----Some controversies are only misunderstanding----The Big Picture - University of Rochester The smallest major research university (among the 29 tier-one research universities) in terms of students and faculty size (but not in terms of research funding and facilities) *About 3600 undergraduates (900 per year) About 3000 graduate students* About 300 faculty in the College (River Campus) About 300 faculty in the Medical School (also Eastman School of Music, and Laboratory for Laser Energetics). Departments at Rochester are about half the size of departments at larger universities.

*Individually we are small, collectively we are large and diverse.* Individual large departments usually fragment into subfields which rarely communicate with each other.

•However, having small departments can be advantageous;

Promotes collaboration between departments and research laboratories - all of UR facilities become available.

And, everybody counts, so

• Aim to provide a supportive environment to our faculty, graduate students, and undergraduates.

# Philosophy of Education:

Depth, Breadth and Diverse

National Academy of Science Committee on Science, Engineering, and Public Policy (COSEPUP) recommended in a 1995 report on "*Reshaping the Graduate Education* of Scientists and Engineers [1d] that:

"To produce more versatile scientists and engineers, graduate programs should provide options that allow students to gain a wider variety of skills. Greater versatility can be promoted on two levels. On the academic level, students should be discouraged from overspecializing. Those planning research careers should be grounded in the broad fundamentals of their fields and be familiar with several subfields. Such breadth might be much harder to gain after graduation. On the level of career skills, there is value in experiences that supply skills desired by both academic and nonacademic employers."

Philosophy of Education: Training Future Leaders

The 1995 National Academy report added that the future training of graduate students should include "especially the ability to communicate complex ideas to non-specialists and the ability to work well in teams. Off-campus internships in industry or government can lead to additional skills and

exposure to authentic job situations."

(I would add, those who fund both education and scientific research must be kept informed of latest developments) <sup>3</sup> One of the most important long term influences on the reputation of a scientific institution is the impact of its Ph.D. graduates.

Good mentoring pays off.

#### Department of Physics and Astronomy At the University of Rochester

	•	
Chair	- Arie Bodek	
Director of Undergraduate Studies	- Nick Bigelow	
(TA and RA support)		
Assistant Chair	- Sondra Anderson	
Teaching Faculty: 30 primary in Physics a	and Astronomy + 15 (joint appointments) (1	1/3)
+ 40 (cross disciplinary physics progra	ims many in the school of engineering	
have PhD degrees in applied physics).		
Research Faculty	- 10	
Research Associates	- 40	
Graduate Students	-120 (20/year)	
Undergraduate Majors	- 60 (20/year)	
+ Technical and Administrative Support		
<b>Facilities:</b>		
Barnes Computing Center - 3 system mana	gers	
Barnes Laboratories: Electronics, Design an	d Machine Shops (Design, Electronics Mach	ninist)
Research Labs in Particle and Nuclear Phys	ics	
Laboratory for Laser Energetics (LLE); Med	es Observatory; Institute of Optics	
Center for Photoinduced Charge Transfer R	eactions	
B&L Research Laboratories in Astrophysics	s, Condensed Matter, Quantum Optics, etc.	
Strong Medical School (Biological/Medical	Physics)	
Facilities at Xerox and Kodak, and collabor	ating UR departments	5
Experiments at Fermilab, CERN, Brookhav	en, CLEO (Cornell), Jefferson Lab, JPARC(Ja	apan)

#### Optics is by its nature an interdisciplinary science

Insti	tute of Optics Faculty - Scl	nool of Engineering - Primary, Secondary, Tertiary Appointments,
1.	Govind P. Agrawal	Optics, Physics, LLE. Fiber Optics, Lasers, Commun (PhD Physics)
2.	Miguel Alonso	Optics - Mathematical Models of Wave Propagation (PhD Optics)
3.	Andrew J. Berger	Optics - Medical Optics (PhD Physics)
4.	Nicholas P. Bigelow	Physics, Optics, LLE - Quantum Optics (PhD Physics)
5.	Robert W. Boyd	Optics, Physics - Nonlinear Optics (PhD Physics)
6.	Thomas G. Brown	Optics, LLE - Optoelectronics (PhD Optics)
7.	Joseph H. Eberly	Physics, Optics, LLE Quantum Optics (PhD Physics)
8.	Philippe Fauchet	Electrical & Computer Engineering, Optics Ultrafast Science,
	Semiconductor Optoelec	tronics (PhD Applied Physics)
9.	James R. Fienup Opt	ics - Image Processing, Wave Front Sensing (PhD Applied Physics)
10.	Thomas H. Foster	Radiology, Physics, Optics - Photodynamic Therapy (PhD Physics)
11.	Nicholas George	Optics, ECE - Physical Optics, Imaging (PhD. EE)
12.	Chunlei Guo	Optics, High Intensity Lasers Interactions, Ultrafast (PhD Physics)
13.	Susan N. Houde-Walter	Optics. Optical Materials and Optoelectronic Design (PhD Optics)
14.	Stephen D. Jacobs	LLE, Chemical, Engin. Optics - Liquid Crystal (PhD Optics)
15.	Wayne H. Knox	Optics, LLE (PhD Optics)
16.	Duncan T. Moore	Optics, Optical Engineering Optical Engineering, Lens Design,
	Manufacturing, & Gradie	nt-Index (PhD Optics)
17.	Lukas Novotny	Optics, LLE - Optics on the Nanometer Scale (PhD Physics)
18.	Wolf Seka	LLE, Optics - Laser Physics and Engineering (PhD Physics)
19.	Carlos R. Stroud	Optics, Physics - Quantum Optics (PhD Optics)
20.	Kenneth J. Teegarden	Optics - Optical Materials, Fiber Optics (PhD Physics)
21.	Gary W. Wicks	Optics - Epitaxy, Semiconductor Lasers (PhD Applied Physics)
22.	David R. Williams	BCS, Optics - The Human Visual System (PhD Psychology)
23.	Emil Wolf	Physics, Optics - Physical Optics, Coherence Theory (PhD Physics)
24.	James Zavislan	Optics, Biomedical Optical Systems (PhD Optics)
8 Fa	culty with primary outside	e of Optics; faculty PhDs in the Institute of Optics: 15 Physics, 1 EE,
	<b>1 Psychology</b> , 7 Optics	. Fraction of faculty with primary appointments elsewhere is $1/3$
	(like Physics)	

#### More of the big picture - everything is inter-related

#### Leading Towards the Future, instead of coasting on the Past

In 1950's and 1960 U of R Lead the Way, Ahead of all Ivy League Institutions in several ways: I will mention only two-done on moral grounds (win-win)

A. *Opening its doors to undergraduate minorities such as Jews and Oriental Americans* - while Ivy League schools had quotas. This propelled the UR to become a leading institution for very talented undergraduates - --And later

B. Robert Marshak, Chair of the Department of Physics and Astronomy (later to become president of CCNY) and started the *Rochester International Conferences in High Energy Physics* - inviting top European, Russian, Indian, Japanese scientist to the USA, and encouraging talented foreign students to come to Rochester (in the height of the cold war). This conference is still called the Rochester conference. This resulted in scientists abroad encouraging their best graduate students to come to Rochester , and Rochester becoming known as a leading International Institution...And later

7

C. Win-win - Emphasis on excellence, while others got mired in elitism...



Rochester Graduate Nobel Winners in Physics Breadth and Depth and Diverse

We aim to train the next generation of top scientists in the 21st century.



Steve Chu - Nobel Prize in Physics **1997** Laser Cooling and Trapping (Stanford University - Physics and Applied Physics)

**BS, Physics and Math UR, 1970** 

**BS work - Particle Physics UR (Ferbel)** 

PhD work - Optical Science

Current Research - Biological Physics King Faissal Prize (Saudi Arabia) Physics

Masatoshi Koshiba - Nobel Prize Astrophysics - **2002** Supenova Neutrinos (U. Tokyo-detector designed to look for proton decay) **UR PhD, Exp. Particle Physics 1955;** Panofsky Prize Particle Physics, 2002; Wolf Prize (Israel) 2002 Astrophysics.

Was Okubo's room-mate

Breadth and Depth Important Within a Subfield American Physical Society W.K.H. Panofsky Prize in Experimental Particle Physics: To recognize and encourage outstanding achievements in Experimental Particle Physics. Prize of \$5,000 presented annually.

**2004 Arie Bodek** (University of Rochester-Faculty) "For his broad, sustained, and insightful contributions to elucidating the structure of the nucleon, using a wide variety of probes, tools and methods at many laboratories."

**2002** Kajita Takaaki, **Masatoshi Koshiba** (UR PhD in Particle Physics,1958) and Yoji Totsuka (University of Tokyo) *"For compelling experimental evidence for neutrino oscillations using atmospheric neutrinos."* (Note this was an accident, detector designed to search for proton decay!)

**1999 Edward H. Thorndike** (University of Rochester-Faculty) *"For a leading role in milestone advances in the study of the b quark with the CLEO collaboration."* 







APS Nicholson Medal for Humanitarian Service: To recognize the humanitarian aspects of physics and physicists.

#### 2001 Nicholson Medal for Humanitarian Service to D. Allan Bromley *Yale University*

"For his roles as a research scientist, an outstanding teacher, a supportive mentor and colleague, a leader of the physics community in this country and worldwide, and advisor to governments." UR Physics PhD in Nuclear Physics,1952

He was the first Cabinet level Assistant to the President of the United States for Science and Technology and Director of the White House Office of Science and Technology Policy (1989-1993). He is a member of the National Academy of Sciences and in 1988 was awarded the National Medal of Science. He has served as President of the AAAS, of IUPAP, and of APS and holds 32 honorary doctorates



#### Rochester Alumni Now Lead Three Hadron Collider Experiments (CDF, Dzero, and CMS at FERMILAB and CERN)

**CDF:** 2003:Young-Kee Kim- Chicago (UR Physics PhD 1990) co-spokesperson of CDF- named by Discover Magazine as one of 20 young scientist to watch for the next 20 years (product of Rochester-Japan-Korea AMY collaboration)

**Dzero**: 2002: Gerald C. Blazey NIU, a former U of R Senior Research Associate, cospokesperson of the Dzero Collaboration

**CMS-LHC:** 1998: Dan Green-Fermilab (UR Physics PhD 1970) is the manager of the US-CMS Collaboration at the Large Hadron Collider at CERN







# First Fermilab Tollestrup Award for best postdoctoral work 2003

Fermilab Today: Jan 15, 2004

(L-R) Juan Estrada (Fermilab), Florencia Canelli (UCLA) and Gaston Gutierrez (Fermilab) are responsible for this new measurement of the top mass, and have also contributed extensively to the construction of the Central Fiber Tracker for Run II. **Florencia's and Juan's PhD theses at the University of Rochester** were based on these novel analyses of data.

Juan Estrada, Rochester Physics PhD 2002, Wins the First URA Tollestrup Award for Best Postdoctoral Work Done at Fermilab in 2003



Two Years in a Row Universities Research Associate Best PhD Thesis Award \$3000 Award:

Un Ki Yang (Rochester Physics PhD 2001) Selected to Receive the URA/Fermilab Award for Best Ph.D. Thesis Done at Fermilab in 2002

# Michael Fitch (Rochester Physics PhD 2000) Selected to Receive the URA/Fermilab Award for Best Ph.D. Thesis Done at Fermilab in 2001

Since prize was introduced in 1998 it was won by:

Ian Adam, Columbia 1998 (on Dzero Experiment)

Peter Maksimovic, MIT 1999 (on CDF Experiment)

Peter Shawhan, Chicago 2000 (on KTeV Kaon Experiment)

Michael Fitch, **Rochester 2001** (Accelerator Experiment, advisor Adrian Melissinos, Cross Disciplinary Physics))

Un Ki Yang, **Rochester 2002** (CCFR/NuTeV Neutrino Experiment, advisor Arie Bodek - MS student on US-Japan-Korea AMY collaboration)

Valmiki Prasad, Chicago 2003

Maria Florencia Canelli, **Rochester - nominated in 2004** on Dzero Experiment- Helicity of the *W*boson in single-lepton topanti top events ( we wish her luck!)





#### Both Breadth and Depth are Important

#### Rochester Ranked 6th in Atomic/Molecular/Optical/Plasma (AMO/Plasma) in 2003 US News Survey

- 1. Massachusetts Institute of Technology (MA)
- 2. University of Colorado, Boulder
- 3. Stanford University (CA)
- 4. Harvard University (MA)
- 5. University of Michigan, Ann Arbor
- 6. University of Rochester (NY)
- 7. University of California, Berkeley
- 8. University of Texas, Austin
- 9. California Institute of Technology
- 10. Princeton University (NJ)
- 11. University of Washington
- 12. University of Arizona
- 13. University of California, Los Angeles
- 14. Georgia Institute of Technology
- 15. Kansas State University; Rice University; University of Maryland, College Park; University of Virginia

AMO/Plasma: both are collaborative programs between Physics and Optics, and Physics, Mech E and LLE

Physics Faculty - Fundamental Atomic Physics/Optics Nicholas P. Bigelow; John C. Howell

Joseph H. Eberly-Charles Townes Award, OSA (1994) Emil Wolf -

Esther Hoffman Beller Award (Optical Society of America, 2002). President of the OSA, Frederic Ives Medal OSA, Albert A. Michelson Medal, Franklin Institute Max Born Award, OSA Institute of Optics Faculty - Optics









*Fundamental and Applied Optics (Agrawal, Boyd, Stroud Joint Appointments)* ECE, Chemistry, Chem E, BME, Med School - *Applied AMO Physics* 

Physics Faculty - Fundamental Plasma Physics and Astrophysics Eric G. Blackman; Adam Frank Mechanical Engineering/LLE Faculty -Applied Plasma Physics

Riccardo Betti, Robert L. McCrory, David D. Meyerhofer; Albert Simon; John H. Thomas !







**APS Julius Edgar Lilienfeld Prize Purpose:** To recognize a most outstanding contribution to physics. prize consists of \$10,000

**2004 Lilienfeld Prize to H. Jeff Kimble California Institute of Technology** "For his pioneering work in quantum optics, for his innovative experiments in singleatom optical experiments, and for his skill in communicating the scientific excitement of his research to a broad range of audiences.

U of R Physics PhD 1977 (with Len Mandel, Quantum Optics) Award on Elected to the National Academy Communic 2000



Einstein Prize for Laser Physics (1989), the Albert A. Michelson Medal of the Franklin Institute (1990), the Max Born Award of the Optical Society of America (1995), and the International Award on Quantum Communication (1998).

#### Both Breadth and Depth are Important

American Physical Society Biological Physics Prize: To recognize and encourage outstanding achievement in biological physics research. Prize consists of \$5,000(biennially).

1994 **Biological Physics Prize** - **Robert S Knox** University of Rochester Physics Faculty member

BS Engineering Physics 1953

PhD in Physics (and Optics) - Univ. of Rochester 1958 Faculty member, Physics, Univ. of Rochester

- Previous research Optical Physics, Biological Physics
- •Most recent research publication 2004 Earth Climate
- •Other accomplishments Past Chair, UR Physics& Astronomy

(Also father of Wayne Knox, Chair and Director, Institute of Optics)

AIP Industrial Applications of Physics Prize 2003 and 1998 Biological Physics Prize: Rangaswamy Srinivasan UVTech Associates PhD Physical Chemistry, UR Postdoc 1960







APS George E. Pake Prize: To recognize and encourage outstanding work by physicists combining original research accomplishments with leadership in the management of research or development in industry. Prize consists of \$5,000,

## 2002 George E. Pake Prize to Paul M. Horn *IBM* For his innovative contributions to the understanding of 1/f noise, the elucidation of surface phases and phase transitions, and his signal achievements in managing IBM Corporation's global research team." U of R PhD Physics 1973



(Condensed Matter Physics)

Currently Research Director of IBM

# UR Physics and Astronomy Ranked 2nd Nationwide in Overall Graduate Student Satisfaction in 2001

A nationwide survey of graduate students ranks the Department of Physics and Astronomy 2nd place in overall graduate student satisfaction. Categories studied were as follows:

# **Ranking Criteria:**

Overall Satisfaction - 2nd place

 Information for Prospective Graduate Students- 1st place

- Preparation for a Broad Range of Careers 2nd place
- Teaching and TA preparation 4th place
- Professional Development 3rd Place
- •Career Guidance and Placement Services -1st Place
- •Controlling Time to Degree 8th Place
- Mentoring 3rd place
- Program Climate 2nd Place

Over 400 Rochester graduates hold faculty positions in schools and programs ranked among the top 25 in the **US** (not including Rochester or Foreign), 36 from Physics and Astronomy and 6 from Optics <a href="http://www.rochester.edu/gradstudies/PhDs.html">http://www.rochester.edu/gradstudies/PhDs.html</a>

- 1) UC Berkeley Korkut Bardakci UR PhD physics Professor of Physics
- 2) Yale Allen D. Bromley physics Sterling Professor of the Sciences
- 3) MIT Daniel J. Ehrlich optics Professor of Biomedical Engineering & Director of Biomems Laboratory
- 4) Pennsylvania Deva Pattanayak physics Professor of Physics
- 5) Chicago **Young-Kee Kim** physics Professor of Physics
- 6) Chicago Donald Q. Lamb physics Professor of Astronomy and Astrophysics
- 7) Cal Tech H. Jeff Kimble physics William L. Valentine Professor of Physics
- 8) Michigan Theodore B. Norris physics Professor of Electrical Engineering and Computer Science
- 9) Wisconsin Sridhara Rao Dasu physics Assistant Professor of Physics
- 10) Cornell Alexander L. Gaeta optics Associate Professor, Applied & Engineering Physics/Director, Graduate Studies
- 11) Cornell Terry L. Herter physics Professor of Astronomy
- 12) Cornell Joseph Rogers physics Associate Professor of Physics
- 13) Johns Hopkins Frederic M. Davidson physics Professor of Electrical and Computer Engineering
- 14) North Carolina John Hernandez optics Professor of Physics
- 15) Washington Gordon Watts physics Assistant Professor of Physics
- 16) Texas Karol Lang physics Professor of Physics
- 17) Texas Charles Radin physics Professor of Mathematics
- 18) Texas Jack L. Ritchie physics Professor of Physics
- 19) Texas E.C. George Sudarashan physics Professor of Physics

#### continued

- 20) Texas Donald E. Winget physics Professor of Astronomy
- 21) Virginia Bob Hirosky physics Assistant Professor of Physics
- 22) Minnesota Ronald Poling physics Professor of Physics
- 23) Minnesota Charles E. Woodward physics Associate Professor of Astronomy
- 24) Vanderbilt Didier Saumon physics Assistant Professor of Physics and Astronomy
- 25) Penn State Iam-Choon Khoo physics Professor, **Electrical Engineering**/Director Liquid Crystals&Nonlinear Optics Lab.
- 26) Penn State Bruce P. Wittmershaus physics Associate Professor of Physics
- 27) Notre Dame Samir K. Bose physics Professor of Theoretical Physics
- 28) Stony Brook Thomas Hemmick Physics, Associate Professor of Physics
- 29) Maryland Mario Dagenais physics Professor of Electrical Engineering
- 30) Maryland Sarah C. Eno physics Associate Professor of Physics
- 31) Maryland Rabindra N. Mohapatra physics Professor of Physics
- 32) Maryland Rajarshi Roy physics Professor of Physics
- 33) Arizona James C. Wyant optics Professor of Optical Sciences, Director Optical Sciences Center
- 34) Mayo Michael G. Herman physics Assistant Professor of Medical Physics
- 35) Rutgers Mark Croft physics Professor of Physics and Astronomy
- 36) Amherst Kannan Jagannathan physics Professor of Physics
- 37) Bowdoin Mark O. Battle physics Assistant Professor of Physics
- 38) BrynMawr Michael Noel optics Assistant Professor of Physics
- 39) Hamilton James Walter Ring physics Winslow Professor of Physics
- 40) Oberlin Robert E. Warner physics Longman Professor of Natural Sciences
- 41) Duke Daniel J. Gauthier optics Associate Professor of Physics
- 42) Duke Moo Young Han physics Professor of Physics

# Title: NSF: Integrative Graduate Education and Research Traineeship Program (IGERT)

E-mail: lclescer@nsf.gov

Program URL: http://www.nsf.gov/pubs/2004/nsf04550/nsf04550.htm SYNOPSIS:

Support is provided to U.S. Ph.D. degree-granting institutions to facilitate greater diversity in student participation and preparation, and to contribute to the development of a diverse, globally-engaged science and engineering workforce. It is anticipated that **\$30.8 million will be available to fund thirty eight** new and renewal awards. Deadline(s): 04/29/2004





PAS has encouraged majors to become double majors. At present, double-majors consist of 50% of our undergraduate class (10 out of 20). Mostly Math, some Optics, some Music, etc.

We practice what we preach - we encourage opportunities for educational breadth and depth.

"Know everything about something and know something about everything."

Introducing BS/MS - Medical Physics this year (proposed by Med School) + BS/MS(education)

Graduating Year	1986	1987	1988	1989	1990	1991	1992	1993	
All Majors in PHY & PAS!!!	19	27	15	23	16	11	17	11	
Double Majors	9	4	3	7	4	1	1	0	
Graduating Year	1994	1995	1996	1997	1998	1999 2	2000 20	001	
All Majors in PHY & PAS!!!	23	15	12	18	24	12	17	16	
Double Majors	3	3	4	5	4	4	8	10	
Graduating Year All Majors in PHY & PAS!!! Double Majors	2002 2003 20 10								
PHY = physics, PAS = physic	es and astrone	omy							

Back to the future: 21st century science will become more interdisciplinary.

A private university must also excel in undergraduate education (Undergraduate Education subsidizes graduate education) 24

# The Big Picture - Responsibility to both undergraduate and

graduate education Undergraduate Tuition pays for Academic Faculty Salaries and for Graduate Stipends in first year, American Taxpayer pays for Faculty Summer salary and for Graduate Stipends after 2nd year. Physics faculty authored 35 textbooks (15 at the undergraduate level and 25 at the graduate level). The book PRINCIPLES OF OPTICS [11], by Born and Wolfs is one of the three mo cited books in Physics. Prof. Emil Wolf 2002 OSA Esther Hoffman Beller Award for Contributions to Optics Education.

**Prof. Steven Manly** was named the **Mercer Brugler Distinguished** Teaching Professor in the College in 2002, and NY State Professor of the Year in 2004 by the Carnegie Foundation for the Advancement of Teaching.

**Prof. Judy Pipher** was awarded the **University's Susan B. Anthony** 

Lifetime Achievement Award for contributions to teaching and research.

Prof. Eberly, Wolfs, Slattery, Auchincloss/ **Bodek/Orr** -5 UR Goergen Awards **Prof. Das, Wolfs, Orr - 3 UR Curtis awards Prof. Tipton, Bocko UR Teacher of the Year Award Prof. Wolf, Bigelow, Meyerhofer, Foster 4 UR Graduate** graduate teaching awards Sixteen Faculty won Department Teaching Award











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Are Breadth Depth and Diverse Important? About 2/3 of Rochester Physics Graduates (>700 PhDs) enter Academia About 1/3 stay as faculty members in various departments

Some Rochester Physics graduates come back to Rochester as faculty

Susumo Okubo - UR Professor of Physics - Particle Physics -UR PhD Particle Physics theory 1958 (Nishina Prize in 1976) (Marshak's program for Japanese Foreign Students) Paul Tipton - UR Professor of Physics - Particle Physics - UR PhD Particle Physics experiment 1987

Robert Knox - UR Professor of Physics - Biophysics -UR PhD in Physics and Optics 1958

Mark Bocko - UR Professor of Computer and Electrical Engineering (and Physics) - Superconducting Electronics - UR Physics PhD 1984

Tom Foster - UR Professor of Radiology (and Physics and Optics) -Cancer Photodynamic Therapy - UR Physics PhD 1990 Esther Conwell - UR Professor of Chemistry (and Physics) Biological Chemistry and Physics - UR MS 1945 - with Weisskoff Theoretical Physics she is a member of all three academies National, American, Engineering)

Thomas A. Edison Medal of the IEEE in 1997 Lewis Rothberg - UR Professor of Chemistry (and Physics) Biological Chemistry and Physics - UR Physics BS 1977 David Mathews - UR Assist Prof of Riochemistry and Riophy

David Mathews - UR Assist Prof of Biochemistry and Biophysics - Computational Biology of RNA (UR Physics BS 1994, UR Chemistry PhD 2002 UR MD 2003)















#### **Physics at small distances: <u>18 faculty (+ 6 Senior Scientists)</u></u>**

Particle Physics (13 faculty) + Ginther, Sakumoto, Budd, deBarbaro, Zielinski Bodek, Demina, Ferbel, Melissinos, McFarland, Slattery, Thorndike, Tipton - Expt Das, Hagen, Rajeev, Okubo, <u>Orr - Theory</u>

















<u>Nuclear Physics/Heavy Ions</u> (5 faculty) **+Wu** Cline, Manly, Wolfs,

(Schroeder-nuclear chemistry) - Expt.

Koltun -Theory

() = faculty with an appointment in another department who participate in the Cross-Disciplinary Physics Program

Experiments at Fermilab (Neutrinos, CDF, Dzero), CERN (LHC-CMS), Cornell (CLEO), BNL (RHIC), LBL, (Japan - JHF/KEK neutrinos), Jefferson Lab, LIGO, and other facilities



# **Physics at large distances:**

<u>Astronomy and Astrophysics (9 faculty + 4 collaborating faculty)</u> Forrest, Pipher, Watson, Quillen - Experiment /Observation Blackman, Helfer, Frank, *Thomas*, Van Horn - Theory

(+ Collaborative Program with 4 faculty at RIT)





<u>Plasma Physics and Laser Fusion (6 faculty+3 collaborating faculty)</u> Frank, Blackman, *Betti, Meyerhofer, McCrory, Simon* - Exp/Theory + LLE (*Craxton, Knaur, McInistrie*)



#### **Physics at intermediate distances:**

Condensed Matter Physics (6 faculty)

Bocko, Douglass, Gao, Wu, Spoonhower - Expt.

Shapir, Teitel - Theory





Quantum Optics and Optical Physics (7 faculty)

Bigelow, Howell, *Boyd* - Expt *Agrawal*, Eberly, *Stroud*, Wolf - Theory







**Biological and Medical Physics (5 faculty)** 

Foster, Zhong, Knox. Rothberg, Conwell - Exp/Theory









**CROSS DISCIPLINARY PHYSICS PROGRAM** Accelerator Physics (With Fermilab) currently 2 students **Atomic and Molecular Physics Biological and Medical Physics Chemical Physics Communication, Computational and Information Plasma Physics and Fusion Imaging Science and Astrophysics Condensed Matter Physics Low Temperature Physics** Materials Science Micro-Electronics **Optical and Laser Physics** Quantum Optics Industry

40 external advisors in other departments: Laser Lab; Optics; Chemistry; Electrical, Chemical & Mechanical Engineering; BME, Medical School; Math; Brookhaven National Lab, Fermilab, Kodak, Lucent, etc.

+ internal advisor in Physics and Astronomy

Approximately 30% of our students do Ph.D. theses in this 2-advisor mode. The PhD degree is in Physics. There is an average of one seminar every day of week.

- 1. <u>Weekly Graduate Research and Teaching Seminars</u>
- 2. <u>Weekly colloquia</u> and <u>seminar series</u> in Astrophysics, Particle Physics, Condensed Matter Physics, Quantum Optics, Mathematical Physics

Communication Skills: All graduate students attend TA training and TA for one year (usually the first year).

Certificate in College Teaching of Physics (5 each year) for future faculty members:

- $\rightarrow \qquad \text{A program to train graduate students to teach} \\ \text{a course as a full instructor (for teaching careers)}$
- → Graduate TA's are trained during the academic year as TA's in an introductory undergraduate physics course
- $\rightarrow$  Subsequently, they teach the same course as a full instructor in the summer session.

As a result of this program, some PhD's have gone directly into faculty positions (e.g., at SUNY Geneseo).

Mostly our graduates first build up their research career as postdocs.

What about communicating with general public - We run a variety of outreach programs for Undergraduates (REU), High School Students, High School Teachers, and the General Public And



Adam Frank, Professor of Physics and Astrophysics at Rochester received the 1999 Popular Writing Award of the from the American Astronomical Society.

Michael Riordan (UR PAS Scientist 1983-1987-Particle Physics) Received the 2002 Andrew Gemant Award by the American Institute of Physics for "skillfully conveying the excitement and drama of science and for clarifying important scientific ideas through his many books, articles and television programs" Where do our graduate students go? Physics has graduated more than 700 Ph.D.'s

At present, about 1/3 or 250 are faculty members at Universities or Academic Research Institutes.

However, they start 2/3 in Academia and 1/3 in Industry In 1999-2000: 28 Ph.D. Graduates (14 per year)

Universities+Labs: 18 (in 99/00) or 2/3 14 Postdocs (Research), 3 Assist. Professors (Teaching), 1 Astronaut

> Industry: 10 (in 99/00) or 1/3 8 Scientists/Engineers, 2 Business

<u>PhD</u>	Employer.	<u>Name</u>	<u>Title</u>	<u>Advisor</u>	
1999	Univ. Washington-St. Louis, Elec. Engr.	Carney, Paul Scott	Postdoc	Wolf, E.	QOT
	Dept.				
1999	Brookhaven National Lab.	Chaloupka, Jan Lucien	Postdoc	Meyerhofer, D.	QMX
1999	TRW	Goodno, Gregory	Scientist	Miller, R.J.D./Bigelow, N.	СМХ
1999	Halcyon Inc., Toronto	Gupta, Vinita	Marketing Coordinator	Myers Kelley, Anne	CMX
1999	Sierra Monolithics	Herr, Andrea	Scientist	Bocko, M.	CMX
1999	Rio Grande Medical Tech.	Hull, Edward L.	Sr. Scientist	Foster, T.	BPX
1999	The Hartford	Khan, Adil A.	Analyst	Schnidman, Y./Shapir, Y.	CMT
1999	Univ. Copenhagen	Lee, Chi-Wei Herbert	Postdoc	Rajeev, S.	PPT
1999	Univ. Washington	Markiel, J. Andrew	Postdoc	Thomas, J./Van Horn, H.M.	A/AP
1999	Univ. Maryland	McNaught, Stuart James	Postdoc	Meyerhofer, D.	PPF
1999	Corning, Inc.	Rahman, Ashiqur	Research Scientist	Eberly, J.H.	QOT
1999	University of Michigan	Reis, David A.	Postdoc.	Melissinos, A.C.	PPX
1999	Univ. Rochester	Simon, Michael Wilhelm	Postdoc	Cline, D.	NPX
2000	Univ. Rochester	Begel, Michael	Postdoc	Slattery, P.	PPX
2000	Albright College	Buerke, Brian	Assist. Prof.	Meyerhofer, D.	PPF
2000	Naval Aviation School	Cassada, Josh	Astronaut Training	Tipton, P.	PPX
2000	Pebbles Technologies	Dadusc, Gami	Engineer	Miller,Dwayne/Wolf, E.	CMX
2000	Advant!	Delamarter, Guy	Engineer	Frank, Adam	A/AP
2000	Univ. Rochester, Inst. Optics	Fitch, Michael	Postdoc	Melissinos, A.	PPX
2000	The College of Wooster, Ohio	Goetz, Jennifer	Assist. Professor	Pipher, J.	A/AP
2000	NEC Research Institute, Inc.	Kuzmich, Alexander	Postdoc	Mandel, L.	QOX
2000	Augustana College	Larkin, John	Assist. Professor	Foster, T.	BPX
2000	Lucent Technologies (NJ)	Liu, Jinbo	Scientist	Bodek, A.	PPX
2000	Naval Research Lab.	Makinen, Antti	Postdoc	Gao, Y.	CMX
2000	Univ. Arizona, Optical Sci. Center	Pu, Hahn	Postdoc	Bigelow, N.	QOX
2000	Univ. Florida (Bryant Space Sci. Ctr.	Raines, S. Nicholas	Postdoc	Watson, D.	A/AP
2000	Univ. of Chicago	Yang, Un Ki	Postdoc	Bodek, A.	РРХ
2000	Lucent Technologies	Ye, Hong	Scientist	Fauchet, Philippe	CME

Bryan, Diane* 1997	Experimental Nuclear Physics	Research Scientist, Eastman Kodak Co.
Casey, Dylan†	Experimental High Energy Physics	Assistant Prof., St. Johns College, MD.
Chen, Tao	Theor. Chemical Physics/Condensed Matter	Manager of Internet Technology, lexisONE
Choong, Vi-En	Exp. Chemical Physics/Condensed Matter	Staff Scientist, Motorola
Collins, Timothy†	Theoretical Astrophysics	Scientist., Univ. Rochester Laser Lab
Diol, Sabrina*	Chemical Physics • (with Chemistry)	Sr.Research Scientist, Eastman Kodak Co.
Fan, Qun	Experimental High Energy Physics	Research Scientist, LBL
Freeman, Charles†	Experimental Nuclear Physics	Assistant Prof., SUNY-Geneseo
Henderson, Robert #	Theoretical High Energy Physics	Vice President, Element Re Capital Products
Herrick, Diane*	Experimental Nuclear Physics	Research Scientist, Eastman Kodak Co.
Kalinski, Matthew	Theoretical Quantum Optics	Research Associate, FOM Institute
Kurz, Kristin*†	Experimental Nuclear Physics	Scientist, Lawrence Livermore Nat'l Lab.
Lobad, Ahmed	Exp. Chemical/ Condensed Matter (with EE)	Research Scientist, Los Alamos
Misra, Aalok	Theoretical High Energy Physics	Sr. Postdoc, Institute of Physics, India
Roberts, Scott <sup>†</sup>	Experimental High Energy Physics	Software Developer, DataChannel
Tollefson, Kirsten* #	Experimental High Energy Physics	Assistant Prof., Michigan State
Torgerson, Justin (17)	Experimental Quantum Optics	Scientist, Los Alamos
Bloomer, John # 1998	Observational Astronomy	Scientist, Raytheon Systems
Branning, David†	Experimental Quantum Optics	Postdoc, NIST
Chaloupka, Jan	Expt. Plasma Physics and Fusion ((with LLE)	Assistant Prof., College of William and Mary
Ejnisman, Renato	Experimental Quantum Optics	Consultant, McKinsey & Co., Brazil
Gupta, Pramod	Theor. Chemica/ Condensed Matter	Staff, IBM Toronto
Hahn, Ki Suk	Experimental High Energy Physics	Research Scientist, Lucent Technologies
Koffas, Thomas	Experimental High Energy Physics	Postdoc, University of Athens
Roald, Colin	Theoretical Astro/plasma physics • (with ME)	Internet Developer, Revbox
Rudy, Paul #	Experimental Quantum Optics	Scientific Engineer, Coherent Laser Group
Solomon, Steven	Observational Astronomy	Scientist, Santa Barbara Research Center
Turano, Edward† (11)	Theoretical Plasma Physics • (with ME)	Postdoc, Lawrence Livermore Nat'l Lab.

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Carney, P. Scott† 1999	Experimental Quantum Optics	Assistant Prof, Univ. IL-Urbana-Champaign
Goodno, Gregory†	Chemical Physics • (with Chemistry)	Staff Scientist, TRW
Gupta, Vinita*	Chemical Physics • (with Chemistry)	Marketing Coordinator, Halcyon Inc., Toronto
Herr, Andrea Domino*†	Chemical Physics • (with Chemistry)	Staff Scientist, Sierra Monolithics
Hull, Edward†	Biological Physids •(with Radiology)	Sr. Scientist, InLight Solutions
Khan, Adil	Theoretical Chemical Physics •(with Kodak)	Analyst, The Hartford
McNaught, Stuart†	Optical Science • (with LLE)	Postdoc, University of Maryland
Rahman, Ashiqur	Experimental Quantum Optics	Research Scientist, Corning, Inc.
Reis, David†	Experimental High Energy Physics	Assistant Prof., University of Michigan
Simon, Michael # (10)	Experimental Nuclear Physics	Postdoc, University of Rochester
Begel, Michael† 2000	Experimental High Energy Physics	Postdoc, University of Rochester
Buerke, Brian	Exp. Plasma Physics and Fusion •(with LLE)	Assistant Professor, Albright College
Cassada, Josh†	Experimental High Energy Physics	U.S. Naval Aviator
Dadusc, Gami *†	Chemical Physics • (with Chemistry)	Engineer, Pebbles Technologies
Delamarter, Guy #	Astrophysics	Software Engineer, Advant!
Fitch, Michael†	Accelerator Physics/Lasers (with Fermilab)	Fellow, Johns Hopkins University
Goetz, Jennifer *#	Observational Astronomy	Assistant Professor, College of Wooster
Kuzmich, Alexander	Experimental Quantum Optics	Postdoc, NEC Research Institute, Inc.
Larkin, John†	Expt. Chemical and Biological Physics • (with	Assistant Professor, Augustana College
[	Radiology)	
Lee, Chi Wei Herbert	Theoretical High Energy Physics	Postdoc, University of Copenhagen
Liu, Jinbo *	Experimental High Energy Physics	Scientist, Lucent Technologies (Illinois)
Makinen, Antti	Exp. Chemical/ Condensed Matter Physics	Postdoc, Naval Research Laboratory
Markiel, J. Andrew	Theoretical Astrophysics	Postdoc, University of Washington
Pu, Hahn	Experimental Quantum Optics	Postdoc, University of Arizona
Raines, Steven Nicholas #	Observational Astronomy	Postdoc, University of Florida
Yang, Un-Ki	Experimental High Energy Physics	Postdoc, University of Chicago
Ye, Hong (17)	Exper. Chemical/Material Science •(with EE)	Scientist, Lucent Technologies, NJ

Armstrong, Michael <sup>†</sup> 2001 Chemical Physics • (with Chemistry)		CEO, Fiber Optics Co., Toronto
Avvakumov, Sergey Experimental High Energy Physics		Postdoc, Stanford University
Estrada, Juan	Experimental High Energy Physics	Postdoc, Fermi National Laboratory
Gardiner, Thomas †	Theoretical Astrophysics	Postdoc, University of Maryland
Gbur, Gregory †	Theoretical Quantum Optics	Postdoc, Free Univ., Amsterdam
Macesanu, Cosmin	Theoretical High Energy Physics	Postdoc, Syracuse University
Ponomarenko, Sergey	Theoretical Quantum Optics	Postdoc, University of Rochester
Raychaudhuri, Subhadip	Exp. Chemical/Condensed Matter Physics	Postdoc, University of California-Berkeley
Young, York # (9)	Experimental Quantum Optics	Sr. Research Scientist, Corning
Averett, Kent 2002	Optical Science (with Optics)	US Air Force
Bielejec, Edward#	Exp. Chemical / Condensed Matter Physics	Scientist, Sandia National Labs
De, Subhranil	Exp.+Th. Chemical Physics •(with Chem E)	Postdoc, Princeton
Panfili, Raphael #	Theoretical Quantum Optics	Sr. Scientist, Spectral Sciences, Inc.
Watkins, Neil †	Exp. Chemical / Condensed Matter Physics	Naval Research Lab (fellow)
Yan, Li	Exp. Chemical/ Condensed Matter • (Kodak)	Postdoc, University of Florida
Zhou, Xingxiang (7)	Quantum Computation • (with EE dual PhD)	Postdoc, University of Rochester
Akant, Levent 2003	Theoretical High Energy Physics	Postdoc, Feza Gursey Institute
Canelli, Maria Florencia*	Experimental High Energy Physics	Postdoc, UCLA
Finlay, Jarod †	Expt. Chemical+Biological Physics • (with	Instructor, Univ. Pennsylvania
	Radiology)	
Johnson, Dean †	Experimental Quantum Optics	Sr. Engineer, Honeywell
Johnson, Eric †	Experimental Nuclear Physics	Postdoc search beginning
Kilminster, Benjamin †	Experimental High Energy Physics	Postdoc, Ohio State
Mitov, Alexander	Theoretical High Energy Physics	Postdoc, Univ. Hawaii
Poulios, Demetrios † Exp. Chemical/Optical Science • (with Kodak)		Scientist, NASA Goddard Flight Center
Rott, Pavel Exp. Chemical/ Condensed Matter (with EE)		Sr. Engineer, Intel
Santhanam, Jayanthi <sup>*</sup> (10) Theoretical Quantum Optics•(with Inst. Optics)		Postdoc search beginning
*Women (12)	† # DOEd/GAANN Fellows (38)	Employers: Domestic (72), Foreign (7)
	<ul> <li>Cross-disciplinary physics (25)</li> </ul>	27
		37

# What about the reverse? The one student from Optics who did a PhD with Nick Bigelow in Physics is now a faculty member.

The few students from material science or optics who are interested in working with physics typically do so because they are interested in a research academic career. Most academic positions in optics or material science are within physics departments. Therefore, knowledge of sub-fields like statistical mechanics is greatly beneficial. Joint (or dual) PhD -standard college rules: Current participants

#### $\rightarrow$ Optics and Physics (2), Physics and Optics (2)

will have one standing committee (instead of 4 different committees) Requested first by 2 students from Optics who are interested in a future academic career (following in the footsteps of Bob Knox). Who knows-> may double the number of Rochester Nobel Prizes in Physical Sciences in the 21st century?

-> **Physics and Neuroscience** (1) one student in Physics who is working with Professors Teitel (Physics) and Pouget (BCS)

->Physics and History of Science (2) - being standardized now

Requested by 2 students in Physics- Our future science writers and connection to the public,

→MD/PhD in Physics (new) (as part of MD/PhD U of R NSF grant that funded MD/PhD Dave Mathews)

→-Joint PhD in Chemical Physics (proposal out for funding)

In previous years, joint PhD degrees with Physics were also awarded in Electrical Engineering and Physics (student in ECE who was interested in academic career (in Quantum Information)

**Physics and Philosophy** (student in Physics who was interested in a broader education)

(separate committee for each individual)

**Small Rochester campus fosters interdisciplinary collaboration between River Campus, LLE, Medical Center.** 

The Physics of Medical Imaging has resulted in three Nobel prizes. First in Physics, Second in Chemistry and Third in Medicine. Last year (all given to physicists). This is true interdisciplinarity.

Will the next breakthrough be in the application of fundamental science to the biology of the brain? Biological Physics is a growing science, Medical Optics and Physics is a growing science, Biomedical Engineering is a growing science.

The university is putting ALL its capital resources over next 10 year \$40M into the new BME /Optics building with the hope that it will be a leader in this new interdisciplinary field. Note that people do research - not buildings. *First effort at joint recruiting of a Biological Physicist/Optical Physicist has started - between BME, Physics, Optics, Neuroscience and BCS department (with BME and Physics contributing one position each).* 

#### Summary: The Big Picture: *We are entering the 21st century*.

Most large corporations have greatly reduced their research efforts in the physical sciences (Bell Labs, IBM Labs, Kodak, Xerox). However, a small institution like Rochester can be successful by capitalizing on the geographical proximity of its small departments, and the collegial collaborative atmosphere within the University. This is how new ideas are exchanged and new discoveries are made.

*Our colleagues, like Professor Boyd and Director Wayne Knox, Dean LeBlanc, and others, share in the overall vision - <u>one</u> <i>small step at a time* (*and a few large steps when we can afford them*).

Some of us are interested in *major discoveries - Nobel Prizes, etc.* Some are interested in major new innovative *practical applications and revenues from new patents. We can do both... while keeping in* mind our responsibility to undergrad and grad. Education, as well as to society (and the U.S. Taxpayer). *And if we do not keep up and improve, other institutions will.* 

... The past does not guarantee the future... (but the present could)...

New Ideas (and old recycled ideas from different fields) require many people to propose and implement. A few of the many examples related to inter- disciplinary research

•Adding Physics to BS/MS program at Rochester (was part of general NYS approved BS/MS program at Rochester but not know to students, so nobody took it). Two students (one in Particle Physics and one in Quantum Optics) wanted to do it, they got department (Lynne Orr) to clarify the requirements and put them on the Web. The two students graduated in 2003.

•BS/MS in Medical Physics - Proposed to by Prof, M. Schell in Radiology at request of two UR employees in Strong (who have BS but not MS in Physics). Now being implemented through a collaborative effort of Physics, Radiology and Biology as part of general approved NYS BS/MS program in Physics). To begin next year, aim at 5 students/year. •Clarification of Optics-Physics Ph.D (on the books as part of general Joint PhD program approved by NY State for Rochester). Clarification asked for by two Optics students to Boyd, initial outline written by Boyd, expanded on in meeting with between Bodek, Boyd, Bigelow Wayne Knox and Gary Wicks. Detailed course schedule and resolving conflicts worked out by Bodek, two additional Physics students also interested in doing it.

•Joint Recruiting of a senior Optical/Neuro/Biophysicist Svoboda. Proposed by Wayne Knox to Bodek, now being coordinated by BME, Physics, Optics, Neuroscience and BCS. Requires resources from all departments. Just started Tentative plan, one senior appointment in BME (Svoboda) one Junior appointment in Physics, joint appointments in Optics, --just started to figure out the small steps in this very big initiative

- Even bigger initiatives also require coordination and must be done in small steps across several disciplines. Everything is coupled. For Example: New buildings.
- (1) Currently Optics resides in the Space Science building which was initially built for Astronomy (note the telescope on the roof). The Optics Annex was build by DOE as the Particle Physics building.
- (2) LLE was proposed and built by Mechanical Engineering Dept.
- (3) Plan for new BME-Optics building initiated by Wayne Knox.
- (a) Relocate faculty and staff in Physics Cyclotron Lab building (built by DOE for particle Physics) -currently being investigated by Physics. Building to be demolished in Fall 2004.
- (b) BME and Optics to share new building. Justification is new interdisciplinary research, 10% funding from foundation for BME, 40% funding from College (by delaying undergraduate Dorm renovations). Remaining 50% (\$15M) still to be raise.
- (c) Keep track of the big picture everything is inter-related

Joint or Interdisciplinary Doctor of Philosophy Degrees - College Rules The following are the College rules for a joint PhD degree (from the Regulations Section of the College Graduate Bulletin page 55) " !Departments/programs authorized to offer work leading to the Ph.D. degree also may cooperate to offer work toward the degree on an interdepartmental basis.

Joint work is supervised by an ad hoc committee for a single student (one member of the ad hoc committee must be from !outside the two programs of study).

Each ad hoc committee is appointed by the University dean of graduate studies upon nomination by the Graduate Committee of the college or colleges in which the departments/programs are located.

A proposal outlining how degree requirements will be fulfilled along with supporting documentation (including program of study, proposed plan for qualifying examination(s), up-to-date advising record, proposed !thesis topic) must be submitted for approval before the student is admitted to candidacy. For a continuing formalized interdisciplinary program (i.e., Visual and Cultural Studies, Neuroscience), a standing committee acts as a "department" and supervises the program requirements for its students. " Note: "appointed by the University Dean of Graduate Studies upon nomination by the Graduate Committee of the College", not the Graduate Curriculum Committees 43 of individual departments. This is why Physics GCC is not involved. Physics and Optics have proposed to the Graduate Dean, for the four students who wish to do joint PhD's (two from Optics and now two in Physics when they heard about the Optics proposal), that instead of having each *ad hoc* committee separately appointed by the University dean of graduate studies, the four students be supervised by the same standing committee, as follows:

The committee to supervise the Physics-Optics Joint PhD! program includes two co-chairs (one appointed by the Chair of Physics and Astronomy and one appointed by!the Director of The Institute of Optics) which in 2003-4 are! Professors **N. Bigelow** (nbig@lle.rochester.edu) ! **and R. Boyd** ( boyd@optics.rochester.edu ),! the two chairs of the Preliminary Examination Committees in both departments (**R. Hagen** hagen@pas.rocheser.edu) in Physics and **G. Wicks** wicks@optics.rochester.edu in Optics in 2003-3004), and the graduate student advisers in both departments (**E. Blackman** blackman@pas.rochester.edu in Physics, and **G. Agrawal** gpa@optics.rochester.edu in Optics in 2003-2004). *The Dean of Graduate Studies has accepted the suggestion that the ad hoc committees for all these four students, and any future students, be a standing committee* appointed by the chairs.

Eventually - every case is individual - The committee decides. However, guidelines to the students and committee are helpful if the committee needs to handle more than one student

So the request to the faculty from Physics and Optics was for *Helpful Suggestions to the Committee* 

To clarify a mis-understanding - The joint PhD program has always existed - we are trying to get it to be more streamlined when there is more that one student participating. Input from faculty and graduate students has always been welcome. As usual in every process, some people's comments are well informed, and some are not as well informed. We count on good leadership to sort these out.

For example, the College Graduate Dean could appoint a committee that includes a subset of the joint appointments in Physics and Optics (currently including N, Bigelow (Physics), J. Eberly (Physics), Emil Wolf (Physics), C. Stroud (Optics), G. Agrawal (Optics), R. Boyd (Optics), or T. Foster (Radiology, Physics and Optics, who can also serve as the the outside member of the committee). Other members could include the graduate advisors in each department and the chairs of the prelim committees in each department, as well as the student advisors in each department.

Faculty Member	Rank and Faculty Status	Principal Area of Research	
Auchincloss, Priscilla S.	Senior Lecturer and Dean for Sophomores	Physics Education/High Energy Physics	I
Bigelow, Nicholas P.	Dubridge Professor of Physics (and Optics)	Experimental Quantum Optics	I
Blackman, Eric G.	Assistant Professor of Physics	Theoretical Plasma and Astrophysics	I
Bodek, Arie	Professor of Physics and Chair	Experimental High Energy Physics	I
Castner, Theodore G.	Professor Emeritus of Physics	Experimental Condensed Matter Physics	I
Cline, Douglas	Professor of Physics	Experimental Nuclear Physics	I
Das, Ashok	Professor of Physics	Theoretical High Energy Physics	I
Demina, Regina	Associate Professor of Physics	Experimental High Energy Physics	I
Douglass, David H.	Professor of Physics	Experimental Condensed Matter Physics	I
Eberly, Joseph H.	Carnegie Professor of Physics (and Optics)	Theoretical Quantum Optics	I
	(director Rochester Theory Cntr. in Optics)		I
Frank, Adam	Associate Professor Physics/Astronomy	Theoretical Astrophysics	I
Ferbel, Thomas	Professor of Physics	Experimental High Energy Physics	I
Forrest, William J.	Professor (director, Mees Observatory)	Observational Astronomy, Astrophysics	I
Fulbright, Harry W.	Professor Emeritus of Physics	Observational Astronomy, Astrophysics	I
Gao, Yongli	Professor of Physics	Experimental Condensed Matter Physics	I
Gove, Harry E.	Professor Emeritus of Physics	Experimental Nuclear Physics	I
Hagen, C. Richard	Professor of Physics	Theoretical High Energy Physics	I
Helfer, H. Lawrence	Professor Emeritus of Physics/ Astronomy	Theoretical Astrophysics	I
Howell, John	Assistant Professor of Physics	Experimental Quantum Optics	I
Jacobsen, Edward H.	Professor Emeritus of Physics	Experimental Condensed Matter Physics	I
Knox, Robert S.	Professor Emeritus of Physics	Theoretical Biological Physics	I
Koltun, Daniel S.	Professor of Physics	Theoretical Nuclear Physics	I
Manly, Steven	Brugler Distinguished Teaching Professor	Experimental. Nuclear/High Energy Physics	I
McFarland, Kevin	Associate Professor	Experimental High Energy Physics	I
Melissinos, Adrian C.	Professor Emeritus	Experimental High Energy Physics	I
Okubo, Susumu	Professor Emeritus	Theoretical High Energy Physics	I
Orr, Lynne	Associate Professor	Theoretical High Energy Physics	I
Pipher, Judith L.	Professor of Physics and Astronomy	Observational Astronomy, Astrophysics	I
Quillen, Alice	Assistant Prof. of Physics and Astronomy	Observational Astronomy, Astrophysics	I
Rajeev, Sarada G.	Professor of Physics	Theoretical High Energy Physics	I
Savedoff, Malcolm P.	Professor Emeritus of Physics/Astronomy	Theoretical Astrophysics	I
Shapir, Yonathan	Professor of Physics (and Chem Engineer)	Theoretical Condensed Matter Physics	I
Sharpless, Stewart L.	Professor Emeritus of Astronomy	Observational Astronomy, Astrophysics	I
Slattery, Paul F.	Professor and Dean of Graduate Studies	Experimental High Energy Physics	I
Sproull, Robert L.	Professor Emeritus of Physics/Astronomy	Experimental Condensed Matter Physics	I
Teitel, Stephen L.	Professor of Physics	Theoretical Condensed Matter Physics	I
Thorndike, Edward H.	Professor of Physics	Experimental High Energy Physics	I
Tipton, Paul L.	Professor of Physics	Experimental High Energy Physics	I
Watson, Dan M.	Professor	Observational Astronomy	I
Wolf, Emil	Wilson Professor of Physics (and Optics)	Theoretical Optics	10
Wolfs, Frank	Professor of Physics	Experimental Nuclear + Physics Education <sup>4</sup>	łð
Wu, Wenhao	Assistant Professor of Physics	Experimental Condensed Matter Physics	I

#### **Table C2: Department of Physics & Astronomy Faculty (42 primary appointments)**

Table C3: Faculty with Joint Appointments in Physics and Other Departments (16)				
<u>Faculty Member</u>	<u>Status</u>	<u>Area of Research</u>		
Agrawal, Govind P	Professor of Optics!and Physics	Optical Physics and Lasers		
Betti, Ricardo	Assoc. Prof. of Mech. Engin (and Physics), Scientist, LLE	Theoretical Plasma Physics/Fusion		
Bocko, Mark F	Professor of Electrical & Computer Engineering (and Physics)	Experimental Condensed Matter Physics		
Boyd, Robert W!	Professor of Optics	Optical Physics and Lasers		
Conwell, Esther	Professor of Chemistry (and Physics)	Experimental Condensed Matter Physics, Biological Physics		
Foster, Thomas H.	Professor of Radiology (and Physics)	Biological/Medical Physics		
Huizenga, John R.	Professor Emeritus (with Chemistry)	Experimental Nuclear Physics		
Meyerhofer, David D.	Professor of Mechanical Engineering (and Physics), Senior Scientist, Asst.Director, Lab. for Laser Energetics	Plasma Physics and Fusion, AMO Physics and Lasers		
McCrory, Robert I	Professor of Mechanical Engineering (and Physics), Senior Scientist and Director, Lab. for Laser Energetics	Experimental Plasma Physics and Fusion		
Rothberg, Lewis	Professor of Chemistry (and Physics)	Experimental Condensed Matter Physics, Biological Physics		
Simon, Albert	Professor of Mechanical Engineering (and Physics), and Senior Scientist Laboratory for Laser Energetics	Theoretical Plasma Physics and Fusion		
Spoohower, John	Senior Scientist, Eastman Kodak (and Adjunct Associate Professor of Physics)	Experimental Condensed Matter Physics and Optical Science		
Stroud, Carlos R., Jr.	Professor of Optics (and Physics)	Optical Science		
Thomas, John H.	Prof. of Mech. and Aerospace Science (and Astronomy)	Theoretical Astro/Plasma Physics		
Zhong, Jianhui	Associate Professor of Radiology!(and Physics)	Biological and Medical Physics		
Van Horn, Hugh	Director, NSF Astronomy Division Adjunct Professor	Theoretical Astro/Plasma Physics 49		

<u>Name</u>	Field	<u> Principal Area of Research!</u>
Berger, Andrew J.	Assistant Professor of Optics	Medical Physics
Brown, Thomas G.	Associate Professor of Optics	Optoelectronics
Chen, Shaw-Horn	Professor of Chemical Engineering!	Chemical Physics
Chimowitz, Eldred H	Professor of Chemical Engineering!	Chemical Physics
Craxton, Stephen R	Senior Scientist Laboratory for Laser Energetics!	Plasma Physics, Lasers and Fusion
Donaldson, William R	Scientist, Laboratory for Laser Energetics!	Optical Physics and Lasers
Farrar, James M	Professor of Chemistry!	Chemical Physics
Fauchet, Phillippe	Professor of Electrical Engineering and Optics, Senior	Material Science, Biological and Optical
	Scientist Laboratory for Laser Energetics!	Physics
Feldman, Marc J	Professor of Electrical Engineering and Senior Scientist,	Quantum Information, Material Science,!
Fignup James P	Professor of Optics	Condensed Matter Physics
George Nicholes	Professor of Optics	Optical Physics and Lesors
George, Nicilolas	Assistant Professor of Option	Uplical Physics and Lasers
Calfarb David	Assistant Floresson of Optics	Anti Aging Drug Research
Houdo Wolton Sucon	Professor of Optics	Anti-Aging Diug Research
Houde-walter, Susan	Professor of Electrical and Computer Engineering	Optical Physics and Lasers
Hslang, Thomas Y.	Professor of Electrical and Computer Engineering	Ultrafast Phenomena
Jacobs, Stephen D.	Professor of Chem Engineering and Scientist, LLE	Liquid Crystal Optics
Jones, Thomas B.	Professor of Electrical Engineering	Micro-Electromechanical Systems.
Jorne, Jacob	Professor of Chemical Engineering!	Chemical Physics
Knauer, Jim	Scientist, Laboratory for Laser Energetics!	Plasma Physics and Fusion
Knox, Wayne H.	Professor of Optics	Ultrafast Optics and Telecommunications
Krauss, Todd	Assistant Professor of Chemistry	Spectroscopy of nanometer-scale materials
McKinstrie Colin, J	Professor of Mechanical Engineering and Senior Scientist	Plasma Physics and Fusion
,	Laboratory for Laser Energetics!	5
Mathews, David	Assistant Professor of Biochemistry and Biophysis	Calculational RNS
Moore, Duncan T.	Professor of Optics	Optical Engineering
Ning, Ruola	Associate Professor of Radiology	Biological and Medical Physics
Novotny, Lukas	Assistant Professor of Optics!	Optical Physics and Lasers
Parker, Kevin	Professor of Electrical Engineering!	Condensed Matter, Biological Physics
Misha Ovchinnikov	Assistant Professor of Chemistry	Chemical Physics (Theoretical)
Seka, Wolf	Associate Professor of Optics and Senior Scientist	Optical Physics and Lasers
	Laboratory for Laser Energetics!	
Schroder, Wolf-Udo	Professor of Chemistry!	Nuclear Chemistry/heavy ions
Sobolewski, Roman	Professor of Electrical Engineering and Senior Scientist,	Ultrafast Optoelectronics, Super-
Synhers Mike	LLE: Accelerator Physicist Fermilah	Accelerator Physics
Teegarden Kenneth I	Professor of Ontics	Ontical Materials
Waag Robert	Professor of Electrical Engineering	Ultrasound
Wicks Gary	Professor of Ontics	Material Science Nano-materials
Williams David R	Professor of Psychology and Professor of Optics	Psychological Optics
Wii David I H	Associate Professor of Chemical Engineering and of	Biological and Medical Physics
, 1, 1, 1, avia j 11	Microbiology and Immunology!	Biological and modical I hysics
Yang, Hong	Assistant Professor of Chemical Engineering	Magnetic Nanoparticles
Yates, Matthew Z.	Assistant Professor of Chemical Engineering	Colloids and Interfaces
Zavislan, Jes	Associate Professor of Optics	Optical Engineering, Biomedical Optics

#### Table C4: Fourty Faculty in Allied Departments who supervise PhD students in the Cross-Disciplinary Physics Program[39])

#### Additional Slides: Philosophy of Graduate Education in Physics and Astronomy Graduate students at Rochester come from diverse national and international backgrounds.

Students' level of preparation varies; therefore, each student progresses at his/her own pace. Advanced students can take second year courses and pass the prelim examination after 1 year. Typical students take the prelim exam after 1.5 years. Students who have not taken certain undergraduate courses can take upper level undergraduate courses, if needed, and take the prelim exam after 2 years.

All students are expected to pass and continue on towards a Ph.D. Our retention rate is high, and the few students who leave the Ph.D. program do so for personal reasons (e.g. changing fields).

The number of available research positions is such that all entering students are expected to join research groups as Research Assistants after one year as Teaching Assistants.

The size of the entering class is determined under the assumption that all students will pass the prelim exam and continue on to a Ph.D. - i.e. it is not determined by the need for TA's. Note that in some large state schools the number of available research positions can accommodate only half of the entering class, and thus half of the entering students are expected to leave. <sup>51</sup>

Each year, we aim at a class of 15-20.

Year	Domestic	Foreign	Total
04			Plan 8
03	20	15	35
02	10	5	15
01	11	11	22
00	8	5	13
99	11	22	33
98	6	9	15
97	10	9	19
96	10	5	15
95	9	8	17
94	8	0	8
93	15	11	26
92	14	11	25
91	14	5	19
90	10	16	26
89	17	11	28
88	11	11	22
87	10	13	23
86	13	11	25
85	17	7	24
84	8	11	19
83	10	11	21
82	10	7	17
81	18	12	30
80	20	6	26

52