Annual Progress Report
Research Experiences for Undergraduates in Physics and Astronomy
Summer 2002

NSF-REU Grant PHY-0097367 (Year 2)

Department of Physics & Astronomy
The University of Toledo
Toledo, Ohio 43606

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Scott A. Lee

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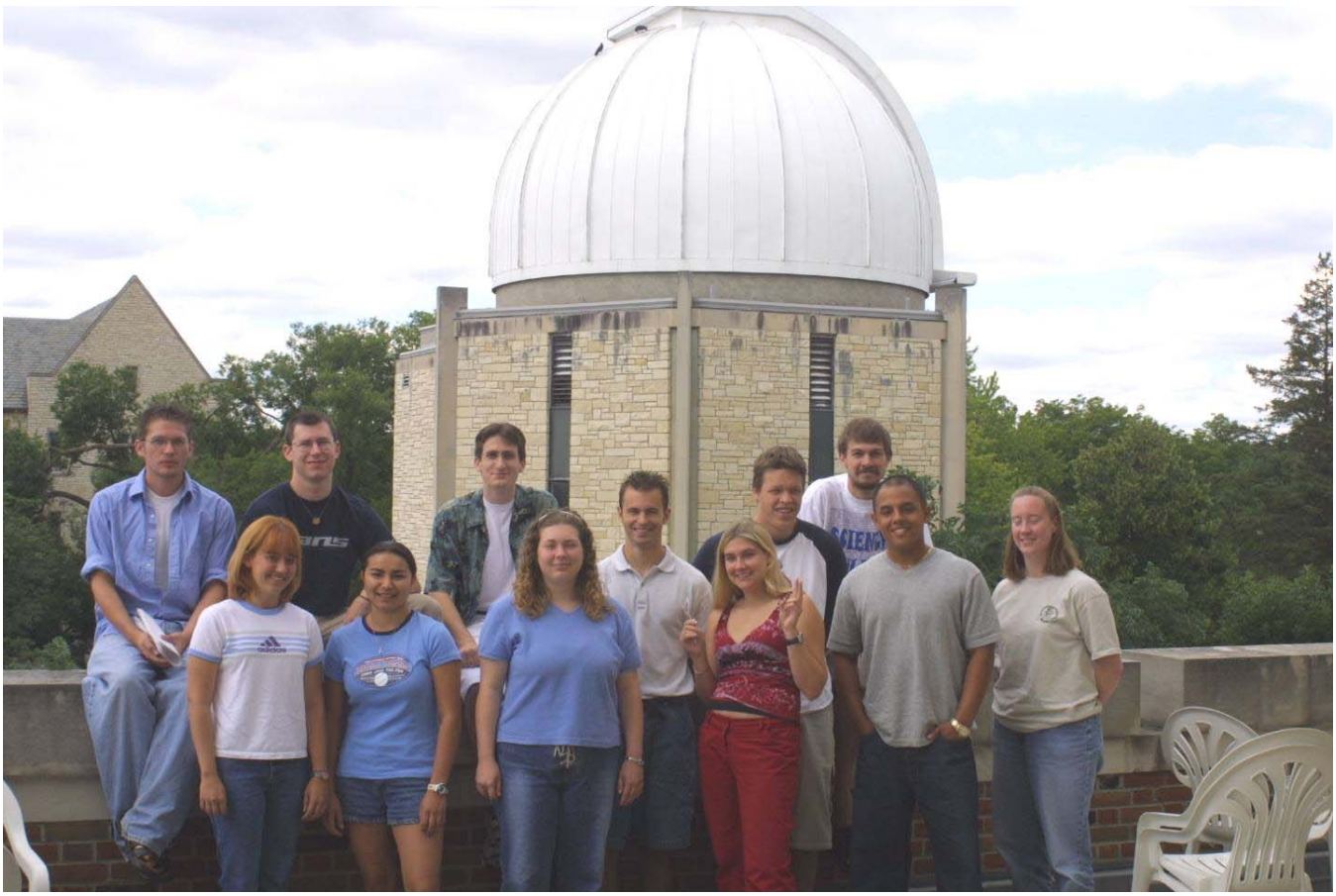
Appendix: Program announcement and application form

RESEARCH PARTICIPANTS in the NSF-REU PROGRAM
SUMMER 2002
DEPARTMENT OF PHYSICS & ASTRONOMY
THE UNIVERSITY OF TOLEDO



TOP ROW (Left to Right): Levi Gorrell, Jeff Durst, Chris Verzella, Jon Skuza, Nick Harmon, Andy Hill

BOTTOM ROW (Left to Right): Melissa Haugen, Marleen Martinez, Rachelle Romer, Chandra Jacobs, Aaron Garcia, Jackie Must

SUMMARY REPORT

Introduction

The Summer 2002 NSF-REU program in Physics and Astronomy at Toledo gave enhanced research opportunities to 12 undergraduate students from 8 colleges and universities in 6 states spread from New Jersey and North Carolina to Washington and California. Originally we were planning on thirteen participants, but one withdrew the weekend before the program began. Of the 12 participants, 11 were supported by the basic NSF-REU program and 1 by other (local) funds. Student participants were chosen competitively; we received 82 applications from students in 34 different states in all parts of the U.S., plus one from Canada (US citizen). This is a significant increase in numbers over last year possibly due to increased web utilization. All the participants were serious and talented young scientists, who tackled substantial problems, participating in all stages of a project, from formulation to conclusion, including oral and written presentations of results. The gender distribution of the participants this year were 7 men (58%) and 5 women (42%). A CD containing over one hundred photos from this year's activities was produced and given to the students at the end of the summer session. The initial web announcement (with secondary links to additional material) can be found at:

http://www.physics.utoledo.edu/~wwwreu/reusummer2002/nsf-reu2002a.html

We are pleased to report that Summer 2002 was a success from both the students' and faculty mentors' perspectives. Several talks were presented at regional and national conferences by the REU participants, in addition to presenting talks on their research at their home institutions. From discussions with faculty mentors, it is anticipated that several manuscripts are in preparation and will be submitted to refereed journals from work conducted by this year's and previous years' REU participants.

Advertisement and Selection

This year we utilized a web-based advertisement and application system. The only paper announcement sent to institutions was a very brief letter alerting the prospective students to our website and a paper copy of our Application form in case the students didn't have readily available access to the internet. The web materials are appended to this report. The table on pages 7 and 8 shows the geographic distribution of inquiries, applicants, offers, and participants. The selection committee was composed of Thomas Kvale (PI) and Scott Lee (Co-PI). This committee also performed the initial matches of the prospective students with their faculty mentors. Various criteria were used for the selection and matching, including the student's course background and class performance, out-of-class experiences, research interests, faculty recommendations, and personal goals. We also tried to select students with a variety of personal, educational, and geographical backgrounds. Although we were successful in all of these areas, we will again try harder to attract more persons of under-represented groups in our program. Listed below are the organizations we encouraged to post our REU announcement.

- Society of Black Physicists
- American Indian Science and Engineering Society (www.aises.org)
- Society for Advancement of Chicanos and Native Americans in Science (www.sacnas.org)
- American Astrophysical Society (www.aas.org)
- National Society of Black Physicists and National Conference of Black Physics Students, March 13-17, 2002, Alabama A & M University.
- over 130 colleges and universities (mainly in the Midwest, but some scattered all over the US).

Registration, Housing, and Social Activities

All student participants were registered in PHYS4910, *Research Problems in Physics and Astronomy*, for 1 semester hour credit. The REU program paid all the instructional and other required fees. We find that there are many advantages to having the REU participants be registered students with all associated benefits and privileges. One of the major benefits is access to the university health center. Other benefits include: course credit to transfer back to the student's home institution if desired, access to recreational facilities, and borrowing privileges at the University library. Several students took advantage of a Machine Shop practices and techniques course run by our professional Machinist under the umbrella of PHYS4910.

This year the student participants lived in the same campus dormitory, with the NSF-REU grant providing the housing costs. One of the goals of the NSF-REU program is to enable social interactions among the students, who will become the scientists of tomorrow. This infrastructure of friendships leads to the fruitful exchange of ideas, which is useful in the advancement of physics and astronomy. We feel that we can best accomplish this goal by housing the students together on campus. The director of Student Housing on the campus of the University of Toledo has cooperated with us fully in this respect for the past 10 summers of NSF-REU support. The students stayed in the Academic (Honors) House, which is organized into suites adjoining a common area that encourage social interactions among the REU students.

Social activities were coordinated by a UT participant (Lori Schmetzer) from last year's REU program. This worked out very well and the students formed a close-knit group. Some of the special events included a departmental picnic, trips to Cedar Point Amusement Park, the Toledo Museum of Art, and the Toledo Zoo, plus many informal activities, including an evening at Tony Packo's, Toledo's famous ethnic Hungarian restaurant. Two windsurfing adventures at Maumee Bay State Park, courtesy of Professor Alvin D. Compaan and his graduate students were very well received.

Weekly Seminars

A weekly "Brown Bag" seminar series is an important part of our summer program. Faculty members and/or outside speakers are asked to present a talk over the lunch hour for the chosen day. However during the first week, the students attended an orientation seminar to cover the basic items such as ID cards, parking, health services, food services, stipend checks, etc. This format fosters more of an informal atmosphere, which the students appreciate when it is their turn to give a presentation at the close of the summer session. This weekly meeting of the entire REU group also provides an opportunity to plan social events and field trips, and discuss any topics of interest to the group. The whole department is invited to attend the Bag Lunches, and the participation has been very good with many graduate students and faculty members also attending. This provides a useful departmental weekly gathering, otherwise absent in the summer. The talks at these weekly meetings are similar to standard physics research talks, but chosen to be appropriate for this REU audience, and with all the speakers being careful to give undergraduate-level introductions. The list of seminars is given below. We also required the students to give a 5 minute presentation of their research about midway into their summer period. These midway progress talks went well and kept the students focused on their projects. We plan to repeat this mid-term Progress talks for this coming summer.

Reports and Conclusion

We feel it is important to involve the students with all aspects of the scientific research process. To the extent possible, depending on the nature of the project, students participate in the selection of the problem, the choice of research method, the collection and analysis of data, the formulation of conclusions, and the presentation of the results. The research problems are parts of ongoing faculty research programs, which

are in most cases supported by external grants. At the same time, every effort is made to identify a piece of the research for which the REU student has the primary responsibility. The students are asked to write a final report, including a carefully-written abstract which could be submitted as a contribution to a regional or national meeting, as well as give a 15 minute presentation at a Bag Lunch in the final week of their research period. The typical length of the final reports is about 20 - 25 pages. The abstracts are included in this Report.

NSF-REU SUMMER 2002 APPLICATIONS

Geographical distribution by undergraduate institution

(82 Applications Received / 31 REU Offers Made / 13 REU Accepted)

Arizona
Arizona State University (2/0/0)

Arkansas
University of Arkansas (1/0/0)

California
California Polytechnic University (2/1/1)
Humboldt University (2/0/0)
Santa Rose Junior College (1/0/0)
Stanford University (1/0/0)
University of LaVerne (1/1/1)
University of California-Berkeley (1/0/0)
University of California-Santa Cruz (1/0/0)

Colorado
University of Northern Colorado (2/1/0)

Florida
Embry-Riddle Aeronautical Univ. (1/0/0)
University of South Florida (1/1/0)

Georgia
Berry College (1/0/0)

Illinois
Greenville College (1/1/0)

Indiana
Indiana University (1/0/0)

Iowa
Drake University (1/0/0)
University of Iowa (1/0/0)

Kansas
Fort Hays State University (1/1/0)
Hesston College (1/1/1)

Kentucky
Transylvania University (1/1/0)
Western Kentucky University (1/1/1)

Maine
University of Maine-Orono (1/1/0)

Maryland
University of Maryland (1/0/0)

Massachusetts
Clark University (1/0/0)

Michigan
Kalamazoo College (1/0/0)
Michigan State University (1/0/0)
Northern Michigan University (1/0/0)

Minnesota
Carleton College (2/0/0)
Gustavus Adolphus College (2/2/1)
Kenyon College (1/0/0)
University of Minnesota-Morris (1/0/0)

Mississippi
Mississippi State University (1/1/1)

Nebraska
University of Nebraska at Kearney (2/0/0)

New Hampshire
Worcester Polytechnic Institute (1/0/0)

New Jersey
The College of New Jersey (1/1/1)

New Mexico
New Mexico State University (1/0/0)

New York
Alfred University (1/1/0)
Cornell University (1/0/0)
Rensselaer Polytechnic Institute (1/0/0)

North Carolina
Duke University (1/1/1)
University of North Carolina (1/0/0)

Ohio

Baldwin-Wallace College	(1/1/1)
Dennison University	(1/1/0)
John Carroll University	(2/2/0)
Ohio Northern College	(2/1/0)
Ohio State University	(1/1/0)
University of Toledo	(5/3/2)
College of Wooster	(2/1/1)

Oklahoma

Cameron University	(1/0/0)

Oregon

Southern Oregon University	(2/1/0)
University of Oregon	(2/0/0)

Pennsylvania

Carnegie Mellon University	(2/1/0)
Moravian College	(1/0/0)

Rhode Island

Rhode Island College	(1/1/0)

Tennessee

Middle Tennessee State University	(1/0/0)

Texas

University of Texas at Austin	(2/0/0)

Virginia

Emory & Henry College	(1/0/0)

Washington

University of Washington	(2/1/1)

West Virginia

West Virginia University	(2/1/0)

Wisconsin

Beloit College	(1/0/0)
University of Wisconsin-Platteville	(1/0/0)

CANADA

University of Waterloo	(1/0/0)

NSF-REU SUMMER 2002 RESEARCH PARTICIPANTS

Phillip J. Durst	UT Faculty Research Advisor:	Jacques Amar
	Undergraduate Institution:	Mississippi State University
	Hometown:	Starkville, MS
Aaron Garcia	UT Faculty Research Advisor:	Song Cheng
	Undergraduate Institution:	University of LaVerne
	Hometown:	North Hollywood, CA
Levi Gorrell	UT Faculty Research Advisor:	Alvin Compaan
	Undergraduate Institution:	University of Toledo
	Hometown:	Delta, OH
Nicholas Harmon	UT Faculty Research Advisor:	Constantine Theodosiou
	Undergraduate Institution:	College of Wooster
	Hometown:	Berea, OH
Melissa Haugen	UT Faculty Research Advisor:	Alvin Compaan
	Undergraduate Institution:	Gustavus Adolphus College
	Hometown:	Brooklyn Center, MN
Andrew Hill	UT Faculty Research Advisor:	Jacques Amar
	Undergraduate Institution:	California Polytechnic University
	Hometown:	San Luis Obispo, CA
Chandra Jacobs	UT Faculty Research Advisor:	Nancy Morrison
	Undergraduate Institution:	Duke University
	Hometown:	Westlake Village, CA
Marleen Martinez	UT Faculty Research Advisor:	Steven Federman
	Undergraduate Institution:	University of Washington
	Hometown:	Seattle, WA
Jacquelyn Must	UT Faculty Research Advisor:	Adolf Witt
	Undergraduate Institution:	University of Toledo
	Hometown:	Dayton, OH
Rachelle Ramer	UT Faculty Research Advisor:	David Ellis
	Undergraduate Institution:	Hesston College
	Hometown:	Harper, KS
Jonathan Skuza	UT Faculty Research Advisor:	Thomas Kvale
	Undergraduate Institution:	Baldwin Wallace College
	Hometown:	Parma, OH
Christopher Verzella	UT Faculty Research Advisor:	Alvin Compaan
	Undergraduate Institution:	College of New Jersey
	Hometown:	Jackson, NJ

NSF-REU SUMMER 2002 STUDENT DEMOGRAPHICS

Gender

Female:	5
Male:	7

Class Rank (at the beginning of Summer)

Freshman:	1
Sophomore:	6
Junior:	4
Senior:	1
Higher:	0

Ethnicity

International Student:	0
American Indian:	0
Alaskan Native:	0
Asian American (or Pacific Islands):	0
African American:	0
Hispanic American:	2
Caucasian/White:	10
Other:	0

Home State:

California	(North Hollywood. San Luis Obispo, Westlake Village)
Kansas	(Harper)
Minnesota	(Brooklyn Center)
Mississippi	(Starkville)
New Jersey	(Jackson)
Ohio	(Berea, Dayton, Delta, Parma)
Washington	(Seattle)

Institution:

Baldwin Wallace College, OH
California Polytechnic University
College of New Jersey
College of Wooster, OH
Duke University
Gustavus Adolphus College, MN
Hesston College, KS
Mississippi State University
University of LaVerne, CA
University of Toledo
University of Washington

Grade Point Average: 3.46

NSF-REU SUMMER 2002 BROWN BAG SEMINARS
THURSDAY, NOON - MH 4009

June 5	David Ellis	*"Improving Wavefunctions for Complex Atoms"*
June 12	Bernie Bopp	*"Producing Elegant - and Bulletproof - PowerPoint"*
June 19	Jacques Amar	*"Kinetics of Submonolayer and Multilayer Epitaxial Growth"*
June 26	REU Students	Mid-summer Progress Reports
July 3	Al Compaan	*"Thin-film photovoltaics: clean and secure electricity"*
July 10	Nancy Morrison	*"Spectroscopy of Hot, Luminous Stars at Ritter"*
July 17	Ale Lukaszew	*"Interfacing a computer to your experiment: how to go about it..."*
July 24	Phil James	*"Two Mars Years of Observations by MGS"*
July 31	Thomas Kvale	*"Tickling Atoms with Light -- What we can learn from photodetachment of negative ions"*
August 6-7-8	REU Students	*"What I Did This Summer"* -- Final Research Project Presentations

NSF-REU SUMMER 2002 FINAL PRESENTATIONS

Department of Physics & Astronomy
The University of Toledo

Tuesday, 06 August, MH4009

12:00n	**Jonathan Skuza**	*"Energy Loss in Ion-Atom Collisions of H^{1}/He"*
12:20p	**Aaron Garcia**	*"Low Energy Proton Impact Disassociation of Acetylene Molecules"*
12:40p	**Chris Verzella**	*"Band Gap Photoluminescence Decay of CdTe Photovoltaic Cells"*
1:00p	**Levi Gorrell**	*"Temperature Dependence of Electroluminescence with CdTe Solar Cells"*

Wednesday, 07 August, MH4009

12:00n	**Rachelle Ramer**	*"Enhancement of wavefunctions for multi-electron atoms"*
12:20p	**Jackie Must**	*"Clumpy Dust in Reflection Nebulae"*
12:40p	**Jeff Durst**	*"Effects of Shadowing on 2-D Polycrystalline Growth"*
1:00p	**Melissa Haugen**	*"Raman Scattering in Thin Films"*

Thursday, 08 August, MH4009

12:00n	**Andy Hill**	*"Simulations of Epitaxial Growth with Shadowing"*
12:20p	**Nicholas Harmon**	*"Elastic Electron Scattering for Closed-shell Atoms "*
12:40p	**Chandra Jacobs**	*"Enhancement of the Control System in Ritter Observatory"*
1:00p	**Marleen Martinez**	*"The Abundance of CH^{+} in the Vicinity of the Pleiades"*

NSF-REU EXTERNAL PRESENTATIONS AND PUBLICATIONS (CY2002)

PRESENTATIONS. (REU students' names in **bold face type** with year of participation.)

R. L. Cooper (1999) and S. A. Lee, "*Differential scanning calorimetry study of deoxyadenosine and its water of hydration*," 2002 March Meeting of the American Physical Society, Indianapolis, IN, March 18-22, 2002.

Amanda Gault (2001), "*Be Stars: Modeling Their Polarization and Infrared Excess*," NASA/Ohio Space Grant Consortium 2001-2002 Annual Student Research Symposium Proceedings, OAI, OH, April 26, 2002.

Kathleen Hinko (2001) and A.D. Compaan, "*Photoluminescence of magnetron sputtered CdTe films: dependence on target purity, substrate, and annealing conditions*," 2002 March Meeting of the American Physical Society, Indianapolis, IN, March 18-22, 2002.

Brian R. Sunderland (2001), A. Gupta and A.D. Compaan, "*Nickel Phosphide as a Copper Free Back Contact for CdTe-Based Solar Cells*," 2002 March Meeting of the American Physical Society, Indianapolis, IN, March 18-22, 2002.

Thomas Kvale, "*Design Improvements in Faraday Cup Detectors*," 17th International Conference on the Application of Accelerators in Research and Industry, November 12-16, 2002, University of North Texas. (Invited Talk. **Joshua Thomas** (2001) acknowledged in the Abstract.)

Joshua Thomas (2001), "*Design Improvements in Data Collection Faraday Cup Detectors*," SPS Zone 7 Regional Meeting, Carnegie Mellon University, October 25-26, 2002.

Joshua Thomas (2001), "*Design Improvements in Data Collection Faraday Cup Detectors*," 2002 National Conference on Undergraduate Research (NCUR), University of Wisconsin-Whitewater, April 25-27, 2002.

Mehrdad Adibzadeh, Constantine Theodosiou, and **Nicholas Harmon** (2002), "*Elastic electron scattering from alkaline atoms*," 55th Annual Gaseous Electronics Conference, Minneapolis, MN, October 15-18, 2002.

REFEREED PUBLICATIONS. (REU students' names in **bold face type** with year of participation.)

J.G. Amar and **D.J. Baxter** (2000), "*Fluctuation-Induced Mound Coarsening in Two Dimensions*," Physica A 316, 19 (2002).

ABSTRACTS OF REU FINAL REPORTS
The University of Toledo
Department of Physics & Astronomy
SUMMER 2002

Effects of Shadowing on 2-D Polycrystalline Growth

Student: Jeff Durst
Advisor: Jacques Amar

Abstract:

The effects of shadowing in 2-D thin film growth were studied using a sputter deposition model. Both cosine and uniform angular distributions were studied. Also studied were the effects of an interfacet diffusion barrier. We find $n = 1/3$ and $\beta = 1$, where n is the mound coarsening exponent and β is the growth exponent, in the case of a cosine distribution with diffusion barrier, and $n = \beta = 1$ in all other cases. We find the facet length coarsening exponent $\delta = 0.8$ for uniform angular distributions. In the case of cosine distribution without diffusion barrier $\delta = 0.8$. Moreover, we find a power law distribution of side lengths of mounds in both cosine and uniform angular distributions when a diffusion barrier is absent. Plotting a scaled graph of $(N)(S_{av})/N_T$ vs. s/S_{av} where N is the number of sides, S_{av} is the average side length, N_T is the total number of sides, and s is side length. F or a uniform distributions, the exponent $\tau = 0.71$. For a cosine
distribution, $\tau = 0.44$. For a uniform distribution both with and without a diffusion barrier as well as a cosine distribution without barrier we find the surface roughening exponent $\alpha = 1.0$. In the case of cosine distribution with diffusion barrier, anomalous scaling of side lengths was found yielding $\alpha = 0.88$. More complex models in three dimensions, especially the cosine-barrier case, could provide a very physical model of experimental sputter deposition thin film growths.

Low Energy Proton Impact Disassociation of Acetylene Molecules

Student: Aaron Garcia
Advisor: Song Cheng

Abstract:

Electrostatic lens was designed via Simion 7 to decrease the kinetic energy of the incident ions from l5keV to 1.5 keV. Total cross sections for single electron capture, single ionization, double ionization, and electron capture plus ionization have been theoretically determined for a specific collision of protons at a specific energy of 1.5 keV with C_2H_2. Recoil time of flights were theoretically obtained for H^+, CH^+, and CH_2^+ fragmentations. In addition. a temporal distribution was obtained through a simulated time of flight spectrum.

Temperature Dependence of Electroluminescence with CdTe Solar Cells

Student: Levi Gorrell
Advisor: Alvin Compaan

Abstract:

In order for CdTe to become a contender in the solar cell market of the future it is imperative that more methods of understanding the properties of cells be produced. Of course when results of experiments don't fit the expected results then it becomes necessary to understand why the behavior is so different. In CdTe solar cells it is important to learn why the behavior of the Electroluminescence of the cells at varying temperatures is different than expected and what causes these differences in order to further our understanding of the cells.

Elastic Electron Scattering for Closed-shell Atoms

Student: Nicholas Harmon
Advisor: Constantine Theodosiou

Abstract:

Differential cross sections of Be, Mg, Ca, Zn, Cd, and Hg were calculated by our program relativistically and non-relativistically. Total cross sections, momentum transfer cross sections, and the Sherman functions were also calculated. The computational results agreed well with the available experimental data on these closed-shell atoms.

Raman Scattering in Thin Films

Student: Melissa Haugen
Advisor: Alvin Compaan

Abstract:

Solar power is quickly growing as an alternative source of energy. This safe, clean, durable technology is making its name as a contender to supply our future energy needs. There are several groups currently working to make solar power both cheap and efficient. They employ many techniques to characterize and study which procedures and materials make the best cells. Often, properties of certain materials provide vital information as to the inner workings of such cells. Physical as well as optical properties, such as Raman scattering, may be very benificial in the study of these materials.

Simulations of Epitaxial Growth with Shadowing in Three Dimensions

Student: Andy Hill
Advisor: Jacques Amar

Abstract:

Compared to simulations done in the past, relatively little attention has been given to models which include shadowing and diffusion. These cases have been for the most part ignored because they are harder to simulate than less realistic, easier to program models simulating vertical deposition in which particles do not move around once they land on the model. While studying the more realistic case of ballistic deposition with shadowing and diffusion, values of $\beta = 1$ and $n = 1$ were found when a uniform distribution was used, indicating an unstable system. Using a cosine distribution, values of $\beta = 1$ and $n = 0.70$ were discovered.

Enhancement of the Control System in Ritter Observatory

Student: Chandra Jacobs
Advisor: Nancy Morrison

Abstract:

This is a very abstract tale of Noah and Miranda, two components of the computer control system in Ritter Observatory at the University of Toledo. They are separated by an umbilical cord-like optical cable that allows Noah, the big strapping CPU on wheels up in the dome to communicate with Miranda, a computer sitting in the fifth floor Ritter control room. Although spoon-fed tender loving care at Ritter's infamous one-meter (40 inch) reflector telescope since a very young, impressionable age, they were unfortunately unable to fully communicate with each other until now -- that is where I come in. I modified Noah's existing telescope controlling program to allow a string containing the telescope's coordinates (right ascension, declination, local mean sidereal time, and hour angle) to pass to Miranda via the half-duplex fiber optic cable. Mission accomplished, and now when one observes in the middle of the night at Ritter Observatory, one does not have to make the desolate journey from the control room, up the flight of steps to the telescope, in order to see where in the sky the telescope is pointed nearly as often.

The Abundance of CH^+ in the Vicinity of the Pleiades

Student: Marleen Martinez
Advisor: Steven Federman

Abstract:

Detection of particular molecules in interstellar space is the beginning of the journey to unlock the mysteries of interstellar chemistry. Using spectroscopy of 20 Pleiades members has provided the foundation for analysis of molecules and gas clouds that are very near to the Pleiades. By analyzing these spectra using IRAF , the abundance and velocity of each molecule reveal interesting trends. For example, filamentary structure is seen in maps of C^+, CH, and Ca II velocity components. These maps will be used to study the relationship between these species.

Clumpy Dust in Reflection Nebulae

Student: Jackie Must
Advisor: Adolf Witt

Abstract:

By using Hubble's equation, log α = !0.2m + K, and data from nebulae catalogues and star catalogues, graphs and histograms were made as a reference basis. From the graphs of the observed data, two questions were asked: If one wants to use the Rubble equation to determine the optical properties of reflection nebulae, how do the physical characteristics such as viewing direction, optical depth, and albedo of the dust grains affect this? How well can the albedos of the dust grains be determined from the observational data? Sixty computer nebulae models were analyzed and compared to the observed data in order to answer these questions. This is the first of many sets of models to be analyzed in order to answer these questions. So far it was found that our models need to be modified in order to take into account dust limited nebulae. It was also found that a good reference to use to determine the albedo of dust in reflection nebulae might be to use the log of the nebular flux plotted against the log of the radius of reflection nebulae.

Enhancement of wavefunctions for multi-electron atoms

Student: Rachelle Ramer
Advisor: David Ellis

Abstract:

Theoretical physics tries to, among other things, model the world around us. One important model to have is the energies of electron orbitals. Although it is possible to find these energies experimentally, it is far simpler to find them through calculation. Of the several models used in the past, the one most used currently is Multi-Configuration Hartree-Fock. When a large number of configurations is used, MCHF provides a good approximation. However, there is an obvious problem. MCHF fails to consider electron correlation when the distance between electrons is relatively small. This can most clearly be seen by MCHF's failure to satisfy Kato's Theorem for the cusp in electron distribution functions at coalescence. For this paper a new wavefunction, ΨN, will be used, with ΨN = Ψ + α i where α is a constant, Ψ is the MCHF wavefunction, and i is an added correlation term. If α is adjusted to find the minimum energy in accordance with the variational principle an improved approximation for the energy can be found. The ground states of He and Li were used as test cases, for the reason that the actual energy is known for both cases. Both He and Li enhancements showed improvement over MCHF. For Li ^{2}S, the difference between the MCHF AS3 energy and the actual energy is !0.04533. Enhancement provides an improvement on MCHF AS3 energy of !0.00139. Clearly, some improvement is offered by enhancement. More configurations for various elements must be run, however, before definite conclusions can be drawn.

Energy Loss in Ion-Atom Collisions of H^1/He

Student: Jonathan Skuza
Advisor: Thomas Kvale

Abstract:

An electrostatic lens system is needed to focus a parallel or almost parallel ion beam at a specific point. The beam must be focused at the entrance to a hemispherical energy analyzer, so that data can taken. The lens system was designed going off of a previous design that had some complications. The design was significantly modified and tested, so that the lens system can be implemented into the University of Toledo's Positive/Negative Ion Energy Loss Spectrometer (UT-P/NIELS).

Band Gap Photoluminescence Decay of CdTe Photovoltaic Cells

Student: Chris Verzella
Advisor: Alvin Compaan

Abstract:

What is the motivation behind studying junction photoluminescence decay for CdTe solar cells? Photoluminescence decay had been observed in GaAs, GaN, Porous Silicon, and Chalcogenide glasses (As2Te3, etc.) however in each case it was attributed to properties specific to the material it was observed in. Earlier studies at The University of Toledo (UT) have shown the existence of photoluminescence decay in CdTe solar cells however the phenomenon has not been considerably studied. The goal of this project was to obtain photoluminescence decay data from various conditions, examine the data for trends, and attempt to fit a theoretical model non-specific to CdTe to the acquired data. All above objectives where obtained to a certain degree.

Faculty Mentor Research Profile, Dept. of Physics & Astronomy
The University of Toledo

JACQUES AMAR (Ph.D., Temple Univ., 1985)

Dynamics of thin-film and epitaxial growth, kinetics of phase separation, scaling and fractal aspects of materials, theory of condensed matter systems far-from-equilibrium, computational physics.

SONG CHENG (Ph.D., Kansas State University, 1991)

Intermediate-energy, atomic and molecular ion collisions.

ALVIN D. COMPAAN (Ph.D., Univ. of Chicago, 1971)

Growth and characterization of semiconductor thin films, laser ablation-deposition, rf sputtering, plasma CVD, ion implantation, laser annealing, solar cell fabrication, II-VI semiconductor light emitters.

DAVID G. ELLIS (Ph.D., Cornell Univ. , 1964)

Theoretical atomic physics, with special interest in spectroscopy of multiply ionized atoms, Rydberg states, relativistic effects in atomic structure, electron-atom collisions, coherent states produced by impulsive excitation.

STEVEN R. FEDERMAN (Ph.D., New York Univ., 1979)

Observational and theoretical investigations into physical processes in interstellar matter.

THOMAS J. KVALE (Ph.D., Univ. of Missouri-Rolla, 1984)

Intermediate-energy, experimental atomic physics concentrating on the dynamical interaction of ions and atoms in collisions. Spectroscopy and structure of negative ions and multiply-excited, near-neutral positive ions and atoms.

NANCY D. MORRISON (Ph.D., Univ. of Hawaii, 1975)

Determination of orbital elements and study of brightness variations in spectroscopic binary stars. Spectroscopic study of atmospheres and winds of supergiant stars.

CONSTANTINE E. THEODOSIOU (Ph.D., Univ. of Chicago, 1977)

Atomic structure and atomic collision processes; photoionization and multiphoton processes.

ADOLF N. WITT (Ph.D., Univ. of Chicago, 1967)

The nature of interstellar dust grains. Scattering and absorption properties of grains in the UV and visible. Near-IR luminescence by hydrogenated amorphous solids. Radiative transfer in reflection nebulae and globules. Depletion of heavy elements in space. Structure of interstellar clouds.

Research Experiences for Undergraduates in Physics and Astronomy Summer 2002

Department of Physics & Astronomy
The University of Toledo
Toledo, Ohio 43606

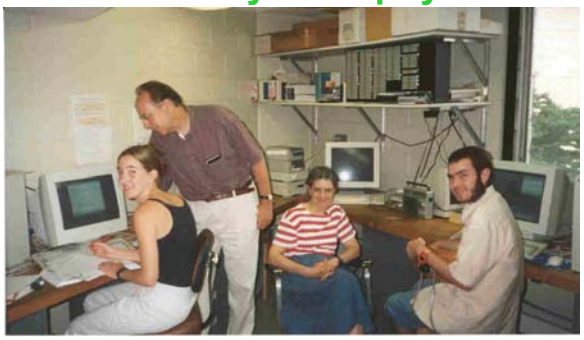
Appendix: Paper Program announcement and application form

Research Experiences for Undergraduates in Physics and Astronomy

Summer 2002

Department of Physics & Astronomy
The University of Toledo, Toledo, Ohio 43606

Astronomy/Astrophysics



Condensed Matter

Atomic Physics

Optoelectronics

Material Science

Research opportunities are also available in:

Biological Physics

and

Plasma Physics

www.physics.utoledo.edu and click on REU

For more information, please visit our website: www.physics.utoledo.edu and click on REU.

APPLICATION for the University of Toledo
NSF-REU Summer Research Program

03 June 2002 - 09 August 2002

Name (First, Middle Initial, Last): _____

Permanent address (line 1): _____

Permanent address (line 2): _____

Permanent address (line 3): _____

Permanent address City, State, Zip Code: _____

Email Address: _____

Telephone Number: _____

College or university you are currently attending: _____

Current address (line 1): _____

Current address (line 2): _____

Current address (line 3): _____

Current address City, State, Zip Code: _____

Email Address: _____

Telephone Number: _____

Expected Date of Graduation: _____

US citizen (or permanent resident): YES ____ NO ____

Please number your top three (1 - 2 - 3) choices for doing research in the subfields of Physics and Astronomy represented in our department.

Astronomy/Astrophysics: _____ Atomic physics: _____

Biological physics: _____ Condensed matter physics: _____

Materials science: _____ Optical physics: _____

Plasma physics: _____

Please indicate your preference (1 - 2 - 3) for the type of research you are interested in doing.

Experimental/observational: _____ Computational: _____

Theoretical: _____

Please arrange for **two letters** of recommendation and your **college transcript** to be sent to me at the address listed at the end of this Application.

Reference #1 Name: _____

Address (line 1): _____

Address (line 2): _____

Address (line 3): _____

City, State, Zip Code: _____

Email Address: _____

Telephone Number: _____

Reference #2 Name: _____

Address (line 1): _____

Address (line 2): _____

Address (line 3): _____

City, State, Zip Code: _____

Email Address: _____

Telephone Number: _____

Please have your letters of recommendation and the official transcript sent to:

Prof. Thomas Kvale, REU summer director
University of Toledo
Department of Physics & Astronomy, M/S 111
Toledo, OH 43606

Please include a brief description of your computer-, apparatus-, experimental-, and/or electronics-skills, and other relevant information for us to consider on a separate sheet of paper.

We will send you an acknowledgment of receipt of your application as soon as possible. If you can, please also send an email note to me (tjk@physics.utoledo.edu) informing me of your application. If you can't attend from June 03 - August 09, please inform us of when you can attend our program.

Thank you for your interest in our research program.