CIPS Annual Report 1999

Director: John R. Cary
Administrative Officer: Carolyn M. James

INTRODUCTION

Modern plasma physics is the study of collective, often nonlinear, electromagnetic processes in ionized gases called plasmas. Plasma physics related research at the University of Colorado is currently carried out primarily in the Physics Department, but also in the Astrophysical and Planetary Sciences Department, the Department of Applied Mathematics, and in the Departments of Mechanical Engineering, Aerospace, and Electrical and Computer Engineering. In the community at large, plasma research is conducted at NIST, at the High Altitude Observatory of NCAR, at the Space Environment Labs of NOAA, and at local companies such as Lodestar Corp. and Science Applications, Inc.

The purpose of CIPS is to provide a focal point and forum for the exchange of both educational and research ideas among scientists with these diverse affiliations. Research in plasma physics is extraordinarily broad, encompassing basic physics of plasmas, fusion sciences, space and astrophysics, beam and accelerator physics, laser-matter interactions, and industrial processing. CIPS possesses scientific expertise in all of these areas and fosters unique new opportunities for sponsored research in interdisciplinary aspects of plasma physics. CIPS sets the guidelines for both undergraduate and graduate education in plasma physics at the University of Colorado, providing research opportunities and guidance for plasma physics Ph.D. candidates.

MISSION STATEMENT

The mission of the Center for Integrated Plasma Studies (CIPS) is to foster plasma and beam related science and research. In particular, CIPS provides a home for interdisciplinary plasma related activities. This includes coordination of high-performance scientific and networking capability. The Center for Integrated Plasma Studies additionally has the mission of scientific outreach, including making plasma physics, general physics and astrophysics highly accessible to the general public.

MESSAGE FROM THE DIRECTOR

The Center for Integrated Plasma Studies has continued its growth over the last year. CIPS members come from the departments of Physics; Astrophysical and Planetary Sciences; Applied Mathematics; and Electrical Engineering. Reimbursed project expenditures for all projects centered in CIPS were roughly $ 1.4 M for 2000 (January - December 99), with new grants arriving in 1999 totaling $1.2 M. This resulted in an increase in indirect cost recovery of 7% over FY99. Several new postdoctoral researchers have joined CIPS in the last year. Overall, CIPS has 25 members, 24 graduate and undergraduate students, 7 research support personnel, and 18 off campus affiliates.

CIPS research programs have made the University increasingly visible to the outside world. Our programs range over the breadth of plasma physics. Our experimental programs are concerned with both in situ measurements of ionospheric plasmas to laboratory plasma experiments investigating the fundamentals of transport in plasmas. Our theoretical programs study solar flares, space plasma turbulence, beam dynamics, and turbulence in strongly magnetized plasma.

Continuing its strong computational program, CIPS has recently completed building a 32 processor Beowulf cluster consisting of Pentium III's linked in a novel way with fast Ethernet. This cluster will enable CIPS researchers to model larger systems more realistically without the limitations of queuing at the national supercomputer centers. At present, we are using the new cluster to model the interaction of lasers with plasma and to calculate levels of turbulence in magnetized plasma.

Our external funding has made it possible to support 11 graduate students as well as eight postdoctoral fellows. Our former students and postdocs are employed at prestigious universities and institutes throughout the country. Two recent postdocs, Carson Chow and Meers Oppenheim, are now in tenure track positions at the University of Pittsburgh and Boston University, while Bill Gabella runs the free-electron laser facility at Vanderbilt University. Other former students and postdocs are employed by at national laboratories or by private

research corporations. In general, the plasma students trained by CIPS faculty and researchers find employment in the field of plasma physics.

CIPS continues to be active in service to the University and professional communities. Professor Goldman's Physics 2000 web site showcases the use of technology in teaching. CIPS members are active in the American Physical Society through membership in and chairmanship of the society and plasma division committees. The University of Colorado has just recently been asked to host the U.S. Particle Accelerator School in June of 2001. This last event will bring scientists from throughout the country to Colorado to give intensive, two-week courses.

Overall, CIPS is experiencing continued growth and success across the areas of research, teaching, service, and outreach, and it is finding the resources needed to carry out its mission.

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PERSONNEL

CIPS FELLOWS

John R. Cary, Director
Scott Robertson, Associate Director
Martin V. Goldman
James Meiss
Scott Parker
Zoya Popovic
Ted Speiser
Raul Stern

CIPS MEMBERS

David Alexander, Research Associate
Fran Bagenal, Professor of APS
Dan Baker, Director of LASP
Yang Chen, Research Associate
Isidoros Doxas, Senior Research Associate
Tim Fuller-Rowell, Senior Research Associate with CIRES
Alan Gallagher, Lecturer with Physics
Kathy Garvin-Doxas, Research Associate
Rodolfo Giacone, Research Associate
Scott Hendrickson, Research Associate
Mihaĺy Horańyi, Research Associate with LASP
James Howard, Research Associate
Alan Kiplinger, Senior Research Associate
David Newman, Research Associate
Yasutaro Nishimura, Research Associate
Svetlana Shasharina, Senior Research Associate
Michael Spector, Research Associate

CIPS SCIENTIST ASSOCIATES

HAO/NCAR
Paul Charbonneau
Tom Holzer
Art Hundhausen
BC Low
Gang Lu
Art Richmond
Ray Roble

Lodestar Corp.
Dick Aamodt
Dan D'lppolito
Jim Myra
David Russell

Space Science Inst.
Paul Dusenbery

SEC/NOAA
Ernie Hildner
Terry Onsager
Vic Pizzo
Howard Singer
Ron Zwickel

NIST
John Bollinger

VISITING SCHOLARS

William M. Tang, Princeton University

Meers Oppenheim, Boston University

Clay Spence, Sarnoff Corporation, Princeton, NJ

Beverly Wolf, University of Massachusetts, Amherst

Robert Walch, University of Northern Colorado, Greeley

CIPS RESEARCH SUPPORT STAFF

John Adams, Professional Research Assistant
Annett Baumgartner, Professional Research Assistant
Krista Beck, Professional Research Assistant
Carolyn M. James, Professional Research Assistant
John Kline, Professional Research Assistant
David Rea, Professional Research Assistant
Zolton Sternovsky, Professional Research Assistant

GRADUATE STUDENTS

Michael Fuchs
Samuel Jones
Charlson Kim
Fernando Perez
Byron Smiley
Brent Goode
Steven Kadlec
Jinhyung Lee
Amanda Sickafoose
Kiran Sonnad

EXCHANGE STUDENTS

Hans Michael Ruder, University of Tübingen

UNDERGRADUATE STUDENTS

Michelle Backus
Chan Doh
Polly Fordyce
Craig Morrison
Matt Triplett
Wenming Ye
Amanda Youngwirth
Zachary Chandler
Danielle Elliot
Taunya Henriksen
Viktor Przebinda
Robin Webb
Richard Younger

INTERNS

Martha Crabb, Jacksonville University
Amaria George, Reed College
Margaret Wessling, Amherst College

CIPS RESEARCH GRANTS ACTIVE DURING CALENDAR YEAR 1999, BY PRINCIPAL INVESTIGATOR

Cary, John R.		
DOE	1994-2000	595,000
DOE	1995-2001	1,049,000
Doxas, Isidoros		
NASA	1997-2000	152,068
University of Texas	1998-1999	196,218
Goldman, Martin V.		
DOE	1998-2001	210,000
NSF	1998-2000	236,465
NASA	2000-2002	79,300
Kiplinger, Alan		
NASA	1997-2000	124,353
NSF	1997-2000	150,000
NASA	1998-1999	18,635
Newman, David		
NSF	1997-2001	240,000
NSF	1998-2001	4,829
NSF	1998-2001	240,000
Parker, Scott		
DOE	1997-2001	270,000
DOE	1997-2000	259,000
DOE	1999-2000	39,999
Robertson, Scott		
NASA	1997-2000	169,500
DOE	1997-2000	273,000
NASA	1998-2002	117,369
NASA	2000-2001	20,800
Stern, Raul		
UCLA	1994-1999	214,319

SEMINAR SERIES

January – May 1999
Seminar Series Coordinator: Yang Chen

Date	Speaker	Title
January 15	Dr. Travis Mitchell, NIST	Crystalline Order and Modes in Laser-Cooled Ion Plasmas
February 5	Dr. Rodolfo Giacone, CIPS	Spatiotemporal Evolution of Stimulated Brillouin Scattering in Homogeneous Plasmas
February 12	Dr. Scott Parker, CIPS	A Simple Explanation of the Ballooning Transformation and TAE Modes
February 19	Dr. Yasutaro Nishimura, CIPS	Particle Transport in Three Dimensional Stellarator Equilibria
February 26	Professor John Cary, CIPS	Efficient Class Library for Differential Algebra
March 5	Dr. Lyon King, NIST	Plasma Space Propulsion: Plume Transport in Hall-Effect Thrusters
March 12	Professor Scott Robertson, CIPS	Transport Experiments with Non-Neutral Plasma in a Modified Penning Trap
April 2	Dr. David Newman, CIPS	The Plasma Dispersion Relation for Arbitrary Smoothed Distribution Functions: Landau Contours in the Land of the Non-Analytic
April 9	Dr. J. R. Myra, Lodestar Research Corporation	Resistive X-Point Modes in Tokamak Boundary Plasmas
April 16	Dr. J. E. Howard, CIPS	Global Dynamics of Charged Dust Particles in Planetary Magnetospheres

SEMINAR SERIES

September - December 1999
Seminar Series Coordinator: Rodolfo Giacone

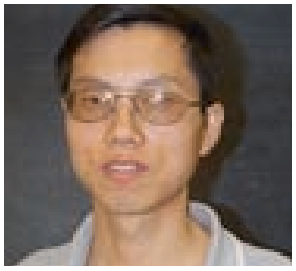
Date	Speaker	Title
April 23	Brent Goode, Physics Department Graduate Student	Is the Dynamics of the Magnetosphere Due to Chaos of Noise?
April 30	Jinhyung Lee, Physics Department Graduate Student	Calculation of Finite-Length, Hollow-Beam Equilibria
May 7	Dr. Yasutaro Nishimura, CIPS	Chaotic Particle Transport Across a Magnetic Island Due to Electrostatic Drift Waves
May 12	Zoltan Sternovsky, CIPS	Charging of Single Dust Grains in the Laboratory
August 27	Professor Yoshi H. Ichikawa, Nagoya University, Japan	Bifurcation of the Period-4 Orbits in the Standard Map
September 24	Amanda Sickafoose, APS Department graduate student	Photoelectric Charging of Dust in Space
October 1	Dr. Alan L. Kiplinger, CIPS and NOAA/SEC	Solar Energetic Particle Acceleration: Observations, Interpretations and New Questions
October 29	Dr. Peter H. Stoltz, Sandia National Laboratory	ALEGRA Simulations of X-Ray Pulses from Sandia's Z Accelerator
December 3	Qudsia Quraishi, Physics Department undergraduate student	Numerical Simulation of Penning Trap Confinement.
	Joe Espejo, Physics Department undergraduate student	Experimental Measurement of Penning Trap Confinement

RESEARCH INTERESTS

JOHN CARY

Research interests: plasma physics, beam (or accelerator) physics, nonlinear dynamics, and computational physics. My plasma physics interests include studies of space plasma physics as well as fusion plasma physics. My beam physics interests are in understanding collective instabilities, the nonlinear dynamics of two-degree-of-freedom symplectic maps, and the use of laser plasma interactions to generate large electric fields for particle acceleration. My computational interests are in massively parallel computing and in scientific Object Oriented Programming.

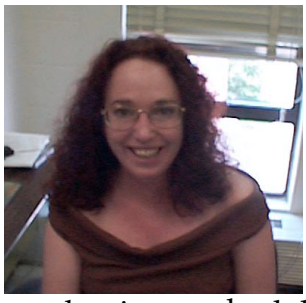
YANG CHEN



My research in 1999 has been in the development of simulation models for the study of turbulent transport in toroidal fusion devices. Two different approaches are pursued: the hybrid model and the fully kinetic model. In the hybrid model the electrons in a tokamak are modeled by a set of fluid equations, while ions are described by gyrokinetic equations. In the fully kinetic approach, both the electrons and ions are described by kinetic equations. The later approach is made possible only recently in a toroidal geometry through the combination of parallel momentum formulation and split-weight scheme. Codes for both models have been successfully implemented for a flux-tube domain and extensively benchmarked against the analytic dispersion-relation in a shearless slab, showing good agreement with theory. Preliminary results have been achieved for toridal cases in terms of the nonlinear energy flux, linear growth rates, etc.

ISIDOROS DOXAS

The main subject of my research has been plasma turbulence in laboratory and space plasmas, especially as analyzed by the methods of nonlinear dynamics and large-scale particle simulations. I have worked on stochastic transport in fusion devises, and on the limits of quasilinear theory. For the past ten years, I have participated in and directed research projects in magnetospheric physics, particularly on magnetic reconnection in the geomagnetic tail, and on global models of the dynamics of the coupled magnetosphere-ionosphere system.



KATHY GARVIN-DOXAS

I am working on assessment and evaluation for the Solar System Collaboratory project, a collaboration of four State schools aimed at developing web-based introductory science courses for non science majors. Assessment and evaluation methodology includes both quantitative and qualitative tools like pre/post questionnaires, videotape analysis, participant observation, and individual and group interviews.

RODOLFO GIACONE

My research activities are in the areas of accelerator physics, especially as related to laser-plasma based accelerators and use of modern computing methods to develop new algorithms for studying laser-plasma interactions. We investigated the laser wakefield accelerator concept performing numerical simulations using the code XOOPIC. This is a two-

dimensional relativistic electromagnetic object-oriented particle-in-cell code. The nature of the problems we want to address needed special capabilities not implemented in the original version of XOOPIC. We modified the code to include an electromagnetic wave launcher, a computational moving window and implemented the new features in massively parallel machines

MARTIN GOLDMAN

Current research interests include: plasma physics, nonlinear waves, electron-beam-plasma interactions, radiation-plasma interactions, nonlinear optics, computer simulations of plasma turbulence and coherent processes, theory of modification of Earth's ionosphere by high-power radar, theory and simulation of laser-plasma interactions, and theory and simulation of auroral ionosphere wave-particle interactions.

JAMES HOWARD

My research interests lie mainly in applications of Hamiltonian dynamics to a broad spectrum of physical problems, ranging from beam dynamics, microwave ionization of Rydberg atoms, and RF ion traps, to fusion plasmas and the motion of planetary dust grains. We are presently incorporating the effects of planetary oblateness, quadruple magnetic field, time-dependent charging, and radiation pressure on our Hamiltonian models. A new project concerns the nonlinear dynamics of ion pairs in an elliptic ion trap, which is directly relevant to current experiments and research on quantum computation.

ALAN KIPLINGER

I am actively involved with a new hard x-ray spectrometer that is to be launched on a Dept. of Energy satellite in March, 2000. The instrument is a prototype that may eventually fly in geosynchronous orbit and serve as a "now casting" instrument to warn of interplanetary proton events. In the fall of 1999, I established the new University of Colorado Alpine Observatory at C.U.'s Mountain Research Station. A computerized 12" Schmidt Cassegrain telescope is the heart of the facility that is housed in an observatory dome donated by the NOAA Space Environment Center. The new observatory is at an altitude of 9500' feet and about 45 minutes from Boulder. It will be used for student research, public outreach and in my research effort to image a coronal mass ejection in the night sky for the first time.

JAMES MEISS

My research is in the area of dynamical systems, in particular the study of the onset and characterization of chaos. My recent teaching includes courses in dynamics, differential equations and chaos.

DAVID NEWMAN

Primary research activities are in the field of nonlinear plasma physics, with emphasis on theoretical modeling and nonlinear simulation of wave and particle phenomena in a variety of near-Earth space plasma environments. Specific research projects in 1999 include: (1.) Theory of bipolar waves observed in the auroral

ionosphere and other space environments. This research has culminated in an analytical model for the interaction of "tubes" in electron phase space with electrostatic whistler waves. Long simulation runs have also shown how a progression of different wave modes participate in the evolution of the bipolar structures. (2.) Langmuir turbulence and electron acceleration during HF excitation of the mid-latitude ionosphere. In this area, new 2-D particle simulations of the radiation-driven ionosphere have shown how dimensionality affects suprathermal electron tail formation, and how asymmetries in the tail electron population can be formed. (3.) An ongoing boundary-injection simulation effort has made contact with a number of phenomena observed beam-plasma experiments at UCLA, including sweepback, modulational instability, and strong Langmuir turbulence. These research projects are complemented by data visualization efforts using state-of-the-art computer graphics packages (such as Data Explorer) to aid in the analysis of multidimensional data sets.

YASUTARO NISHIMURA

Research activities include theoretical research in fusion plasma physics; in particular, investigation of magnetic surface formations in three dimensional omnigenous stellarator equilibria and corresponding neoclassical particle transport. The omnigenous configuration being studied is predicted to have good plasma confinement properties and allows compact, economically feasible fusion reactor designs. The research is conducted both analytically (application of Hamiltonian dynamics to magnetic field line behavior) and numerically (large scale MHD equilibrium and stability code).

SCOTT PARKER

My research in large-scale nonlinear three-dimensional plasma simulation has taken a new direction. What is new, is that we are now studying low-frequency electromagnetic (or Alfvenic) turbulence, rather than using more conventional electrostatic turbulence models. We are now including fairly sophisticated electron physics and electromagnetic fluctuations. Our research group is vigorously developing fluid-electron models, kinetic electron models and Kinetic-MHD hybrid models, and we are leaders in this area. This year we were awarded a grant to develop Kinetic-MHD models for one of the two large nonlinear MHD codes in the magnetic fusion community.

ZOYA POPOVIC

Projects in microwave and millimeter-wave quasi-optical systems, microwave high-efficiency amplifiers, antennas for wireless communications and Fr photonics. Project with the Netherlands Foundation for Radioastronomy on a broad long-term (20-year) international project developing a new very large radiotelescope.

SCOTT ROBERTSON

My research interest is experimental plasma physics (the study of ionized gases) with emphasis on 1) space and laboratory plasmas containing dust, aerosols or large molecular clusters; 2) non-neutral plasmas with emphasis on transport processes; and 3) and particle beams as plasmas.

SVETLANA SHASHARINA

Nuclear Fusion Theory: confinement, transport; Computer Science: C++ modeling.

TED SPEISER

Magnetospheric substorms, the geomagnetic tail, current sheets and their stability, remote sensing of the topology of the geomagnetic tail current sheet using satellite observations of energetic ions along with our model, and theories of the onset of geomagnetic substorms.

RAUL STERN

Research: Experimental Basic Plasma Physics, a variety of programs, one at CU and additional programs in collaboration with major research and educational institutions (Caltech, UCLA)

PUBLISHED PAPERS IN REFEREED JOURNALS, IN 1999

JOHN CARY

"The OptSolve++ software components for nonlinear optimization and root finding." Computing in Object Oriented Parallel Environments, D. L. Bruhwiler, S. G. Shasharina and J. R. Cary, Lecture Notes in Computer Science (1732), 154-163 1999.

"The solar–wind driven magnetosphere–ionosphere as a complex dynamical system." W. Horton, J. P. Smith, R. Weigel, C. Crabtree, I. Doxas, B. Goode, and J. R. Cary, Phys. Plasmas (6), 4178 1999.

ISIDOROS DOXAS

"The solar-wind driven magnetosphere--ionosphere as a complex dynamical system." Horton, W., J. P. Smith, R. Weigel, C. Crabtree, I. Doxas, B. Goode, and J. Cary, Phys. Plasmas (6), 4178 (1999).

"Magnetospheric dynamics from a low dimensional nonlinear dynamics model." Doxas, I., and W. Horton, Phys. Plasmas (6), 2198 (1999).

"A physics based nonlinear dynamical model for the solar wind driven magnetosphere--ionosphere system." Doxas, I., W. Horton and J. P. Smith, , Phys. Chem. Earth, (94), 67 1999.

RODOLFO GIACONE

"Accurate formulas for the Landau damping rates of electrostatic waves." McKinstrie, R. E. Giacone and E.A. Startsev, Phys. Plasmas (6), 453 1999.

"Angular dependence of stimulated Brillouin scattering in a homogenous two-dimensional plasma." R. E. Giacone, C. J. McKinstrie and T. Kolber, Phys. Plasmas (6), 3587 1999.

MARTIN GOLDMAN

"Nonlinear two-stream instabilities as an explanation for auroral bipolar wave structures." M. V. Goldman, M.M. Oppenheim and D.L. Newman, Geophysical Research Letters (26), 1821-1824, 1999.

"Theory of localized bipolar wave-structures and nonthermal particle distributions in the auroral ionosphere." M. V. Goldman, M.M. Oppenheim and D.L. Newman, Nonlinear Processes in Geophysics (6), 221-228 1999.

"Evolution of electron phase-space holes in a 2-D magnetized plasma." M. Oppenheim, D.L. Newman and M. V. Goldman, Physical Review Letters (83), 2344-2347, 1999.

JIM HOWARD

"Stability of Relative Equilibria in Arbitrary Axisymmetric Gravitational and Magnetic Fields." Celest. Mech. (74), 19, 1999.

"Global Dynamics of Charged Dust Particles in Planetary Magnetospheres." M. Horányi and G. Stewart, Physical Review Letters, (83), 3993, 1999.

JAMES MEISS

"Quadratic volume preserving maps: an extension of a result of moser." K.E. Lenz, H. E. Lomeli and J. D. Meiss, Regular and Chaotic Motion (3), 122-130 1999.

"Homoclinic bifurcations for the Hénon map." D. Sterling, H. R. Dullin and J. D. Meiss, Physica D (134) 153-184 1999.

DAVID NEWMAN

"Evolution of electron phase-space holes in a 2-D magnetized plasma." M. Oppenheim, D.L. Newman and M. V. Goldman, Physical Review Letters (83), 2344-2347 1999.

"Nonlinear two-stream instabilities as an explanation for auroral bipolar wave structures." M. V. Goldman, M.M. Oppenheim and D.L. Newman, Geophysical Research Letters (26), 1821-1824 1999.

"Theory of localized bipolar wave-structures and nonthermal particle distributions in the auroral ionosphere." M. V. Goldman, M.M. Oppenheim and D.L. Newman, Nonlinear Processes in Geophysics (6), 221-228 1999.

SCOTT PARKER

"Comparisons and physics basis of tokamak transport models and turbulence simulations." A. M. Dimits, G. Bateman, M. A. Beer, B. I. Cohen, W. Dorland, G. W. Hammett, C. Kim, J. E. Kinsey, M. Kotschenreuther, A. H. Kritz, L. L. Lao, J.

Mandrekas, W. M. Nevins, S. E. Parker, A. J. Redd, D. E. Shumaker, R. Sydora, and J. Weiland, Physics of Plasmas, (7), 969 2000.

"Electromagnetic gyrokinetic simulations using a drift-fluid electron model." S. E. Parker, Y. Chen and C.C. Kim, accepted in Computer Physics Communications, to appear (127), 2000.

"Large-scale gyrokinetic turbulence simulations: Effects of profile variation." S. E. Parker, C.C Kim and Y. Chen, Physics of Plasmas (6), 1709 1999.

"Massively-parallel three-dimensional toroidal gyrokinetic flux-tube turbulence simulation." C.C. Kim and S. E. Parker, submitted to the Journal of Computational Physics, 1999.

"Simulation of ion-temperature-gradient turbulence in tokamaks." A. M. Dimits, B. I. Cohen, N. Mattor, W. M. Nevins, and D. E. Shumaker, S. E Parker and C. Kim, accepted for publication in the journal Nuclear Fusion, to appear March 2000.

SCOTT ROBERTSON

"Annular Malmberg-Penning trap for studies of plasma confinement." Review of Scientific Instruments (70), 2993-2996 1999.

"Coulomb crystals of oil droplets" S. Robertson and R. Younger, American Journal of Physics (67), 310-315 1999.

"Simulation of rocket-borne particle measurements in the mesosphere." M. Horányi, J. Gumbel, G. Witt and S. Robertson, Geophysical Research Letters (26), 1537-1540 1999.

RAUL STERN

"Added discussion of observations of fast anisotropic ion heating, ion cooling and ion recycling in large-amplitude drift waves" S. J. Sanders, R. F. Boivin, P. M. Bellan and R. A. Stern, Physics of Plasmas (6), 4118-9 1999.

INVITED PAPERS IN 1999

JOHN CARY

"Object oriented C++ software components for accelerator design." D. L. Bruhwiler, J. R. Cary, S. G. Shasharina, Proc. 1999 Particle Accelerator Conference, 20, New York City, NY, 1999.

"Efficient differential algebra computations." S. G. Shasharina and J. R. Cary, Proc. 1999 Particle Accelerator Conference, New York City, NY, 1999.

John R. Cary for the National Transport Code Collaboration, "Development of a physics application by a geographically distributed team", Opening Invited Talk presented at the Australia/Japan/US Workshop on High Performance Computing and Advanced Visualization in Plasma Physics Research, July, 1999.

"Calculation of finite-length, hollow-beam equilibria." J. Lee, J. R. Cary, Proc. 1999 Particle Accelerator Conference, 174, New York City, NY, 1999.

"Molecular dynamics of a strongly magnetized non-neutral plasma." J. Lee and J. R. Cary, Bulletin American Physical Society, 44 (7), 106 1999.

"Progress on the data server for the national transport code." K. Luetkemeyer, G. Bateman, J. R. Cary, T. Fredian, D. Greenwood, R. Jong, J. Wiley, NTCC Demo Team, Bulletin American Physical Society, 44 (7), 307 1999.

"Study of beam confinement and emittance growth in and intense charged particle beam using PIC simulations." K. Sonnad, J. R. Cary, and R. Giacone, Bulletin American Physical Society, 44 (7), 203 1999.

"National transport code collaboration" Kritz, Cary, et al, Bulletin American Physical Society, 44 (7), 306, 1999.

"Simulations of pulse propagation in the laser wakefield accelerator using an object-oriented particle in cell code." R. Giacone, J. Cary, and K. Sonnad, Bulletin American Physical Society, 44 (7), 297, 1999.

"NTCC Demo Team, "Status of the NTCC python physics server." R. H. Cohen, R. Jong, T. B. Yang, J. Cary, K. Luetkemeyer, J. Kinsey, H. St. John, J. Wiley, Bulletin American Physical Society, 44 (7), 307, 1999.

"An improved levenberg-marquardt solver for multiple-target optimization." S. G. Shasharina and J. R. Cary, Bulletin American Physical Society, 44 (7), 82, 1999.

ISIDOROS DOXAS

"Developing an integrated learning and teaching environment on the web." Doxas, I., and F. Bagenal, The Solar System Collaboratory, American Geophysical Union, San Francisco, CA, 1999.

"The Magnetotail as a driven stochastic system; dimensionality, stationarity, and colored noise." Goode, B., J. R. Cary, I. Doxas, and W. Horton, American Geophysical Union, San Francisco, CA, 1999.

"Properties of the WINDMI model for the solar wind driven nightside magnetosphere." Horton, W., R. S. Weigel, J.P. Smith, and I. Doxas, American Geophysical Union, San Francisco, CA, 1999.

"The solar system collaboratory; an innovative way to teach astronomy to non-science majors." American Association of Physics Teachers, Anaheim, CA, 1999.

KATHY GARVIN-DOXAS

"Kenneth Burke's implicit theory of power." G. Cheney, K. Garvin-Doxas, and K. Torrens, In B. Brock (Ed.) Kenneth Burke and the 21st Century 133-150, SUNY Press, NY, 1999.

"A web based introductory astronomy course for non-science majors: The solar system collaboratory." Doxas, I., F. Bagenal, B. Allen, E.~V-B Tompkins, and K. Garvin-Doxas, American Association of Physics Teachers, San Antonio, TX, 1999.

"Assessing learning outcomes for a web-based introductory astronomy course." B. J. Allen, Elaine, V-B. Tompkins, and K. Garvin-Doxas, American Association of Physics Teachers, Anaheim, CA, 1999.

RODOLFO GIACONE

"Simulations of pulse propagation in the laser wakefield accelerator using an object-oriented PIC code." R. E. Giacone, J. R. Cary and K. Sonnad, Bulletin of the American Physical Society 44 (7), 279, 1999.

MARTIN GOLDMAN

"Turbulence and phase space holes driven by two-stream instability in a magnetized plasmas." M. V. Goldman, American Physical Society, Seattle, WA, November, 1999.

"The Physics-2000 Project- evaluation of interactive Web-based physics learning." M. Goldman, D. Rea and G.

"Theory of localized bipolar wave structures and nonthermal particle distributions in the auroral ionosphere." M. V. Goldman, M. Oppenheim and D. Newman, Third International Workshop on Nonlinear Waves and Chaos in Space Plasmas, Carlsbad, CA, March, 1999.

"Theory and simulations of electron beam-driven localized wave structures." M. V. Goldman, D.L. Newman, K.D. Kang, F. Crary and M.M. Oppenheim, International Topical Conference on Plasma Physics: New Frontiers of Nonlinear Sciences Faro, Portugal, September, 1999.

"Generation of turbulence and wave-induced heating during ionospheric modification." D. L. Newman and M. V. Goldman, RF Ionospheric Interactions Workshop, Santa Fe, NM, April, 1999.

"Langmuir turbulence: From heater absorption to electron acceleration." D. L. Newman and M. V. Goldman, URSI XXVI General Assembly, Toronto, ON, Canada, August, 1999.

"Assessment of an instructional web site: What are the learning and affective outcomes?" G. C. Weaver, M. Goldman, K. Beck and D. Rea, 218th American Chemical Society National Meeting, New Orleans, Louisiana, August 22-26, 1999.

"Invited one hour presentation to the National Science Foundation — Math and Physical Sciences Directorate: The Physics-2000 Project (accompanied by Chancellor Byyny)." Washington DC, July 16, 1999.

"Invited two hour lecture at the CU Center for Lifelong Learning and Design: The Physics-2000 Project ECCS 128." Sept. 22, 1999.

JIM HOWARD

"Global Dynamics of Charged Dust Particles in Planetary Magnetospheres." AGU Division of Dynamical Astronomy, Estes Park, 1999.

ALAN KIPLINGER

"A study of CMEs in H-alpha, EUV and X-rays." N. Nitta, A. L. Kiplinger and B. J. Thompson, American Geophysical Union, San Francisco, CA, December, 1999.

DAVID NEWMAN

"Dynamics of electron phase-space holes in a 2-D magnetized plasma." D. L. Newman, M. V. Goldman, and M. M. Oppenheim, 41st Annual Meeting of the Division of Plasma Physics of the American Physical Society, Seattle, WA. November, 1999.

“Theory and simulations of electron beam-driven localized wave structures. " M. V. Goldman, D.L. Newman, K.D. Kang, F. Crary and M.M. Oppenheim, 45 (invited), International Topical Conference on Plasma Physics: New Frontiers of Nonlinear Sciences, Faro Portugal, September, 1999.

"3-D simulations of electron phase-space holes." M. M. Oppenheim, D. L. Newman, and M. V. Goldman, 41st Annual Meeting of the Division of Plasma Physics of the American Physical Society, Seattle, WA, November, 1999.

"Beam-driven localized wave structures: Simulations and connection to FAST E-Field measurements." M. Oppenheim, D. Newman, and M. Goldman, National Radio Science Meeting, Boulder, CO, January, 1999.

"Electrostatic ion cyclotron waves in the late time evolution of the electron two-stream instability." M. V. Goldman, D. L. Newman, F. Crary, R. E. Ergun, and M. M. Oppenheim, 1999 Fall Meeting, American Geophysical Union, San Francisco, CA. December, 1999.

"HF excitation of langmuir turbulence: Comparison of F-region and sporadic-E heating." D. L. Newman, M. V. Goldman, F. T. Djuth, and P. A. Bernhardt, National Radio Science Meeting, Boulder, CO, January, 1999.

"Interaction of bipolar electron phase-space vortex tubes with electrostatic whistlers: A Vlasov analysis." David L. Newman, Martin V. Goldman, and Meers M. Oppenheim, American Geophysical Union, Boston, MA, June, 1999.

"Langmuir turbulence: From heater absorption to electron acceleration." D. L. Newman and M. V. Goldman, (invited), URSI XXVI General Assembly, Toronto, ONT, Canada, August, 1999.

"Theory of whistler wave interaction with bipolar wave structures in the auroral ionosphere." Martin V. Goldman, David L. Newman, Fernando Perez, Michael Spector, and Meers M. Oppenheim, American Geophysical Union, Boston, MA. June, 1999.

SCOTT PARKER

"A nonlinear correction to Landau-fluid closures suitable for Gyrofluid simulations.” S. Parker, Bulletin of the American Physical Society, (44), 359 (1999). APS Centennial Meeting, International Sherwood Fusion
Theory Conference, Atlanta, GA, March 20-26, 1999.

"Diagnosing simulations of plasma turbulence.” W. Nevins, B. Cohen, A. Dimits, D. Shumaker, Z. Lin and S. Parker, Bulletin of the American Physical Society, (44), 261 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-19, 1999.

"Effects of temperature ripples and self-consistent equilibrium Er shear in a gyrokinetic flux-tube simulation." C. Kim and S. Parker, Bulletin of the American Physical Society, (44), p. 359 (1999). APS Centennial Meeting, International Sherwood Fusion Theory Conference, Atlanta, GA, March 20-26, 1999.

"Gyrofluid simulation of magnetospheric alfven waves." S. Jones and S. Parker, Bulletin of the American Physical Society, (44), 152 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-29, 1999.

"Gyrofluid simulation of magnetospheric Alfven waves." S. Jones and S. Parker, Meeting of the American Geophysical Union, San Francisco, CA, December 1999.

"Gyrokinetic simulation of turbulence and transport with zero-mass fluid electrons." Y. Chen and S. Parker, Bulletin of the American Physical Society, (44) , 301 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-19, 1999.

"Kinetic-MHD: making the micro-macro connection." S. Parker, Bulletin of the American Physical Society, (44), 153(1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-29,1999.

"Massively parallel 3D gyrokinetic flux-tube simulations." C. Kim and S. Parker, Bulletin of the American Physical Society, (44), 302 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-19, 1999.

"Recent algorithmic and computational efficiency improvements in the NIMROD code." S. Plimpton, C. Sovinec, T. Gianakon and S. Parker, Bulletin of the American Physical Society, (44), 82 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-19, 1999.

"Turbulence simulation using a gyrokinetic-ion fluid-electron hybrid model." Y. Chen and S. Parker, Bulletin of the American Physical Society, (44), 356 (1999). APS Centennial Meeting, International Sherwood Fusion Theory Conference, Atlanta, GA, March 20-26, 1999.

"Two-point correlation measurements of large-scale gyrokinetic turbulence simulations." M. Crabb, C. Kim and S. Parker, Bulletin of the American Physical Society, (44), 136 (1999). Meeting of the Division of Plasma Physics, Seattle, WA, November 15-29, 1999.

"Gyrokinetic plasma turbulence simulations." S. Parker, Campus-wide Plasma Seminar, Univ. of Wisconsin, Madison, November 18, 1998.

"Large-scale kinetic plasma turbulence simulations." S. Parker, Invited Talk at the APS Centennial Meeting, Division of Computational Physics, March 20-26, 1999, Atlanta, GA. Bulletin of the American Physical Society, (44), 1510, 1999.

"Similarities and differences between gyrokinetic and gyrofluid simulations." S. Parker, Theoretical Plasma Seminar, Univ. of Wisconsin, Madison, November 18, 1998.

"Synergies in kinetic-MHD and turbulence simulations." S. Parker, Fusion Summer Study, Snowmass, CO, July 11-23, 1999.

SCOTT ROBERTSON

"An annular penning trap for studies of plasma confinement." J. Kline, S. Robertson, and B. Walch, Non-Neutral Plasma Physics III, edited by J. Bollinger et al. (American Institute of Physics, New York, 1999), (498), 290-298.

"Electron confinement in an annular Penning trap." S. Robertson and R. Walch, Proc. of the 1999 Workshop on Nonneutral Plasmas, Princeton University, August 2-5, 1999.

"An annular Malmberg-Penning trap for tests of drift kinetic theory." S. Robertson, J. Kline and R. Walch, Proc. of the 1999 Workshop on Nonneutral Plasmas, Princeton University, August 2-5, 1999.

"Experiments relating to noctilucent clouds." by S. Robertson and M. Horányi, National Radio Science Meeting (URSI), Boulder, CO, 4-8 January 1999.

"Photoelectric charging of dust particles." A. Sickafoose, J. Colwell, M. Horányi and S. Robertson, Bulletin of the American Physical Society, (44), 49 1999.

"Neoclassical transport in an annular Penning Trap." B. Walch, J. Kline and S. Robertson, Bull. Am. Phys. Soc. (44), 108 (1999).

"A Rocket-borne Detector for Charged Atmospheric Aerosols," S. Robertson, M. Horányi, B. Smiley and B. Walch, *Frontiers in Dusty Plasmas*, Proc. of the Second International Conference on the Physics of Dusty Plasmas, Hakone, May 24-28, 1999, (Elsevier, Amsterdam, 2000), p. 275-280.

"Dusty plasma experiments relation to mesospheric aerosols." S. Robertson, M. Horanyi, B. Smiley, and Z. Sternovsky, Bulletin of the American Physical Society (44), 196 1999.

"Dusty plasma experiments relation to mesospheric aerosols." B. Smiley, S. Robertson, M. Horányi, and Z. Sternovsky, National Radio Science Meeting (URSI), Boulder, CO, January, 2000.

CURRENT RESEARCH PROGRAMS

COMPUTATIONAL SPACE PLASMA PHYSICS (NSF, DOE, NASA)

Ionospheric Modification:
This is a part of an international project in which high-power radio waves are used to heat and modify Earth's ionosphere. Experiments have been carried out at Arecibo, Puerto Rico, at several facilities in Alaska, and at various other sites around the world. Multidimensional kinetic simulations have been developed and run at CIPS for studying the generation of wave turbulence and the subsequent acceleration of electrons to high energies under a variety of ionospheric conditions. The simulation results will be compared with observations, such as airglow measurements and radar backscatter diagnostics, and will serve as the basis for new theoretical models. Analytical studies of the role of background density gradients on heater-induced turbulence have also been carried out, and applied to recent observations of intense airglow associated with highly-inhomogeneous "sporadic-E" events.

Auroral Ionosphere.
FAST and other spacecraft has recently measured intense bipolar electric fields in the auroral ionosphere. Kinetic simulations of turbulence driven by intense beams have resulted in bipolar electrostatic fields with characteristics similar to the bipolar fields that have been observed by FAST. The simulations reveal that these fields are associated with coherent "tube-like" structures in phase space, which subsequently break up due to interactions with electrostatic whistlers (see Figure 1). An analytical model for the interaction of these tubes with whistlers has been developed, which agrees quantitatively with the simulation results. New simulation runs with magnetized ions reveal a sequence of stages in the evolution of the turbulence over multiple timescales. Among the phenomena observed are the driving of low-frequency ion-cyclotron (or Bernstein) waves nearly perpendicular to the

background magnetic field, and the subsequent decay of these waves into other magnetized wave modes.

Magnetosphere

Global models for the magnetotail and the magnetospheric-ionospheric coupling are being developed and compared to data-driven predictive techniques, such a linear and nonlinear filters and neural networks. Current research attempts to determine whether the fractal nature of the statistics of magnetospheric data is due to the system being chaotic, low-dimensional system in a strange attractor, or due to it being a stochastic system with colored noise. A technique for distinguishing between these two systems has been developed, and shows that this system is not a stochastic system with colored noise. Large scale particle simulations are used to tune the parameters of the models giving good agreement with observations. A 32-node cluster was recently constructed to allow us to run the large number of particles required for 3-D simulations.

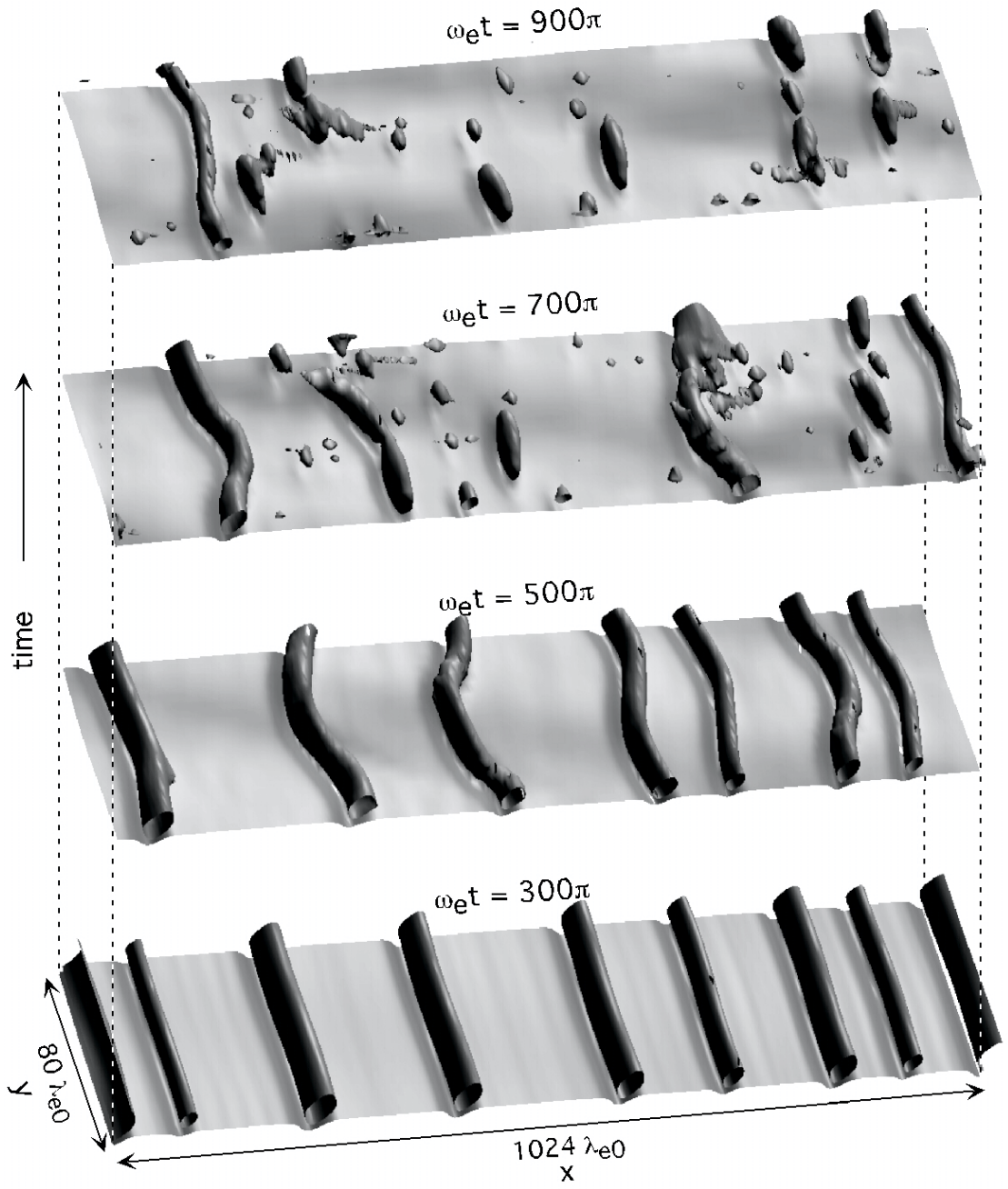


Figure 1:

BEAM PHYSICS (DOE)

Beam physics is the study of the creation and evolution of intense directed beams, of either charged particles or light. The study of this physics has permitted the design of beams of higher energy, higher quality, greater intensity, and reduced size. Such beams are used for cancer therapy, the study of elementary particles, and processing of semiconductors. Hence, the study of how intense beams propagate has an impact on large areas of basic science and technology.

Recently, we have become involved in the simulation of beams using the OOPIC (Object Oriented Particle in Cell) code for the study of two physics problems. The first is that of laser-plasma interactions for the purpose of accelerating particles by the large electric fields produced. (A contour plot of these simulations is shown in Figure 1.) These simulations are studying the injection of plasma particles by auxiliary lasers into the accelerating buckets. The second is a study of the effects of a nonlinear focusing system on beam halo. Beam halo can cause potentially large wall activation. It arises due to resonances of the beam particles with fields produced by beam oscillations. Our studies will show whether these effects can be mitigated by a nonlinear transport system.

Our studies of the nonlinear dynamics of beams has shown how to make it easier to capture a larger beam by reducing the volume of chaotic orbits. Current research is on how to optimize these complex systems in a flexible manner. Our work on beam instabilities showed that there is a nonlinear mechanism for extracting beam energy by the interaction of the beam with weak cavity modes.

Lastly, we have begun studies of non-neutral plasmas, which can be used to elucidate beam physics and are used for beam sources. In the limit of strong magnetic field and low temperature, transfer from parallel to perpendicular energy is minimized, and the dynamics is governed by guiding-center motion. Thus, in the limit of strong magnetic field there are three thermodynamic variables, the parallel

temperature, the perpendicular temperature, and the magnetic field. Our molecular dynamics simulations are now mapping out the phase transition curve in this three-dimensional space.

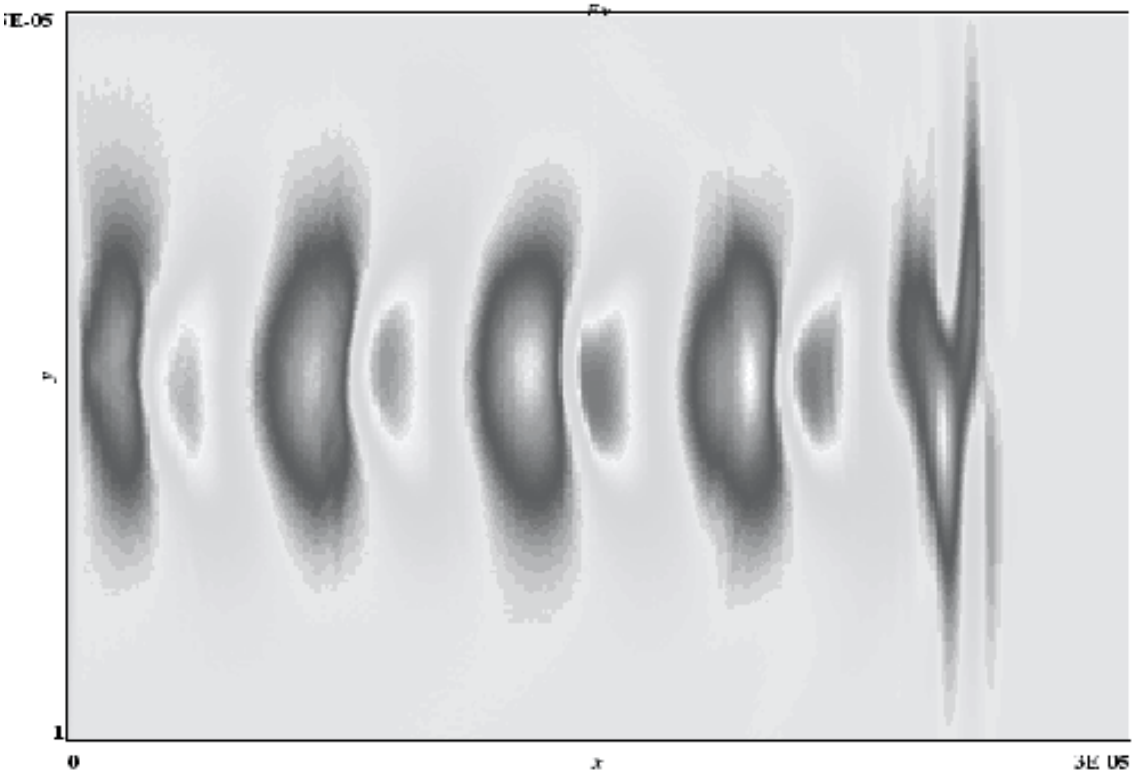


Figure 1. Grayscale contours of the large fields produced in a plasma by a laser pulse.

FUSION PLASMA THEORY AND COMPUTATION (DOE)

Recent developments in algorithms, massively-parallel computing, and object-oriented programming are having an enormous impact on plasma physics. Theoretical developments in nonlinear dynamics, kinetic-fluid closures as well as theory-based numerical methods such as delta-f and symplectic integration have also had an enormous impact. CIPS is unique in its international leadership in all of these areas of theoretical and computational basic plasma science.

Fusion plasma theory and computation is being investigated by several researchers at CIPS. Topics include large-scale massively parallel turbulence simulations; the use of modern computer science methods in modeling; optimization of three-dimensional magnetic confinement systems to eliminate chaotic orbits; macroscopic kinetic-MHD hybrid simulation; development of gyrokinetic-fluid hybrid models and the effects equilibrium and self-generated shear flow on turbulent transport. CIPS is playing a leadership role in developing electromagnetic electron physics models for large-sc

PHYSICS-2000 OUTREACH EDUCATION PROJECT (NSF)

The Physics-2000 Outreach Education Project is carried out with the participation of members of the Physics and Chemistry Departments, and funded in 1998 by the Math-Physics Directorate of NSF.

Physics-2000 is a uniquely multidisciplinary program which strives to create an environment of integration between education and technology. This is accomplished by bringing together students, educators, and the general public to experience a highly-accessible authoritative popular exposition of the underlying 20th century science, all of which is made widely and freely accessible on the Internet. In a project directed by Professor Goldman, individuals can perform their own virtual experiments by the simple manipulation of the computer mouse. These experiments include both "thought" experiments and simplified "real" experiments illustrating basic physical principles. Interaction is not limited to experienced users. With the help of this program, educators are teaching physics over the web to K-12, college students, and the general public. Faculty and students have worked with a capable staff of programmers, artists, formatters, and other developers to create the virtual experiments and the accompanying narrative on the web site, www.colorado.edu/physics/2000. Some of these interactive applets include a dynamic periodic table of the elements, nuclear reactions, principles of polarization, CRT operation, color mixing, liquid crystals, and LCD displays.

This program has been highly acclaimed throughout the nation and has received national press coverage. Content developed over the last year includes X-rays, CT scans, microwave ovens, the Bose-Einstein condensate, quantum interference, and the physics of electromagnetic waves, including production for radiation at the atomic level. Professors Scott Parker, Carl Wieman, and Carl Lineberger all contributed to the development of this educational project. This web site was used as a teaching supplement in a variety of undergraduate Physics department courses.

SOLAR SYSTEM COLLABORATORY (DEPT. OF ED)

The Solar System Collaboratory is a collaboration of four Colorado schools: The University of Colorado at Boulder (UCB), The University of Northern Colorado at Greeley (UNC), The University of Southern Colorado in Pueblo (USC), and Fort Lewis College in Durango (FLC). The purpose of the collaboratory is to develop educational modules which can be incorporated into science courses at all levels of the undergraduate curriculum, and then to assist participating schools in teaching the modules collaboratively across the state. The educational objective is to help schools introduce student-centered learning into their science classes, and to give their students the open-ended problem solving skills that the increasingly high-tech economy demands. Resent research has concentrated on the development of web-based tools that aid instructors in introducing the modules into their class. These include exam and assignment databases, a database on student's most common mistakes and misconceptions, and a video database on collaboration issues that emerge when students are assigned group projects.

DUSTY PLASMA PHYSICS (NASA, DOE, NSF/DOE)

Small solid particles are frequently found in laboratory and space plasmas. These become charged and their equations of motion are more complicated than those for ions because their charge fluctuates and there are additional forces such as gas dynamic drag and gravity. There are several projects, sponsored by NASA and DOE, to understand these phenomena. These projects are carried out in association with researchers Mihaĺy Horańyi and Josh Colwell at the Laboratory for Atmospheric and Space Physics.

A) Laboratory study of the microphysics of noctilucent clouds

In the arctic, the ionosphere becomes sufficiently cold for water vapor to form cluster molecules of ice at altitudes from 80-90 km. These are visible in twilight as noctilucent clouds and are detectable by radar when not visible. Rocket-borne detectors have found that the charge balance in the ionosphere is disturbed when these particles are present. Modeling of these processes is difficult because cross-sections for charging processes such as electron attachment, photoionization and photodetachment are not known. A source of ice cluster molecules has been constructed in the laboratory so that they can be studied under controlled conditions. A supersonic nozzle is used to create an adiabatic expansion of argon and water vapor in which ice cluster molecules are formed. Clusters with 4 to 11 water molecules have been created and detected. The cross section for collisions of these clusters with other gas molecules has been measured and further experiments with electron beams and ultraviolet light sources are in progress to measure cross sections related to charging.

B) Rocket-borne instrumentation for aerosols in the ionosphere

Small particles in the ionosphere that may become charged include the noctilucent cloud particles discussed above as well as dust formed by the condensation of ablated meteoric material (Fe, Na, Mg, etc.). The altitude for these layers of charged material (80-100 km) is too high for measurements by balloon and thus requires

rocket-borne instruments which pass through the layers in a few seconds. We have constructed a charged aerosol detector which was launched from White Sands, 2 November 1998. A charge layer was detected at 86 km altitude with a density of 2000 charges/cm^3. Data analysis included computer simulations of the flow of particles around the rocket which found the fraction of these particles which were incident upon the active area of the detector. This layer was most likely an iron or sodium layer with a meteoric origin. A second launch is planned for November, 2000 with four detectors with differing mass sensitivities that will allow the masses of the particles to be bracketed.

C) Dusty plasma dynamics near surfaces in space

The Moon and Mars are covered with a fine layer of dust and recent data show that asteroids and small moons are also covered. A study of the evolution of airless bodies (and Mars) requires understanding of the forces causing levitation and transport of these dust particles. In the past we have studied simulated lunar dust and dust returned from the Apollo 17 landing sight. These particles were dropped through a chamber containing plasma with energetic electrons and the charging by electrons, ions, and secondary electron emission was measured. This past year, these studies were extended to the photoelectric charging of simulated lunar and martian dusts as well as other materials (glass, graphite, metals). An unexpected outcome of these experiments was that there is considerable triboelectric charging (by rubbing) of the lunar and martian simulants when these dusts are agitated.

D) Undergraduate research into strongly coupled dusty plasma

Particles with the same sign of charge repel one another and may form crystalline arrays when confined to a sufficiently small volume by an external force. A Paul trap with an alternating electrostatic field has been constructed to confine dozens of identically charged oil droplets and these have been observed to form regular arrays. The structure has been determined from analysis of videotapes of rotating arrays. A significant effort was required to develop a steady source of identically charged oil droplets.

NONNEUTRAL PLASMA PHYSICS (NSF)

A new table-top experiment was constructed in 1998 to investigate collisional transport of electrons across magnetic field lines. The experiment uses a Penning trap in which electrons are confined radially by an axial magnetic field and confined axially by electrostatic fields at the ends. The collision frequency is varied by changing the pressure of helium gas. The experiment is unusual in that there are conductors along the axis for creating an additional azimuthal field which causes the field lines to twist. The neoclassical theory of transport which applies to many fusion devices applies to this much simpler device. This allows some fundamental aspects of the theory to checked in a straightforward way. Research projects have been carried out primarily by undergraduates. A second, larger device is under construction which will study the transition from classical to neoclassical behavior which occurs as the collision frequency is increased

BASIC AND APPLIED EXPERIMENTAL PLASMA PHYSICS (NSF, CNRS (FRANCE))

Stochastic Ion Heating

A new plasma diagnostic technique which addresses a problem of primary importance in experimental plasma physics is being developed. Based on a concept originated by us, it exploits the fact that atomic transition rates between nearly-degenerate, optically connected Lamb-shifted states are exceptionally sensitive to electric and magnetic fields, because of the small energy difference between the states. During 1999 as well as currently, i. signal/noise and sensitivity limits for variants of this technique are being analyzed, including the use of laser-induced fluorescence to measure the field-induced state density decrease; and ii. A graduate student is completing experimental work on this topic. Future directions for research and funding will depend on the results of the analysis and the experiment.

A collaboration with Gekelman's group at UCLA, making use of the UCLA research device LAPD, was initiated in 1995. It is based on the laser fluorescence diagnostic technique (LIF) developed by us for the measurement of plasma wave-ion interactions at the kinetic level. The initial stage of research , ending in 1999, indicated that the existing LAPD configuration was not suitable: specifically, LIF in He plasmas could not be carried out because of excessive electron broadening of the He II lines. Also, whereas LIF in Argon plasmas proved successful, the launching of waves turned out to be marginal because the high Argon mass increases the Alfven wavelength beyond the dimensions of the LAPD device. An upgraded facility, nearly twice as long as LAPD, is being assembled and expected to be on air in December.

A long-term collaboration with P. M. Bellan at Caltech, making use of the Caltech research torus device ENCORE, has been carried out since 1984. The topic is the study of wave-particle interactions in stochastically heated plasmas – a subject of

high current interest – making use of LIF diagnostics. In 1999, a detailed analysis of our latest experimental data was completed. It revealed that our physical model for the regenerative aspects of the process was correct, and was published S. J. Sanders, R. F. Boivin, P. M. Bellan, and R. A. Stern, Physics of Plasmas (6), 4118 (October 1999)].

ACTIVITY HIGHLIGHTS FOR 1999

JOHN CARY

- Chair of Session at the Australia/Japan/US Workshop on High Performance Computing and Advanced Visualization in Plasma Physics Research, July, 1999.
- Chair, Publications Committee, Division of Plasma Physics.
- American Physical Society. Fellowship Committee.
- Division of Plasma Physics, American Physical Society Member.
- National Stellarator Program Planning Committee Program Committee.
- Particle Accelerator Conference Organizer.
- Fusion Snowmass Summer Study, July 1999 & Co-Chair, Science Working Group. This involved extensive work to set up the most wide ranging and critical meeting of the fusion research community.
- Session Chair, Particle Accelerator Conference, New York City, March 29, 1999.
- Supervisor of Dr. Kathy Garvin-Doxas, a Research Associate in CIPS.
- Physics Department's Chair's Advisory Committee.
- Director, Center for Integrated Plasma Studies.
- Member, Self Study, Dept. of Physics.
- Supervisor of Dr. Isidoros Doxas, a Senior Research Associate in CIPS.
- Graduate School Executive Advisory Committee Member, Joint Committee for evaluation of combined BA/MA degrees.
- Member, Council on Research and Creative Work Evaluation Panel Natural.
- Science Coordinator of the Area Teaching Scholars Program. This is a lot of work, and it has been well received. Served on the Internal Review Panel for LASP.
- Supervisor of Dr. Yasutaro Nishimura and Dr. Rodolfo Giacone, Research Associates in CIPS.
- Selected as Editor for Physical Review E for 3 year term, 2000-2002.
- Peer Review of Manuscripts, Grants or Creative Work Many reviews, like 12-15, of papers and proposals.

YANG CHEN

- Organized the Spring 1999 CIPS Plasma Seminar.

ISIDOROS DOXAS

- Advisor for Brent Goode, Ph.D. Candidate in Physics Department.
- Advisor for 25 Political Science majors.
- Mentor to 2 post-doctoral fellows.

RODOLFO GIACONE

- Organized the Fall 1999 CIPS Plasma Seminar.

MARTIN GOLDMAN

- Serials Committee of American Institute of Physics (AIP). Oversees journal and refereeing policies for scientific journals published by the American Institute of Physics. Sets prices and develops the transition to electronic journals. I have been elected Chair for next year.
- Publication Committee of Division of Plasma Physics of American Physical Society. Oversees activities of plasma physics journals such as Physics of Plasmas.
- Plasma Astrophysics Working Group of the International Astronomical Unison (IAU). Sets policy and selects invited speakers for annual IAU meetings.
- International Advisory Board of European Center for Nonlinear Sciences (ECNOS). Member of this group which determines scientific programs and speakers for its annual meeting.
- Chair of Computational Physics Committee. (Prepares budgets for new computational resources, manages new computer lab, and recommends policies).
- Director of Physics-2000.
- Director of Center for Integrated Plasma Studies (includes all normal duties and responsibilities of a unit head in the College of Arts and Sciences-through June 1999 only).
- Chair of Chancellor's Committee to Study Formation of a Center for Technology-Assisted Science Education (this would be a multi-campus Center or Institute devoted to instructional technology).
- Member of ATLAS Steering Committee (Alliance for Technology, Learning and Society - headed by Bobby Schnabel. This is a campus-wide initiative aimed at distinguishing CU Boulder nationally and regionally in teaching, research and service related to information and communication technology).
- Member of Technology & Arts Media Committee (This committee advises ATLAS on the creation of a new certificate degree combining technology and arts.)
- Mentor to Dr. David Newman, a Senior Research Associate in CIPS.
- Mentor to Dr. Michael Spector , a Research Associate in CIPS.

JIM HOWARD

- Reviewed several papers for leading journals.

JAMES MEISS

- Service to Scholarly or Professional Organizations Created and maintain the "Frequently asked questions" document for the science nonlinear usenet newsgroup. See http://amath/appm/faculty/jdm/faq.html
- Organizer, Southwest Dynamical Systems Meeting to be held at UCLA in Nov, 2000.
- Paid Consulting Activities Reviewer for Textbook proposals for McGraw-Hill publishing company
- Reviewer for Textbook proposals for Addison-Wesley publishing company.
- Oversee computer staff, laboratory procedures and software & hardware maintenance for our research lab (15 Sun, 7 SGI), staff computers (11 Macintosh), and undergraduate lab (3 SGI).
- Graduate Committee. Graduate applications and vetting. Preliminary Examination Committee, Jan 98 and Aug 98. write and grade the PDE preliminary exam for M. S. and Ph.D. students
- Textbook Selection subcommittee for APPM 2360
- Applied Mathematics Alumni Newsletter. Created, and edited the first issue. Sent to over 600 alumni.
  See it at < http://amath/appm/alumni/newsletter_1.pdf.
- Computer Technology Liaison Boulder Campus University of Colorado Goldwater Scholarship: recruit and select applicants for this National Scholarship International Education Scholarship Committee.

DAVID NEWMAN

- Referee for peer-review journals: Physical Review Letters, Geophysical Research Letters, and Physics of Plasmas.
- Write-in grant reviewer for NASA.
- Advisor on Physics-2000 web-based physics education project (M. V. Goldman, Director).

SCOTT PARKER

- Chair, Executive Committee, International Sherwood Fusion Theory Conference. This is the primary conference on Magnetic Fusion Theory.
- Member, Executive Committee of the American Physical Society - Division of Plasma Physics.
- Member, Executive Committee of the DOE Numerical Tokamak Turbulence Project.
- Organizer of the Physics Department Holiday Party.
- Physics Department Computing Committee.
- Physics Department Graduate Committee.
- Physics Department Junior Faculty Steering Committee.
- Member, Faculty Teaching Excellence Program Internal Review Committee, Academic Program Review.

- Reviewed a grant for DOE in fusion plasma theory.
- Reviewed a paper submitted to the Journal Physics of Plasmas.
- Supervisor of Dr. Yang Chen, a Research Associate in CIPS.

SCOTT ROBERTSON

- Thesis advisor for Byron Smiley, Ph. D. candidate, Physics Dept.
- Member, Thesis Committee for Amanda Sickafoose, APS Dept. I direct Amanda's research but am not formally her thesis advisor because she is an APS student.
- Mentor to Zoltan Sternovsky, a Professional Research Associate in CIPS.
- Member, Thesis Committee for Charlson Kim, Physics Department.
- Member, Thesis Committee for Jeremy Richardson, Physics Department.
- Supervised Independent study for Joe Espejo, Fall 1999, undergraduate Physics Department.
- Supervised Honors project for Qudsia Quraishi, Fall 1999, undergraduate Physics Department.
- Advisor for Engineering Physics undergraduates.
- American Physical Society, referee of papers for Physical Review Letters (2), Physics of Plasmas (1), Review of Scientific Instruments (3).
- Department of Energy - refereed proposal for Los Alamos National Lab.
- Member of the organizing committee of the Conference on Non-neutral Plasma Physics, held at Princeton University, August, 1999.
- NASA - refereed proposal.
- University Fusion Association, elected to the Executive Committee for a three year term. This organization represents the interests of about 30 University research groups to the Department of Energy's Office of Fusion Energy.
- Member of the Engineering Physics Advisory Committee and represented Eng. Phys. at Engineering Days.
- Physics Department, Evaluation Panel, member (Spring), Chair (Fall).

RAUL STERN

- Principal thesis advisor for Christopher G. Boozer, Ph. D. Candidate, APS Department.
- Department of Physics, Colloquium committee, member.