2015-2016

INSTITUTE FOR TERAHERTZ
SCIENCE AND TECHNOLOGY

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ANNUAL REPORT

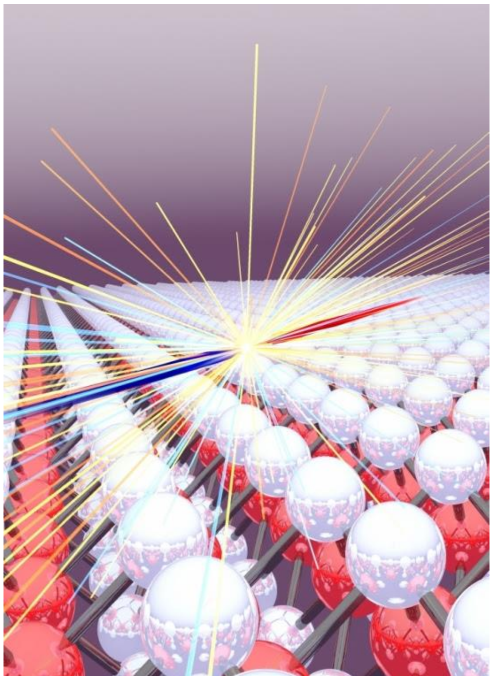

Illustration by Fabian Langer, University of Regensburg

Dr. Mark Sherwin, Director | Rita Makogon, Manager
Website: http://www.itst.ucsb.edu | rita@itst.ucsb.edu

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Mission Statement

The mission of ITST is to

advance science and technology at the heart of the electromagnetic spectrum* while

training and inspiring new generations of scientists, engineers, and the public at large and

supporting research with outstanding service in a warm, welcoming and fun workplace.

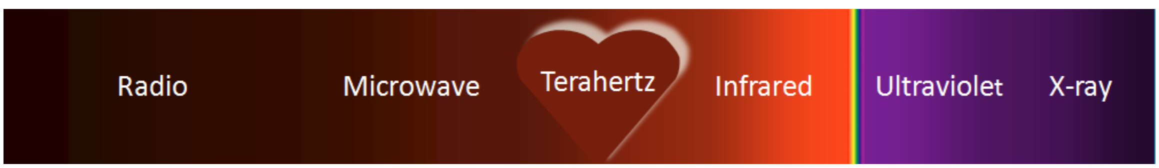


Figure 1: Chart showing ITST's research emphasis at the heart of the electromagnetic spectrum.

*roughly 0.1-10 terahertz (1 terahertz= 10^{12} cycles/s). For reference, cell phones transmit near 1 GHz (10^{9} cycles/s) and the spectrum of visible light stretches from about 400-800 terahertz.

Director's Statement

In last year's annual report, I noted the astounding advances in Terahertz technology over the last 30 years. Of course, this new technology opens many doors to exciting new science. The image on the cover of this report is one example of Terahertz science. It shows two "quasiparticles"—a positively charged "hole" and a negatively charged electron that were created in a semiconductor by a near-infrared laser—as they collide with one another after having been accelerated by intense Terahertz radiation. The ability to accelerate and collide quasiparticles using Terahertz radiation provides a fascinating new window into the physics of quantum matter driven very far from thermal equilibrium, which is an important frontier in science.

The Institute for Terahertz Science and Technology (ITST) is well-positioned for continued leadership in the study of systems driven by very strong Terahertz radiation. In June 2016, I learned that the NSF had funded a Major Research Instrumentation grant entitled "Development of a single-mode terahertz free electron lasers for research in materials, physics, chemistry and biology." The ambitious goal of this grant proposal is to enable the FEL to lase on a single mode (that is, as a perfect sine wave) at any frequency within its tuning range, and to implement a much more efficient and flexible capability for generating sequences of THz pulses. These capabilities will enable many exciting new experiments in condensed matter physics, materials science, molecular spectroscopy, and protein dynamics. Many thanks to all who contributed to this proposal, including my co-PIs Andrea Young (UCSB Physics), Mattanjah de Vries (UCSB Chemistry & Biochemistry), Andrea Markelz (University of Buffalo Physics) and Chris Palmstrøm (UCSB Materials), and my collaborators Songi Han (UCSB Chemistry and Biochemistry), Susumu Takahashi (USC Chemistry), Jun Kono (Rice Physics and ECE) and Xiaodong Xu (University of Washington, Physics and Materials).

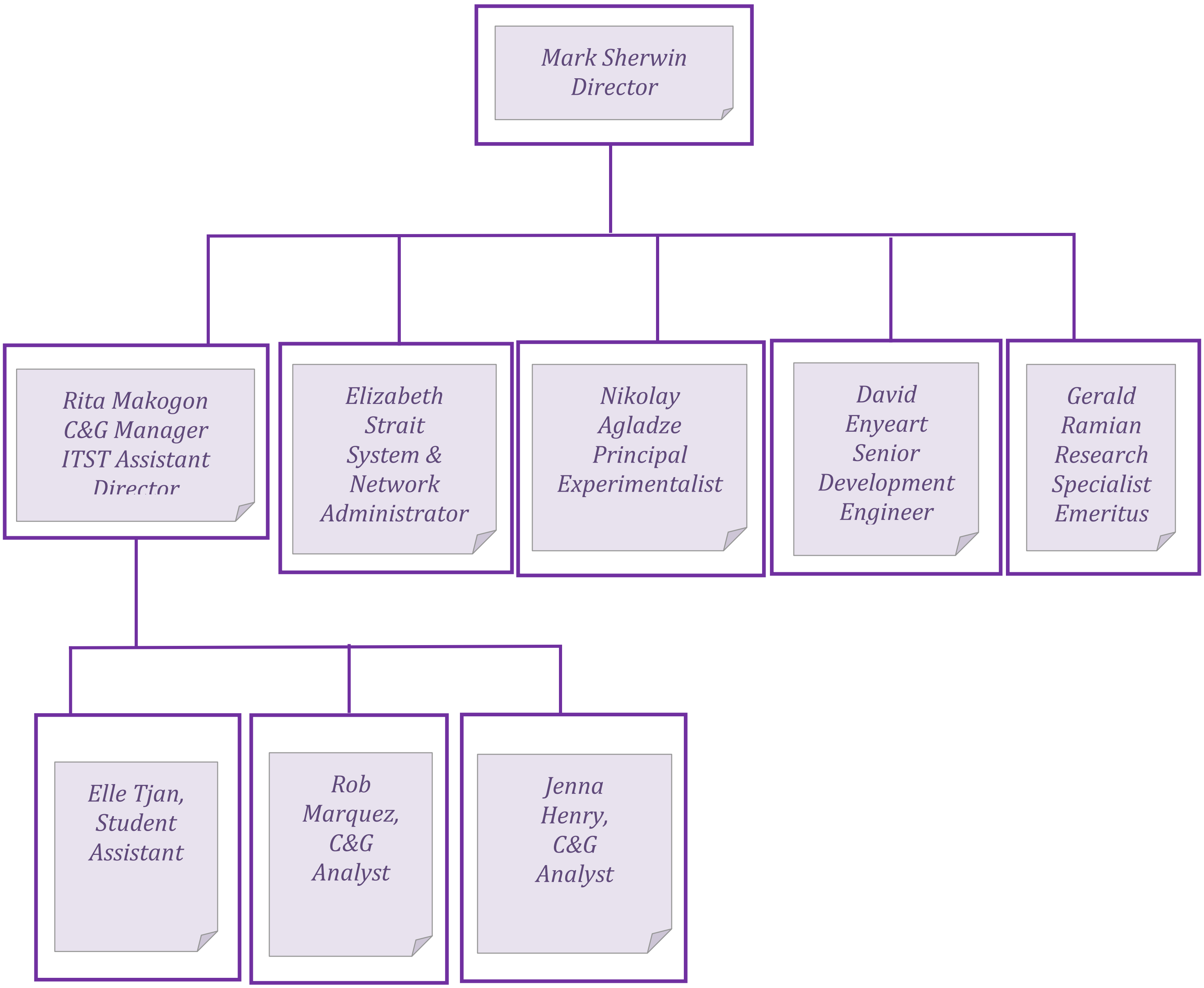
ITST hosted an active and vibrant interdisciplinary seminar series, featuring 25 talks on topics ranging from how human joints are lubricated to ultra-stable atomic clocks to superconductivity in small metal clusters. Titles and abstracts are on pp. 7 to 13.

There have also been some important administrative and personnel changes. After more than 30 years of brilliant and dedicated service, Mr. David Enyeart retired as Principal Development Engineer. He began his employment at UCSB in the very early days of the UCSB FEL project, coming from a job working on marine electronics. Over the course of his time at UCSB, he learned and took on a large number of new responsibilities, including operating, tuning and maintaining FEL electronics, ultra-high vacuum, and mechanical design and production. David left the FEL operating better than it ever has, as a result of his continual improvements, and the accelerator upgrade discussed in previous annual reports. As of this writing, the University has given us permission to bring David back two days per week to work on implementing the upgrade funded by the above-mentioned grant.

As of June 30, 2016, ITST completed the transition from being an Organized Research Unit that reports to the Vice Chancellor for Research to being a Center within the Physics Department. All Physics Department contracts and grants are now submitted and managed by Rita Makogon and her staff. The charts on pp. 57-61 tell the story in numbers. The number of proposals submitted increased from 23 in 2013-2014, before the beginning of the transition, to 91 in 2015-2016. Over the same interval, the number of proposals funded increased from 22 to 60, the value of funded proposals increased from \$3.6M to \$13.7M, the number of awards administered increased from 24 to 103, and the value of contracts and grants administered increased from \$13M to \$51.8M. Rita and her staff have accomplished a truly remarkable and heroic feat in handling this enormous increase in workload. In addition, Rita continues as my Assistant Director, and Elizabeth Strait continues to assist me with matters related to Information Technology. THANK YOU, RITA and ELIZABETH!!!

I am very excited about the future of ITST, working on fantastic science and technology with wonderful people. Please stay tuned!

Organizational Chart



Advisory Committee

Song-I Han	**Chemistry and Biochemistry, Committee Chair**
S. James Allen	Former iQuest Director, Physics
Mattanjah de Vries	Chemistry
Ania Jayich	Physics
Jon Schuller	Electrical and Computer Engineering
Wim Van Dam	Computer Science
David Weld	Physics
Stephen Wilson	Materials

Ex Officio Members

Rick Dahlquist	Chair, Chemistry and Biochemistry
Fyl Pincus	Chair, Physics
Mark Sherwin	Director, ITST, Physics

Personnel

Administrative Staff-ITST

Rita Makogon, C&G Manager, ITST Assistant Director
Rob Marquez, C&G Analyst
Jenna Henry, C&G Analyst
Elizabeth Strait, Computer and Network Administrator

Technical Staff-ITST

Nick Agladze, Principal Experimentalist
David Enyeart, Senior Development Engineer
Gerald Ramian, Research Specialist Emeritus

Seminars and Workshops

ITST continued its very successful lunchtime Seminar Series. Refreshments were provided. The following seminars took place throughout the year:

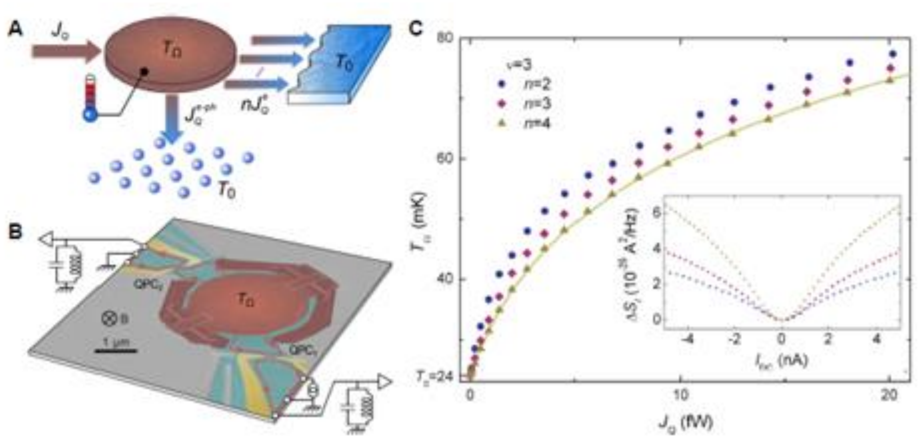
Thursday, September 24, 2015
Speaker: Matt Yankowitz, University of Arizona, Physics Department
Topic: Local Probe Spectroscopy of 2D Van Der Waals Heterostructures
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS09242015.pdf

Wednesday, September 30, 2015
Speaker: David Britt, UC Davis
Topic: Mechanisms of Solar Fuel Reactions as Probed by Advanced EPR Spectroscopy

Thursday, October 1, 2015
Speaker: David Britt, Department of Chemistry, UC Davis
Topic: EPR Instrumentation at the UC Davis CalEPR center

Thursday, October 8, 2015
Speaker: Francois Parmentier, Nanoelectronics Group, Service de Physique de l'Etat Condensé, IRAMIS/DSM (CNRS URA 2464), France
Topic: Quantum limit of heat flow across a single electronic channel
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS10082015.pdf

Thursday, October 15, 2016
Speaker: Donghun Lee, Physics Department, UCSB
Topic: Hybrid quantum systems: mechanical oscillators coupled to photons and solid-state defects
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS10152015.pdf



Thursday, October 22, 2015
Speaker: Mark Rudner, Neils Bohr Institute, University of Copenhagen
Topic: Topology and universality in periodically driven many-body systems
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS10222015.pdf

Thursday, October 29, 2015
Speaker: Matthew Rakher, HRL Laboratories
Topic: Electrically Controlled Qubits in Silicon
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS04232015.pdf

Thursday, November 5, 2015
Speaker: Xibo Zhang, JILA, University of Colorado at Boulder
Topic: Using precision measurements to study quantum manybody physics

Thursday, November 12, 2015
Speaker: Laura DeLorenzo, Schwab group at CalTech
Topic: Exploring the Macroscopic Quantum Physics of Motion with Superfluid He-4
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS11122015.pdf

Friday, November 13, 2015
Speaker: Jesse Crossno, Harvard University
Topic: Observation of the Dirac fluid in graphene: a (slightly less) strange metal
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS11132015.pdf

Thursday, November 19, 2015
Speaker: Brian Youngblood, ITST
Topic: Skyrmions in Thin Magnetic Films
Abstract: http://www.itst.ucsb.edu/itst/Seminar15/CMTS11192015.pdf

Tuesday, January 19, 2016

Speaker: Shruti Badwar

Topic: Lateral confinement in THz quantum cascade lasers and graphene based Thz-optics

Thursday, January 12, 2016

Speaker: Quentin Wilmart, ENS Paris

Topic: Dirac fermion electronics using engineered doping profiles

Abstract: The two dimensional nature and chirality of the graphene charge carriers have brought exciting opportunities for a new kind of electronics. We are now able to realize devices exploiting the Dirac nature of graphene electrons. They rely on i) the stacking of graphene on hexagonal boron nitride (hBN) for the access to the ballistic regime and ii) a full control of the doping profile using local bottom gate arrays to induce p-n junctions that are sharp at the scale of the Fermi wavelength. I will present the realization and characterization of such devices and illustrate their potential for GHz electronics with two examples: the gated contact transistor and the Dirac fermion pinch-off transistor. The first relies on the Klein tunneling at the contact junction; the second on the inhomogeneous doping profile in local gated graphene combined with the velocity saturation by remote hBN surface phonons.

Thursday, January 28, 2016

Speaker: Amir Safavi Naeini, Stanford University

Topic: Quantum Optomechanics with Silicon Nanophotonic Structures

Abstract: Mechanical resonators are the most basic and ubiquitous physical systems known. In on-chip form, they are used to process high frequency signals in every cell phone, television, and laptop. In this talk, I will present our recent work with mechanical systems in the megahertz to gigahertz frequency range, formed by nanofabricating novel photonic/phononic structures on a silicon chip. These structures are designed to have both optical and mechanical resonances, and laser light is used to address and manipulate their motional degrees of freedom through radiation pressure forces.

Thursday, January 28, 2016

Speaker: Eric Spanton, Stanford Institute for Materials and Energy Sciences

Topic: Scanning SQUID investigations of topological and high spin-orbit materials

Abstract: I will discuss two separate scanning superconducting quantum interference device (SQUID) experiments: Transport current imaging of prospective topological insulator InAs/GaSb and direct measurements of the current-phase relations of InAs nanowire Josephson junctions. In InAs/GaSb heterostructures expected to be in the topological regime, we imaged conducting edge states in the Si-doping-induced insulating gap. The resistance of the edge states extracted from images is constant up to temperatures of order the insulating gap, putting strong constraints on the possible scattering mechanisms leading to non-quantized resistance of the edge states in large devices. More recently, we have imaged current in dual-gated InAs/GaSb where we can tune between topological and trivial regimes. Surprisingly, we found that conducting edge states exist continuously across the phase diagram, including in the region we identify as the trivial gap. In the second half of my talk, I will discuss direct measurements of the current-phase relations (CPRs) in many rings with single Josephson junctions formed by InAs nanowires. We find that the shapes of the CPRs match theoretical predictions for short SNS junctions and indicate high transmission in the nanowires. This work highlights scanning SQUID's ability to glean detailed information about the properties of junctions with a small number of Andreev bound states and paves the way for measurements of more exotic phenomena, such as searching for parity switching of Majorana quasiparticles.

Monday, February 1, 2016

Speaker: Avishai Benyamini, Weizmann

Topic: Attraction by repulsion paring electrons with electrons

Abstract: One of the defining properties of electrons is their mutual Coulombic repulsion. In solids, however, this basic property may change. A famous example is that of superconductors, where coupling to lattice vibrations makes electrons attractive and leads to the formation of bound pairs. But what if all degrees of freedom are electronic? Is it still possible to make electrons attractive via their repulsion from other electrons? Such a mechanism, termed 'excitonic', was proposed fifty years ago by W. A. Little, aiming to achieve stronger and more exotic superconductivity, yet despite many experimental efforts, direct evidence for such 'excitonic' attraction is still lacking. Here, we demonstrate this unique attraction by constructing, from the bottom up, the fundamental building block of this mechanism. Our experiments are based on quantum devices made from pristine carbon nanotubes, combined with cryogenic precision manipulation. Using this platform we demonstrate that two electrons can be made to attract using an independent electronic system as the binding glue. Owing to its large tunability, our system offers crucial insights into the underlying physics, such as the dependence of the emergent attraction on the underlying repulsion and the origin of the pairing energy. We also demonstrate transport signatures of 'excitonic' pairing in tunneling. Our experiments provide a direct demonstration of the 'excitonic' pairing mechanism and pave the way for generalizing it to the design of exotic states of matter.

Thursday, February 4, 2016

Speaker: Benjamin Hunt, Department of Physics, Carnegie Mellon University

Topic: Quantum metal and Ising superconductivity in two-dimensional NbSe2

Abstract: Atomically-thin transition metal dichalcogenides have recently become a very popular subject. NbSe2, a classic layered superconductor, is the first of these that exhibits superconductivity down to one or two atomic layers. I will discuss our recent experiments on bilayer and few-layer NbSe2 and our observation of an anomalous metallic phase in the zero-temperature limit induced by a small perpendicular magnetic field. This quantum metal phase has only been observed in highly-disordered thin film superconductors and its observation in a crystalline superconductor, along with a distinct magnetic field scaling, forces us to reexamine the diagram of possible electronic phases in two dimensions at zero temperature.

The atomic-scale thickness of the NbSe2 crystals also implies that we can explore the regime where quenching of superconductivity is entirely due to paramagnetic effects. We study this regime, where superconductivity can survive up to 30 T in-plane, and find a strong enhancement of the upper critical

field relative to the Pauli limit. I discuss the implications of this for spin-orbit coupling effects and possible exotic phases of superconductivity.

Thursday, February 11, 2016

Speaker: K. Unterrainer, Photonics Institute and Center for Micro&Nanostructures, Technische Universität Wien

Topic: THz quantum cascade lasers: from novel materials to circuits

Abstract: Quantum cascade lasers (QCLs) are most successful quantum devices which cover a broad spectral range from the infrared to the THz. However, their operation is still limited in terms of operating temperature, output power and beam properties. Therefore, we investigate new materials system and active regions designs. We use InGaAs/GaAsSb due to the lower effective mass and lower conduction band offset. We have achieved record operating temperatures despite the large interface roughness asymmetries in this material. We compare this to InGaAs/InAlAs structures which show even higher operating temperatures. For InAs/AlAsSb quantum cascade structures lasing is observed in moderate magnetic fields.

The unique properties of QCLs allow the fabrication of double metal micro-cavities. They show very low threshold currents and coupling between them allows the realization of circuits. We show that quantum cascade structures can also work as detector, modulator and amplifier. The coupling between the devices can be adjusted from weak to strong coupling with an unexpected dependence due the existence of an exceptional point.

Thursday, February 18, 2016

Speaker: Jairo Velasco, Berkeley/UC Santa Cruz

Topic: Nanoscale control of rewritable doping patterns in graphene/boron nitride heterostructures

Abstract: Heterostructures of graphene and hexagonal boron nitride (BN) are highly tunable platforms that enable the study of novel physical phenomena and technologically promising nanoelectronic devices. Common control schemes employed in these studies are electrostatic gating and chemical doping. However, these methods have significant drawbacks, such as complicated fabrication processes that introduce contamination and irreversible changes to material properties, as well as a lack of flexible control. To address these problems we have developed a new method that employs light and/or electric field excitation to control defect charge (from the single impurity level to ensembles) in the underlying BN. We have used optoelectronic and scanning tunneling spectroscopy measurements to characterize these BN defects. We find that by manipulating defect charge in BN it is possible to create rewritable tip-induced doping patterns such as gate-tunable graphene pn junctions and quantum dots. This creates new opportunities for mapping the electronic states of confined electrons in graphene and to visualize their quantum interference behavior.

Thursday, March 3, 2016

Speaker: Ni Ni, Physics Department, UCLA

Topic: Interplay of structure, magnetism and superconductivity in the 112 Fe based superconducting family

Abstract: Both cuprates and Fe-based superconductors, the two known high Tc superconducting families, show rich emergent phenomena near the superconductivity (SC). To understand the mechanism of unconventional SC, it is crucial to unravel the nature of these emergent orders. The 112 Fe pnictide superconductor (FPS), Ca1−xRExFeAs2 (CaRE112), shows SC up to 42 K, the highest bulk Tc among all nonoxide FPS [2]. Being an exceptional FPS where the global C4 rotational symmetry is broken even at room temperature, it is important to extract the similarities and differences between 112 and other FPS so that critical ingredients in inducing SC in FPS can be filtered. In this talk, I will review current progress in the study of 112. The comparison between Co doped CaLa112 and Co doped 10-3-8 will be made and the importance of interlayer coupling will be discussed.

Thursday, March 10, 2016

Speaker: Jakob Klein, Weizmann Institute, Israel

Topic: Osteoarthritis: a physicist's perspective

Abstract: Osteoarthritis (OA) is a debilitating disease involving joint-cartilage degradation affecting millions (> 30M in US alone). It is associated with friction and wear as joints slide past each other, but there is emerging realization that the relation between lubrication and gene expression, via cellular mechanotransduction, is at the heart of this disease. I describe here the physics of the basic pathways of energy dissipation as cartilage surfaces slide past each other, whose understanding is key to improved biolubrication and potential suppression/reversal of OA. Over the past decade or so the motif of hydration layers arising from the large electric dipole of the water molecule has been shown to underlie the lubrication of healthy cartilage1-6: the talk will describe the basic ideas, recent progress and current understanding.

Thursday, April 7, 2016

Speaker: Nathan Gabor, UC Riverside

Topic: Natural Regulation of Energy Flow in a Green Quantum Photocell

Abstract: Thermodynamic heat engines manipulate the flow of energy between two reservoirs, hot and cold, to extract power from the temperature difference. Quantum heat engines (QHEs) operate under the same principle yet are composed of quantum states, e.g., discrete electronic energy levels coupled to thermal reservoirs through narrow energy bands. QHEs are ubiquitous in condensed matter physics - examples include lasers, cavity polariton systems, Pomerachuk cooling, and adiabatic demagnetization - but have also emerged as a compelling description of biological systems. Here, we describe an intrinsic, passive regulation mechanism that emerges exclusively from the electronic structure of a quantum heat engine photocell. We show that by incorporating two light-absorbing channels, regulation of energy flow is achieved by suppressing power fluctuations and maintaining an input energy flux that matches the output power demand of a solar photocell. Remarkably, the regulating QHE structure determined from the incident photon spectrum at the Earth's surface exhibits striking similarity to the molecular organization, photo-protective function, and greenness of terrestrial photosynthesis.

Thursday, April 28, 2016

Speaker: Angela Kou, Department of Applied Physics, Yale University

Topic: Using the Fluxonium Qubit for Quantum Simulation

Abstract: Superconducting qubits are created by connecting Josephson junctions, which are non- linear, non-dissipative elements, to simple electrical circuits. Using this same toolbox of inductors, capacitors, and Josephson junctions, one is also able to generate different interactions between qubits. In this talk, I will discuss prospects for using the fluxonium qubit for quantum simulation. The fluxonium qubit is particularly suited to quantum simulation because its energy spectrum is strongly anharmonic and tunable with applied external flux. I will describe a gradiometric circuit based on the fluxonium qubit; this circuit is the smallest building block for realizing a σzσz -type interaction between fluxoniumqubits. We find excellent agreement between the measured spectroscopy of the circuit and the theoretically predicted level transitions. In addition, this circuit is engineered to be insensitive to global magnetic field noise and allows us to bound the local and global flux noise present in the circuit. I will conclude with a proposal for coupling fluxonium qubits in a 1-dimensional array. This array can be mapped to an Ising chain and exhibits multiple quantum phase transitions, whose signatures can be observed experimentally

Thursday, May 12, 2016

Speaker: Chih-Chun Chien, Department of Physics, UC Merced

Topic: Quantum transport in ultracold atoms

Abstract: Recent advance in cooling and trapping atoms has brought exciting quantum phenomena, including atomic Bose-Einstein condensate (BEC), superfluid, Mott insulator, and topological phases. One realistic yet ambitious goal is to use cold-atoms and optical potentials to simulate and complement electronic devices, and this leads to a thriving field called atomtronics. In contrast to electronic systems, cold-atoms are charge neutral and isolated from their environment. Moreover, strong quantum effects drastically alter transport properties of cold-atoms. I will first review breakthroughs in the study of quantum transport using various cold-atom systems and contrast theoretical descriptions from open- vs. closed-system approaches. Then I will discuss the question of whether quantum memory effects can arise in simple, isolated, and noninteracting systems. Although a lack of competing time scales commonly results in a negative answer, I will show that an affirmative answer can be found in cold-atom systems by utilizing geometrical effects of optical lattices.

Thursday, May 19, 2016

Speaker: Vitaly Kresin, Department of Physics and Astronomy, USC

Topic: Shell structure and high-temperature pairing in size selected metal nanoclusters

Abstract: Nanoclusters are agglomerates of a countable number of atoms or molecules, from a few to thousands. They form a bridge between individual molecules on one side, and quantum dots and bulk materials on the other. By studying the properties of size-resolved clusters their evolution can be traced electron-by-electron and atom-by-atom. Delocalized electrons in metal nanoclusters organize into a "superatom" shell structure which governs the particles' stabilities, shapes, and other properties. These highly degenerate shell levels represent sharp peaks in the electronic density of states and give rise to the possibility of exceptionally strong superconducting pairing in individual nanoclusters. This has been confirmed in our recent spectroscopic study of free aluminum clusters which revealed a transition at approximately 100 K, exceeding the critical temperature of the bulk metal by two orders of magnitude. Pairing in nanocluster particles introduces an entirely new class of high-temperature superconductors and highlights their potential as building blocks for materials and tunneling networks

Awards Administered

(July 2015 – June 2016)

NOTE: Dates in **red** are the projected end dates and dollar value in **red** is the projected total award value.

Guenter Ahlers
National Science Foundation, DMR-1158514
Turbulent Convection in a Fluid Heated from Below
06/01/12-05/31/16
$640,000

Turbulent convection in a fluid heated from below is of utmost importance in many natural phenomena and in industry. It occurs in Earth's mantle where it contributes to the motion of continental plates and influences vulcanism. In the outer core of the Earth it determines the magnetic field in which we live. It is the important heat-transport mechanism in the outer layer of the Sun and thus impacts the temperature of our environment. It plays a significant role in many industrial processes, where its enhancement or inhibition may have significant economic consequences. These applications range from miniature heat-transport devices in computer applications to the giant cooling systems of power plants. And yet much remains unknown to the scientist and engineer about these processes. The proposed work will extend our understanding of turbulent convection to fluids with properties similar to the Earth's atmosphere; this property range has remained relatively unexplored in the laboratory. The work will also be extended to samples that are rotated about their vertical axis. The rotation will exert a force on the fluid known as the Coriolis force and thus will change the behavior of the system in a manner related to how Earth's rotation modifies the nature of hurricanes and ocean currents. These experiments require the construction of complex apparatus and the automatic computer-control of numerous intricate processes. Thus they are an exceptionally good training ground for our young coworkers, many of whom will evolve into the leaders of the next generation of scientists and engineers.

Leon Balents
National Science Foundation, DMR-1206809
Quantum Phenomenae in Solids
09/01/12-08/31/16
$345,000

Leon Balents
National Science Foundation, 1506119
Quantum Phenomenae in Solids (Renewal)
08/15/15-07/31/18
$236,000

Leon Balents
US Department of Energy DE-FG02-08ER46524
Resolving Frustration in Complex Materials/Interplay of Electron Correlations and Spin-orbit Coupling
09/01/08-08/31/17
$855,000

Lars Bildsten
National Science Foundation, AST-1109174
Explosions in white Dwarf Binaries
09/01/11-08/31/16
$785,289

Lars Bildsten
National Science Foundation, AST-1205574
Collaborative Research in Modeling Advanced LIGO Gravitational Wave Sources and their Electromagnetic Counterparts
08/15/12-07/31/16
$211,192

Lars Bildsten
National Science Foundation, ACI-1339581
Collaborative Research: SI2-SSE: Modules for Experiments in Stellar Astrophysics
01/01/14-12/31/16
$163,586

Lars Bildsten
National Aeronautic & Space Administration, #NNX14AB53G
The SPIDER Network: Supernova Progenitor, Internal Dynamics & Evolution Research UCSB Node
01/01/14-12/31/17
$508,916

Lars Bildsten
Gordon and Betty Moore Foundation
Amoore Foundation Initiative in Time-Domain Astrophysics: New Theoretical Insights into Cosmic Cataclysms
02/23/16- 03/15/2020
$2,400,000

Omer Blaes
National Science Foundation, #14102417
Local Radiation MHD Simulations of the Hydrogen Ionization Instability in Accretion Disks: Constraining MRI with Dwarf Novae and X-Ray Binary Outbursts
06/15/14-05/31/17
$235,400

Omer Blaes
National Aeronautic & Space Administration, NNX13AG61G
Using Local Radiation MHD Simulation to Attempt to Understand the Very High/Steep Power Law State of Black Hole X-Ray Binaries
04/1/13- 03/1/16
$277,170

Dirk Bouwmeester
National Science Foundation, PHY-1206118
Quantum Post-Selected Optomechanics
09/01/12-08/31/16
$670,000
This proposal is the result of an analysis of the currently limiting factors in achieving macroscopic superpositions of optomechanical systems. We propose a new scheme based on quantum post-selection that will remove two of the main limitations of the current approaches. With the implementation of this

new scheme together with proposed advances in the design and fabrication of optomechanical systems (based on the use of Graphene, Boron Nitride and Carbon nanotube technology) we expect to make very significant progress towards testing quantum mechanics at the macroscopic scale.

Dirk Bouwmeester
National Science Foundation, PHY-1314982
Implementing a Quantum CNOT Gate Using Solid State Cavity QED
09/01/13-08/31/16
$270,000

By combining single-photon technology with semiconductor electro-optical devices we investigate a scheme for a quantum CNOT gate. Such a gate is a fundamental building block of quantum computers and quantum communication systems. Nanofabrication and material-growth concepts will be implemented to create optical micro cavity structures with embedded artificial atoms in the form of a nanoscale semiconductor structure, called a quantum dots. A quantum dot, if positioned at the center of the cavity and at the cavity resonant frequency, will interact with an incoming photon in such a way that the photon polarization will become entangled with the electronic state of the quantum dot. This interaction establishes the quantum CNOT gate; the quantum state of the photon is changed depending on the quantum state of the electron.

The research topic directly relates to the micro optoelectronics industry as well as to fundamental studies of confined electron properties in semiconductors. Potential applications in classical and quantum information storage and processing are expected to follow from this project. Since the interactions are at the single photon level, the devices will in principle be very energy efficient. It should however be mentioned that this study does require low-temperature operation conditions. Alternative implementations based on different cavity designs and different optical emitters that remain active a room temperature will also be considered.

Michael Bowers
National Science Foundation NSF CHE-1301032
Peptide Assembly: Mechanism and Inhibition
09/01/13-08/31/16
$495,000

The award CHE-1301032 provided by the Chemical Structure, Dynamics and Mechanism-B Program (CSDM-B) and the Chemistry of Life Processes of the National Science Foundation to Professor Michael T. Bowers at the University of California at Santa Barbara will be used to investigate the mechanism of peptide assembly. This is currently a very active area of research both for its fundamental importance and because of possible therapeutic applications in neurological diseases. These studies will include the determination of oligomer distributions, the structures of sized selected oligomers and the effect of select inhibitors on this process. Peptides will be selected to test existing models for beta sheet formation and eventual fibrilization and for their possible implications in amyloid based diseases. Experimental methods will include ion mobility spectrometry coupled with mass spectrometry, atomic force microscopy and transmission electron spectroscopy and a newly developed oligomer size selected infrared spectroscopy experiment constructed at the Fritz Haber Institute in Berlin, Germany. The experiments will be complimented by high level theoretical calculations including both DFT and replica exchange molecular dynamics. Inhibitors will include both naturally occurring substances like polyphenols and specially synthesized molecules designed for select peptide attachment.

The two fastest growing major diseases in the US today are Alzheimer's disease and Type 2 Diabetes. These seemingly dissimilar diseases share the common trait of having toxic agents that come from the assembly of ordinarily innocuous agents (peptides) in the body: one process occurring in the brain causing Alzheimer's disease and the other in the pancreas causing Type 2 Diabetes. It isn't clear how these normally safe species assemble into deadly ones nor is it clear how they kill cells once they do assemble. This is a difficult problem to study with the normal tools of biochemistry that can't select specific assembled peptides and hence can't tell their structure or how toxic they are. The thrust of this proposal is to provide a new set of methods that can do this selecting and to apply these methods to model peptide systems to learn the factors that control peptide assembly in general and then test simple molecules that can stop this assembly in its tracks. Finally the results are translated into presentations that can be given to local high schools and each Bowers group member visits several such schools each year to make these presentations.

Michael Bowers
Air Force FA9550-11-1-0113
Litigated Metal Clusters: Structures, Energetics and Reactivity
06/15/11-12/14/15
$620,000

The field of metal clusters, their reactivity and ligand binding energies has undergone a renaissance in recent years. There are two principle drivers: The importance of metal clusters in catalysis and their fundamental importance as bridging agents between the atomic and the solid phases of matter. The Bowers group is uniquely positioned to contribute to this important area of research. They have developed two tools that allow structural determination for size-selected clusters: ion mobility methods that yield accurate cross sections and sequential ligand binding energies that identify equivalent binding sites. These have been applied primarily to coinage metals but here the group will extend these studies to transition metal clusters.

Michael Bowers
National Institute of Health 1 R01 AG047116-01
Amyloid β-Protein: Wild Type and Familial Mutant Assembly and Inhibition
09/01/13-06/30/17
$883,460 ($1,768,028)

The overarching goal of our research is to determine the molecular basis for amyloid β-protein's contribution to Alzheimer's disease. Specifically we intend to measure early oligomer-size distributions of a series of natural and intentionally mutated Aβ40, Aβ42 and tau fragment peptides, determine their structures and use this information to establish the aggregation mechanism. In parallel, we will investigate the effect of a series of aggregation inhibitors on this process to obtain their inhibition mechanism and evaluate their suitability as potential therapeutic agents. Finally, we will investigate the general mechanism of peptide aggregation using a series of model peptides. We will use ion-mobility-based mass spectrometry (IMS-MS) experimental methods coupled to high-level molecular dynamics simulations in pursuing these goals. My group has pioneered the modern development of IMS-MS and its application to complex macromolecular systems. We first used it to unravel the size-specific structural evolution of carbon cluster growth in arcs, leading to the characterization of the mechanism for fullerene formation. More recently we have focused on aggregating biological systems including prions (mad cow and other TSE diseases), α-synuclein (Parkinson's disease), hIAPP (type 2 diabetes) and amyloid β-protein. This work has depended on complementary high-level simulations which will continue. We feel the excellent progress made to date on Aβ peptides and on other amyloid systems strongly indicates our ability to successfully achieve the goals set out in The Specific Aims of this proposal.

Steven Buratto
Michael Bowers
Horia Metiu
National Science Foundation NSF CHE-1152229
Model Nanocluster Catalysts: The Role of Size, Shape and Composition on the Catalytic Activity of Small Metal Oxide and Bimetallic Clusters on Oxide Surfaces
04/01/12-03/31/16
$450,000

A large number of industrial processes use nanometer-size clusters (both metal and metal oxide) supported on oxide surfaces to perform reactions that would not take place, or would be commercially unsuccessful if performed on the bulk material. In research supported by this grant the investigators will utilize state-of-the-art experimental and theoretical methods to probe the catalytic activity of well-defined nanocluster catalysts in great detail and develop a fundamental understanding of the catalytic chemistry at the atomic level. The concepts developed through this research will help optimize important industrial processes using these nanoscale catalysts and provide valuable insight into the discovery of new nanoscale catalytic materials. Researchers supported by this grant will also be active in outreach to K-12 schools in the Santa Barbara area. They plan to develop a tutorial presentation on an atomistic view of heterogeneous catalysis that will be included in the currently active outreach program in the department at UCSB. In addition, researchers working on this project will visit high schools in the Santa Barbara and Ventura Counties three times per year to discuss their research and its impact as well as to promote science education.

Steven Buratto
National Science Foundation NSF CHE-1213950
Connectivity and ION Conductance in Field Cell Membranes Probed by Tunneling Atomic Force Microscopy
07/01/12-06/30/16
$283,864

Proton exchange membrane (PEM) fuel cells, which convert chemical energy into electricity using an electrochemical cell, could be used as efficient power sources, offering high power density and low environmental impact. Critical to PEM fuel cell performance is the polymer electrolyte, which is an efficient proton conductor but electric insulator. The most common PEM material is the polymer electrolyte Nafion®, which is composed of a hydrophobic Teflon® backbone and side chains terminated with hydrophilic sulfonic acid (SO_3H) groups. In a Nafion® film the hydrophilic pores, which conduct protons, form via phase separation of the side chains from the polymer backbone. The proton conducting channels in these films are strongly dependent on the film morphology and the environmental conditions. A detailed understanding of proton conduction, in terms of the size and distribution of the chemical domains responsible for transport, is central to both a complete understanding of fuel cell performance and a systematic approach to improving the performance. Toward this end, conductive atomic force microscopy (cAFM) will be used to gain a fundamental understanding of ion conduction in proton exchange membrane fuel cells. Using the nanoscale resolution afforded by cAFM, the size, spatial distribution, and electrochemical activity of ion transport domains in polymer electrolytes will be explored under operation fuel cell conditions.

Claudio Campagnari
University Research Association (Fermi Research Alliance), #604705
Fermilab CMS LPC Distinguished Researcher Program 2016
01/01/16-12/31/16
$74,436

Claudio Campagnari
Jeffrey Richman
University Research Association (Fermi Research Alliance), #604705
UC CMS EMU Subsytem
12/12/11-12/31/16
$853,123

Claudio Campagnari
University of Notre Dame
CMS Virtual Visits with Southern California Schools
05/01/16-12/31/16
$6,000

Jean Carlson
National Science Foundation, EAR-1345074
Collaborative Research: Statistical Collaborative Research: Statistical Physics of Fault Behavior - Dynamic Friction, Strain Localization, Comminution, Heat Transfer and Compaction
08/01/14-07/31/17
$152,359 ($230,000)

Jean Carlson
Packard, #93-6481
David and Lucile Packard Foundation Fellowship
09/24/93-10/15/16
$500,000

Nathaniel Craig
Department of Energy, #DE-SC0014129
Leveraging the Higgs to Discover Physics Boyond the Standard Model
07/15/15-07/14/16
$150,000 ($750,000)

Matthew Fisher
National Science Foundation, DMR-1404230
Quantum Entanglment in Many-Body systems
10/01/14-09/30/17
$255,000 ($435,000)

Steven Giddings
David Berenstein
Department of Energy, DE-SC0011702
UCSB High Energy Group Proposal for DEFOA-0000948
04/01/14-03/31/17
$648,000

Steven Giddings
Silicon Valley Community Foundation, #2014-131272
Information-Theoretic Foundations for Quantum Gravity and Space-time
09/01/14-08/31/15
$3,697

Steven Giddings
Silicon Valley Community Foundation, #2013-111418
Information-Theoretic Foundations for Quantum Gravity and Space-time
09/01/13-08/31/15
$46,065

Steven Giddings
Silicon Valley Community Foundation, #2015-144082
Observables in Quantum Spacetime
09/01/15-08/31/17
$101,899

Carl Gwinn
National Science Foundation, AST-1008865
Shape and Size of Pulsar Emission Regions via Statistics of Scattering
10/01/10-09/30/16
$265,469

Beth Gwinn
National Science Foundation
DNA-Protected Silver Clusters for Atomically Pecise Nanophotonics and Wiring
11/03/15-01/31/19
$165,000 ($465,000)

Songi Han
BNSF, 2014149
The Role of Electron Spin Dynamics in Static and MAS DNP
11/01/15-10/31/19
$22,500 ($90,000)

Gary Horowitz
Don Marolf
James Hartle
National Science Foundation, PHY-1205500
Reserac hin Classical and Quantum Gravity
06/01/12-05/31/16
$1,320,000

Gary Horowitz
Don Marolf
James Hartle
National Science Foundation, PHY-1504541
Reserac hin Classical and Quantum Gravity (renewal of HGNF6K)
06/15/15-05/31/18
$880,000 ($1,320,000)

Joseph Incandela
Fermi Research Alliance (Incl. Fermilab-DOE GOCO), #618150
US CMS High Granularity Calorimeter Project UCSB
07/01/14-06/30/16
$753,996

Joseph Incandela
Brendon Brewer
Department of Energy, DE-SC0007994
Protocols and IP-Cores for control and Readout in Future High Energy Physics Experiments
05/01/12-10/31/15
$577,000 ($585,000)

James Langer
Oak Ridge National Lab, 4000100283
Nonequilibrium Properties of Amorphous Materials
11/10/10-10/31/16
$330,000

Bruce Lipshutz
NSF Awrd #1561158
SusChEM: New Technologies Based on Organocopper Catalysis
03/21/16-04/30/19
$345,292 (500,000)

Bruce Lipshutz
NOVARTIS Pharmaceutical SB140127
New Methodologies in Synthesis Using Micellar Catalysis
06/15/14-12/31/16
$364,000

The goal is to develop environmentally benign methods that avoid use of organic solvents as the traditional reaction medium. A postdoctoral student will be hired to develop a variety of new methodologies that rely on nanoreactors formed in water using surfactant technology developed in the group. New Synthetic methodologies in the following fields could be investigated:

Iron-mediated chemistry
Ullman-type chemistry
Oxidation methodologies
Reduction methodologies
Organometallic chemistry (organozincates, others)
Amide bond formation – extension of scope where potential epimerization, catalytic methods
Selective carboxyl reduction methods
C-N bond-formation transformations

Chemistry of highly energetic compounds (nitroalkanes, azides, nitration…)
Gas-mediated transformations (hydrogenations, hydroformylation, hydrocarbonylation…)

Bruce Lipshutz
NOVARTIS Pharmaceutical SB150084
New Methodologies Based on Transition Metal Catalysis Enabled by Micellar Catalysis
01/01/15-01/04/17
$470,000

The goal is to develop several environmentally attractive synthetic methods utilizing transition metal catalysts that can involve water alone as the reaction medium, rather than the traditional use of organic solvents. Two graduate students will be hired to investigate applications of our designer surfactant technology in water for several different types of metal-mediated prcesses. Thus, new synthetic methodologies in the following fields will be studied:

- Palladium-catalyzed chemistry, including name reactions, such as Suzuki and Sonogashira couplings, and aminations
- Cyclizations mediated by organogold catalysts
- Isomerizations mediated by catalytic amounts of ruthenium
- Conjugate reductions and addition reactions by organocopper complexes

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Philip Lubin
Jet Propulsion Laboratory, JPL1367008
Planck Educational and Public Outreach Effort at UCSB
02/10/09-09/30/15
$67,700

This award will fund a cosmology summer session that brings in students from a local high school (Dos Pueblos High and perhaps others) and a local community college (Santa Barbara City College). Graduate students, post doc (Rodrigo) Peter Meinhold and Dr. Lubin will orient the students on the Planck mission and relevant science and technology issues, and then the students will work during the summer as a team on various CMB technology programs for a hands-on summer program. We hope to run this program over a six week period each summer.

Philip Lubin
UC San Diego, NNX10AT93H
California Space Grant Consortium (NASA)
08/26/10-08/25/16
$145,000

Philip Lubin
UC San Diego, NNX10AT93H
California Space Grant Consortium (NASA)
08/26/10-08/25/16
$15,000

Philip Lubin
UC San Diego, NNX10AT93H
California Space Grant Consortium (NASA)
08/26/10-08/25/16
$145,000 (34,000)

Philip Lubin
Jatila Van Der Veen
UC San Diego, #NNX10AT93H
Developing Interactive Computer Applications in Cosmology Education with Date and Simulation from the International Planck Collaboration
08/26/10-08/25/16
$4,000

Philip Lubin
University of Copenhagen, #50506600-50-DeepSpace
Greenland Deployment
08/01/15-12/31/17
$428,282

Philip Lubin
Peter Meinhold
NASA, #NNX15AL91G
DEEP IN Directed Energy Propulsion for Interstellar exploration
06/01/15-02/29/16
$99,926

Andreas Ludwig
National Science Foundation, #DMR-1309667
Field Theoretical Methods in Strongly Interacting, Topologica, and Disordered Condensed Matter System
09/01/13-08/31/16
$180,000 ($270,000)

Don Marolf
Simons Foundation, #385604
Qubit: Simons Foundation on Quantum Fields, Gravity and Information
09/01/15-08/31/19
$440,000

Crystal Martin
Space Telescope Science Institute, #HST-GO-13407.01-A
COS Gas Flows: Challenging the Optical Perspective
01/01/14-12/31/16
$50,992 ($63,739)

Crystal Martin
Jet Propulsion Laboratory, #1434779
Exploring the Dust Content of Galactic Winds with Herschel Program #1434779
06/01/11-09/30/15
$25,426

Crystal Martin
National Science Foundation, AST-1109288
Evolution of circumgalactic Gas Flows
08/15/11-07/31/15
$455,481

Crystal Martin
Packard, #2002-23795
David and Lucile Packard Foundation Fellowship
11/14/02-10/31/16
$562,500

Crystal Martin
Joo Heon Yoon
Space Telescope Institute, #HST-GO-13833.010
Characterizing the Cool and Worm-Hot Intergalactic Medium in Clusters at z<0.4
02/01/15-01/31/18
$26,146

Crystal Martin
Alaina Henry
Space Telescope Science Institute, HST-GO-12533.01-A
Escape of Lyman-Alpha Photons from Dusty Starbursts
11/14/02-10/31/15
$82,967

Benjamin Mazin
SUBARU, SB#160128
Deliverables for the Design and Manufacture of MEC, the MKID Exoplanet Camera for SCExAO on the Subaru Telescope
04/01/16-03/31/16
$88,995

Benjamin Mazin
National Science Foundation, AST-1411613
Understanding Pulsar Emission with ARCON
09/01/14-08/31/17
$347,992

Benjamin Mazin
National Science Foundation, AST-1308556
Darkness: Dark-speckle Near-IR Energy-resolved Superconducting Spectrophometer
09/15/13-08/31/16
$744,991

Benjamin Mazin
NASA, NNX16AE98G
Fundamental Performance Improvement of Microwave Kinetic Inductance Detectors for UVOIR Astrophysics
03/01/16-02/28/19
$130,297 ($616,257)

Benjamin Mazin
NASA , #NNX15AJ26G
Large Imaging X-ray MKID Arrays for Astrophysics
04/22/15-04/21/19
$397,739 ($913,486)

Benjamin Mazin
Paul Szypryt
NASA, #NNX13AL70H
Microwave Kinetic Inductance Detector Development
08/01/13-07/31/17
$98,000

Benjamin Mazin
Paul Szypryt
NASA, #NNX13AL70H
Microwave Kinetic Inductance Detector Development
08/01/13-07/31/17
$38,000

Benjamin Mazin
NASA, #NNX11AD55G
Large Arrays of UV to Near-IR Lumped Element Kinetic Inductance Detectors
01/11/11-01/10/17
$988,271 ($1,088,271)

Benjamin Mazin
NASA, #NNX11AN29H
Coronagraphic Planet Finding with Energy Resolving Detectors
08/01/11-07/31/15
$265,000 ($268,000)

Benjamin Mazin
California Association for Research in Astronomy, #12454
64KRAKENS Science Case Development
08/01/14-09/30/15
$10,000

Benjamin Mazin
Subaru Telescope, #SB150123
Deliveables for the Design and Manufacture of MEC, the MKID Exoplanet Camera for SCExAO on the Subaru Telescope
04/01/15-03/31/16
$190,000

Benjamin Mazin
University of Georgia, #RR185-427/4787526
CDI-Type Quantum Cyberinfrastructure for the Simulation of Complex Quantum Systems
11/01/10-10/31/15
$389,899 ($386,899)

Peter Meinhold
Philip Lubin
Jet Propulsion Lab, #1492976
Remote and On-site Support for LFI Integration and Test, US Planck Internal Advisory Board and Planck Data Analysis
11/08/13-02/15/16
$813,681

Benjamin Monreal
Department of Energy, #DE-SC0014130
New Measurements on the Neutrino Mass: KATRIN and Project B
08/01/15-08/31/17
$175,000 ($355,000)

Ruth Murray-Clay
National Science Foundation, AST-1411536
A Framework for Thermal Atmospheric Escape from Extrasolar Planets
09/15/14-08/31/17
$250,300

Ruth Murray-Clay
NASA, NNX15AH59G
Current Dynamics of Neptune's Mean Motion Resonances
08/01/15-07/31/18
$57,518 ($180,711)

Ruth Murray-Clay
National Science Foundation, 1555385
CAREER: Origins of Structure in Planetary Systems
04/01/1603/31/21
$456,620

Harry Nelson
Lawrence Berkeley Laboratory, #7041610
LBNL Travael
11/15/12-12/31/16
$79,545 ($103,782)

Harry Nelson
Michael Witherell
Lawrence Berkeley Laboratory, #7062971
Development of the LZ Dark Matter Experiment
06/04/13-12/31/15
$262,925

Peng Oh
NASA, NNX15AK81G
Nonthermal Processes in the ISM and ICM
05/13/15-05/12/18
$265,813 ($404,704)

Peng Oh
NASA, #NNX12AG73G
Turbulence and Cosmic Rays in Clusters of Galaxies
04/01/12-03/31/16
$330,000

Peng Oh
Space Telescope Science Institute
Turbulent Mixing and Thermal Instability in the Circumgalactic Medium
04/01/16-03/31/19
$88,642

Peng Oh
UCLA, #20150507sb (MR-15-328388 prime)
University of California Cosmic Dawn Initiative
01/01/15-12/31/16
$73,540

Stan Peale
Carnegie Institution of Washington, DTM-3250-09
Phase E of the MESSENGER Mission to Mercury
09/14/04-05/31/15
$155,566

Philip Pincus
Oak Ridge National Lab, #40000139641
Prof. Philip Pincus, Neutron Sciences Directorate
06/04/15-12/31/15
$68,016

Joseph Polchinski
Simons Foundation, #385610
Qubit: Simons Foundation on Quantum Fields, Gravity and Information
09/01/15-08/31/19
$440,000

Joseph Polchinski
Robert Sugar
David Gross
Mark Srednicki
Anthony Zee
National Science Foundation, PHY-1316748
Problems in Theoretical Physics
12/01/13-11/30/16
$1,320,000

Jeffrey Richman
Claudio Campagnari
Joseph Incandela
Benjamin Monreal
Harry Nelson
David Stuart
Department of Energy, DE-FOA-0000948
UCSB High Energy Physics Group Proposal for DE-FOA-0000948 (Energy Frontier) (Detector R&D) (Cosmic Frontier)
04/01/14-03/31/17
$5,630,000

Douglas Scalapino
Oak Ridge National Laboratory, 4000129396
Studies of the Properties of Strongly Correlated Materials
04/14/14-03/31/16
$197,269 ($253,802)

Using recently developed algorithms and new state of the art computer hardware and architecture, we are seeking to understand the properties of strongly correlated electronic materials. Our work is particularly focused on the challenges posed by the high temperature cuprate superconductors. We believe that an understanding of these materials will open an important area of material science and applications.

Kasper Schmidt
Tommaso Treu
Space Telescope Science Institute, HST-GO-12572.08-A
The Brightest of Reionizing Galaxes Pure Parallel Survey
03/01/12-08/31/15
$302,071.66 ($302,082)

Kasper Schmidt
Space Telescope Science Institute
Classifying and Following a Strongly Lensed Supernova with Multiple Images
04/01/15-01/31/16
$17,697

Mark Sherwin
Jet Propulsion Lab
Frequency Agile Heterodyne Detector for Submillimeter Spectroscopy of Planets and Comets
08/19/15-07/31/17
$165,000 ($450,000)

Mark Sherwin
Song-I Han
U.S.-Israel Binational Science Foundation 2010130
Development of Gd^{3+}-Based Spin Labels for Probing Structure, Dynamics and Interfaces by Electron Paramagnetic Resonance Techniques
10/01/11-09/30/15
$92,910

EPR and DNP (dynamic nuclear polarization) rely on the introduction of spin probes or labels to intrinsically diamagnetic systems and the standard, widely used spin labels are based on the nitroxide group that has a spin, S=1/2. The recent development of high field EPR opens new opportunities in spin labeling by exploiting the unique spectroscopic properties of half-integer high spin systems at high fields that can offer high sensitivity and resolution. The objective of this proposal is to establish a new family of Gd^{3+} (S=7/2)-based spin labels for probing structure, dynamic and interfaces of molecules and materials using EPR and DNP at high magnetic fields. The basic spin physics and dynamics of Gd^{3+} spin labels at high fields must be explored and understood in order to realize their tremendous promise for EPR and DNP. Using a variety of mono- and bis-Gd^{3+} compounds we will measure spin lattice relaxation, phase memory time and spectral diffusion as a function of field (95 and 240 GHz. 3.5 and 8.5T), temperature and Gd^{3+} concentration. Having established a good understanding of the spin dynamics that is needed for the optimum measurements conditions and the design of appropriate Gd^{3+} chelators we will explore Gd^{3+} spin labels for structure determination through Gd^{3+}-Gd^{3+} distance measurements and their potential to probe protein dynamics and light triggered conformational changes. Finally, we propose to develop a Gd^{3+} spin label based methodology to study polymer interfaces in systems with nanometer scale heterogeneities and phase boundaries using solid state DNP of ^{1}H and natural abundance ^{13}C NMR at 7T

Mark Sherwin
S. James Allen
Christopher Palmstrom
Thuc-Quyen Nguyen
Song-I Han
National Science Foundation, DMR-1126894
MRI: Development of a Free-Electron Laser for Ultrafast Pulsed Electron Paramagnetic Resonance
10/01/11-09/30/15
$992,270

The world's brightest source of tunable terahertz radiation will be developed to manipulate electron spins faster than has ever been possible. This ultrafast spin manipulation will enable pathbreaking studies with applications ranging from development of inexpensive solar cells to understanding how protein molecules fit together and move to regulate the flow of energy, information and matter in living organisms.

Electrons and atomic nuclei both have a property called spin, which makes them behave like (very tiny) magnets. In nuclear magnetic resonance (NMR), which is the basis for magnetic resonance imaging (MRI), a strong external magnetic field aligns nuclear spins, while powerful pulses of radio-frequency electromagnetic radiation manipulate nuclei to discover otherwise invisible information about neighboring atoms. Electron paramagnetic resonance (EPR), in a fashion similar to NMR, uses an external magnetic field to align electron spins (rather than nuclear spins). Typically, pulses of microwave-frequency electromagnetic radiation manipulate these electrons to learn about local environments over larger neighborhoods. EPR becomes even more powerful when extremely high-frequency terahertz is used.

The free-electron lasers (FELs) at the University of California at Santa Barbara (UCSB) are famous as the world's brightest sources of tunable terahertz radiation. Recently, researchers at UCSB demonstrated that one of the UCSB FELs could be used to rotate electron spins 50 times faster than ever before at .25 terahertz. This project will fund the construction of an even more powerful FEL. The new FEL, which will be used by scientists from all over the nation and world, will be 100 times more powerful than the existing one, and will pulse ten times faster, enabling at least 1000 times more rapid acquisition of experimental data. The EPR spectrometer powered by this new FEL will create an unprecedented capability to observe the structure and ultrafast dynamics of molecules, materials and devices at nanometer length scales.

Mark Sherwin
National Science Foundation, MCB-1244651
Robust GD^{3+} -Based Spin Labels for Structural Studies of Membrane Proteins
01/01/13-12/31/16
$848,526

Understanding the structure and functional dynamics of membrane proteins in a life-like environment is one of the grand challenges of biology.
Site-directed mutagenesis and spin labeling (SDSL) combined with electron paramagnetic resonance (EPR) enables quantitative studies of the structure and dynamics of membrane proteins and protein complexes. If two sites are labeled on a protein or protein complex, the distance between them can be measured using EPR. The spin ½ nitroxide moiety forms the basis for nearly all spin labels in use today. The goal of this research is to develop a new class of spin labels that are based on the spin 7/2 Gd^{3+} ion. The attributes of nitroxide and Gd^{3+} -based spin labels are very different and make them optimal for environments that are largely complementary. In particular, the Gd^{3+} ion, with its paramagnetic core shielded by outer electrons, is less sensitive to its local *chemical* environment than the nitroxide moiety, which is delocalized between nitrogen and oxygen atoms. Unlike for nitroxides, phase memory times and linewidths of Gd^{3+} spin labels are relatively insensitive to nearby protons, enabling them to be useful for cw and pulsed EPR on sites and in environments that are not deuterated. The paramagnetic attributes of the Gd^{3+} ion are particularly favorable at high magnetic fields and frequencies, one of the frontiers of EPR. The development of Gd^{3+} spin labels is expected to enable structural studies under a variety of conditions that are biologically important but difficult or impossible to study with nitroxide spin labels.

Mark Sherwin
NSF DMR-1405964
Terahertz Electron Hole Recollisions
07/01/14-06/30/17
$565,000

In high-energy physics, the structure of matter is explored by accelerating and colliding elementary particles like electrons and protons. In condensed matter physics, the fundamental excitations are called quasi-particles. The most familiar quasi-particles are electrons and holes in semiconductors, which can be created for example in a solar photovoltaic cell - by light with a sufficiently short wavelength. In this project, electrons and holes will be created by a weak near-infrared laser with a wavelength slightly longer than is visible to the human eye, and will be made to accelerate and then recollide with one another by a very strong electric field oscillating nearly 1 trillion times per second (1 Terahertz). The recollision process will be studied by analyzing the spectrum (which wavelengths are present) in the transmitted near-infrared light. This spectrum has been shown to contain up to 18 separate nearinfrared wavelengths, or sidebands, in addition to the wavelength of the near-infrared laser that creates electron-hole pairs. This research will elucidate how much quasiparticles can be accelerated without being disturbed by defects or the motion of atoms in their host material. The proposed research may lead to faster and more energy efficient optical communications and internet, and improved optical clocks that are necessary in the global positioning system. This project will support the training of two Ph. D. students, who will learn a variety of skills that are critical to preserving U. S. competitiveness in the high-technology sector.

High-order sideband generation, a new phenomenon in the interaction of light with matter, was recently discovered in the PI's research group. A relatively weak, continuous-wave near-infrared (NIR) laser at frequency ~350 THz, and an intense laser at frequency ~0.5 THz are incident on a thin film of semiconductor. A comb of equally-spaced sidebands is emitted, with sharp lines at sideband frequency = NIR frequency + 2n THz frequency, where n is an integer. Combs with up to 14 sidebands (order up to 2*14=28) above NIR frequency have been observed. The high-order sidebands can be understood in terms of a semiclassical model similar to one that was first introduced to explain high-order harmonic generation, an analogous phenomenon that occurs for atoms in intense laser fields. In high-order-sideband generation (HSG), the NIR laser creates excitons, bound electron-hole pairs. The strong THz field ionizes the excitons, and accelerates the resulting electron and hole into a large-amplitude oscillation. When the electron and hole recollide, the excess kinetic energy is carried off in sidebands above the NIR frequency. This project will explore the onset of high-order sideband generation, whether there is a fundamental limit on the number of observable sidebands, whether the shape of the sideband spectrum can be controlled, and whether, in the case of a circularly-polarized terahertz field, the polarization of the near-ir radiation is rotated. By exploring the limits of HSG, the proposed research will elucidate potential applications of HSG to electro-optic technologies ranging from optical communications to optical clocks.

Mark Sherwin
National Science Foundation
Time Resolved Conformational Changes of Proteins by Very High Frequency Gd3+ EPR
05/19/16-06/30/16
$800,000

Mark Sherwin
University of Pittsburgh 2013PR0455
Nanoscale Terahertz, Infrared and Plasmonics Platform Using Graphene-Complex Oxide Heterostructures
07/31/13-07/30/16
$346,875

Sherwin/UC Santa Barbara will hire 1 graduate student researcher for the duration of this proposal. They will perform the following tasks:

1) *Measure x3 and x5 frequency multiplication from CVD graphene:* Illuminate CVD graphene sample with ~1 kW pulses from the UCSB free-electron lasers tuned to a frequencies near (a) 0.6 THz and (b) 3 THz. For case (a), measure output at 1.8 and 3 THz. For case (b) measure output at 9 and 15 THz.
2) *Construct a spectrometer to measure high-order frequency multiplication:* We will construct a spectrometer which is capable of measuring frequency multiplication of 0.6 THz by more than a factor of 10.
3) *Design and fabricate slot antennas to enable high-order harmonic generation from subwavelength size (~10 µm) samples.* Exfoliated graphene samples and patterned GCO structures are considerably smaller than the wavelength of terahertz radiation. A simple slot antenna will enable effective coupling to study harmonic generation from samples with ~10 µm dimensions.
4) *Measure Terahertz harmonic generation from mechanically-exfoliated graphene flakes*. Flakes will be placed in slot antennas, then terahertz harmonic generation experiments will be performed.

Measure plasmon-enhanced harmonic generation from GCO nanostructures. GCO nanostructures will be patterned by Levy group and inserted into slot antennas. These structures will be sent to UCSB for measurements of frequency multiplication.

Boris Shraiman
National Science Foundation, PHY-1220616
Intercellular Interactions and Dynamics of Morphogenesis
09/01/12-08/31/17
$617,739 ($783,481)

Boris Shraiman
Simons Foundation, #326844
Natural Selection in Rapidly Mutating and Mitichondrial Aging
07/01/14-06/30/17
$783,780

David Stuart
Benjamin Monreal
Harry Nelson
Department of Energy, DE-SC0013892
UCSB High Energy Group Detector R&D
04/01/15-03/31/17
$300,000

Robert Sugar
National Science Foundation, OCI-0832315
Natural Selection in Rapidly Mutating and Mitichondrial Aging
04/15/09-09/30/15
$39,123

Tommaso Treu
Space Telescope Science Institute, #HST-GO-13459.01-A
The Grism Lens-Amplified Survey from Space (GLASS)
01/01/14-12/31/16
$255,141

Tommaso Treu
Omer Blaes
Space Telescope Science Institute, #HST-GO-13330.016-A
Mapping the AGN Broad Line Region by Reverberation
02/01/14-09/30/15
$51,444 ($64,305)

Tommaso Treu
Packard Foundation, 2007-31765
Measuring the Invisible: Black Holes and Dark Matter over Cosmic Times
10/10/07-11/30/17
$825,000

Jatila van der Veen
Phillip Lubin
Jet Propulsion Laboratory, JPL 1388406
The Planck Visualization Project: Education and Public Outreach Effort of the U.S. Planck Mission
10/01/09-06/30/16
$581,515

Planck is a mission to measure the anisotropy of the cosmic microwave background (CMB), sponsored by the European Space Agency (ESA) with significant input from NASA. Launched on May 14, 2009, Planck will measure the sky across nine frequency channels, with temperature sensitivity of 10^{-6} K, and spatial resolution up to 5 arc minutes.
NASA participation in Planck is approved and funded, and is manages by the Planck Project at the Jet Propulsion Laboratory in Pasadena, California. The US Planck project is required by NASA to perform Education and Public Outreach (E/PO) as an integral part of the science development. This award serves at the focal point for the E/PO activities of the US Planck team.

David Weld
National Science Foundation
CAREER: Quantum Emulation of Strongly Driven Interacting Systems
03/01/16-02/28/21
$181,145 ($712,610)

David Weld
Alfred P. Sloan Found, BR2013-110
Alfred P. Sloan Award
09/15/13-09/14/15
$50,000

David Weld
UC Los Alamos National Laboratory
Design/Construction of a High-Temperature Micro-Crucible
03/30/16-09/30/16
$15,540

Michael Witherell
Harry Nelson
Lawrence Berkeley National Lab
LUX/Zeplin (LZ) Project
11/24/15-12/31/19
$293,047 ($1,790,557)

Cenke Xu
National Science Foundation, DMR-1151208
CAREER: Quantum Critical Points around Topological Phases
09/01/12-08/31/17
$324,000 ($402,750)

Cenke Xu
National Science Foundation, DMR-1151208
CAREER: Quantum Critical Points around Topological Phases
09/01/12-08/31/17
$16,000 ($22,250)

Cenke Xu
Alfred P. Sloan Found, BR2011-029
New States of Quantum Matter: Integrating Strong Correlation and Topology
09/15/11-09/15/15
$50,000

Cenke Xu
David and Lucile Packard foundation, #2012-38226
Packard Fellowship for Science and Engineering
10/17/12-10/16/17
$875,000

Contracts/Grants Awarded 2015-2016

California Association for Research in Astronomy

Siang peng Oh
20160076 04/01/2016-03/31/2019 $ 88,642
Turbulent Mixing and Thermal Instability in the Circumgalactic Medium

California Association for Research in Astronomy Subtotal $ 88,642

Caltech

Matthew Fisher
20160427 10/01/2012-09/30/2016 $ 182,630
Institute for Quantum Information and Matter (IQIM)

Caltech Subtotal $ 182,630

Department of Energy DOE

Leon Balents
20161407 09/01/2008-08/31/2017 $ 105,000
Theory of fluctuating and critical quantum matter

Nathaniel J. Craig
20161328 07/15/2015-07/14/2017 $ 150,000
Leveraging the Higgs to Discover Physics Beyond the Standard Model.

Benjamin Monreal
20161404 08/01/2015-07/31/2017 $ 180,000
New Measurements of the Neutrino Mass: KATRIN and Project 8

Benjamin Monreal
20150905 08/01/2015-07/31/2016 $ 175,000
New Measurements of the Neutrino Mass: KATRIN and Project 8

Jeffrey D. Richman
20161050 05/01/2014-03/31/2017 $ 2,080,000
Theory of fluctuating and critical quantum matter
UCSB High Energy Physics Group Proposal for DE-FOA-0000948

David D. Stuart
20161025 04/01/2015-03/31/2017 $ 150,000
UCSB High Energy Physics Group Detector R & D

Department of Energy DOE Subtotal $ 2,840,000

Fermilab

Claudio F. Campagnari
20160725 01/01/2016-12/31/2016 $ 74,436
Fermilab CMS LPC Distinguished Researcher Program 2016

Claudio F. Campagnari
20160701 01/01/2016-12/31/2016 $ 17,885
US CMS EMU Subsystem

Joseph Robert Incandela
20160163 07/01/2014-03/31/2016 $ 180,000
UC CMS Phase 2 Upgrade R&D Subsystem

Joseph Robert Incandela
20160926 01/01/2016-12/31/2016 $ 376,292
UC CMS Phase 2 Upgrade R&D Subsystem

Fermilab Subtotal $ 648,613

Jet Propulsion Laboratory

Peter Russell Meinhold
20160749 11/08/2013-12/31/2016 $ 93,243
Remote and On-Site Support for LFI Integration and Test, US Planck Internal Advisory Board and Planck Data Analysis

Mark Sherwin
20160129 08/19/2015-07/31/2017 $ 165,000
Frequency Agile Heterodyne Detector for Submillimeter Spectroscopy of Planets and Comets

Jatila Van der veen
20161150/20160871 10/01/2009-06/30/2016 $ 66,600
The Planck Visualization Project: Education and Public Outreach Effort of the U.S. Planck Mission

Jet Propulsion Laboratory Subtotal $ 324,843

Lawrence Berkeley National Laboratory LBNL

Harry Norman Nelson
20160705 11/15/2012-12/31/2016 $ 5,000
Lawrence Berkeley National Laboratory Travel

Michael Witherell
20161176 11/24/2015-12/31/2019 $ 150,000
LUX/Zeplin (LZ) Project

Michael S. Witherell
20160833 11/24/2015-12/31/2019 $ 100,000
LUX/Zeplin (LZ) Project

Michael S. Witherell
20160375 11/24/2015-12/31/2019 $ 43,047
LUX/Zeplin (LZ) Project

Lawrence Berkeley National Laboratory Subtotal $ 298,047

Los Alamos National Laboratory

David Weld
20160972 03/30/2016-09/30/2016 $ 15,540
Design/Construction of a High-Temperature Micro-Crucible

Los Alamos National Laboratory Subtotal $ 15,540

Moore Foundation

Lars Bildsten
20160556 02/23/2016-03/15/2020 $ 2,400,000
A Moore Foundation Initiative in Time-Domain Astrophysics: New Theoretical Insights into Cosmic Cataclysms

Moore Foundation Subtotal $ 2,400,000

NASA Washington, DC Hq

Lars Bildsten
20160640 01/01/2014-12/31/2017 $ 162,587
The SPIDER Network: Supernova Progenitor, Internal Dynamics & Evolution Research UCSB Node

Philip M. Lubin
20150558 06/01/2015-02/29/2016 $ 99,926
DEEP IN Directed Energy Propulsion for Interstellar exploration

Benjamin Mazin
20160611 04/22/2015-04/21/2018 $ 125,000
Exploration of apex predators and deepwater Biodiversity in an unfished, pristine atoll

Benjamin Mazin
20151063 03/01/2016-02/28/2019 $ 100,000
Fundamental Performance Improvement of Microwave Kinetic Inductance Detectors for UVOIR Astrophysics

Benjamin Mazin
20161321 04/22/2015-04/21/2019 $ 124,576
Exploration of apex predators and deepwater Biodiversity in an unfished, pristine atoll

Benjamin Mazin
20161151 03/01/2016-02/28/2019 $ 30,297
Fundamental Performance Improvement of Microwave Kinetic Inductance Detectors for UVOIR Astrophysics

Benjamin Mazin
20151042 08/01/2013-07/31/2017 $ 72,000
Microwave Kinetic Inductance Detector Development

Siang Peng Oh
20161324 05/13/2015-05/12/2018 $ 134,831
"Nonthermal Processes in the ISM and ICM"

Siang Peng Oh
20150016 05/13/2015-05/12/2018 $ 130,982
"Nonthermal Processes in the ISM and ICM"

NASA Washington, DC Hq Subtotal $ 980,199

National Science Foundation-NSF

Leon Balents
20150471 08/15/2015-07/31/2018 $ 236,000
Quantum Phenomenae in Solids

Dirk Bouwmeester
20160111 09/01/2013-08/31/2016 $ 90,000
Implementing a Quantum CNOT Gate Using Solid State Cavity QED

Dirk Bouwmeester
20160113 09/01/2012-08/31/2016 $ 150,000

Quantum Post-Selected Optomechanics

Michael T. Bowers
20160302 09/01/2016-08/31/2019 $ 160,000
Amino Acid and Peptide Assembly: Mechanism and Structures

Gary T. Horowitz
20161131 06/15/2015-05/31/2018 $ 440,000
Research in Classical and Quantum Gravity

Elisabeth Gray Gwinn
20150444 02/01/2016-01/31/2019 $ 165,000
DNA-Protected Silver Clusters for Atomically Precise Nanophotonics and Wiring

Bruce H. Lipshutz
20160194 05/01/2016-04/30/2019 $ 345,292
SusChEM: New Technologies Based on Organocopper Catalysis

Andreas W. Ludwig
20151335 09/01/2013-08/31/2017 $ 90,000
Field Theoretical Methods in Strongly Interacting, Topological, and Disordered Condensed Matter Systems

Ruth Murray-Clay
20160064 04/01/2016-03/31/2021 $ 456,620
CAREER: Origins of Structure in Planetary Systems

Joseph G. Polchinski
20160315 12/01/2016-11/30/2016 $ 338,699
Problems in Theoretical Physics

Joseph G. Polchinski
20160748 12/01/2013-11/30/2017 $ 101,301
Problems in Theoretical Physics

Boris I. Shraiman
20160296 09/01/2012-08/31/2017 $ 163,296
Intercellular Interactions and Dynamic of Morphogenesis

David Weld
20160056 03/01/2016-02/28/2021 $ 181,145
CAREER Quantum Emulation of Strongly Driven Interacting Systems

Cenke Xu
20161411 07/01/2012-08/31/2017 $ 85,000
CAREER: Quantum Critical Points around Topological Phases

National Science Foundation-NSF Subtotal $ 3,002,353

National Institute of Health NIH

Michael T. Bowers
20160114 07/15/2015-06/30/2016 $ 429,015
Amyloid β-Protein: Wild Type and Familial Mutant Assembly and Inhibition

Michael T. Bowers
20160114 07/01/2016-06/30/2017 $ 442,284
Amyloid β-Protein: Wild Type and Familial Mutant Assembly and Inhibition

National Institute of Health NIH Subtotal $ 871,299

Novartis Pharmaceutical (Switzerland)

Bruce H. Lipshutz
20160011 06/15/2014-12/31/2016 $ 182,000
New Methodologies in Synthesis Using Micellar Catalysis

Novartis Pharmaceutical (Switzerland) Subtotal $ 182,000

Oak Ridge National Lab

Philip A. Pincus
20151327 06/04/2015-03/31/2016 $ 68,016
Prof. Philip Pincus, Neutron Sciences Directorate

Philip A. Pincus
20160688 06/04/2015-03/31/2016 $ 100,661
Prof. Philip Pincus, Neutron Sciences Directorate-Continuation of Science Program, cross cutting themes and incubator workshops

Douglas J. Scalapino
20160119 04/01/2014-03/31/2016 $ 38,000
Study of the Properties of Strongly Correlated Materials

Douglas J. Scalapino
20160576 04/01/2014-03/31/2016 $ 56,533
Study of the Properties of Strongly correlated Materials

Oak Ridge National Lab Subtotal $ 263,210

Silicon Valley Foundation

Steven B. Giddings
20160397 09/01/2015-07/31/2017 $ 101,899
Observables in Quantum Spacetime

Silicon Valley Foundation Subtotal $ 101,899

Simons Foundation

Donald M. Marolf
20151064 09/01/2015-08/31/2019 $ 440,000
Qubit: Simon Collaboration on Quantum Fields, Gravity and Information

Joseph G. Polchinski
20151077 09/01/2015-08/31/2019 $ 440,000
Quibit: Simons Collaboration on Quantum Fields, Gravity and Information

Simons Foundation Subtotal $ 880,000

Subaru

Benjamin Mazin
20161083 04/01/2016-03/31/2017 $ 88,995
Deliverables for the Design and Manufacture of MEC, the MKID Exoplanet Camera for SCExAO on the Subaru Telescope

Subaru Subtotal $ 88,995

U.S.-Israel Binational Science Foundation (BSF)

Songi Han
20150504 11/01/2015-10/31/2016 $ 22,500
The role of electron spin dynamics in static and MAS DNP

U.S.-Israel Binational Science Foundation (BSF) Subtotal $ 22,500

UC Los Angeles

Siang Peng Oh

20161004	01/01/2016-12/31/2016	$ 42,009

University of Cosmic Dawn Initiative

UC Los Angeles Subtotal $ 42,009

University of Copenhagen (Denmark)

Philip M. Lubin

20151231	08/01/2015-12/31/2017	$ 428,282

Greenland Deployment

University of Copenhagen (Denmark) Subtotal $ 428,282

University of Notre Dame

Claudio F. Campagnari

20161210	05/01/2016-12/31/2016	$ 6,000

CMS Virtual Visits with Southern California Schools

University of Notre Dame Subtotal $ 6,000

Research Support Summary
(2015-2016)

Federal and Federal-Flow			
Air Force	1%	1%	620,000
Caltech	1%	1%	587,700
DOE	21%	18%	9,123,000
Fermilab	4%	3%	1,681,555
Jet Propulsion Laboratory	5%	4%	1,937,622
Lawrence Berkeley National Laboratory	5%	4%	2,157,264
Los Alamos National Laboratory	0%	0%	15,540
NASA	11%	9%	4,823,441
National Institute of Health	4%	3%	1,768,028
National Science Foundation	41%	34%	17,532,194
Oak Ridge National Laboratory	2%	1%	651,818
Space Telescope Science Institute	2%	2%	900,719
University of Georgia	1%	1%	386,899
University of Notre Dame	3%	0%	6,000
University of Pittsburgh	1%	1%	346,875
UCLA	0%	0%	73,540
UCSD	0%	0%	198,000
Federal Totals	100%	83%	$42,810,195
International			
University of Copenhagen	70%	1%	428,282
U.S.-Israel Binational Science Foundation	30%	0%	182,910
International Totals	30%	1%	$611,192
Private			
California Association for Research in Astronomy	0%	0%	10,000
Carneggie Institution of Washington	2%	0%	155,566
Moore Foundation	29%	5%	2,400,000
Novartis Pharmaceutical	10%	2%	834,000
Packard Foundation	33%	5%	2,762,500
Silicon Valley Foundation	2%	0%	151,661
Simons Foundation	20%	3%	1,663,780
Sloan Foundation	1%	0%	100,000
Subaru	3%	1%	278,995
Private Totals	100%	16%	$8,356,502

Awards Summary		
Federal Totals	83%	$42,810,195
International Totals	1%	$611,192
Private Totals	16%	$8,356,502
TOTALS	**100%**	**$51,777,889**

Charts and Graphs

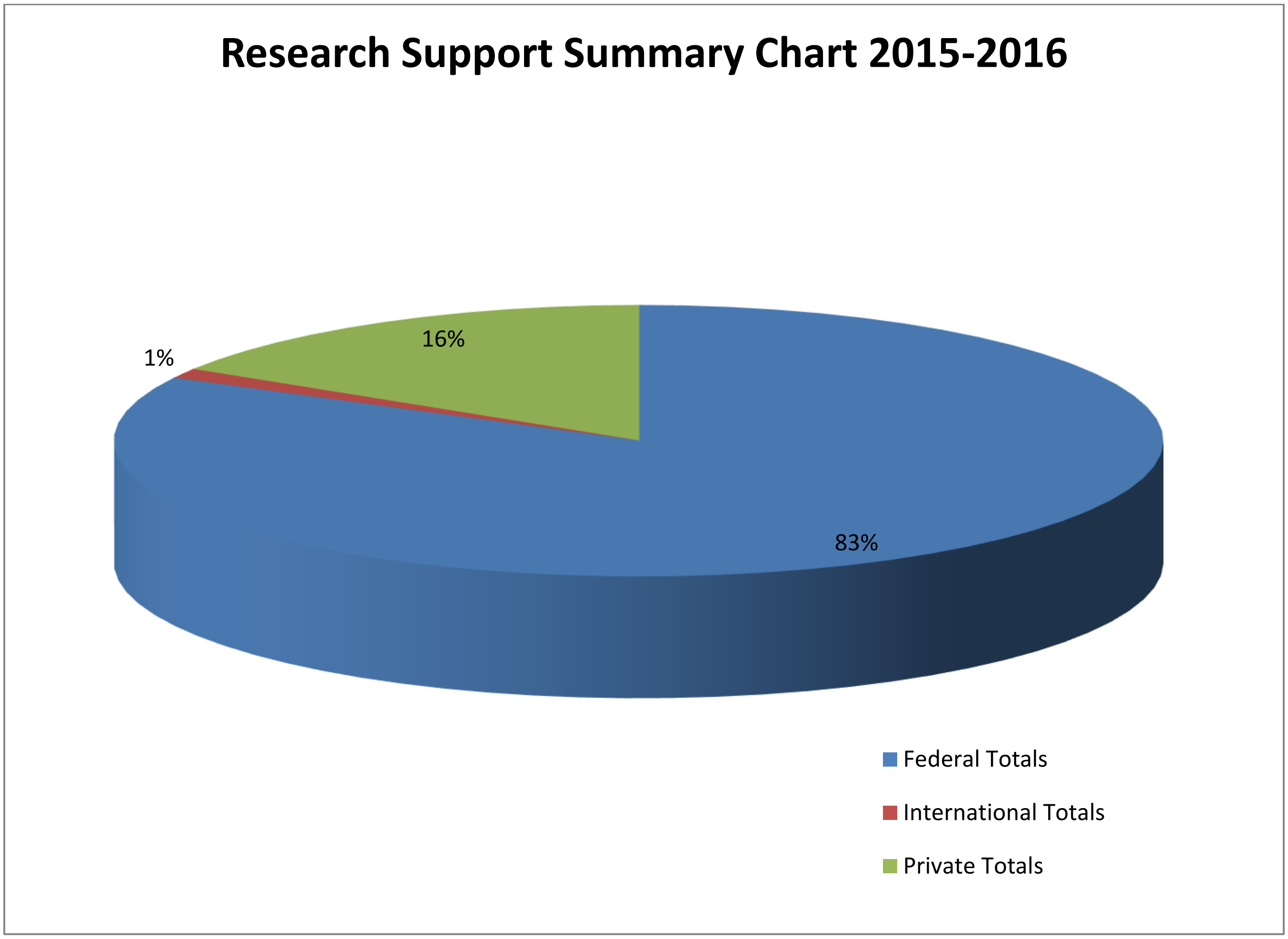


Chart 1: Research Support Summary Chart

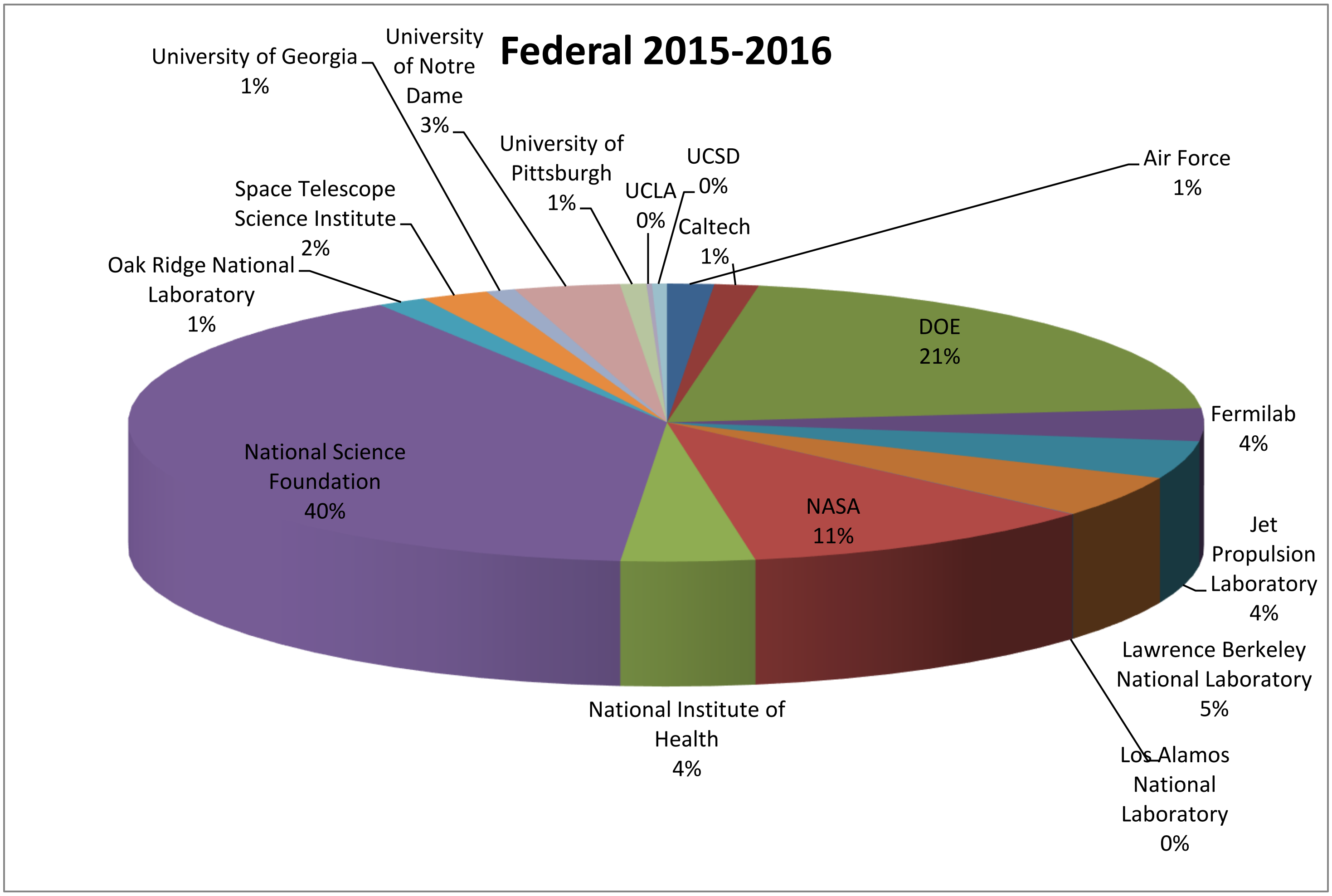


Chart 2: Federal Research Support Summary Chart

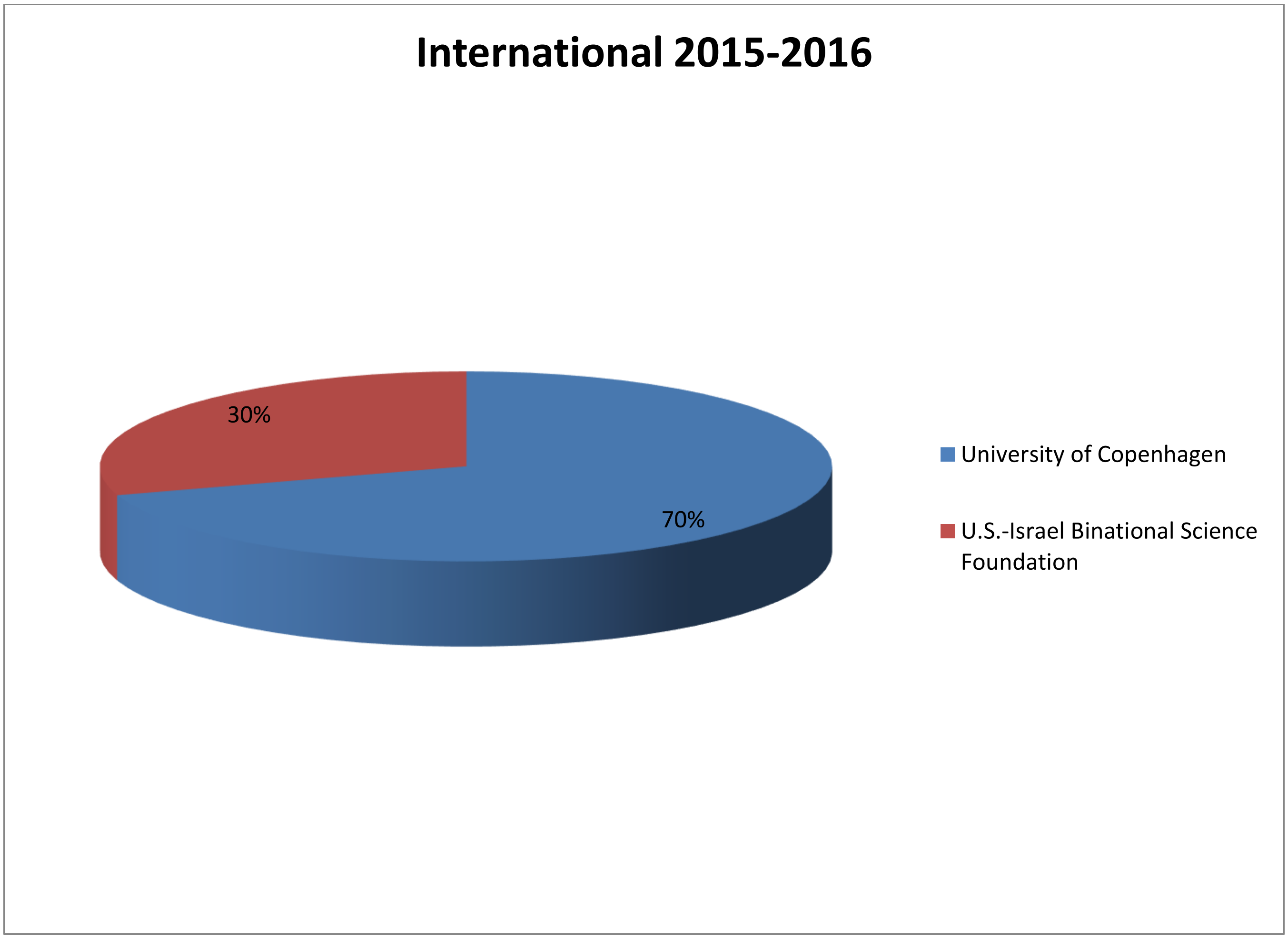


Chart 3: International Research Support Summary Chart

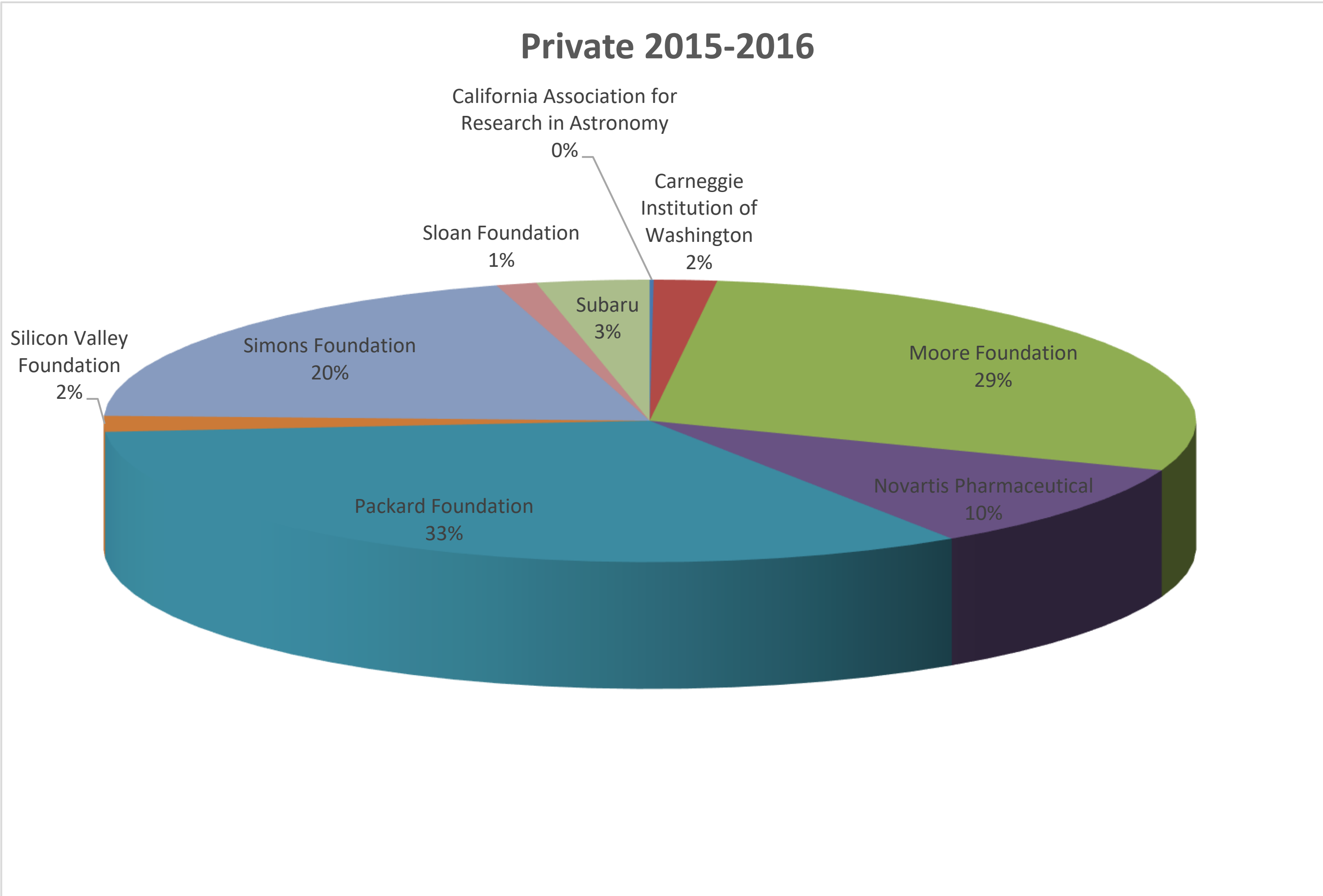


Chart 4: Private Research Support Summary Chart

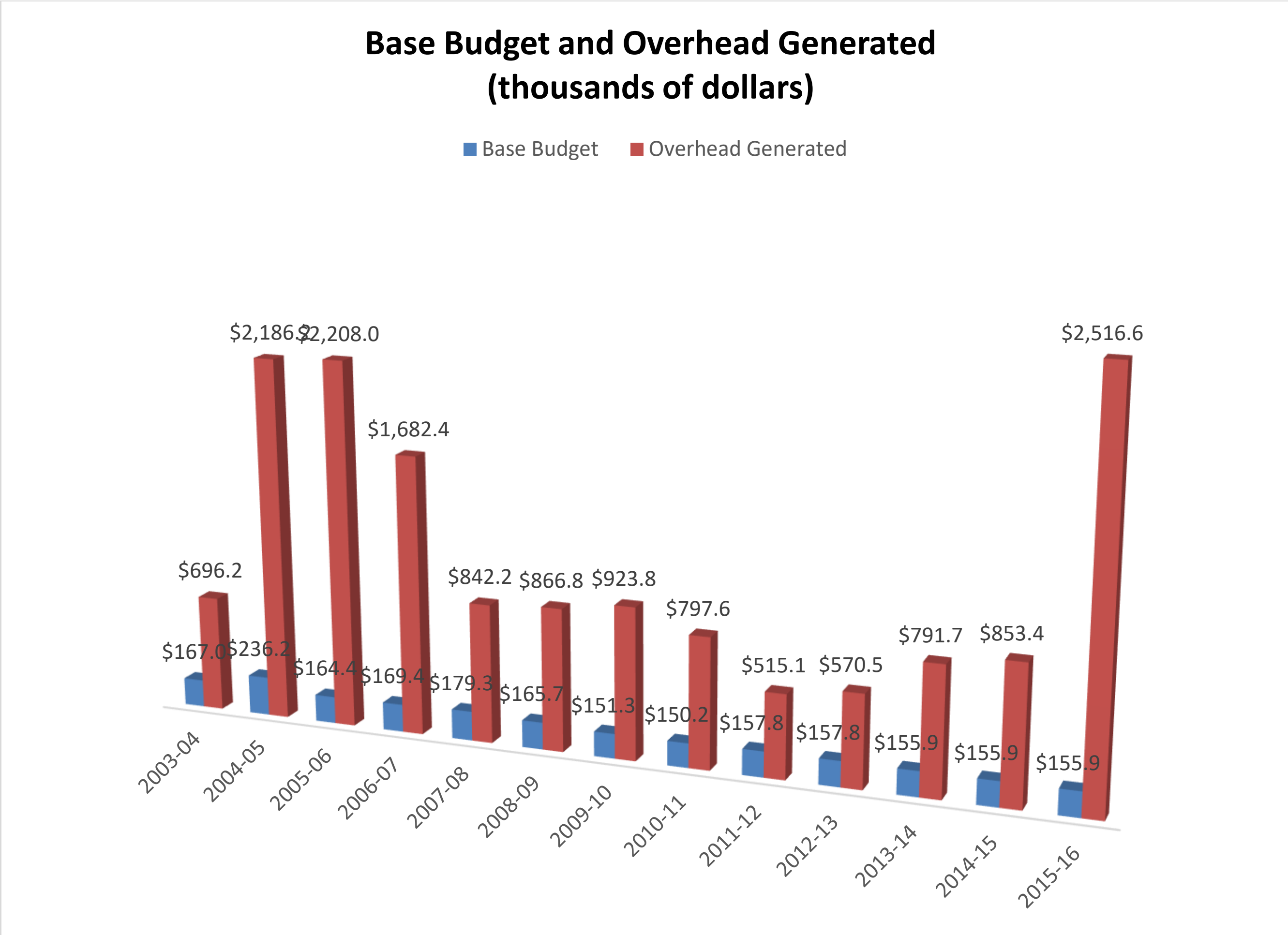


Chart 5: Base Budget and Overhead Generated

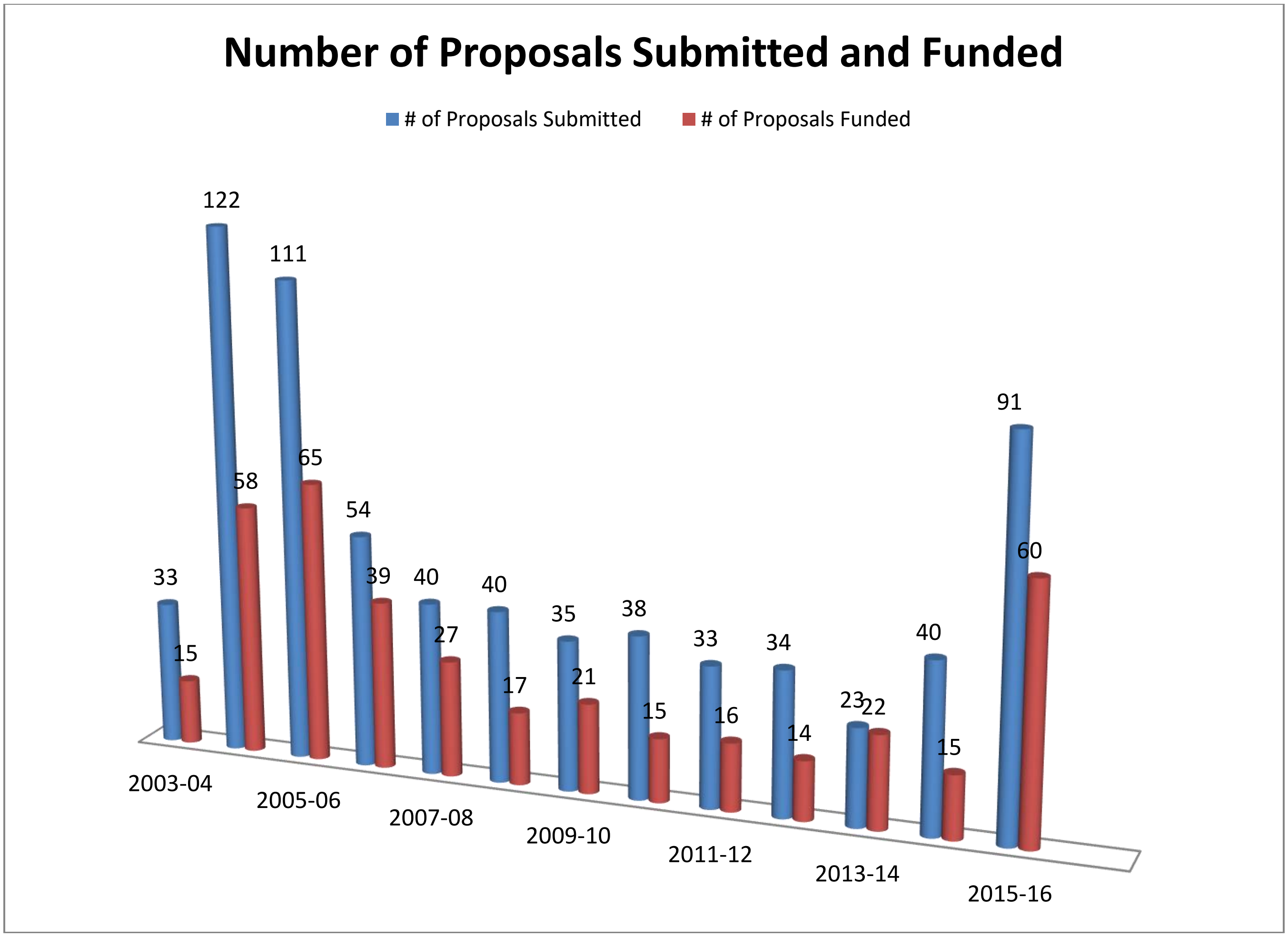


Chart 6: Number of Proposals Submitted and Funded

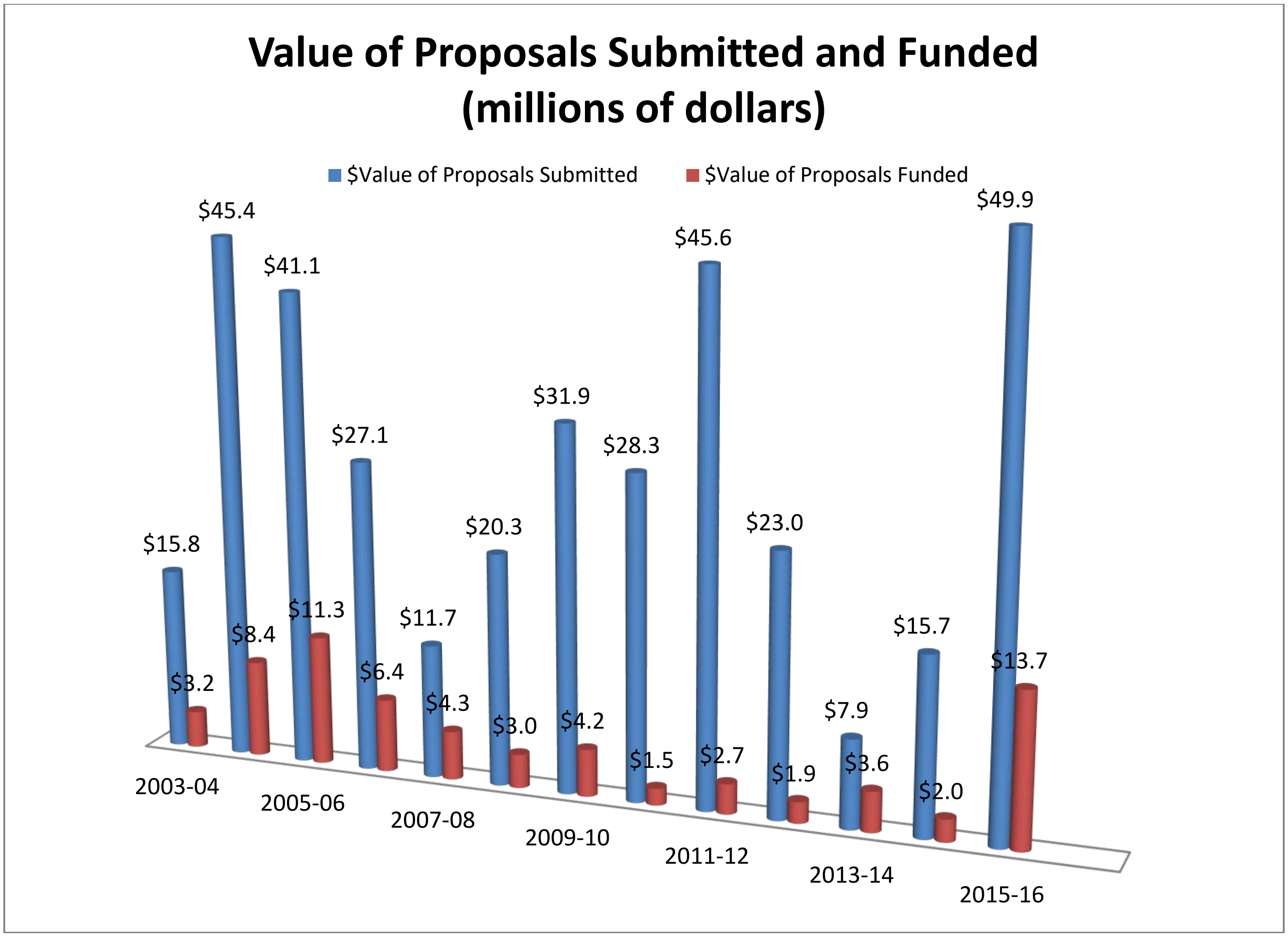


Chart 7: Value of Proposals Submitted and Funded

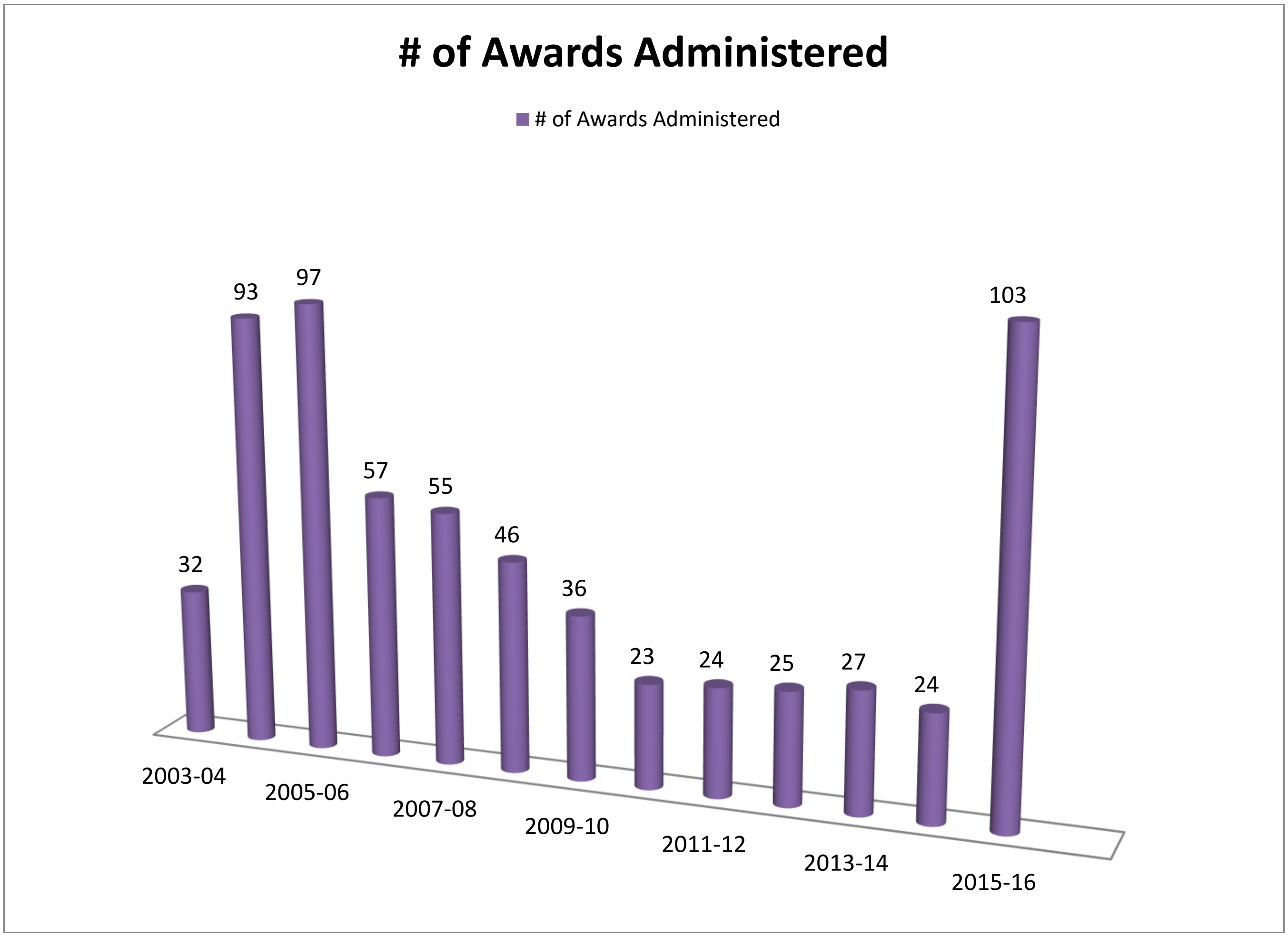


Chart 8: Number of Awards Administered

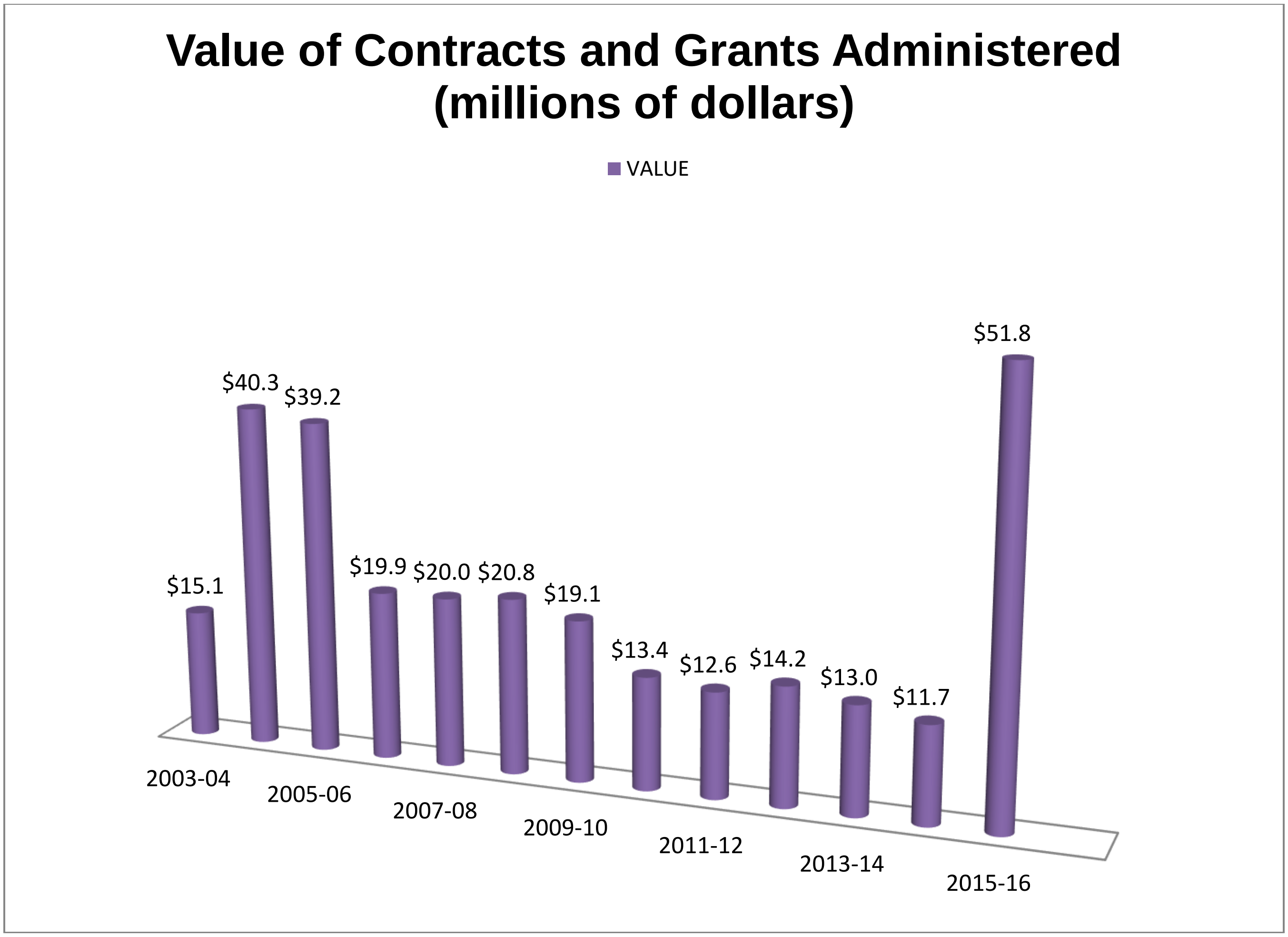
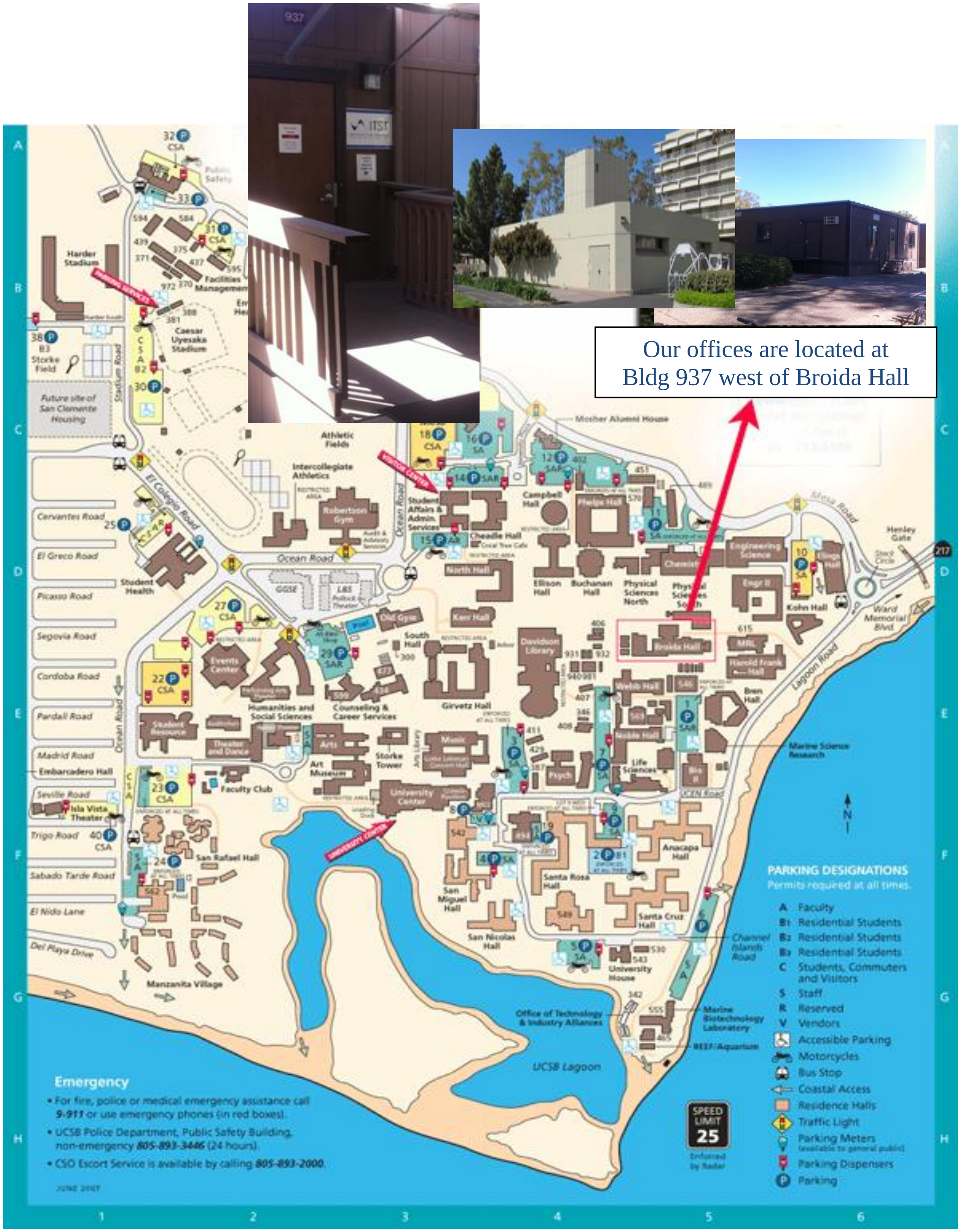


Chart 9: Value of Contracts and Grants Administered

Map



Our offices are located at
Bldg 937 west of Broida Hall
937
Harder Stadium
Caesar Uyesaka Stadium
Facilities Management
Storke Field
Future site of San Clemente Housing
Athletic Fields
Intercollegiate Athletics
Robertson Gym
Student Affairs & Admin. Services
Cheadle Hall
North Hall
Campbell Hall
Phelps Hall
Mosher Alumni House
Ellison Hall
Buchanan Hall
Physical Sciences North
Physical Sciences South
Engineering Science
Chemistry
Engr II
Kohn Hall
Henley Gate
Mesa Road
Ocean Road
El Colegio Road
Student Health
Cervantes Road
El Greco Road
Picasso Road
Segovia Road
Cordoba Road
Pardall Road
Madrid Road
Embarcadero Hall
Seville Road
Isla Vista Theater
Trigo Road
Sabado Tarde Road
El Nido Lane
Del Playa Drive
Manzanita Village
San Rafael Hall
Faculty Club
Events Center
Old Gym
Kerr Hall
South Hall
Davidson Library
Broida Hall
MRL
Harold Frank Hall
Girvetz Hall
Humanities and Social Sciences
Counseling & Career Services
Student Resource
Theater and Dance
Arts
Art Museum
Storke Tower
Music
University Center
Webb Hall
Noble Hall
Psych
Life Sciences
Bren Hall
Marine Science Research
Lagoon Road
Ward Memorial Blvd
UCEN Road
Anacapa Hall
San Miguel Hall
Santa Rosa Hall
Santa Cruz Hall
San Nicolas Hall
University House
Channel Islands Road
Office of Technology & Industry Alliances
Marine Biotechnology Laboratory
REEF/Aquarium
UCSB Lagoon
SPEED LIMIT 25
Enforced by Radar
Emergency
• For fire, police or medical emergency assistance call 9-911 or use emergency phones (in red boxes).
• UCSB Police Department, Public Safety Building, non-emergency 805-893-3446 (24 hours).
• CSO Escort Service is available by calling 805-893-2000.
JUNE 2007
PARKING DESIGNATIONS
Permits required at all times.
A Faculty
B1 Residential Students
B2 Residential Students
B3 Residential Students
C Students, Commuters and Visitors
S Staff
R Reserved
V Vendors
Accessible Parking
Motorcycles
Bus Stop
Coastal Access
Residence Halls
Traffic Light
Parking Meters (available to general public)
Parking Dispensers
Parking