IN-35

MORGAN STATE UNIVERSITY

Cold Spring Lane & Hillen Rd. Baltimore, Md. 21239

Semi- Annual Report

August 22, 1990

Data Reduction of Digitized Images Processed From Calibrated Photographic and Spectroscopic Films Obtained From Terrestial, Rocket and Space Shuttle Telescopic Instruments

Ernest C. Hammond, Jr.

Department of Physics

Principal Investigator

Morgan State University

Baltimore, MD 21239

NSG 5074

Data Reduction of Digitized Images Processed From
Calibrated Film Photographic and Spectroscopic Films

The Microvax II Computer has arrived and the basic software in VMS has been installed. The Mitsubishi High Speed Disk has been installed and racked. But, the final connections to the Microvax II is being delayed because of the unavailability of software necessary to interface with the Perkin-Elmer 1010M Microdensitometer. As soon as this software problem has been corrected, the digital imaging laboratory can resume operations in the VMS rather than the RSX11 environment.

Further, the spring saw the receipt of a digital scanning tunneling microscope which was fully installed by the research team and is currently operational. At the Fifth International Conference on Scanning Tunneling Microscopy and Spectroscopy, this research team presented a poster session on a new technique using pseudocolor analysis of the line plot images of a scanning tunneling microscope. Over sixteen international inquirers requested the proposed preprint of the enclosed paper.

At the National Conference entitled "Research Interchanges", sponsored by the Goddard Space Flight Center with the Historical Black Colleges and Universities, I was the luncheon guest speaker in which I presented an overview of the research projects. Two graduate students also made presentations on the structure of the human hair strand using scanning electron microscopy and x-ray analysis. The other presented updated research on the annual rings produced by the surf clam of the ocean estuaries of Maryland.

Because of the delay of the Astro mission, in which this Morgan State University research team did the basic research of the film for that mission, we are anxiously awaiting its launch. There is one article and reference to our contribution which is herewith enclosed.

In the May 1990 issue of the Journal of Applied Physics there is and article entiteld "Mossbauer and Magnetic Susceptibility Studies on $MmNi_{4.15}Fe_{.85}$ and its Hydride was published. This research team did the scanning electron microscopy work for this study.

Further, at the Twelfth International Congress for Electron Microscopy, held in Seattle, Washington,a paper on the study of Micro-crystalline structures of 2-(2,4-Dinitrobenzyl) Pyridine .

Mathematical measurements for film sensitivity, found in the Journal of the National Technical Association, is the most recent publication for the team. This paper represents an attempt to do computer studies and mathematical modeling of the emperical data associated with many of the film calibration studies sponsored by this research team.

As a result of a summer project, and undergraduate student examined microscopic fossils from Calvert Cliffs, Maryland. There were many varieties of diatoms observed.

The current research team has also loaded and prepared a gas can follow-up experiment which will be launched in September, on the Space Shuttle STS-50. On board these canisters, which will be exposed to the orbital environment of space, we have over the counter medicines in which a potency experiment is planned along with nuclear emulsion film to detect any cosmic rays, as well as samples of IIaO film that will be flown on the Astro mission on August 31, 1990.

The future thrust of the research project will include the scanning tunneling microscopy of DNA and the improvement of our image processing capabilities.

STM '90

The Fifth International Conference on Scanning Tunneling Microscopy/Spectroscopy

and

NANO I

The First International Conference on Nanometer Scale Science and Technology

July 23-27, 1990

Hyatt Regency Hotel
Baltimore, Maryland USA

Under the Auspices of
The American Vacuum Society
and
The Office of Naval Research

FINAL PROGRAM AND ABSTRACT BOOKLET

WP 13 PSEUDO COLOR ANALYSIS OF THE LINE PLOT IMAGES FROM A SCANNING TUNNELING MICROSCOPE: Ernest C. Hammond
Department of Physics, Morgan State University,
Baltimore, MD

Analyzing the line plot images from a scanning tunneling microscope can enhance areas of the surface, particularly at the measurement from 1 - 2 nanometers scale. We will attempt to interpret the pseudo color patterns associated with these line plot atomic images. For the examination of these line plot images we used an external digital image processor (Gould IP 8500). The topology of the pseudo color images substantially enhances the viewing area. The research team has created stereo scanning tunneling micrographs using regular optical stereoscopy and integrated color sterographic techniques. Using separate scanned images deep 3 - dimensional resolution is achieved, clearly explicating the valleys and ridges associated with the surface of the sample. This research team has also produced stereoscopic line plot images of the surface area dramatic stereoscopic images are observed.

Future Research Interchanges

Presented by

Goddard Space Flight Center

With

Historically Black Colleges and Universities

June 18-20, 1990

TUESDAY, JUNE 19, 1990 (CONT'D)	BUILDING 3, AUDITORIUM
10:00 a.m. - 10:15 a.m.	Break
10:15 a.m. - 11:50 a.m.	Plenary Session Continued Dr. Vincent Salomonson, Director, Earth Sciences Mr. Thomas E. Huber, Director, Engineering Ms. Valerie Thomas, Assistant Director National Space Science Data Center (NSSDC) Minority University - Space Interdisciplinary Network (MU-SPIN)
11:50 a.m.	Bus Pick-Up — Travel to Recreation Center
12:00 Noon - 1:30 p.m.	Luncheon — Recreation Center Guest Speaker - Professor Ernest Hammond, Morgan State University
1:30 p.m.	Bus Pick-up — Travel to Building 26
1:30 p.m. - 5:30 p.m.	**BUILDING 26 - ROOM 212** Students' Poster Displays
1:40 p.m. - 2:40 p.m.	**BUILDING 26 - ROOM 205** Student Technical Presentations
2:45 p.m. - 5:30 p.m.	**BUILDING 26 - ROOM 205**
2:45 p.m. - 3:45 p.m.	Concurrent Technical Round Tables Space Sciences Mission Operations & Data Systems
3:45 p.m. - 4:00 p.m.	Break
4:00 p.m. - 5:00 p.m.	Concurrent Technical Round Tables Earth Sciences Engineering
5:00 p.m.	Bus Pick-Up — Travel to Recreation Center
5:00 p.m. - 6:00 p.m.	Reception — Recreation Center
6:30 p.m. - 8:30 p.m.	Dinner — Recreation Center Guest Speaker — Mr. Joseph Fuller, President, Futron Corporation

Become a homeowner see HUD listings pg 22

Child Abuse is a National Disgrace

The Baltimore Times

Complimentary | Vol. 4 No. 29 | June 4– June 10, 1990

New Shiloh's "done deal"

by Peter Bramble

Success is catching. Success in one area is transferable, because success is transfield. Success in one area can be repeated in other areas. Success represents a "done deal" that need not be done again.

The New Shiloh Baptist Church has successfully built a new house or temple at the corner of Monroe and Clifton in Baltimore. The structure is fine, rising like a phoenix out of the ashes of ghetto depression. The membership of that church made a bold commitment to this West Baltimore community. Only fools would invest $8 million in a church in any area they planned to abandon.

And you can take it from me, the people of Shiloh with whom I broke bread last Monday, in celebration of the 25th year of their pastor, Dr. Harold A. Carter (he holds two earned doctorates) are not foolish They exude class and style to go with their vision for West Baltimore.

I live in West Baltimore. This part of town was falling apart fast. Now, churches like New Shiloh Baptist, St Katherine's Episcopal and organizations like BUILD are making commitments to West Baltimore. St Katherine's Episcopal Church is in the process of building housing for the elderly, 66 units, with financing from HUD, at the corner of Pennsylvania and North Aves. BUILD will place 300 houses in the Sandtown–Winchester area. And Shiloh has already placed the steeples of hope.

Baltimore needs to congratulate

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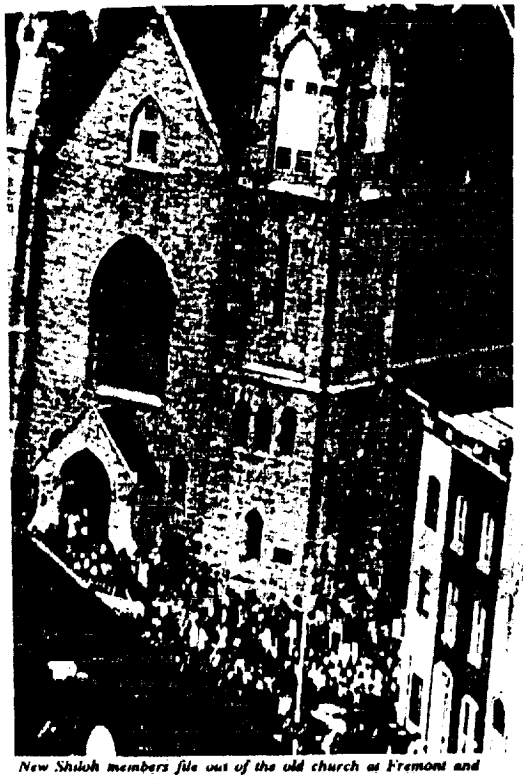
New Shiloh Baptist Church marches into new era



New Shiloh members file out of the old church at Fremont and Lanvale St. for the last time as they prepare to walk to the New Church.

Worshipers file into the new sanctuary of New Shiloh Baptist at Clifton Ave and Monroe St.

New Shiloh has invested in the inner city and brought a sense of renewal to its neighbors. The church invested $8 million in a facility that will be a family center as well as a church.

Leading the marchers in the new church building were (left to right) Pastor Harold A.Carter, Mayor Kurt L. Schmoke, Rev. Jesse Jackson and Mrs. Wepuanmah B. Carter.

Morgan St. research aids space shuttle

by R.B.Jones

When the space shuttle flight was canceled last week due to a hydrogen leak on The Columbia, the chance was delayed for Morgan State University's latest contribution to space research to be verified.

Professor Ernest C. Hammond Jr. and Kevin A. Peters of Morgan St. conducted an experiment that discovered that a special scientific film H_2O would fog up if loaded aboard the Ultraviolet Image Telescope six months prior to launch. The fogging would distort images collected by the Astro Observatory slated to go up in last

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Larry Stappler,Dr. Delores Kelley, president-elect Charles Tildon, Bernice Seiden and John Ferron.

City Councilwoman Vera Hall, at mike, presents a proclamation to LeRoy Hoffberger, Elnora Fullwood and Rabbi Murray Saltzman, president BLEWS.

BLEWS hold successful dinner cruise on the Bay

They came from all over the Baltimore Metropolitan area to enjoy the late afternoon sunshine and warm sociability of the Dinner Cruise sponsored by the Black/Jewish Forum of Baltimore (BLEWS), on Monday evening, May 14. More than 230 guests were welcomed by BLEWS President Rabbi Maury Saltzman, vice-president Dr. Delores Kelley, and co-hosts Harlow and Elnora Fullwood and LeRoy and Rebecca Hoffberger.

They dined and danced, applauded the talented young performers' entertainment, and most of all, had a good time talking with old friends and making new ones. The Dinner Cruise was an opportunity to raise funds for the many programs of the Black/Jewis Forum and to give visibility to the organization and its activities.

The Black/Jewish Forum is a coalition committed to strengthening relationships between the Black and Jewish communities, both of which have been the targets of oppression, humiliation and discrimination. Recognizing that discrimination against one group inevitably threatens all, the organization brings African Americans and Jews together to promote their common vision of justice, freedom and human dignity. The program works through dialogue and action programs to increase understanding, to counter group suspicions and to discourage stereotyping.

For more information about the Black/Jewish Forum of Baltimore, write to the organization at 2500 West North Avenue, Baltimore, MD., 21216 or call 333-5960.

Morgan

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week's shuttle launch.

As a result of the Morgan research team's findings, the 70mm film was loaded six days prior to launch which will substantial reduce the fogging levels in the film allowing the images collected on the film to be clearer and more accurate.

"The current shuttle mission has been in the planning stages for 14 years, " said Professor Hammond. "It was delayed for four to five years because of the Challenger disaster. The mission would have been compromised if the film had been loaded six months prior to launch. We tried to sensitize the scientists and technicians to the importance of the treatment of the film. Temperature and aging affect the film. If the film had been loaded for six months the exposure to the high temperatures could have caused a great deal of information to be lost."

In a shuttle flight scheduled for August, Morgan St. will have an experiment, continuing the research on the effects of space exposure on film and how much that exposure will cause the film to fog. Gerald R. Baker of Goddard Space Flight Center was the technical monitor on the research.

The experiment results were presented at the NASA-HBCU Space Science and Engineering Research Forum Proceedings at Alabama A&M University in March 1989.

Exceptional Children's Week

The week of June 4 to 8, 1990 is set aside as a time to emphasize the accomplishments and the potential of our children and to bring information about our programs to the public. Please

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ASTRO-1 OBSERVATORY MISSION

Astrophysicist from Hopkins poised for flight

By Luther Young

After nearly seven years of waiting for a space shuttle ride, Samuel T. Durrance is cautious about appearing too eager before the Astro-1 mission actually gets off the ground.

But the thrill is still there for the research scientist in physics and astronomy at Johns Hopkins University, who has trained since 1984 as an astronaut to operate the astronomical observatory in orbit 220 miles high.

"I've made observations from mountains in South America and Arizona," said Dr. Durrance, 46. "And the experience of going to the highest 'mountain' that we have, I'm looking forward to with great anticipation . . . I know it'll be the experience of a lifetime."

The native of Tallahassee, Fla., arrived at Hopkins as a postdoctoral fellow in 1980, after earning a Ph.D. in astro-geophysics from the University of Colorado. His main research interest was in the origin and evolution of planets.

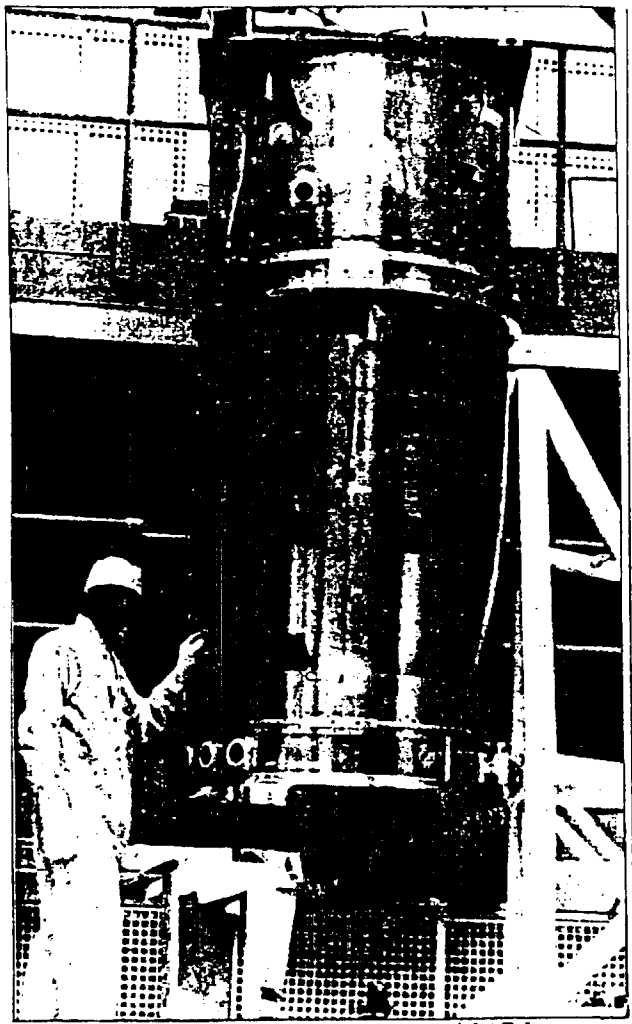
And, two years later, he joined the university team building the $20 million Hopkins Ultraviolet Telescope (HUT), one of the three ultraviolet instruments — combined with an X-ray telescope from Goddard Space Flight Center — that make up the Astro-1 observatory.

In 1984, the National Aeronautics and Space Administration chose Dr. Durrance and two astronomers representing Astro's other ultraviolet telescope teams to train as civilian "payload specialists" at astronaut headquarters at the Johnson Space Center in Houston.

And — with his wife, Rebecca, and two small children — he moved from Lutherville to a condominium near the Johnson Space Center in the summer of 1985 to await his launch on March 6, 1986, the next scheduled mission after teacher-in-space Christa McAuliffe was to fly aboard space shuttle Challenger.

Dr. Durrance was watching on television during a pause in training on Jan. 28, 1986, when Challenger exploded 74 seconds after liftoff and killed Mrs. McAuliffe and the six other crew members.

"Everyone immediately knew what happened, that it [Challenger] was essentially gone," he recalled in an interview two years later. "There was absolute silence."



Samuel Durrance helped build the Hopkins Ultraviolet Telescope.

down and shake-up of the shuttle program was a jarring, frightening time for the HUT team of engineers and astronomers, many of whom had been involved in the project since its inception in 1979.

Dr. Durrance returned to his research at Hopkins. But there was never any serious thought about giving up his hard-won position in the Astro-1 crew, as did several of the veteran astronauts originally assigned to the mission. During the hiatus, he continued to train in Houston and worked on improvements made to HUT.

"For me, it's been a marvelous experience," said Dr. Durrance. "The development of space hardware of this class was quite an experience for somebody who came from a university laboratory. I've found the whole process very exciting and very rewarding."

With his family once again relocated to Houston — where Benjamin, 8, and Susan, 5, are enrolled in school — Dr. Durrance is ready, as he was in the spring of 1986, for his space adventure to finally become reality.

But the most recent launch delay is a reminder that predicting when Astro will fly is risky business.

"Whenever it goes," said Sam

Space shuttle Columbia set to carry Maryland telescope and three others

By Luther Young

Pity poor Astro.

A pioneering astronomical observatory with four state-of-the-art telescopes to scan the heavens from space shuttle Columbia's open cargo bay, it is scheduled to launch this week deep in the shadow of the widely heralded Hubble Space Telescope.

But the $150 million mission, carrying both a Maryland telescope and a Maryland astronaut, promises to greatly expand astronomers' knowledge about the universe of distant ultraviolet and X-ray light sources invisible to telescopes on Earth.

And Astro — originally set to precede Hubble into space before the missions were delayed four years by the Challenger accident — could answer some fundamental questions about the universe long before the space telescope is checked out and ready for serious discovery.

The "space telescope is one of the premier astronomy efforts ever," said astronaut/astronomer Robert A. R. Parker, one of Astro's seven crew members. "But we should beat them to the punch on getting down the first science data."

The launch is currently set for Wednesday at 12:38 a.m., after a two-week delay while a bad cooling valve in the shuttle's payload bay was replaced by NASA technicians at Kennedy Space Center in Florida.

It's been a long time coming for the project officials and scientists who spent years shepherding the observatory to completion, including Samuel T. Durrance, the 46-year-old Johns Hopkins University astrophysicist chosen in 1984 to train as a payload specialist for Astro.

Dr. Durrance will work a 12-hour daily shift during the 9- to 10-day mission operating the three ultraviolet telescopes aboard, with particular expertise on the $20 million Hopkins Ultraviolet Telescope designed and built at the university.

A fourth instrument — the Broad Band X-Ray Telescope, or BBXRT — rides on a separate pointing platform and will be operated from the National Aeronautics and Space Administration's Goddard Space Flight Center in Greenbelt where it was constructed.

Together, the instruments are known as the Astro-1 Observatory, and the three ultraviolet telescopes represent a reincarnation of the [illegible] on the shuttle once in 1983 and three times in 1985.

Astronomers are eager to orbit the sensitive observatory to capture light from celestial objects in X-ray and ultraviolet wavelengths, not the visible light that is the main source of information about stars gathered through ground-based telescopes.

"The light that penetrates to the surface is just a tiny part of the electromagnetic spectrum, and objects like black holes, quasars and things emit over the entire spectrum," said Dr. Durrance. "So all we see from Earth is just a tiny indication of what's going on."

It wasn't until the advent of observations from space that the present picture emerged of a 15-billion-year-old universe populated with such exotica as exploding stars, colliding galaxies and mysterious black holes, theorized to be collapsed stars so dense that not even light can escape their gravity.

"We used to think of the universe as fairly smooth and uniform. Now we know it's an extremely dynamic, violent place undergoing a dramatic evolution," said Dr. Arthur F. Davidsen, the Johns Hopkins University professor of physics and astronomy who has led the HUT project since it began in 1979.

And the hot, dynamic objects emit high-energy, short-wavelength radiation in the ultraviolet, X-ray and gamma-ray regions of the spectrum. Cooler objects emit mainly in the low-energy, long-wavelength regions of infrared and radio.

Other orbiting telescopes opened the window on X-ray and ultraviolet observations a decade ago. But much of our understanding of the ultraviolet universe has come from brief sounding-rocket flights of several minutes' duration.

"They've been things that went up for a few minutes, got above the atmosphere, observed the wavelengths they could and then came right back down," said astronaut Vance D. Brand, commander of the Astro mission.

"We're taking up almost 26,000 pounds of instruments, and instead of getting a few minutes of observing time, we'll get nine or 10 days."

The Astro instruments and their objectives:

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In addition to Dr. Durrance, the crew includes three other astronomers — payload specialist Dr. Ronald A. Parise, 38, selected from the UIT team, and career astronauts Dr. Parker, 53, and Dr. Jeffrey A. Hoffman, 45, mission specialists responsible for controlling the instrument pointing system for the ultraviolet observatory.

Rounding out the biggest crowd since shuttle flights resumed in September 1988 are Mr. Brand — at 58 the oldest active astronaut — the pilot, Air Force Col. Guy S. Gardner, 42, and mission specialist John M. "Mike" Lounge, 43.

And all seven will be as busy as any crew in the program's history. They hope to observe 230 astronomical targets, or at least two per 90-minute orbit, an ambitious schedule that will require a record number of more than 300 shuttle maneuvers

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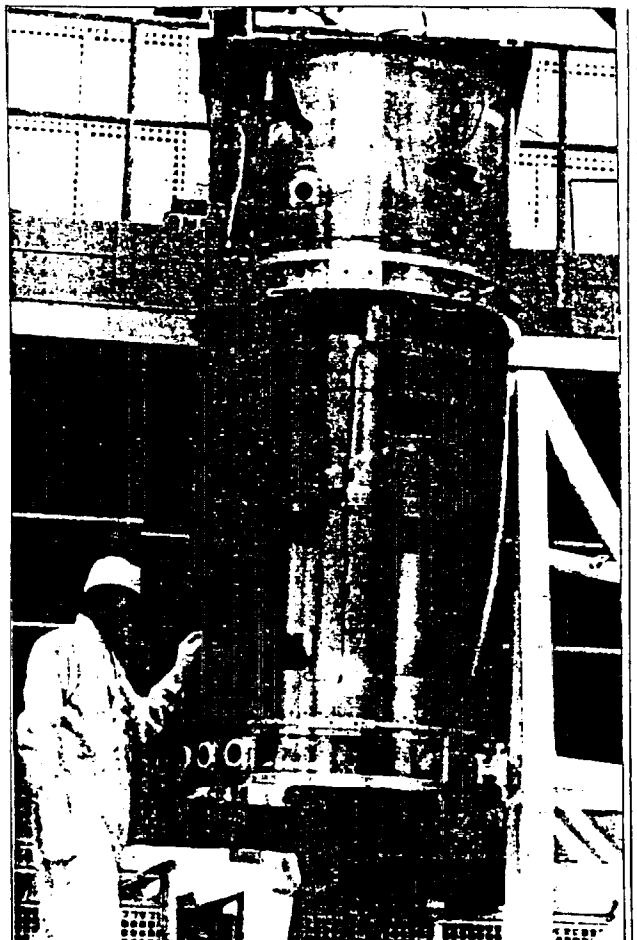

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Journal of
APPLIED PHYSICS

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Pages 5223–6026

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a publication of the American Institute of Physics

(Continued)

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Mössbauer and magnetic-susceptibility studies on $MmNi_{4.15}Fe_{0.85}$ and its hydride

F. W. Oliver, E. C. Hammond, L. Bang-Zheng,[a] and L. Meng-Zhao[a]
Morgan State University, Baltimore, Maryland 21239

M. S. Seehra
West Virginia University, Morgantown, West Virginia 26506

Results are reported on $MmNi_{5-x}Fe_x$ ($x = 0.85$) (Mm = mischmetal) and its hydride from magnetic susceptibility (χ), Mössbauer, and scanning-electron-microscopy studies. The magnitude of χ, the shape of the χ-vs-T curve (50–300 K), and the magnitude of T_c ($\simeq 200$ K) are all close to the values reported for $LaNi_4Fe$. The magnetic properties are significantly changed by the hydriding process. χ (at 100 Oe) above T_c is increased by 100%, whereas at 77 K, χ is lowered by 25%, although T_c is unaffected. The Mössbauer spectra above T_c yield a paramagnetic doublet (isomer shift -0.13 ± 0.01 mm s^{-1}); however, as the temperature decreases, the doublet disappears at 125 K. Hydriding causes only a very small change in the isomer shift.

I. INTRODUCTION

Research on the magnetic properties of rare-earth transition-metal alloys is receiving considerable interest because of the many areas of application for these compounds. In addition to their use in permanent magnets,[1] they have been studied for their possible applications in hydrogen-storage devices.[2] Intermetallics of the form AB_5 (where A is a rare earth and B is a transition element) have been frequently used. Changes in the magnetic and structural properties accompanying hydriding provide information on the hydrogen bonding in materials.[3-5] Mössbauer experiments have previously been used to investigate interactions at both the rare-earth and transition-element sites.

In an effort to alleviate the demand for certain rare earths and to lower the cost of the alloy, mischmetal (Mm) is being considered as a possible substitute.[6,7] Mischmetal is a naturally occurring mixture of the light-rare-earth elements,[8] and typically contains 48–50 % Ce, 32–34 % La, 13–14 % Nd, 4–5 % Pr, and 1.5% other rare earths. Although there have been previous investigations of the substitution of Mm for rare earths, very little work has been reported on Mm in hydrogen-storage materials.

In this work, we are interested in looking at the magnetic properties of an intermetallic when mischmetal is used as the rare-earth component for both a hydrided and unhydrided compound. We have therefore investigated the properties of a mischmetal nickel-iron intermetallic and its hydride using Mössbauer, magnetic-susceptibility, x-ray-diffraction, and scanning-electron-microscopy (SEM) measurements.

II. EXPERIMENT

The compound $MmNi_{4.15}Fe_{0.85}$ was prepared by Ergenics Corporation, and a pressure-composition isotherm generated (Fig. 1). The mischmetal used had a composition of 56 wt. % Ce, 24 wt. % La, 14 wt. % Nd, and 6 wt. % Pr. X-ray diffraction of the samples was done at room temperature using a Philips 12045 x-ray diffractometer. Effects of hydriding on the compound and particle size were determined using an ISI SS40 scanning electron microscope and standard analysis methods. A Faraday-type susceptibility apparatus was used to make magnetic measurements. For Mössbauer measurements, the source was at room temperature, and ^{57}Fe transmission measurements were made using a ^{57}Co source in copper. Spectra were obtained on a commercially available Austin Science S-600 Mössbauer spectrometer operated in a constant-acceleration mode with

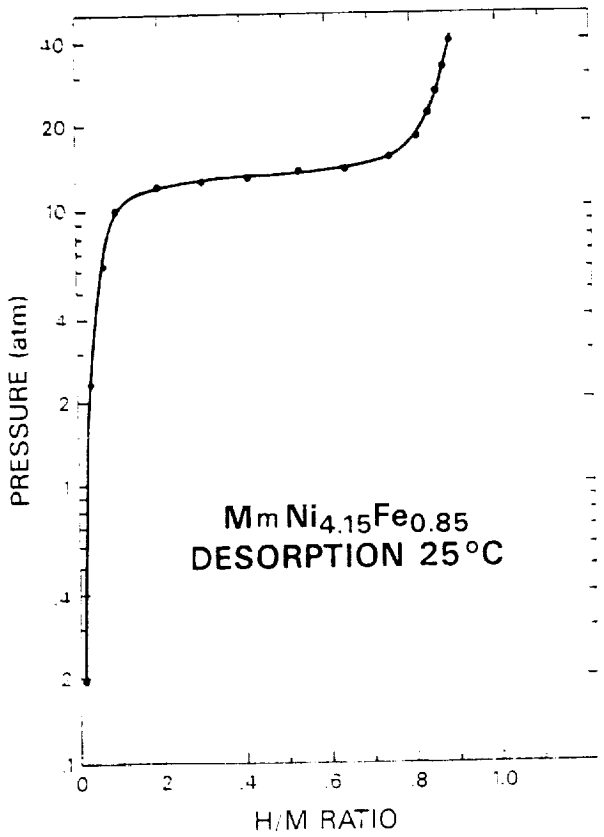

FIG. 1. Desorption isotherm for $MmNi_{4.15}Fe_{0.85}$.

[a] Present address: Yunnan Institute, Kunming, China.

0021-8979/90/095873-03$03.00

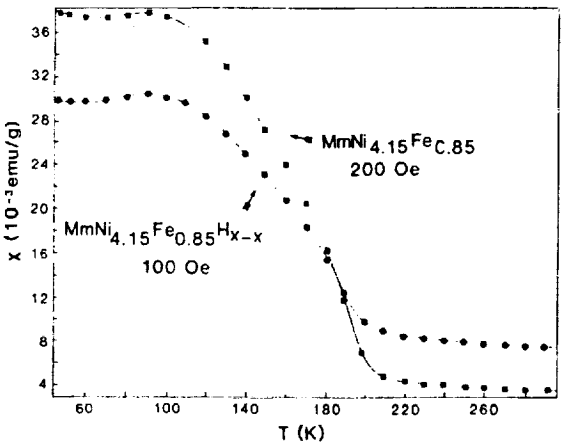

FIG. 2. Magnetic susceptibility vs temperature for $MmNi_{4.15}Fe_{0.85}$ and its hydride.

moving-source geometry. Data were recorded with a Tracor multichannel analyzer driven in multiscaler mode, and the results were analyzed using a computerized least-squares routine. Hydriding was accomplished by exposing the compound to high pressure (1000 psi) from a hydrogen cylinder at room temperature for 20 h. Volumetric measurements showed that most of the hydrogen escapes when the sample is exposed to atmospheric pressure. Cycling was done by repeated hydriding and pumping on the sample with a vacuum pump to remove the hydrogen.

III. RESULTS AND DISCUSSIONS

$MmNi_5$ forms an unstable hydride, requiring impractically high pressures for hydriding and exhibiting a large hysteresis.[7] Partial substitution of Ni atoms with Fe atoms lowers the absorption pressure and reduces hysteresis. X-ray-diffraction measurements on our sample before and after hydriding showed the intermetallic to be single phase with the hexagonal structure of the $CaCu_5$ type. Scanning electron microscopy showed a decrease in particle size with hydriding. Cracks due to straining in the material as a result of hydriding were quite visible.

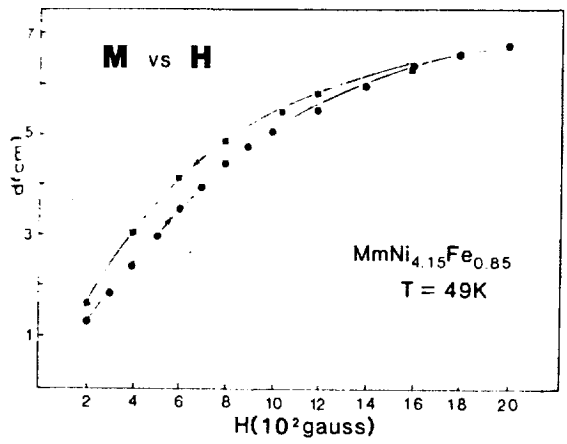

FIG. 3. Magnetization of 49 K.

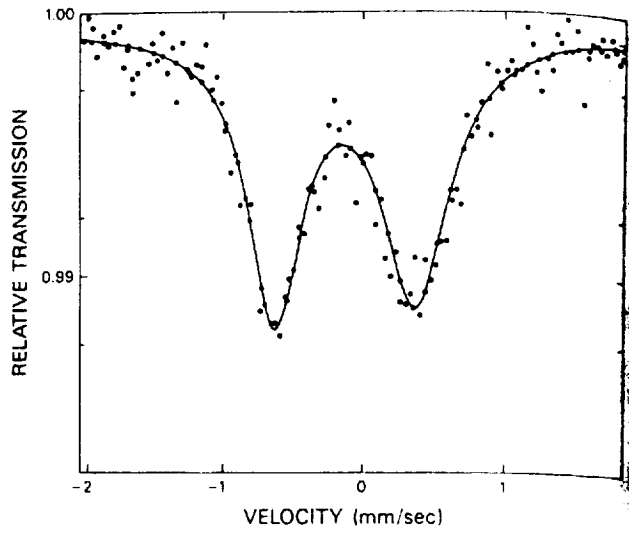

FIG. 4. Mössbauer spectrum of $MmNi_{4.14}Fe_{0.85}$ at room temperature. The solid line represents a least-squares fit of the experimental data to Lorentzian lines.

The magnetic susceptibility of the unhydrided sample in an applied field of 200 Oe was 7×10^{-3} emu/g at room temperature and increased as the temperature decreased. There was a change in magnetic character of the sample around 200 K (Fig. 2). Susceptibility measurements on the hydrided sample also showed a T_c of 200 K. Above T_c, hydrogenation increased the susceptibility, whereas below T_c there was a decrease in the susceptibility. Both samples exhibit broad peaks around 95 K. Escorne *et al.*[9] studied the magnetic phase diagram of the $LaNi_{5-x}Fe_x$ system. For $x>0.4$ they found that a transition to an inhomogeneous ferromagnetic phase occurs as the sample is cooled from high temperatures. The behavior of χ observed in our sample near 200 K is characteristic of a transition to a ferromagnetic phase. Our sample also shows hysteresis of M vs H (Fig. 3).

Mössbauer measurements at room temperature on $MmNi_{4.15}Fe_{0.85}$ indicated the sample as being single phase, paramagnetic, and having a quadrupole splitting of 1.00 ± 0.01 mm s^{-1} and an isomer shift of -0.13 mm s^{-1} with respect to Fe foil (Fig. 4). These values are similar to those found for $LaNi_{4.9}Fe_{0.1}$ (Ref. 10) and $LaNi_4Fe$ (Ref. 11) (Table I). Our results here, coupled with previous mea-

TABLE I. Mössbauer data of $CaCu_5$-type hydrogen-storage compounds at room temperature.

Compound	Isomer shift (mm s^{-1}) (relative to Fe metal)	Quantum shift (mm s^{-1})
$LaNi_4Fe$[a]	-0.13 ± 0.02	0.98 ± 0.02
$LaNi_{4.9}Fe_{0.1}$[b]	-0.13 ± 0.01	1.01 ± 0.01
$MmNi_{4.15}Fe_{0.85}$	-0.13 ± 0.01	1.00 ± 0.01
$MmNi_{4.15}Fe_{0.85}H_{0.27}$	-0.09 ± 0.01	1.00 ± 0.01
$MmNi_{4.15}Fe_{0.85}H_{x-x}$[c]	-0.13 ± 0.01	1.00 ± 0.01

[a] Reference 11.
[b] Reference 12.
[c] Sample alternately hydrided and desorped ten times and all hydrogen removed.

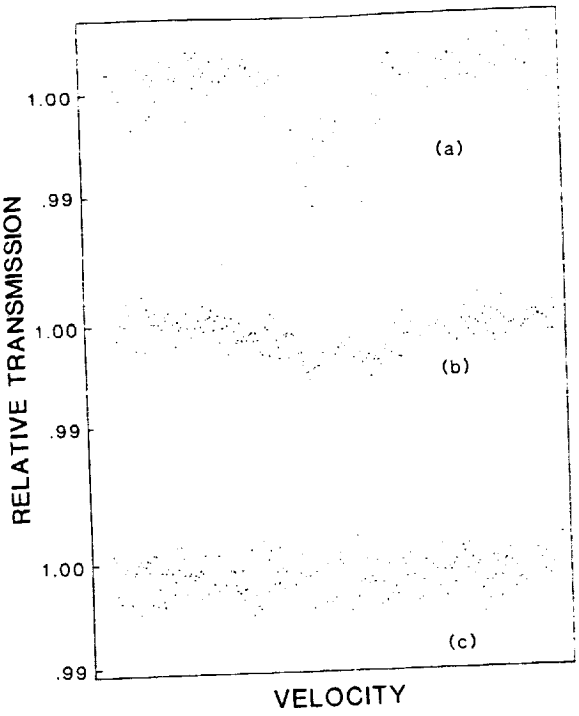

FIG. 5. Mössbauer spectra of $MmNi_{4.15}Fe_{0.85}$ at (a) 200 K, (b) 150 K, and (c) 125 K.

surements, indicate that the crystal structure and the environment of the iron have the greatest influence on the electron density and electric field at the Mössbauer active site. It also appears that these parameters are not affected by the element at the rare-earth site since the rare earths in mischmetal are quite different from those studied previously. Our results also conclusively explain why previous measurements of hydrides do not show larger changes at the transition-element site due to hydriding. This is quite different from Mössbauer results on intermetallics at the rare-earth site which indicate that hydriding is accomplished by the formation of binary rare-earth hydrides.[12,13] Measurements on a hydrided sample taken at room temperature showed an increase in the isomer shift. This increase represents a decrease in the electron density at the nuclear site and may be interpreted as electron transfer from Fe to H. When the hydrogen was desorbed, the isomer-shift values were the same as that found for the unhydrided compound. Mössbauer measurements as a function of temperature show that the paramagnetic spectra gradually disappear at 125 K (Fig. 5) which may be caused by fluctuations at frequencies higher than the nuclear Larmor frequency. The lack of observation of hyperfine splitting in the Mössbauer spectra at low temperatures suggests that the system lacks long-range order and may be indicative of a transition to a disordered state, which is consistent with the phase-diagram results by Escorne *et al.* on the $LaNi_{5-x}Fe_x$ system.

IV. CONCLUSIONS

The magnetic properties of our mischmetal nickel-iron intermetallic are found to be very similar to those found for the AB_5 lanthanum nickel-iron intermetallic. It is clear that the magnetic properties are significantly changed by the hydriding process. The Mössbauer isomer-shift results indicate that the hydrogen acts as an electron acceptor in this compound.

ACKNOWLEDGMENTS

The authors would like to thank J. S. Dean for his contribution to the magnetic measurements for this work. We would also like to thank D. Hill and D. Trotter for their technical assistance. Computer time for the work was supported by the facilities of the Morgan State University Computer Center. The work of F.W.O. was supported by the Howard Hughes Institute; that of E.C.M. by the National Aeronautics and Space Administration.

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Proceedings of the XIIth International Congress for Electron Microscopy

TITLE ➡

A SCANNING ELECTRON MICROSCOPY STUDY OF THE MACRO-CRYSTALLINE STRUCTURE OF 2-(2,4-DINITROBENZYL) PYRIDINE

Jacqueline Ware and Ernest C. Hammond, Jr.

Department of Physics, Morgan State University, Baltimore, Maryland 21239

The compound, 2-(2,4-dinitrobenzyl) pyridine, was synthesized in the laboratory; an introductory level electron microscopy study of the macro-crystalline structure was conducted using the Scanning Electron Microscope (SEM). The structure of these crystals was compared with the macro-structure of the crystals of 2-(2,4-dinitrobenzyl) pyridinium bromide, a salt of the compound which was also synthesized in the laboratory. A Scanning Electron Microscopy crystal study was combined with a study of the principle of the electron microscope.

Sandy colored crystals of 2-(2,4-dinitrobenzyl) pyridine have the interesting property of turning a deep blue color in sunlight, which then, reverts again to the sandy color in the dark. The phenomenon is expained by the formation of a tautomeric form by the action of light. Study of the macro-structure of these unique and tiny crystals, as well as, a comparison study of the macro-structure of a salt derivative is possible because of the excellent resolving power of the electron microscope, as opposed to the optical microscope. Several instrumental parameters of superiority include the wavelength of the electron, magnification, resolution, and depth of focus. The overwhelming superiority of the electron microscope makes possible the resolution of infinitesimal surface features such as cracks or subsurface features in holes of tiny crystals.

Sample preparation for examination in the electron microscope involved the technique of sputter coating. Advantages and disadvantages of this technique are evidenced in the micrographs of the crystals. Thermal damage caused by excessive heating in the SEM are also manifested in the micrographs, and vary in its affect on the crystals.

In a comparison study, the salt derivative, 2-(2,4-dintrobenzyl) pyridinium bromide, lacked both the interesting subsurface features, as well as, the phototropic properties of the crystals of 2-(2,4-dinitrobenzyl) pyridine from which they were prepared. However, an interesting outcome of the study is the detection of an inner layering phenomenon in the macro-crystalline structure of the photochromatic compound.

12 lines

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- ☐ *Imaging*
- ☐ *Analytical*
- ☐ *Biological*
- ☐ *Materials*

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mass up to $10^{12} M_{\odot}$ and a radius of few light-months. Outside the soliton star, the space-time can be represented by either Schwarzschild metric or Kerr metric. But unlike a black hole, a soliton star does not have a horizon. We propose a soliton star model for quasars. The absence of a horizon and the interaction between matter and the surface of a soliton star is the main difference between our soliton star model and the black hole model. These differences may have observable consequences. This work is supported in part by the D.O.E.

10:36
J11 9 Neutron Viscosity in Accretion Disks. N. GUESSOUM, D. KAZANAS, NASA/Goddard Space Flight Center. — We present a model for galactic black holes' accretion disks in which the neutrons produced in nuclear breakup reactions are the agents of viscous dissipation of the kinetic energy of the infalling matter. Because they do not interact with the ambient magnetic field, the neutrons have mean free paths that are much larger than those of electrically charged particles (and of the order of the size of the compact object), a fact that greatly enhances their transport coefficients and allows them to carry out the dissipation task. In our model the neutrons are produced in thermonuclear breakup reactions (we assume thermal conditions) in the innermost regions of the accretion disks, where the ion temperatures can be higher than about 3 MeV, as needed for the dissociation of ^{4}He. The ion temperatures are determined by balancing their heating, ccaused by the neutron-induced viscous stresses and dissipation, with their cooling by Coulomb collisions with the electrons. Thus self-consistent solutions are obtained for the neutron production and their impact on the energy dissipation. Our results indicate that neutrons can indeed provide the necessary dissipation to sustain the steady state accretion of matter with rates $\dot{M} \lesssim 10^{-8}\ M_{\odot}\ yr^{-1}$ and electron temperatures ~ 100 keV-1 MeV and thus present a promising way of modeling the bright galactic X-ray sources like Cyg X-1.

10:48
J11 10 **Particle Dynamics Under Coulomb Attraction and Radiation Pressure**. H. A. ZACHARIADES AND E. A. JACKSON, University of Illinois at Urbana-Champaign.---Particle dynamics in electromagnetic fields similar to those in the outer pulsar magnetosphere were studied. The fields used are those of an oblique, rotating magnetic dipole and a central attractive charge. A class of solutions was found corresponding to bounded orbits at a distance greater than c/Ω, where Ω is the angular speed of the dipole. In an independent particle picture, particles started with different initial conditions within the basin of attraction of this class of orbits eventually establish such a phase relationship with one another as to form a ring of particles around the rotational axis of the dipole. We also showed the existence of phase-locked dynamics for this system. The results suggest the existence of a disjoint region of trapped plasma in the outer pulsar magnetosphere.

11:00
J11 11 PC 1 Events Observed in the Magnetosphere with the DE 1 Satellite and at Siple Station, Antarctica. B. RADMAN, School of Physics, University of Minnesota. - In a detailed analysisis of data from the Dynamics Explorer 1 satellite and the ground station at Siple, 10 events have been discovered some of which indicate a correlation between PC 1 waves observed at DE 1 and Siple station due to similiar time and field location. In these cases the DE 1 satellite was near the field lines connected to the search coil magnetometer at Siple station. These 10 PC 1 events are in the frequency range 0.1 to 4 Hz, some are broad-band in structure, often occuring at high latitudes, others narrow-band and observed near the equator. There exists a frequency structure in the 10-20 minute time duration of the events, it initially consists of a low frequency signal then developing a higher frequency band. One of the events was observed to have a frequency band between 0.5 and 1 Hz both at DE 1 and Siple.
*submitted by E.D. Dahlberg

11:12
J11 12 Observation of Sinusoidal Waves in the Polar Cap J. SCHMIDT, L.J. CAHILL, SCHOOL OF PHYSICS, UNIVERSITY OF MINNESOTA. --- The region of the polar cap is defined to be to the area surrounding the magnetic pole and above 70° in geomagnetic latitude. It is the location where magnetic field lines emerging from the earth do not return but remain unclosed in the magnetotail. From analysis of data from the Dynamics-Explorer 1 satellite and the South Pole ground station in Antarctica while passing through the polar cap region, sinusoidal waves have been observed in various frequencies from 5Hz(Pc-1) to .001Hz(Pc-5) The origin of these waves is not known and their presence is not expected on the open field lines.

11:24
J11 13
Scanning Electron Microscopy and X-Ray Analysis of Fossilized Materials from Calvert Cliffs, MD. E.C. Hammond, Morgan State University, M.E. Moses, Stanford University.---As a part of a science project, several students went to Calvert Cliffs, MD, on the western shore of the Chesapeak Bay, near the confluents of the Patuxent River in southern Maryland. Fossils were collected with the intent of examing them with both optical and scanning electron microscopes. Ultimately, small scrappings from the fossilized materials were viewed under the scanning electron microscope and analyzed for their elemental content using x-ray analysis techniques. Approximately three types of objects were observed at very high magnifications of approximately 6,000 to 11,000 X. The x-ray analysis for these objects indicates that these microscopic fossils contained large quantities of silicon, calcium, magnesium and iron peaks. The dimensions of these objects are between 6 and 9 microns. Identification of these objects is in progress.

Supplementary Paper

J11 14 The Coupling of Charged Superfluid Mixtures to the Electromagnetic Field. D.D.HOLM, Theoretical Division and Center for Nonlinear Studies, LANL, L. LINDBLOM and G. MENDELL, Dept. of Phys., Montana State U., --- In order to understand the interiors of neutron stars the system of equations that describes the macroscopic properties of a mixture of charged superfluids is derived. The superfluid-mixture equations of Andreev and Bashkin are generalized to include new vorticity-perserving forces. The affects of these forces on the dynamics is investigated by using a macroscopic phenomological approach developed by Berkarevich and Khalatnikov. A Hamiltonian formulation of the theory is developed and used to couple the equations to the electromagnetic field. The physically relevant values of the additional vorticity-perserving forces is determined by requiring that each component of the superfluid mixture responds to the electromagnetic field via an appropriate Lorentz force law. The magnetohydrodynamic limit of the resulting system of equations is found.

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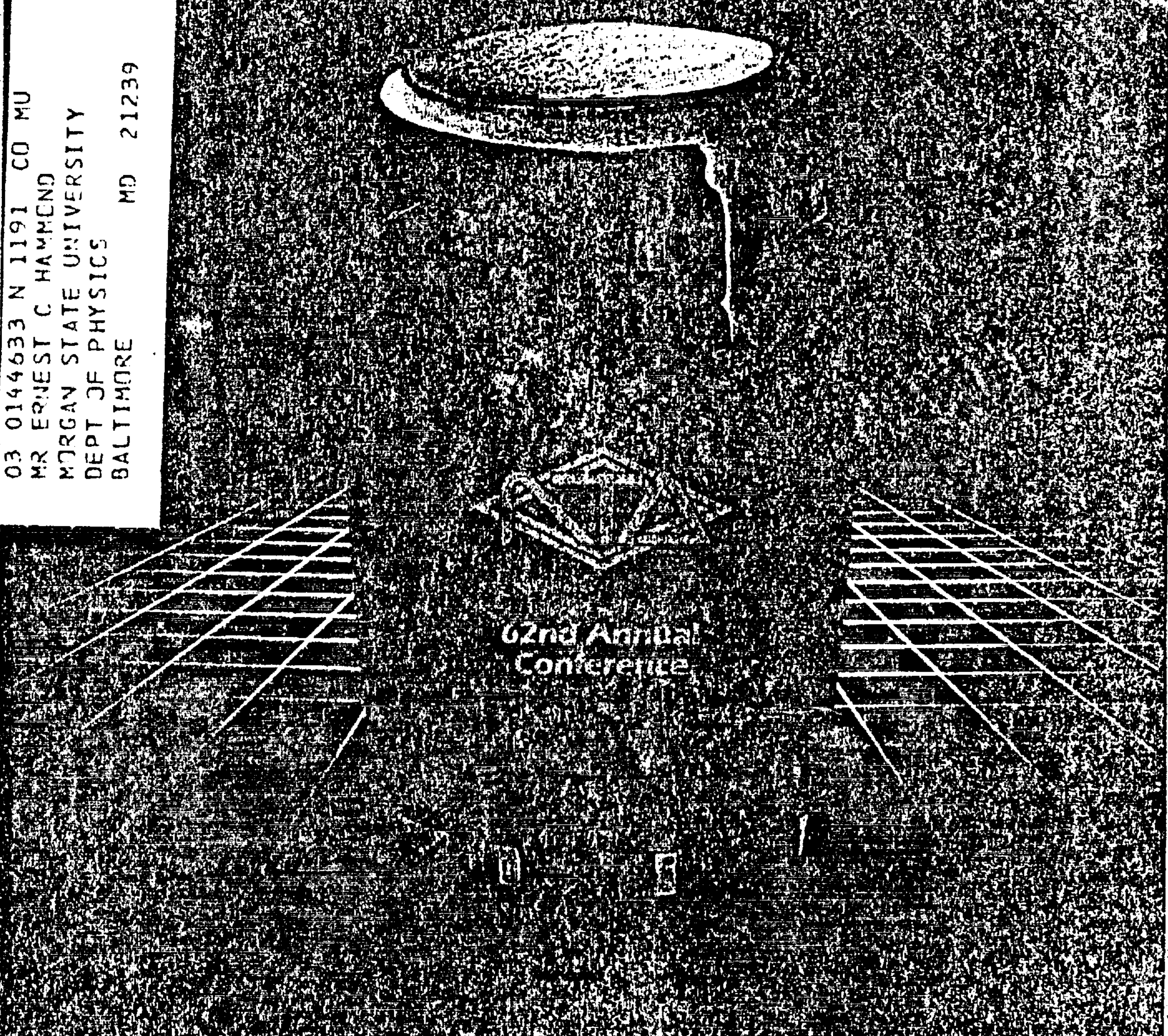

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Mathematical Models For Film Sensitivity Measurements

by Ernest Hammond, Stephen Gewirtz, Osborne Parchment

Abstract

The quality of the pictorial record developed from photographic material depends on the composition of the material, the procedures used in its exposure and processing, and the nature of the physical and temporal environment extant during the creation of the record. By holding many of the variables fixed, we examine the effect of two environmental parameters, namely temperature and aging, on the characteristic curve of a given film. Polynomial and exponential functions are evaluated as empirical formulas for the characteristic curve, and the sensitivity of derived coefficients to the selected parameters is assessed.

I. Data Description and Rationale for Data Analysis

In a variety of applications of scientific photography, there is an unavoidable time lapse between film exposure and film processing. During this time, the exposed film may be subject to levels of ambient temperature. Such is the case, for example, when films of experiments are exposed at various times during a space mission and developed at the end of the mission. A similar scenario occurs when films are exposed at distant experimental sites and returned by common carrier to a central location for processing. In such cases the extent to which the photographic record may be affected by the aging period and/or the temperature is an important consideration. The data used in this analysis were obtained to assess the effect of these physical parameters on one type of commercial film. A description of the method used follows.

Film of the type selected was exposed for a fixed time using a light intensity wedge of 30 gray levels. Following exposure, the film was aged for a selected number of days at a selected temperature and then developed. The density for each gray level in the wedge was measured using a densitometer to produce data similar to that shown in Table 1. For this analysis, aging periods were assigned in multiples

Wedge Number	Density (15 days, 11°C)	Density (15 days, 40°C)
0	0.22	0.31
1	0.23	0.31
2	0.24	0.32
3	0.25	0.34
4	0.27	0.38
5	0.30	0.41
6	0.35	0.51
7	0.39	0.57
8	0.46	0.66
9	0.53	0.73
10	0.62	0.82
11	0.72	0.91
12	0.78	1.00
13	0.90	1.10
14	1.03	1.19
15	1.13	1.26
16	1.25	1.35
17	1.35	1.43
18	1.47	1.56
19	1.60	1.64
20	1.68	1.69
21	1.75	1.74
22	1.82	1.78
23	1.88	1.82
24	1.93	1.91
25	1.99	1.94
26	2.03	1.97
27	2.07	2.00
28	2.11	2.03
29	2.14	2.04

Table 1: Density Values for Kodak IIaO Film Aged 15 Days at 11°C and 40°C.

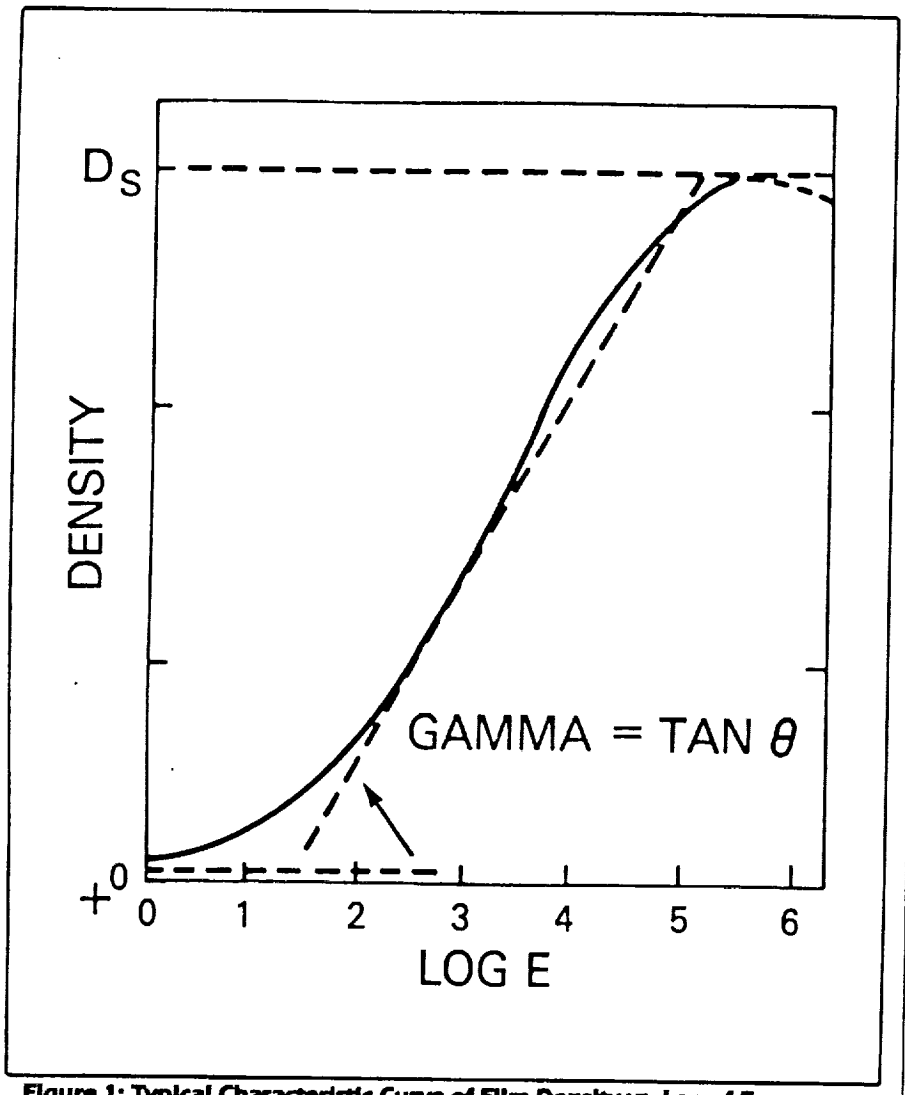

Figure 1: Typical Characteristic Curve of Film Density vs. Log of Exposure

of three days to a maximum of twenty days and the incubation temperatures were 11°C and 40°C. The development procedure was identical for all the films used in this phase of the project. The actual film used to generate the density readings used in this report was Kodak IIaO.

The density readings, accurate to two decimal places as shown, are dependable for the method as outlined. No attempt is made to correct for differences in storage times between film manufacture and film exposure. However, the supplier maintains manufacturing and shipping practices designed to minimize the effects of this factor [1].

II. Selection, Implementation, and Testing of Empirical Models

The earliest researchers in the science of photography realized that a functional relationship exists between photographic densities and the exposures which produced them. F. Hurter and V. Driffield [2] originated the method of plotting density against the common logarithm of exposure to obtain empirically the characteristic curves (see Figure 1), commonly called H&D curves, so central to the theory of sensitometry. Researchers in population biology may also notice a strong similarity to the logistic growth curve.

Despite many attempts to describe this curve globally by a single mathematical formula, no satisfactory functional relationship has so far been commonly accepted as theoretically based and empirically accurate. Consequently, this study uses regression analysis on a selection of curves to represent the experimental data and presents the root mean square error resulting from each choice.

A. Polynomial Fit by Regression Analysis

Although characteristic curves exhibit segments which appear to be approximately linear, the graph of density versus the logarithm of admissible exposures is obviously not globally a straight line. Thus an attempt to model these curves by polynomials requires them to be at least quadratic. In fact, the presence of at least one inflection point suggests that cubics are the minimum degree needed if a reasonably accurate fit is to be assured. Consequently, this analysis begins with the selection of the most general cubic polynomial as a possible regression curve and proceeds to test higher degree functions until there is no perceptible change in the root mean square error computed.

The regression method for fitting a polynomial x

The earliest researchers in the science of photography realized that a functional relationship exists between photographic densities and the exposures which produced them.

$$P_N(X)=C_0+C_1 X+C_2X^2 + \dots C_NX^N \quad (1)$$

to the data set (X_k, Y_k), k=0... N, involves finding the coefficients C_k so that the expression for the least square error

$$LSE = (Y_k - P_N(X_k))^2 \quad (2)$$

or for the root mean square error

$$RMSE = (LSE/N)^{1/2} \quad (3)$$

is minimum. This is a standard procedure in numerical or statistical analysis. The procedure results in a set of M+1 simultaneous, linear equations for the unknown coefficients.[4] Using the Gauss-Jordan method [5] for solving such equation, we derived the unknown coefficients which determine the best fitting polynomial. The algorithms to do this were coded in Pascal and the code may be obtained by writing to the authors. Figure 2 shows the experimental data together with cubic and quintic regression curves.

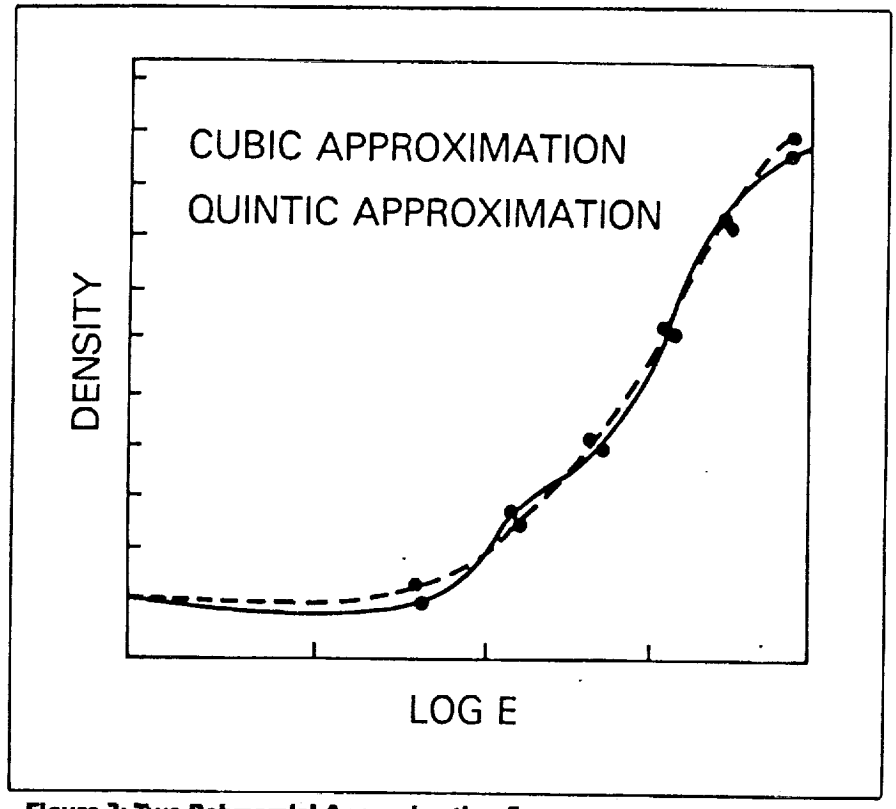

Figure 2: Two Polynomial Approximation Curves

Film Density Data Approximated by Selected Polynomials

B. Exponential Fit by Regression Analysis

The polynomial curves derived in the preceding section produce very good fits with the experimental sensitometric data. However, the simplest of the models considered requires the determination of four unknown coefficients. A useful question to consider is the existence of other curves capable of producing an acceptable fit with fewer adjustable constants. The general nature of the characteristic curves suggests that the rate of change of density y with respect to the logarithm of exposure x should have the form

$$dy/dx = y(a-by), \quad (4)$$

where a and b are unknown constants. Viewing this as a differential equation for y in terms of x, we could impose the initial condition y(0) = the fog density of the film. Solving the resulting initial value problem using methods outlined, for example in [6], yields the general solution:

$$y = a/[b + (a/y(0) - b)\exp(ax)]. \quad (5)$$

The problem is to determine the constants a, b from the experimental data. It will be helpful to note two relevant properties of solutions of equation (4):

Property I: For large values of x, the values of y approach the ratio a/b.

Property II: Any solution has a flexpoint at the value y=a/(2b) and the rate of change at this flexpoint is $a^2/(4b)$.

The first property is obvious from the solution formula (5); the second can be derived by the substitution of a/(2b) for y in the right hand side of (4). A reasonable assumption is that the solutions approximated the linear portion of the characteristic curve. Using this assumption together with Property I and Property II gives:

$a^2/(4b)$ = slope of linear regression line

a/b = maximum density of exposed film

Consequently, the values for the

A useful question to consider is the existence of other curves capable of producing an acceptable fit with fewer adjustable constants.

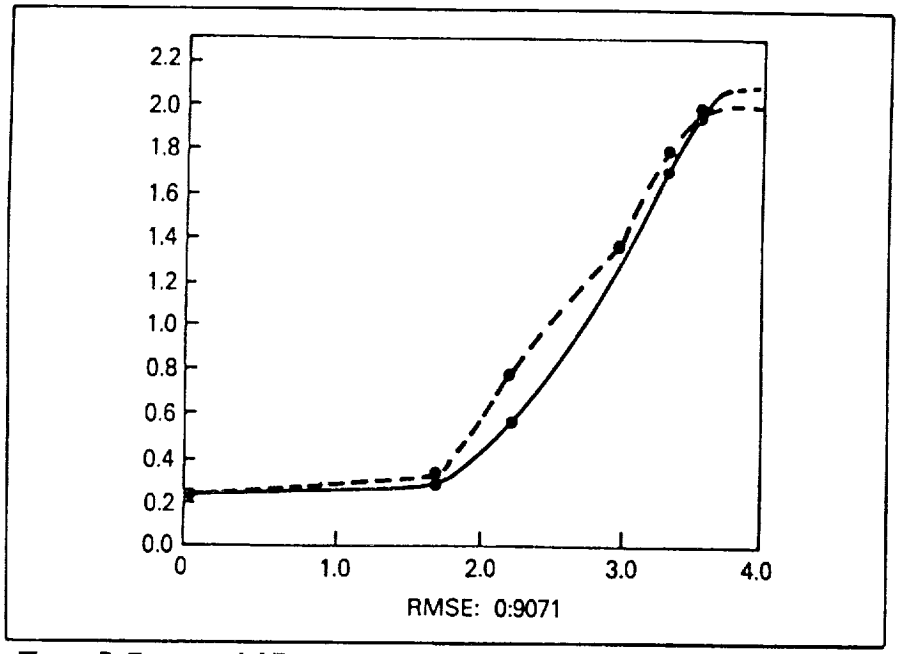

Figure 3: Exponential Regression Fit to Data

constants a and b are determined by the data. Figure 3 compares the experimental data with the exponential regression curve derived as described above.

C. Comparison of the Models

Analysis of the approximation data shows a very good agreement of the experimental data with cubic polynomials. Although there is evident improvement resulting from the use of quintic regression curves, the changes are not significant enough to warrant the significant amount of additional computation required. Furthermore, extending mathematical approximations to accuracies beyond the error tolerance of the measuring instruments is not generally a useful exercise.

The results obtained by exponential regression show a considerably higher error when compared to the polynomial regression figures. When tempered by the fact that this method needs the determination of only two arbitrary constants compared to four and six respectively in the polynomial cases considered, the geometric properties of the exponential regression curve suggest better agreement for longer exposure time.

III. Conclusions and Questions for Further Study.

If the commitment has been made to model the data by polynomial regression, it is clear from the study that quintic polynomial regression provides a better fit than the same procedure applied to cubic ones. However, the increase in accuracy is not dramatic enough to justify the additional complexity and computation time required for the higher degree. Cubic splines, although not used in this analysis, are likely to provide even better fits, but they are not global polynomials although they belong locally to this class of functions. Lagrange polynomials are not practical for this model because of the high degree required to fit the data and the consequent increase in computation time.

Choosing the model by exponential regression has some theoretical appeal. However, the errors generated are an order of magnitude higher when compared to the cubic polynomial fit.

The results of the temperature/aging studies were as follows: For fixed temperature, the coefficients of the respective regression curves used remained stable as functions of aging. On the contrary, for a fixed age there was significant variation in the respective coefficients as functions of temperature. Because the data were available only for three distinct temperatures, this variation is not enough to support a claim of instability of the coefficients as functions of temperature. Additional analysis with more closely spaced temperature readings would be necessary to support such a claim. □

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