became the first to use real gas EOS physics in solar structure studies with continuous calculations from the center of the sun to the surface – where the Rouse ionization equilibrium EOS is in a subroutine, hence no table look-ups or extrapolations. Dr. Rouse's unique approach to solar structure calculations has led to a model of the present sun that is consistent with (1) the observed solar neutrino counting rates from two of the three operating solar neutrino experiments; (2) low degree acoustic mode frequencies of solar oscillation with periods of about five minutes; and (3) the solar lithium problem where the lithium abundance of the sun is less than that observed in other similar stars.

Earl D. Shaw
1937-



During his years with Bell Labs, Earl Shaw contributed to the development of infrared lasers with the spin-flip Raman laser. This achievement was cited in his 1989 election as a Fellow of The American Physical Society. Dr. Shaw was with Bell Labs for 19 years, including three years on the faculty of the University of Rochester. He joined Rutgers in 1991 and moved to the Newark campus a new laser technology – the far-infrared free electron laser – that he developed at Bell Labs. The laser, which is to be operational in 1999, generates short tunable far-infrared light pulses that will permit the analog of pulsed magnetic resonance techniques for the first time in the optical wavelength regime. Dr. Shaw will study the time dependence of the vibrational motion of DNA and other biological molecules with the ultimate aim of enhancing biochemical activity with far-infrared radiation. Dr. Shaw earned his Ph.D. in 1969 from the University of California, where he studied magnetic systems using pulsed magnetic resonance techniques.

Arthur B. C. Walker II
1936-



After completing his Ph.D. work at the University of Illinois, Arthur Walker turned to the study of high-energy radiation from astronomical sources, using space-borne platforms. He and H. R. Rugge developed the first satellite-borne x-ray spectrometer, and carried out a series of pioneering studies of the x-ray spectrum of the sun. Their studies helped establish the temperature, composition and dynamic nature of the sun's corona, and provided basic insights into the interaction of matter and radiation in a diffuse million-degree plasma. Their work provided a foundation for later studies of similar plasmas that in our galaxy, in the gas between galaxies and in the gas surrounding quasars constitute a significant fraction of the matter in the universe. Upon joining the Stanford faculty, Dr. Walker and his student Sally Ride – later NASA's first female astronaut – developed the first comprehensive model of the interaction of x-rays and the interstellar gas, and resolved several controversies over the composition of this fundamental component of the galaxy.

Realizing the potential of a new technology developed by his Stanford colleague T. Barbee that permitted the fabrication of synthetic mirrors that selectively reflect x-rays of a specific wavelength, he and his collaborators R. Hoover and J. Lindblom developed a series of astronomical x-rays telescopes that have provided the most detailed images and the most incisive thermal models so far obtained of the sun's outermost atmosphere, the corona. These investigations have revealed a previously unknown component of the solar atmosphere, and inspired new theories concerning the generation of another fundamental component of the solar atmosphere, the chromosphere. The first x-ray image of the solar corona published by Walker and his collaborators demonstrated the power of the new x-ray mirror technology, and inspired its use in the fabrication of microelectronics and in studies of the properties of materials at synchrotron laboratories throughout the world.

Michael D. Williams
1957-



Michael Williams' research investigates physics and chemistry at surfaces and interfaces, using surface sensitive techniques such as ultraviolet photoemission spectroscopy. Dr. Williams has made seminal contributions to the understanding of the effects of growth morphology and interfacial strain on the electronic band structure of epitaxially grown, thin film, compound semiconductors. In particular, he has explored the mechanism responsible for the segregation of indium in indium-based alloys and their subsequent effect on the performance of integrated optoelectronic device structures.

He also has made use of recent advances in microfabrication techniques to design and fabricate novel microelectronic and photonic device structures such as the negative electron affinity vacuum transistor and the free standing quantum well (FSQW). The latter structure consists of a quantum well which is confined on both sides by air or vacuum. It is ideal for probing the local properties of solids, e.g., the interaction of quantum confined states with surface and interface states. The FSQW is of particular interest to laser technology, and a patent has been awarded to Dr. Williams for this concept.

Williams has published more than 65 papers. He is an associate professor in the department of physics and director of the Center of Excellence in Microelectronics and Photonics at Clark Atlanta University.

About the Project Directors

This publication, the exhibit *The African American Presence in Physics*, and the related brochure were prepared under the direction of the National Society of Black Physicists. These are the committee members.

Lonzy J. Lewis – Project Co-Director

(B.S., Morehouse College 1971; Ph.D., Atmospheric Physics. SUNY-Albany, 1980). More than 20 years of experience in science teaching, research, and administration. Research interests include solar radiation measurements, and aerosol and cloud physics, air pollution, and minority science education. Currently: Professor of Physics at Clark Atlanta University, Atlanta, Ga., and past president – NSBP.

Ronald E. Mickens – Project Director

(B.A., Physics, Fisk University 1964; Ph.D. Theoretical Physics, Vanderbilt University, 1968). Author of 160 research publications, five books and two edited volumes in the areas of difference and differential equations, mathematical models of bio-systems, chemical reactions, and the history of science. Currently: Distinguished Fuller E. Callaway Professor of Physics at Clark Atlanta University, and historian – NSBP.

Selected Readings on African Americans in Science
Compiled by
Ronald E. Mickens, Ph.D., Historian – National Society of Black Physicists
and Distinguished Fuller E. Callaway Professor – Physics
Clark Atlanta University, Atlanta, GA

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