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1 October 1994

RESEARCH INTERESTS
and
BROAD AGENCY ANNOUNCEMENT
95-1
of the
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

BOLLING AIR FORCE BASE WASHINGTON, D.C. 20332-0001

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RESEARCH INTERESTS OF THE AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

CONTENTS

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FOREWORD

The Air Force Office of Scientific Research (AFOSR) directs the Air Force's entire basic research program. AFOSR's technical experts foster the transfer of research results accomplished under AFOSR sponsorship in Air Force laboratories, academic institutions, U.S. industry, and other government agencies. Using a carefully balanced research portfolio, AFOSR research managers create new technology and advance current knowledge, enabling users in the Air Force and U.S. industry to produce world-class, militarily significant, and commercially valuable products.

Through grants to university scientists, academic support, contracts for industry research, cooperative agreements, and support for basic research in Air Force laboratories, AFOSR funded approximately 1,300 grants and contracts in fiscal year 1994, totaling more than $200 million to about 350 academic institutions and industrial firms.

Technology sharing and transfer is encouraged, and, in this respect, AFOSR welcomes proposals that envision university-industry cooperation. Nonindustry proposers are encouraged to spell out in their proposals their interactions with industry and Air Force laboratories, including specific points of contact. Cooperation with, or use of, facilities in an Air Force laboratory is also encouraged. To this end, we are encouraging those who prepare proposals to contact appropriate activities in the Air Force laboratories. The *Directory* section of this pamphlet provides some initial contact points to assist you.

This pamphlet will guide you in your efforts to participate in our research program. To facilitate the preparation of proposals, the pamphlet is divided into five sections:

The *Introduction* section describes the Broad Agency Announcement (BAA), the mechanism used by AFOSR to solicit research proposals. It also provides an overview of the general approach used to submit proposals.

The *Research Interests* section describes the basic research AFOSR is interested in sponsoring.

The *Researcher Assistance Programs* section discusses research associateship programs, faculty programs, and graduate school programs. Most of these programs foster mutual research interests between the Air Force laboratories and institutions of higher education.

The *Proposal Guidance* section is a reprint of our general BAA 95-1, which provides details about the proposal process.

The *Directory* lists the names, telephone numbers, mailing addresses, and e-mail addresses of AFOSR scientific directors and program managers, and the names, telephone numbers, and mailing addresses of Air Force chief scientists and Air Force laboratory task managers.

Anyone qualified to perform research is encouraged to contact AFOSR in accordance with the appropriate BAA and the guidelines given in this pamphlet. We particularly encourage proposals from Historically Black Colleges and Universities, minority institutions, and minority researchers.

Helmut Hellwig

HELMUT HELLWIG
Director

I

Introduction

The Air Force Office of Scientific Research (AFOSR) manages all basic research under this Broad Agency Announcement (BAA) conducted by the U.S. Air Force. To accomplish this task, AFOSR solicits proposals for research through a general BAA and through specialized BAAs. Availability of all BAAs is published in the *Commerce Business Daily* (CBD).*

This general BAA outlines the Air Force Defense Research Sciences Program and is reprinted in Section IV, Proposal Guidance, for your convenience. AFOSR invites proposals for basic research in many broad areas. Section II of this pamphlet describes those areas in greater detail.

Specialized BAAs outline specific Air Force high-interest programs. Examples of recent BAAs include the University Research Initiative and Historically Black Colleges and Universities (HBCU) programs. HBCUs are those institutions determined by the Secretary of Education to meet the requirements of 34 Code of Federal Regulations Section 608.2, and Minority Institutions are those certified by the Department of Education, Office of Civil Rights, to meet the new minority institution criteria contained in 10 U.S.C. 2323(a)(1)(C), which reads, in part: "minority institutions (as defined in section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5)), which, for purposes of this section, shall include Hispanic-serving institutions (as defined in section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)))." Portions of this pamphlet may be applicable to the research opportunities described in these specialized BAAs as well.

Each BAA specifies deadlines, proposal formats, and other unique requirements. Unnecessarily elaborate brochures or presentations beyond those sufficient to present a complete and effective proposal are not desired. All proposals must be submitted in hard-copy form directly to the office listed in the applicable BAA. Be sure to mark your proposal with the specific BAA number to ensure that it receives proper consideration. Information about current BAAs is available from the address below. In addition, the *AFOSR Proposer's Guide* (AFOSR Pamphlet 70-11) describes procedures to follow when submitting proposals.

Before submitting a research proposal, you may wish to further explore proposal opportunities. This can be done by contacting the AFOSR program manager, who can provide greater detail or who may ask for a preliminary proposal; however, in your conversations with any Government official, be aware that only contracting officers are authorized to commit the Government. Names and telephone numbers of AFOSR program managers are listed in Sections II and III of this pamphlet.

If you would prefer (or if the program manager requests) you may submit a preliminary proposal, which should be in letter format and *briefly* describe the following: (1) objective; (2) general approach; (3) impact on Department of Defense (DOD) and civilian technology; and (4) any unique capabilities or aspects such as collaborative research activities involving Air Force, DOD, or other Federal laboratories. Preproposal letters should not exceed three typewritten pages, but example figures and one-page vita(e) for the principal investigator(s) may be attached.

To obtain additional copies of this pamphlet, send a self-addressed label with your request to

AFOSR/XPT

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General information can be obtained by calling (202) 767-4910. DOD personnel can call DEFENSE SWITCH NETWORK (DSN) 297-4910.

This pamphlet, as well as other AFOSR publications, may be downloaded from the Federal Information Exchange (FEDIX), an on-line information system accessible via computer and modem. Call the FEDIX computer at (800) 783-3349 (eight data bits, one stop bit, no parity). There is no charge to the user for accessing the information. The FEDIX help line is available at (301) 975-0103 from 8:30 a.m. until 5:00 p.m. EST. Also, FEDIX is accessible via Internet at the following telnet address: "fedix.fie.com." At login, type "fedix" or Telnet to "192.111.228.33," or to web server HTTP:\\web.fie.com\.

* The CBD publishes synopses of proposed U.S. Government contract actions that exceed $25,000 in value. Subscriptions to the CBD are available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402-9371, Tel. (202) 783-3238.

II

Research Interests

Aerospace and Materials Sciences

Structural Mechanics

The objective of this research program is to study solid mechanics fundamentals and structural principles that are necessary to ensure the integrity of current and future aerospace structures, including aircraft, missiles, and spacecraft. Proposals are sought that will lead to fundamental understanding of the behavior of structures that are composed of current metallic materials as well as advanced composite materials, and that will develop principles to predict nonlinear aerospace structural characteristics under coupled fluid, thermal, and mechanical loads. We are interested in solid mechanics principles that govern nonlinear coupled deformation and damage mechanisms that dictate anisotropic and heterogeneous medium response and structural performance. Topics such as damage localization, instability formation, homogenization, energy dissipation, and local and global response correlation are of interest. Structural nonlinear behavior and control owing to coupled mechanical, fluid, acoustic, and thermal loads are important to the design and performance prediction of aerospace systems. Fluid-structure interaction, aerothermoelasticity, and the development of intelligent materials and structures are of interest in this research program. The degradation of materials and structures over long periods of service is also of interest, since current Air Force weapon systems will remain in service much longer than originally anticipated. This research includes the prediction of material degradation under combined mechanical and environmental loads, as well as the nondestructive detection and quantification of internal damage such as corrosion and fatigue cracking.

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Mechanics of Materials

Research in this program seeks to establish the fundamental understanding required to design, process, and predict thermomechanical performance of aerospace structural material systems. Projected Air Force applications will require multifunctional material systems capable of sustained performance in extreme loading environments. Candidate structural material systems are almost all highly heterogeneous, composite media. These systems include metallic and intermetallic alloys, advanced composite material systems (including polymer-matrix, metal-matrix, ceramic-matrix, and carbon-carbon composites), and solid rocket propellants and liners. Innovative new material systems, such as nanostructural materials and functionally graded materials, are also of interest.

The continuing drive for safer, more durable aerospace vehicles with improved performance characteristics depends on researchers' ability to understand, characterize, and quantitatively model the expected behavior of such emerging material systems. Therefore, this program focuses on developing and applying the mechanics principles and methodology appropriate for treating advanced materials. Particular emphasis is placed on material systems that are capable of operating in extreme-temperature environments, such as those to be utilized in future engine and airframe component designs. Quantitative connections between evolving microstructural features and resulting performance parameters must be established, along with an analytical understanding of the relationship between processing and microstructure. Interdisciplinary approaches that include mechanics, materials science, chemistry, physics, and applied mathematics are encouraged, as are combined analytical-experimental efforts. Interaction with Air Force laboratory researchers who are conducting basic research is also encouraged, as is interaction with Air Force personnel in exploratory and advanced development programs.

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Particulate Mechanics

Particulate mechanics research aims to develop a fundamental understanding of the behavior of particulate material systems based on first principles. Here, particulate materials are those that can be represented as an assemblage of physically discrete particles—either alone or in a matrix of materials having significantly different properties. Examples of particulate materials include metallic and ceramic powders used for manufacture of advanced aerospace materials, powdered foods and cereal grains used in food preparation, and geologically derived materials such as soil, rock, and concrete. Research in this area also seeks to understand the fundamental physics governing flow in porous media.

Many current and future aerospace structural materials of interest to the Air Force are manufactured from powder precursors. The manufacturing process, and resultant product, are frequently dominated by the mechanical behavior of these powders, whether dry or in suspension. In addition, many current structural design and analysis methods are based on empirical relationships derived from phenomenological data and fail to address the factors affecting behavior of these heterogeneous, anisotropic, multiphase discrete systems. This research will provide a knowledge base from which analytical models can be developed to design and evaluate new material processing technologies, leading to improved design and analysis methods for aerospace systems and their supporting infrastructure.

Proposals for research in particulate mechanics should emphasize the behavior of particulate material systems with characteristic lengths that range from nanometers to meters. We seek to obtain quantitative relationships to describe the fundamental mechanics of particulate material systems. Interdisciplinary theoretical, analytical, or experimental approaches that include mechanics, materials science, physics, and applied mathematics are encouraged. Proposed research in this area should focus on the influence of material microstructure on overall constitutive behavior, the constitutive behavior of multiphase (heterogeneous) particulate systems, and localization and instabilities in particulate media, including their potential to flow and liquefy.

Closely related research seeks to provide an understanding of the physical and chemical processes which govern flow in porous media. There exists an underlying similarity between the physics associated with nonreactive and reactive flows in materials manufacturing processes and the contaminant fate and transport problems in environmental quality research. A better understanding of the fate and transport of current and future Air Force contaminants, such as fuels, solvents and lubricants, and solid rocket propellants is required. Interdisciplinary theoretical, analytical, or experimental approaches that include mechanics, chemistry, physics, and applied mathematics are encouraged. Research in this area should focus on the effect of porous media structure, sorption/desorption mechanisms, and the presence of nonaqueous phase liquids and gases on fluid flow and contaminant transport in porous media.

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External Aerodynamics and Hypersonics

This research program seeks to improve the understanding of viscous and inviscid fluid flow phenomena that strongly influence the mission-requirements-driven design, aerodynamic performance, and efficiency of Air Force flight vehicles. This program comprises three technical thrust areas: advanced computational fluid dynamics (CFD), unsteady aerodynamics, and hypersonics. Research should focus on the underlying physical mechanisms that govern these classes of complex flows.

Research in advanced CFD is sought to develop autoadaptive, unstructured grid methods. Research is ongoing to develop methods capable of simulating the complex, three-dimensional, time-dependent flows created by aircraft and missile platforms during dynamic combat maneuvers. Research is also sought to address flows with multiple bodies in relative dynamic motion, such as store separation. These full Navier-Stokes simulations include viscous effects that range from laminar, through transitional, to fully turbulent boundary layer states. Of particular importance is the development of advanced LES and DNS methods for high speed, viscous, compressible flows over aircraft and missile components (wings/fins and fuselages), as well as internal flows in supersonic engine inlets and hypersonic SCRAMJET inlet systems. LES methods using spectral element or other DNS subgrid scale simulations are of particular interest. We are also interested in developing analysis capabilities for dynamic, three-dimensional, viscous, hypersonic engine inlet unstart processes.

Research in unsteady aerodynamics should reveal the fundamental viscous processes associated with vorticity generation within the boundary layer along wing leading edges, the mechanisms responsible for the transfer of that vorticity through feeding sheets from within the boundary layer into discrete vortices outside the boundary layer, and the convection of those vortices once they are shed from the boundary layer into the free stream flow around and beyond the wing. Research to identify the influence of wing leading-edge geometry and aircraft motion on these processes is also sought. It is critically important to develop nondissipative CFD algorithms that are capable of tracking multiple shed vortices with no diffusive loss of vorticity. This includes phenomena related to vortex convection, vortex surface impingement, and multiple vortex coalescence.

Research in hypersonics should improve the understanding of complex, time-dependent, three-dimensional viscous flows with and without finite rate chemistry effects and should advance the accuracy of high-altitude numerical simulation methods. We are especially interested in three-dimensional Burnett-equation numerical methods. Boundary layer stability and transition analyses for flows over hypersonic flight vehicles based on the Burnett equations are of particular interest. Direct numerical simulation methods with rate chemistry are also sought. We are also interested in shock-tunnel research that investigates the fundamental fluid mechanics of high Reynolds number as well as high-enthalpy hypersonic flows at realistic flight conditions. New concepts for hypersonic, high-enthalpy, and high Reynolds number shock tunnels are of particular interest.

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Internal Fluid Dynamics

Research in this area is motivated by problems relevant to the airbreathing propulsion requirements of the Air Force. This research focuses on understanding and controlling complex internal flows, as in axial flow compressors and axial flow turbines. Emphasis is on understanding the role of unsteadiness and three-dimensionality in design, performance, stability, and heat transfer to obtain more efficient and lightweight high-performance engines. We are exploring active control strategies for rotating stall and surge instability in gas turbine engine compressors as well as examining compressibility effects and the influence of inlet distortion on forced response. We are also developing improved understanding and predictive techniques for unsteady and turbulent heat transfer in gas turbines.

The principal areas of concentration include high free stream turbulence, stagnation point heating and wing-body juncture flows, and transition heat-transfer phenomena. An important goal is to integrate fluid dynamics with heat transfer to aid in determining and modeling the key mechanisms responsible for high heat-transfer rates in these severe environments. Research on the nature of turbulent heat transfer is of primary interest, particularly in the context of turbine blade cooling. Innovative approaches to understanding, predicting, and controlling turbulent heat transfer are sought.

We are interested in innovative research that illuminates the physical mechanisms governing internal flows in a rotating environment. Recently, we have begun to address high-speed, high-flow turning phenomena in direct support of low-aspect-ratio, high-work compressors and turbines. We encourage an interdisciplinary approach to understanding and solving the problems associated with rotating stall and surge, incorporating bifurcation analysis and nonlinear control theory, to improve the modeling of compressor instabilities.

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Turbulence Prediction and Control

This research program seeks fundamental understanding of physical mechanisms governing the onset and evolution of turbulence in bounded and free shear flows. It also seeks application of that understanding to develop advanced models and concepts for predicting and controlling turbulent and transitional flows. A primary issue is the effect of compressibility on turbulence physics, models, and controllability.

We are interested in theoretical, computational, and experimental approaches to understanding flow instabilities and the mechanisms of transition from laminar to turbulent flow, in both bounded and free shear flows. We encourage research on the receptivity of transition phenomena to background and imposed flow disturbances and on bypass mechanisms. The effects of pressure gradient, three-dimensional base flows, and compressibility are of particular interest. Mixing in compressible shear layers is of special interest.

Direct numerical simulations of the temporal and spatial evolution of transitional and turbulent flows are pursued to provide insights into governing physical mechanisms, guide the formulation of new predictive models, and suggest innovative concepts for controlling aerodynamic lift and drag as well as turbulent mixing and transport. Of most interest are ideas to advance principles and methods for large-eddy simulation, especially subgrid modeling, and ideas to advance the understanding and prediction of turbulence at high Reynolds numbers. We seek original ideas and concepts leading to new approaches to modeling turbulent transport, especially ideas incorporating the physics of turbulence into predictive turbulence models.

We are interested in advanced diagnostics research that targets new concepts and new approaches for measuring and interpreting very large arrays of time- and space-resolved data. We seek new ideas for significantly advancing our experimental diagnostic capability in turbulent flows, providing time- and space-resolved data on fundamental flow structures and their interactions. Application of new diagnostic approaches to understanding turbulence-induced optical distortions is of special interest.

Research on the development of diagnostic sensors and integrated arrays of sensors and actuators, including neural network approaches, is of interest for application to flow control. The use of microelectromechanical systems in this context may offer promising new approaches. We also seek collaborative, interdisciplinary research involving fluid dynamics and control theory that may lead to new approaches for controlling transition and turbulence. Fundamental research on the control of vorticity production on surfaces is of interest in the context of leading-edge and forebody vortex control, thrust vectoring, aerodynamic tailoring, and high lift. We emphasize enhancing aerodynamic performance, especially aircraft agility, through understanding and controlling energetic unsteady flow fields. Basic interdisciplinary research combining unsteady aerodynamics and flight mechanics is also needed.

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Airbreathing Combustion

Fundamental understanding of the physics and chemistry of multiphase, turbulent reacting flows is essential to improve the performance of airbreathing propulsion systems. We are interested in innovative research proposals that use simplified configurations for experimental and theoretical investigations.

Our highest priorities are studies of supersonic combustion, atomization and spray behavior of slurries and liquids, fuel combustion chemistry, and supercritical fuel behavior in precombustion and combustion environments. Other topics of interest include turbulent combustion, soot formation, and interactive control.

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Space Power and Propulsion

Wide-area surveillance and space-based defense require affordable on-demand, on-schedule launch and orbit transfer vehicles as well as accurate plume prediction models.

Research activities fall into two areas: nonchemical orbit-raising propulsion and chemical propulsion. Research in the former area is directed primarily at advanced space propulsion and is stimulated by the need to transfer very large payloads between orbits. It includes studies of the sources of physical (nonchemical) energy and the mechanisms of release. Our emphasis is on understanding electrically conductive flowing gases (plasmas) that serve to convert beamed or electrical energy into kinetic form. Theoretical and experimental investigations are being conducted on the phenomena of energy coupling and the transfer of plasma flows in electrode and electrodeless systems under plasmadynamic environments.

Topics of interest include characteristics of pulsed and steady-state plasmas; characteristics of equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, -electrode, -magnetic, and -electric fields; losses to inert parts; characteristics of plasmas in high-magnetic fields and pressures; and plasma diagnostics (new and unique noninterfering measuring techniques).

Research is being conducted on chemical propulsion to predict and suppress combustion instability in solid and liquid rocket systems, to control the complex role of advanced energetic ingredients in solid propellant burning, and to permit the use of metal fuels (studying condensation and oxidation dynamics of metal-atom-doped clusters).

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Aero Propulsion Diagnostics

Research is directed at new techniques for sensing temperatures, concentrations of chemical constituents, and velocities in energy conversion systems without interfering with the operation of the systems. The research emphasizes diagnostics of laboratory systems that simulate the hostile environments of high-performance combustion and plasma systems and sensors for onboard control of propulsion systems.

Of interest are combustion and plasma flows, including multiphase reactions, gas-solid interactions, sprays, and reactions under supersonic conditions. We are exploring sensing and diagnostic techniques and strategies consistent with advances that are expected in adaptive controls. Topics include the quantitative imaging of plasma flows, monitoring rapid surface reactions, using nonoptical sensors, instantaneously mapping velocities, and formalisms for exploiting array data. We seek proposals that introduce techniques rather than apply advanced diagnostics as part of the research.

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Metallic Structural Materials

The goal of research in metallic structural materials is to provide the fundamental knowledge required to develop metallic alloys and composites for aerospace applications. Potential applications of these materials include turbine airfoils and disks, engine casings and nozzle components, airframe and spacecraft structural components, and hypersonic vehicle skins. Improved metallic structural materials will be capable of higher operating temperatures at significantly reduced densities as compared with currently available materials.

This goal will be accomplished by understanding the relationships between processing, chemistry, structure, and properties of metallic and metallic composite materials. Specific scientific topics include the development and experimental verification of theoretical and computational (atomistic) models; phase transformations; interfacial phenomena; strengthening mechanisms; plasticity; creep; fatigue; environmental effects; and fracture of structural metallic materials. Materials under research include refractory metals, intermetallic alloys, metal matrix composites, intermetallic matrix composites, nanocrystalline metallics, and protective metallic coating systems. Emphasis will be on materials for high-temperature application. A new initiative will begin in fiscal year 1995 to study functionally graded materials (FGM's) for use in demanding applications with a large variation in material property requirements. Understanding the design, processing, thermal stability, and mechanical property mechanisms in FGM's will be an important aspect of this initiative.

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Ceramics and Nonmetallic Structural Materials

The objective of this research program is to provide scientific background for current and future Air Force-related applications of ceramics, ceramic-matrix composites (CMC's), and carbon-based composites. One of the major components of this program is understanding high-temperature strength and creep resistance of ceramic materials on the atomic and microscopic levels. This basic knowledge is necessary to develop reliable, creep-resistant, and affordable ceramics for high-temperature structural applications that will improve propulsion and vehicle performance. Of particular interest are creep-resistant oxide materials, such as yttrium aluminum garnet, alumina, and zirconia. Additionally, silicon nitride, silicon carbide, and other refractory nonoxide ceramics are investigated for very high temperature applications.

One of the major detriments in using ceramics for structural applications is their brittleness. This program addresses the issue of reducing or controlling the brittleness of ceramics in three ways: (1) study of fracture, fatigue, and reliability of ceramics, providing criteria for predicting their performance under a variety of conditions; (2) evaluation of transformation toughening, flaw- and stress-induced toughening, and other techniques of increasing toughness; and (3) design, fabrication, and evaluation of fiber, laminate, and particulate ceramic-matrix composites that fracture in a metallike, "graceful" manner. It is expected that fiber-reinforced CMC's will satisfy requirements for tough, reliable materials capable of prolonged operation at and above 2,700 degrees Fahrenheit (1,500 degrees Celsius). To meet these goals, this program emphasizes research efforts on oxidation-resistant, thermally stable fiber-matrix interfaces, optimization of strength of fiber-matrix interfaces, and novel processing techniques that improve performance and affordability of CMC's.

Lightweight, high-temperature-resistant carbon-carbon composites are increasingly used as structural elements for hypersonic aircraft and space structures. To facilitate their use, resistance to oxidation of these materials must be improved. To this end, this program seeks to elucidate oxidation mechanisms of carbon materials, with the goal of inhibiting oxidation by using dopants and surface modifiers. Also studied are carbonlike materials, such as BC_3, which resist oxidation better than carbon. In addition, new approaches to oxidation-inhibiting coatings for carbon-carbon composites are of interest.

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Physics and Electronics

Joint Services Electronics Program

The Joint Services Electronics Program (JSEP) is a mutual enterprise of the Army, the Navy, and the Air Force designed to provide the Department of Defense with a university-based research capability in the electronic sciences and related areas. Each of the 12 major universities currently involved in the program carries on a multidisciplinary research program in one or more of the following subjects: solid-state electronics (devices, materials, integration); electromagnetics (waveguides, propagation, scattering, antennas); quantum electronics and optics; information electronics (computers, signal processing, communications, circuits and systems), together with interdisciplinary programs in physics, chemistry, engineering, mathematics, and materials science that are in support of these broad areas.

The JSEP is reviewed by the Tri-Service Technical Coordinating Committee (TCC), consisting of senior scientists or science administrators from the three services. The TCC has a continuing interest in the expansion of the JSEP, including the addition of new universities, provided future funding allotments or program changes in current JSEP universities make it advantageous. The TCC will give due consideration to proposals from universities desiring membership, taking into account the following criteria: a capability for performing high-quality, multidisciplinary research in the electronic and related sciences; a competent management structure with a highly capable individual fully responsible for the successful execution of the research program; a professional staff with recognized scientific competence; and a demonstrated capability in support functions and facilities.

Proposals should address the problems to be investigated, approaches to be used, expected results, qualifications of the principal investigators, and cost of the proposed research.

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Electronic Devices, Components, and Circuits

This research program emphasizes electronic devices and semiconductor materials topics directly connected with advances in such devices. The emphasis currently is on devices for high-speed/high-frequency applications, although novel device concepts for other applications will be considered. Interest remains in devices from compound semiconductor materials, particularly III-V and III-nitrides. Special focus is on III-V semiconductor materials and their applications produced by low-temperature molecular beam epitaxy (MBE) growth (so-called LT GaAs) or nonstoichiometric III-V materials produced by other means. Support continues for SiGe/Si structures as a means of extending silicon technology in ways analogous to AlGaAs/GaAs technology. Special consideration is given to research in the above topics where strong, direct coupling to in-house efforts at Air Force laboratories is in place or clearly indicated.

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Optoelectronic Information Processing: Devices and Systems

This program includes investigations in two affiliated arenas: (1) the development of optical materials and optoelectronic devices and (2) the insertion of these components into optoelectronic computational and information-processing systems. Emphasis is on coordinating device exploration and architectural developments; synergistic interaction of these areas is expected, both in structuring architectural directions to reflect device capabilities and in focusing device investigations according to system needs.

Research in optical materials and devices focuses on insertion of optical technology into computing, image-processing, and signal-processing systems. This program continues to foster surface-normal interconnect capabilities, combining detector arrays with spatial light modulators or with optical modulator (or source) arrays at local processing elements. An ancillary emphasis explores optical memory capabilities demonstrated by persistent spectral hole-burning techniques, or by photorefractive materials, in page-oriented or holographic configurations. The investigation of spectral diversity in processing—implemented by devices that enable emission, transmission, filtering, and switching—is also being pursued. Understanding the fundamental limits of the interaction of light with matter is important. Semiconductor technology incorporating engineered materials is encouraged to implement device components. The devices considered under this program will be high speed, low energy, and robust and will incorporate gain, logic, or memory capabilities, with prospects for array configurations. This approach will lead to "building block" components that can be used in diverse optical implementations.

System-level investigations incorporate these devices into processing architectures, taking advantage of their demonstrated and envisioned attributes and determining appropriate problem classes for optical or optoelectronic approaches. The computational advantages and proper use of parallelism provided by optical implementations continue to guide architecture and device development. In addition, a new emphasis is evolving, stressing the use of the inherent extremely wide bandwidth of optical carriers. Computer processing components continue to encounter increasing difficulty in signal transmission, constrained by wire-crossing restrictions, electromagnetic interference, and crosstalk, an impediment that may be ameliorated by optical interconnect approaches. Serial access to memory slows processing, causing what has come to be known as the Von Neumann bottleneck; parallel access capability promised by optical approaches may alleviate this constriction. Concepts to incorporate the extremely wide bandwidth capacity of the optical carrier may enhance the capability of future switching and processing computational machines. System-oriented efforts match computing architectures to these optical capabilities. Several architectural issues are presently being investigated. Optical interconnects contribute to communication between electronic processors. Optical technologies provide the capacity for random, space-variant interconnects with fan-in and fan-out capability. Optical and optoelectronic devices, organized into processing elements, perform digital computation functions. Optical access and storage physics in memory devices resolve capacity, latency, and access limitations. Processing in the spectral domain can perform data-packet routing, byte-parallel transmission, and functions of medium-scale integration complexity. A new, multidisciplinary program area applies both device and architectural capabilities to aero-optic diagnostics, image processing, and wavefront correction in aerodynamically turbulent environments in concert with aerodynamics and mathematics program thrusts. This research pursues the development of intensively parallel, adaptive, or fault-tolerant computing systems that will be used to alleviate Air Force problems in areas such as smart munitions, electronic warfare, and artificial intelligence.

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Quantum Electronic Solids

The components of this program involve materials that exhibit cooperative quantum electronic behavior, with the primary emphasis on superconductors, and any conducting materials with surfaces that can be modified and observed through the use of scanning, tunneling, and related atomic-force microscopies. The program also deals with device concepts utilizing these materials for electromagnetic detection and signal processing in Air Force systems.

The long-standing materials aspects of the program are based on the fabrication, characterization, and electronic behavior of thin films, which can ultimately lead to the discovery of new and improved electronic circuit elements. There is already a strong effort to understand the mechanisms that give rise to superconductivity in selected ceramics and to produce high-quality Josephson tunneling structures. There is also increasing interest in studies to find superconducting behavior in other families of materials, with the hope of discovering such behavior at ever-higher temperatures. This year the program has been expanded to include bulk superconducting materials that can be useful in producing current-carrying wires in power applications. A continuing interest in this program is the search for new electronic device concepts that involve superconductive elements, either alone or in concert with semiconductors and normal metals, while there is new interest in understanding high-power absorption in high-temperature superconducting materials at microwave frequencies.

A relatively new (and small) aspect of this program is the inclusion of scanning probe techniques to fabricate, characterize, and manipulate atomic-, molecular-, and nanometer-scale structures, with the goal of producing a new generation of improved sensors and resulting in the ultimate miniaturization of analog and digital circuitry.

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Semiconductor and Electromagnetic Materials

Air Force electronic and photonic signal processing, communications, surveillance, and electronic warfare systems require continual improvements in performance. This research program is directed toward developing advanced electronic, optoelectronic, and electro-optical materials to provide the required improvements in future Air Force electronic and photonic systems. In particular, we seek to generate the fundamental knowledge and the materials data base required for the growth and use of novel, as well as existing, electronic and photonic materials and structures. No single electronic material has the combination of properties required for all applications, so several classes of single-crystal semiconductor materials—including a variety of heterostructural combinations—are currently under investigation. Similarly, several classes of photonic materials, including semiconductor heterostructures and nonlinear optical materials, are also under investigation.

Compound semiconductors such as gallium arsenide and indium phosphide, the ternary alloy gallium aluminum arsenide, and heterostructural combinations of such materials are the foundation of a whole new generation of ultra-high-speed, high-frequency digital and microwave devices. These materials provide the electronic and optoelectronic properties necessary for advanced information- and signal-processing applications and for optoelectronic communications. We are currently investigating the compound semiconductors for potential use in high-temperature electronics, in detectors for the ultraviolet-to-far-infrared region, in display and emitter sources, and in infrared-active optoelectronic countermeasures. Material issues are being pursued in the III–V nitride, III–V antimonide, and III–V phosphide-based compound semiconductors.

An effort is under way to develop a Group IV semiconductor—specifically, silicon-germanium and silicon-germanium-carbon—heterostructure technology for next-generation digital computer, microwave, and optical sensor and emitter systems. Efforts continue to combine Group IV and Group III–V material, heterostructure technology with Group II–VI and Group III–V material for future device applications. Novel concepts are being explored in low-dimensional systems. Interface issues and understanding of equilibrium and nonequilibrium growth processes through modeling are also important in heterostructure technology. Interest exists in nanoscopic processing and includes growth on patterned or nonplanar substrates. Our overall emphasis is to combine materials science with solid-state physics to investigate the fundamental aspects of growth, defects, and properties of multilayer semiconductor structures. Numerous opportunities remain to be explored in the area of heteroepitaxy of dissimilar materials and the bulk growth of nonlinear-optical and semiconductor materials that will continue to have a substantial impact on electronics, optoelectronics, and electro-optics.

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Photonic Physics

The Air Force seeks new ideas, knowledge, and insights in broad aspects of photonics. Ultrafast optoelectronic techniques are being investigated in hopes of dramatically advancing the speeds and available power of electronic circuits. Picosecond and femtosecond optical pulses are being investigated to generate very wide band signals, as well as to control and test electronic circuits at frequencies into the millimeter-wave range, and far beyond, into the terrahertz range. Optical interconnect techniques are being investigated for application, especially to millimeter-wave circuit interconnections. Optoelectronic generation of very high power terrahertz pulses are being studied, which could significantly contribute to so-called impulse radar systems. Very wide band, mode-locked semiconductor lasers are being devised and investigated as important devices in their own right, as well as for practical implementations of the ultra-high-speed electronic studies. Semiconductor laser arrays are being intensively investigated, as research support to ongoing important Air Force development programs. Very low noise and very low threshold semiconductor lasers are being pursued for applications in communications and information processing. Directed energy beams, particularly laser beams, are being explored in a wide variety of direct-write materials-processing techniques, which offer broad and extremely important new capabilities, particularly in microelectronics fabrication and packaging.

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Optics

This research emphasizes optically pumped solid-state lasers, nonlinear optics and adaptive optics, and a variety of novel optical techniques with promise for advancing Air Force goals in a wide variety of applications. Nonlinear-optical (NLO) techniques, particularly two-wave and four-wave mixing techniques in photorefractive materials, and four-wave mixing in Kerr media, are being investigated for a variety of novel, potentially important applications, such as optical beam combining and quality enhancement, image amplification, and novelty filtering. Novel nonlinear optical materials are being investigated, including the use of resonances in gases. The latter are very attractive because of their capabilities to produce semiconductor diode lasers that are accurately tuned to the resonances. Gases embedded in "caged" solids are being studied. These materials could offer the benefits of resonances in gases at high pressure, but in solid-state form. Induced transparency is being studied as a means for taking advantage of resonances for nonlinear optics, without the concomitant absorption. Many other novel phenomena related to induced transparency are also potentially useful and important. Novel, efficient means are being devised to convert the wavelength of existing lasers into new regimes important for applications. A new initiative is being pursued in infrared sources for countermeasure applications. Of interest are laser and NLO research which could lead to infrared sources, tunable or multiple fixed frequency, CW or high repetition rates, and (most important) potentially high average power. Nonlinear optical techniques are being extended to the millimeter-wave region, principally through the study of nonlinear transmission lines and artificial Kerr media, with large effective nonlinearities. New techniques are being developed in near-field optical microscopy, a field with revolutionary technological possibilities.

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Atomic and Molecular Physics

This program involves experimental and theoretical research on the properties and interactions of atoms and molecules and forms the basic underpinning of a large range of technological applications in navigation, guidance, communications, atmospheric physics, low- and high-altitude nuclear weapons effects phenomenology, directed-energy weaponry, and lasing mechanisms.

Topics to be pursued include the following:

1. Trapping and cooling atoms and ions for high-resolution spectroscopy, studying cold-atom collisions, and developing advanced frequency standards.
2. Ultraviolet emission cross sections of atmospheric species by electron impact.
3. Interactions of atoms in strong electric, magnetic, and radiation fields.
4. Atomic physics fundamental to understanding plasma-enhanced deposition and microetching processes.
5. Antiproton capture, confinement, transport, injection, and annihilation processes.
6. Production of antihydrogen.

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Plasma Physics

We are seeking innovative approaches for exploring novel concepts that exploit the collective interactions of charged particles with electromagnetic fields. Our primary areas of interest include the following:

1. Electron-beam-driven sources of high-power microwave and millimeter-wave radiation.
2. Microwave interactions with plasmas.
3. Numerical simulation of plasma phenomena.
4. Plasma propulsion concepts for space platforms.
5. Energy-efficient methods to generate and maintain free electron densities of 10^{13} per cc in sea-level air.

Research proposals will also be considered for funding under the Exploratory Concepts portion of the DOD/Tri-Service Vacuum Electronics Initiative. That program is seeking novel ideas for military vacuum electronics systems that could be exploited by the U.S. vacuum electronics industry. In addition to technical excellence, successful proposers under this initiative must also demonstrate strong university or industry ties. Proposed concepts must be sensitive to military constraints (i.e., low voltage, compact, lightweight, rugged, and energy efficient).

Other plasma research topics will be considered on a case-by-case basis. However, in general, this program is not interested in dense (strongly coupled) plasmas nor in space plasmas.

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Chemistry and Life Sciences

Chemical Reactivity and Synthesis

Through this research we seek advanced materials and associated processes with low initial cost and minimal life-cycle impact on the environment. Three major research areas include studying potential chemical and biochemical transformations of materials with the objective of learning their fate when released into the environment, searching for alternatives to environmentally unacceptable materials and processes, and investigating biological/biochemical and biomimetic approaches to aerospace materials preparation and degradation.

Current objectives include studies aimed at learning potential chemical, photochemical, and biochemical/biological transformations that developmental aerospace materials may undergo upon accidental or deliberate release into the environment. Particular emphasis is on soil surface, subsoil, and aqueous environments. Materials of interest for study include, but are not limited to, fuels, propellant chemicals, lubricants, deicing chemicals, paints, and cleaning agents. We seek to understand reaction kinetics and mechanisms with a goal of learning product species and distributions. We are exploring molecular designs, associated preparative methods, mechanisms associated with end application and environmental impact, and relevant characterization in order to obtain environmentally acceptable replacements for Air Force materials whose use has been restricted or prohibited because they represent a hazard to the environment. Materials of interest for study include, but are not limited to, fire suppressants, deicing chemicals, paints, and primers. We are exploring research on alternative, environmentally benign design and synthesis pathways for chemical building blocks associated with advanced aerospace polymeric composites. This effort will address chemicals for which there may not be current use restrictions, but for which risk assessment projections indicate a strong probability of future restrictions. These chemicals may include solvents, resin synthesis intermediates, and resin components. We seek knowledge about biochemical transformations that may be useful for selective, high-yield biosynthesis/biomimetic synthesis of organic chemicals that may be utilized as intermediates for aerospace materials. We are also investigating the use of biosynthesis/biomimetic synthesis for controlled preparation of inorganic crystals with ordered structures applicable to electro-optical or structural applications. We are studying biochemical transformations in order to shed light on microbial-induced corrosion processes that may affect aerospace materials.

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Polymer Chemistry

The goal of this research is to gain a better understanding of the influence of chemical structures and processing conditions on the properties and behaviors of polymeric and organic materials. This understanding will be important in the utilization of these materials in Air Force advanced systems. The approach to meeting this goal is to study the chemistry and physics of these materials through synthesis, processing, and characterization. This area addresses both functional properties and properties pertinent to structural applications.

One of the emphases of the current program is to study electronic nonlinear-optical (NLO) organic and polymeric systems for photonic and optoelectronic applications. A current emphasis is to identify physical and electronic mechanisms and chemical structures that can improve the second- and third-order macroscopic optical nonlinearity of polymeric materials beyond the state of the art. Improvements in processibility, optical quality, and temporal stability of these materials, especially for the second-order NLO materials, are highly desirable.

There is interest in studying the fundamentals of combining different properties in a single material system. This concept is being broadened to include ceramers, an alloy of ceramics and polymers. Many advanced devices and systems require a combination of different properties to operate properly. Materials based on this concept will make it possible to combine different devices into one system, such as a head-up display built into a canopy system.

Another goal of this research is to create new properties through combinations of properties, such as generating photorefractivity through the combination of photoconductivity and electro-optic properties. An additional goal is to provide materials that possess coupled properties, so that the change of one property—either in a controlled fashion or otherwise—can change the other properties of the materials. These materials can be very useful for sensors, smart structures, and function-control applications.

Another area of interest is organic superconductivity. Research is being conducted to understand the fundamental mechanism, and thus the molecular requirement, for superconductivity in organic or polymeric systems.

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Inorganic Materials Chemistry

Inorganic materials chemistry supports basic research on synthesis, processing, reactivity, and analysis of surfaces, thin films, and interfaces. The ultimate goal of this research is atomic-scale control in the chemistry and morphology of inorganic materials during the manufacturing process. The desire is to control chemistry at the atomic level by depositing and removing individual atoms at specified atomic sites.

Chemical processing of solution ceramics, sol-gel glasses, and quantum dots and quantum wires produces structural, optical, and electronic materials of better performance and at lower cost than those currently available. This technology is being expanded to support subterranean sensing for the Air Force environmental cleanup program. A significant technology transfer that occurred this past year was production of polyhedral oligomeric silsesquioxane polymers to be used for rocket motor insulation.

Research on thin films, tribochemistry, catalysis, and corrosion/materials degradation will determine the basic chemical phenomena that control epitaxy, ferroelectric behavior, friction and wear, and heterogeneous reactions. Recent work supported by this program shows a step doubling of nickel (977) crystal surfaces in the presence of small amounts of oxygen immediately prior to bulk oxidation; this may lead to development of diagnostic tools to alert technicians of areas of an aircraft that may experience corrosion in the near future, and so they can prevent its occurrence.

The scientific objectives of this program involve chemical processing of semiconductors, tribochemistry, chemical synthesis, and chemical corrosion. This program will provide the Air Force technological payoffs in advanced communications and data storage, novel lubricants and lubrication systems, coatings for space vehicles, and nondestructive evaluation and inspection of aircraft components.

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Theoretical Chemistry

The objectives of the theoretical chemistry program are to develop and apply predictive tools for designing new materials and improving processes important to the Air Force. Areas of interest include the structure and stability of molecular systems that can be utilized as advanced propellants; methods to calculate the nonlinear-optical properties of materials; determining, predicting, and modeling the atomic interactions at interfaces that affect wear and lubrication and that control deposition and growth of nanostructures on surfaces; calculating properties of bulk materials from atomistic considerations; and using theory to describe and predict the details of ion-molecule reactions relevant to ionospheric and space effects on Air Force systems.

Interest in advanced propellants focuses on the High Energy Density Matter program (managed jointly with the Phillips Laboratory), which aims to develop new propellant systems that can double the payload capacity that can be put into orbit. Theoretical chemistry is used to predict promising energetic systems, to assess their stability, and to guide the efficient synthesis of selected candidates. Current emphasis is on identifying novel energetic molecules and investigating the interactions that control or limit the energy that can be stored by energetic dopants in cryogenic solids. Research on metals and ceramic materials emphasizes clusters and nanophase materials. We also encourage development of new methods and algorithms that take advantage of parallel computing architectures to predict properties with chemical accuracy for systems having a very large number of atoms.

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Molecular Dynamics

The objectives of the molecular dynamics program are to understand, predict, and control the reactivity and flow of energy in molecules. This knowledge will be used in atmospheric chemistry to improve our detection and control of signatures; in high-energy-density material research to develop new energetic materials for propellants and explosives; in chemical laser research to develop new high-energy laser systems; and in many other chemical systems in which predictive capabilities and control of chemical reactivity and energy flow at a detailed molecular level will be of importance.

Areas of interest in atmospheric chemistry include the dynamics of ion-molecule reactions relevant to processes in weakly ionized plasmas in the ionosphere; gas-surface interactions in space; and reactive and energy transfer processes that produce and affect radiant emissions in the upper atmosphere. In the latter, rotational energy transfer processes are of particular current interest. Research on high-energy-density matter for propulsion applications investigates novel concepts for storing chemical energy in low-molecular-weight systems, the stability of energetic molecular systems, and the storage of energetic species in cryogenic solids. Work on chemical reactivity and energy localization in solids is focused on understanding the processes that control the sensitivity of explosives. Research in energy transfer and energy storage in metastable states of molecules supports our interest in new concepts for chemical lasers. Fundamental studies aimed at developing predictive capabilities for and control of chemical reactivity, bonding, and energy transfer processes are encouraged.

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Neuroscience

This program supports basic research on the neurobiology of behavior. The ultimate objective is to understand the neural mechanisms that determine the effectiveness of skilled, healthy persons performing demanding mental and physical tasks. Areas of emphasis are fundamental studies of the neurobiological mechanisms underlying neuronal responsiveness, learning and memory, fatigue, stress, attention, and arousal.

A strong focus is on the psychobiology of stress. We encourage studies to determine the neurochemical and behavioral consequences of stress and how to regulate the stress response.

We give high priority to investigations that rigorously examine the behavioral consequences of neurochemical regulation. We accept proposals for neurobiological research that does not study behavior but that would clearly further understanding of behavior. We rarely support applied studies of human performance.

In conjunction with other programs described in this pamphlet, the neuroscience program may support neurobiological research on visual and auditory information processing, multisensory integration, and higher cognitive functions.

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Chronobiology

The objective of the chronobiology program is to elucidate the biological mechanisms responsible for circadian rhythmicity and how they influence behavior relevant to skilled human performance. We seek proposals on the location and function of circadian pacemakers; mechanisms by which pacemakers such as the suprachiasmatic nucleus are entrained or reset; and the sensory, motor, and cognitive manifestations of circadian activity. Experimental approaches involving lesion studies, neurochemistry, molecular biology, neurophysiology, pharmacology, and behavior will address how the circadian timing system is regulated. Studies with vertebrates are of most interest. Reproductive studies will not be considered.

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Perception and Recognition

This program supports visual and auditory theory, modeling, and psychophysical research on human adults. The primary objective is to discover and quantitatively model featural processing mechanisms underlying sensory pattern perception and recognition. We encourage multidisciplinary research, particularly if the results can be constrained by behavioral data. Collaboration between psychophysicists and scientists in other disciplines is often valuable. Theoretical efforts are most welcome.

The program currently supports theoretical and experimental work on topics related to featural processing and pattern classification, including the visual mechanisms of contrast detection and discrimination, motion, eye movements, color, and stereopsis, as well as auditory mechanisms that underlie recognition, localization, and speech.

We also support theory and modeling of neural circuitry in the sensory and sensorimotor pathways of biological systems, primarily in higher vertebrates. Multidisciplinary approaches, as well as models and simulations of the dynamic behavior of neuroanatomically distinct regions, are especially emphasized.

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Spatial Orientation

This program supports research focused on the accurate integration of the visual, visual-vestibular, visual otolith, and proprioceptors as they apply to the dynamic aviation environment, including perceived location and movement through space. Research is especially encouraged to identify and model the sensory and sensorimotor mechanisms that process environmental cues from single and multiple sensory sources. Studies of the sub-, trans-, and suprathreshold stimuli that influence the spatial orientation process are encouraged. We will consider both theoretical and experimental work.

Theoretical approaches may include analytic and computational models that attempt to explain performance, preferably in terms of underlying neural processes. Experimental approaches may include human or animal studies, but those leading more directly to models of human performance will be emphasized.

Proposals are considered for work on the following and other related topics: visual vision, visual orientation and posture, auditory cues, vestibular and proprioceptive perception of movement, multisensory integrative mechanisms, simple sensorimotor behaviors (e.g., ballistic movement), and adaptation.

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Cognition

This program supports basic research on cognitive processes of individuals and small teams, particularly the performance-related aspects of attention, memory, information processing, learning, reasoning, problem solving, and decision making under stress. The study of these topics under conditions of high workload in training environments or in team situations is especially welcome.

The goal of the program is to support theoretical and experimental research that illuminates the fundamental mechanisms underlying human performance. We support research using behavioral methods alone or a combination of behavioral and biological or computational methods.

Three special programs provide for collaboration with Air Force laboratory scientists:

1. *Center for Learning Ability*

This effort provides awards for collaboration with scientists at the Armstrong Laboratory outside San Antonio, Texas, a large test facility for research on individual differences in cognitive ability. This unique facility includes 30 test stations with microcomputers and associated equipment and a mainframe computer for reducing data. Several hundred new subjects are available for testing each week. One current research project measures individual differences in processing speed and working memory capacity to predict learning performance. Proposers are encouraged to describe other studies related to individual differences in learning ability. Awards will support visits to this facility for collaborative research.

2. *Intelligent Teaching*

This program supports collaboration with scientists at the Armstrong Laboratory to develop theory-based automated instructional techniques. A laboratory of flexible microcomputer-based training delivery systems is available for investigations of training strategies using large samples of subjects.

3. This effort provides access to facilities for team research at the Armstrong Laboratory. Collaborative research and modeling of distributed team decision making and performance is appropriate.

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Bioenvironmental Sciences

Air Force operations utilize chemical and physical agents that are potentially harmful to Air Force personnel, the surrounding populace, and the environment. These agents include fuel components, lubricants, solvents, heavy metals, and aerospace materials. (A list of chemicals is available on request.) Furthermore, these materials may be contained in waste streams on Air Force installations or as contaminating compounds in ground water and soil. To protect humans and the environment and to facilitate the cleanup of contaminated sites, the Air Force supports basic research efforts in understanding the effects of toxic agents on biological systems, the mechanisms of toxicity, and the ability of microorganisms to degrade and detoxify hazardous chemicals. We support fundamental research on Air Force hazardous agents in areas of predictive and environmental toxicology and bioremediation.

The following topics represent basic research interests of the Air Force's program in Bioenvironmental Sciences:

1. *Predictive Toxicology*

a. Cellular/molecular mechanisms of toxicity.
b. In vitro structure-activity relationships and their quantitative and predictive implications.
c. Biologic markers of toxicity and metabolism.
d. Pharmacokinetic modeling of toxic Air Force chemicals.

2. *Environmental Toxicology*

a. Toxic effects of chemicals on organisms and the resultant ecological stress.
b. Predicting effects of chemical mixtures on ecological systems.
c. Mechanisms of metabolic activation of chemicals in the environment.
d. Biologic markers of environmental toxicity.

3. *Bioremediation*

a. Novel microbial metabolic pathways (anaerobic and aerobic) and the removal/degradation of metals and chemicals, including nitrogen-containing propellants.
b. Modification of metabolic pathways, co-metabolism, and enhanced biodegradation.
c. Improving biodegradation techniques via gene manipulation.
d. Role of ecological niches and biotic interrelationships in optimizing degradative potential.

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Organic Matrix Composites

This program addresses the materials science issues relating to developing improved performance or lower cost polymer matrix composite (PMC) systems and to processing and utilizing these structures for Air Force systems. The goal is to provide the science base that would lead to higher performance and more affordable PMC structures for Air Force applications. Polymer precursor chemistry and processing for ceramic and carbon-carbon structures are also within the scope of this program.

The emphasis of the current program is to study the environmental effects on the long-term properties of polymer matrix composites. These environmental effects include harsh processing environments (e.g., high-temperature processing), application environments (e.g., high-temperature exposure under pressurized conditions), and service environments (e.g., moisture and solvent). The research will address the chemistry and physics of the degradation mechanisms that lead to deterioration of the performance of the PMC structures. The scope will cover the matrix, the reinforcement, the interphase, and the composite as a whole. The research results will lead to accurate prediction of PMC structures' service life and to alternative material systems, processing procedures, and service practices that can increase the service life of these structures.

Another emphasis of the current program is to address the effects of PMC processing on the environment. The goal is to seek environmentally benign processing for PMC. The processing elements include resin formulation, prepregging, cure and postcure, and assembly. Evaporation of solvents or evolution of airborne particles that are harmful to the environment and human workers are to be minimized or eliminated.

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Mathematics and Geosciences

Dynamics and Control

Research in this program leads to improved techniques in the design and analysis of new control systems with enhanced capabilities and performance for use in future Air Force missions. Applications include the development of robust feedback controllers for advanced high-performance aircraft and adaptive, reconfigurable flight control systems; control of vibrations and the shape of large, flexible space structures; active control of wing camber using embedded smart sensors and actuators; control of combustion and fluid flow processes associated with aerospace vehicles; control of electromagnetic radiation by controlling the properties of a propagating surface; and novel hierarchical control systems that can intelligently manage actuator, sensor, and processor communications in complex systems. We emphasize research in distributed-parameter control (including control of complex coupled fluid-structure systems); robust, adaptive multivariable feedback control for both linear and nonlinear systems; and, to a lesser degree, fundamental applied research in stochastic control, design optimization, control of discrete event dynamical systems, and use of neural networks for control design.

Research in robust multivariable feedback control will develop mathematical methods that allow the design and analysis of feedback systems that achieve stability and satisfy other performance objectives in the face of model uncertainties. There is special interest in the development of a theory of robust control for nonlinear and distributed-parameter systems and in novel approaches to effective robust-control-oriented system identification techniques.

Distributed-parameter control problems involve systems with dynamics given by partial differential equations, integro-differential equations, or equations with delays. New integrated approaches are needed to develop approximation techniques for the identification, control, and optimization of distributed-parameter systems. While efforts continue in dynamics and control theory for flexible structures, increased attention is focused on mathematical techniques that support the development of modern control theory applicable to controlling fluid flow and combustion processes, as well as complex, highly nonlinear coupled interactions between structural deformation and unsteady flows. These research efforts are coordinated with ongoing efforts in aerospace engineering that emphasize experimental research.

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Physical Mathematics and Applied Analysis

This program pursues mathematical models and their analysis in areas of interest to the Air Force. Our goal is to distill focused mathematical models of particular physical phenomena and the mathematical methods for their analysis, as well as to produce models sufficient for numerical computation. The payoffs include understanding and modeling physical phenomena such as nonlinear optics or turbulent flow, leading to methods for their simulation and control.

While supporting a broad range of topics, this program concentrates on several special interests: nonlinear optics, inverse problems (the radar interpretation problem and nondestructive evaluation), mathematical materials science, and theoretical fluid mechanics (including hypersonics). All of these areas have in common the nonlinearity of their mathematical descriptions. Nonlinear mathematics exhibits a spectrum of behavior for which effective mathematical understanding either is unavailable or is only beginning to emerge. What is striking is the ubiquitous appearance of coherent structures (solitons and their relatives), chaotic solutions, or formation of singularities in many seemingly disparate physical scenarios. Research emphasizes both analytical and numerical tools that tackle these problems.

One goal of nonlinear optics is the effective exploitation of lasers. Solitons, chaos, and other operational possibilities that affect beam control, imaging, and diode array stability are stressed. Research on laser-induced ocular damage involves identification of field filamentation and incipient singularity formation.

Recent work in mathematical materials science involves a blend of nonconvex energy integrands and modern variational approaches that attempt to incorporate measure theory and homogenization in a computationally useful way. The inverse-problems area seeks, for example, to deduce the nature of the scatterer from the waves it scatters back to the observer. The emphasis here is to confront scenarios in which the Born approximation and its obvious extensions are inapplicable.

Research in hypersonics could seek to include real gas effects and rarefied flow regimes. Nonlinear stability, important distinguished limits, and clarification of unresolved issues in noncontinuum models are some areas of interest.

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Computational Mathematics

This program aims to develop improved mathematical methods and algorithms to utilize advanced computational capabilities to support the scientific computing interests of the Air Force. For the most part, this effort concentrates on supporting the development of innovative methods and algorithms that enable the improved modeling, simulation, understanding, and control of complex physical phenomena of interest to the Air Force. These phenomena include fluid flow, combustion processes, control of flexible space structures, nonlinear optics, directed energy weapons, high-energy-density materials, crystal growth, weather modeling, high-power microwaves, and electromagnetic pulse source output. Our research also supports the national agenda in high-performance computing.

We are developing numerical methods and algorithms to fully exploit the potential of parallel computing for fast, accurate numerical solution of complex systems occurring both in engineering design of Air Force systems and in operations. Efficient use of available parallel machines requires that we pay increased attention to dynamic resource allocation and load balancing, domain decomposition techniques, scalable parallel algorithms, adaptive meshing for shock tracking, and parallel schemes for adaptive grid generation. As the cost of hardware continues to decrease, the results of this program may affect the design of specialized architectures for solving critical scientific problems.

Typically the computational models in this program rely on some numerical scheme that implements a discretization of continuum mechanics equations—generally partial differential equations—that represent the physics of the situation. However, alternative computational models may be appropriate for many problems. We are investigating both traditional and radical approaches in this program. We are developing and improving a variety of numerical methods in this subarea, including homogenization techniques, continuation methods, finite elements, particle and vortex methods, finite difference methods, essentially nonoscillatory methods, and spectral methods. In addition, fast, accurate, and robust methods for solving large systems of linear equations lie at the heart of many scientific computing problems of interest to the Air Force. For this reason, computational linear algebra, especially multilevel or multigrid techniques, continues to receive attention. This emphasis is, however, diminishing.

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Optimization and Discrete Mathematics

Our goal is to develop mathematical methods for solving large or complex problems, such as those occurring in logistics, engineering design, or strategic planning. These problems can often be formulated as mathematical programs. Therefore, research is directed at linear and nonlinear programming methods, especially those that can be implemented on parallel computers. We are also emphasizing discrete structures, as they often represent important Air Force problems.

Three areas of particular importance are emphasized in discrete mathematics. First is the optimal solution of integer programming models and other combinatorially based structures. These structures arise in areas of interest to the Air Force, such as design of very-large-scale integrated networks, frequency assignment, and scheduling and routing. Second, in addition to the evolution of traditional solution methods, the program supports new algorithmic paradigms such as simulated annealing and genetic algorithms. Third, we support research in computational geometry, especially as it relates to electronic prototyping.

Research in optimization focuses on the development of special algorithms for the particular structures that arise, emphasizing implementation on parallel architectures. Since networks are so important for military logistics problems, optimization over networks is a major component of our program. Some research on stochastic optimization, which will benefit from increased parallelism, will begin, as will research on the use of nonlinear programming for the optimization of polymers and biomolecules.

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Signal Processing, Probability, and Statistics

This research activity is concerned with the systematic analysis and interpretation of data. Data for communications (signaling) and for surveillance and tracking (imaging) are both of special importance, and they are tied to various electromagnetic media for physical propagation. Modern radar, infrared, and electro-optical sensing systems produce large quantities of raw information that may have hidden correlations, corruption by noise, and features with a physical cause or origin. Statistical research that treats spatial and temporal dependencies in such data is necessary in order to identify the usable information that they hold.

Among the outstanding problems and issues in signal processing is the need to develop resilient algorithms for data representation in fewer bits (compression), image reconstruction/enhancement, and spectral/frequency estimation in the presence of extraneous corrupting factors. These factors can involve deliberate interference, noise, ground clutter, and multipath effects. We maintain an interest in sophisticated mathematical methods that are continuing to prove effective in handling these effects of corrupting transmission, including time-frequency analysis and generalizations of the Fourier and wavelet transforms. These methods hold promise in the detection/recognition of characteristic transient features, in the synthesis of hard-to-intercept communications links, and in the achievement of high rates of faithful compression of audio and video data.

The Air Force has a responsibility to interpret and utilize data for logistics and human resource management. The methods of probability modeling have proven effective in upgrading the performance of both human and automatic systems. However, even greater facility with these models will be an essential element in designing a better system architecture and in planning for the testing and evaluation strategies that come into play once the system is built. We emphasize probabilistic methods whereby prior information can meaningfully be integrated into the performance-monitoring process, with a view toward achieving an optimum degree of situation awareness and reactive capability during critical engagement.

With an ever-improving repertoire of tools from modern signal processing and statistical science, the Air Force will maintain its lead in communications flexibility, command an encompassing scope in reconnaissance, and project air power through efficient and responsive systems, all at a manageable cost.

Dr. Jon Sjogren, AFOSR/NM
(202) 767–4940; DSN: 297–4940
FAX: (202) 404–7496

Software and Systems

The goal of this research effort is to develop advanced information-processing capabilities needed to support future Air Force needs in areas such as avionics, logistics, engineering design, and command, control, communications, and intelligence (C3I). The primary research emphasis is on software. Research focuses on scientific methods of improving the software engineering process and methods of exploiting distributed hardware. The goal is improved performance for complex Air Force applications on future hardware.

Achievement of these goals currently has two principle thrusts: (1) formal methods in software engineering and (2) distributed computing. Formal methods involve the use of mathematics and logic as the primary element of software engineering. The process begins in the specification stage. The desired product is specified using mathematical and logical notation that provides two key advantages: First, the specifications can be checked for consistency and harmony; second, a form of "supercompiler" can generate code either automatically or semiautomatically from the specifications.

As the Air Force, and the entire military, grows into a more interconnected environment, forces will seek more effective ways of sharing information and resources. Improved tools will be needed to harness the power of distributed processors for analyzing the increasing flow of data from advanced (perhaps physically distributed) sensor systems. In particular, a major thrust has been established in distributed computing for C3I. The objective is to enable the confident construction (design and implementation) and maintenance (evolution and upgrading) of distributed, heterogeneous computing systems for C3I. These critical systems continue to pose research challenges in meeting the simultaneous constraints of real-time (or deadline-driven) response, fault tolerance including survivability, and security in stochastic environments.

Maj. David R. Luginbuhl, AFOSR/NM
(202) 767–5028; DSN: 297–5028
FAX: (202) 404–7496

Artificial Intelligence

Research within this program includes the fundamental building blocks of artificial intelligence: knowledge representation and computer-based reasoning. Applications areas of interest include machine vision and intelligent teaching.

A critical Air Force requirement is automatic reasoning methods to support rapid decision making under conditions of high information loading with conflicting and complex data. Research efforts are directed toward real-time decision making, reasoning under uncertainty, and managing incomplete or unreliable information.

The Air Force needs improved capabilities in coordinating distributed automated systems, especially automated planners and schedulers. Research efforts are being supported to develop a theory to support the design and control of distributed intelligent agents.

Image-understanding vision is important for many Air Force applications such as surveillance, target identification, object recognition, and cartography. Research in image understanding of scenes from sensors using the visual and nonvisual bands of the electromagnetic spectrum includes both model- and physics-based approaches and the application of geometrical and algebraic invariant theories in image recognition.

Intelligent teaching for understanding, operating, and maintaining complex systems is an area of increased Air Force interest. Adaptive teaching systems and advanced presentation methodologies are two areas of research interest to this directorate. Cognitive aspects of intelligent teaching are being supported within the Chemistry and Life Sciences Directorate.

Dr. Abraham Waksman, AFOSR/NM
(202) 767–5028; DSN: 297–5028
FAX: (202) 404–7496

Electromagnetics

This program focuses on state-of-the-art antenna systems for communications, radar, and propagation. Basic electromagnetic radiator research focuses on improvements in efficiency, radiation pattern control, effective bandwidth, impedance matching, radar cross section, and propagation through dispersive and random media. Scattering research seeks to characterize and exploit the radar cross-section characteristics of both targets and terrain. Future research may also include models for the control of adaptive nonperiodically spaced phased arrays and three-dimensional algorithms for scattering by large objects. The latter is the emphasis of a fiscal year 1995 initiative in computational electromagnetics.

Dr. Arje Nachman, AFOSR/NM
(202) 767–4939; DSN: 297–4939
FAX: (202) 404–7496

Terrestrial Sciences

The purpose of this research is to increase our understanding of solid earth dynamics, earth structure, and processes that may impact Air Force operations. Fundamental investigations in seismology are required that will broadly contribute to mitigating nuclear weapons proliferation and to global monitoring compliance with a Comprehensive Test Ban Treaty.

The main emphasis of seismic research is improved understanding of wave-propagation characteristics and discrimination methodologies, including evasion techniques, in regions where nuclear weapons might be under development. We want to improve detection thresholds, enhance discrimination by location, improve the capability to estimate yields of isolated shots detonated in nonstandard environments, and resolve the basic paradox between observing earthquakes and explosions. Some topical examples are source-depth and near-source-structure effects on the excitation of regional phases; empirical descriptions of seismic records generated by earthquakes and explosions from the same source region; determining source depth from depth phases in various geological provinces; seismic coupling as a function of rock type; and regional phase propagation, attenuation, and scattering in complex three-dimensional structures.

Geological and geophysical investigations are also needed in order to adequately characterize regions of geopolitical interest; this is referred to as regionalization research.

Dr. Stanley Dickinson, AFOSR/NM
(202) 767–5028; DSN: 297–5028
FAX: (202) 404–7496

Meteorology

A fundamental understanding of the physics underlying weather and climate is essential for improving our capability to support strategic and tactical military readiness.

We are interested in innovative research proposals that seek to illuminate the dynamic distribution of energy among large, medium, and small scales of atmospheric motion and the nature of relationships between cloud processes and large motion scales. While we recognize that measurements and measurement techniques are important in the research, we currently place a higher priority on efforts to extract the underlying physics than on proposals that concentrate on gathering data.

We assign highest priority to research ideas in mesoscale dynamics and predictions; physics and dynamics of precipitation systems; cloud microphysics; boundary layer dynamics; atmospheric electricity; and satellite and radar meteorology, including the development of new remote measurement techniques and analytical techniques for extracting meteorological data.

Research is directed toward understanding the atmospheric processes that could influence design and operation of communication, navigation, surveillance, and weapons systems operating in the optical and infrared-to-millimeter wavelengths. Our highest priorities are research ideas in auroral backgrounds, atmospheric transmission and absorption, and natural airglow. Other topics of interest include remote sensing of atmospheric quantities, theoretical studies of molecular parameters, and coherence effects in spectroscopy.

Maj. James Kroll, AFOSR/NM
(202) 767–5028; DSN: 297–5028
FAX: (202) 404–7496

Ionospheric Research

Our research goal is to define the physical and chemical properties of the Earth's upper atmosphere and ionosphere and to determine effects of these properties on Air Force systems operating in or through these regions.

Our main interests are understanding the structure and chemistry of the upper atmosphere and the physics and dynamics of the ionospheric region. This effort includes modeling atmospheric tides, solar radiation, high-energy particles, magnetospheric disturbances and their effects on ionospheric dynamics, and electron density structure.

While we recognize that measurements and measurement techniques play an important role in this area, we are convinced that significant progress will require programs that carefully combine theory with experiment. In the near term, we will emphasize analyzing information to extract the fundamental physics rather than gathering data. We place the highest priorities on research in ionospheric disturbances; ionospheric physics; plasma turbulence and dynamics; ionospheric-magnetospheric coupling; and ion/neutral structure, chemistry, and transport mechanisms.

Maj. James Kroll, AFOSR/NM
(202) 767–5028; DSN: 297–5028
FAX: (202) 404–7496

Space Sciences

The effects of electromagnetic radiation, charged atomic particles, and electric and magnetic fields can endanger the mission and degrade the performance of Air Force systems operating in near-Earth space. Both the ambient and the disturbed space environment can disrupt the detection and tracking of missiles and satellites, distort communications, and interfere with surveillance operations.

This research provides basic knowledge of the space environment for the design and calibration of Air Force systems operating in and through space. Experimental and theoretical methods are used to study the following:

1. Solar activity.
2. Solar outbursts and their travel from the Sun to the Earth.
3. The particle and field composition of the space environment, especially the Earth's magnetosphere.
4. Changes in this environment caused by natural and artificial disturbances.
5. The response of spacecraft systems and operations to conditions in space.

Current topics of interest include the following:

1. Developing a capability to forecast solar activity—for example, by identifying phenomena on the Sun and in interplanetary space that are associated with perturbations of the aerospace environment.
2. Investigating the production and transport of magnetospheric plasma to understand geomagnetic storm phenomena and to predict the expected charged-particle distributions encountered by Air Force spacecraft.
3. Developing models to simulate wave modes generated during injection of artificial beams into space plasmas.

Dr. Henry R. Radoski, AFOSR/NM
(202) 767-5028; DSN: 297-5028
FAX: (202) 404-7496

III

Researcher Assistance Programs

The Directorate of Academic and International Affairs sponsors researcher assistance programs that stimulate scientific and engineering education and increase the interaction between the broader research community and the Air Force laboratories. Applications for these programs do not require proposals, but generally have specific deadlines, formats, and qualifications shown with each program discussed.

National Research Council Resident Research Associateship (NRC-RRA) Program

The NRC-RRA Program offers postdoctoral scientists and engineers opportunities to perform research at sponsoring Air Force laboratories. The objectives of the program are (1) to provide researchers of unusual promise and ability opportunities to solve problems, largely of their own choice, that are compatible with the interests of the sponsoring laboratories and (2) to contribute to the overall efforts of the Federal laboratories.

Postdoctoral Research Associateships are awarded to U.S. citizens and permanent residents who have held doctorates for less than 2 years at the time of application. They are made initially for 1 year.

Senior Research Associateships are awarded to individuals who have held a doctorate for 5 or more years. U.S. citizenship is not a requirement. Successful applicants will have significant research experience and be recognized internationally as experts in their specialized fields, as evidenced by numerous publications in reviewed journals, invited presentations, authorship of books or book chapters, professional society awards of international stature, etc. Although awards to Senior Research Associates are usually for 1 year, awards for periods of 3 months or longer will be considered.

Associates receive a stipend from the NRC while carrying out their proposed research. Currently, the annual stipend for a Postdoctoral Research Associate is $39,000 with additional increments for each year past the Ph.D. An appropriately higher stipend is offered to Senior Research Associates.

Awardees also receive a relocation reimbursement and funds for limited professional travel, if the research adviser recommends the travel and the NRC approves it in advance. Funding is normally provided for approximately 50 associates each year.

For additional information, contact—

Associateship Programs (TJ-2094)
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418
(202) 334-2760

or

AFOSR/NI
(202) 767-5013; DSN: 297-5013
FAX: (202) 767-5012

University Resident Research Program (URRP)

The URRP enables highly qualified university faculty members to spend 1 year, or 2 years with an extension, at Air Force laboratories working on research problems of interest to the Air Force. Through this program faculty members can use their expertise to contribute fresh ideas to Air Force research. AFOSR funds and manages the program. Air Force laboratories furnish the necessary support services, facilities, and equipment for the research. This program is limited to U.S. citizens.

Assignments are for 1 year unless the needs of the Air Force require an extension. The Air Force, the faculty member, and the university must agree to the extension, which will not exceed 1 year.

Participants continue to receive salaries from their universities. AFOSR and the Air Force laboratories negotiate with the university for travel and moving expenses and the amount of the salary needed to cover the time of the sabbatical or leave of absence. AFOSR provides the funds to the Air Force laboratory at which the research is done. The laboratory then reimburses the university for the assignee's salary and for the university's contribution to basic fringe benefits, such as health and life insurance, retirement, and Social Security. Cost sharing on the part of the university is encouraged.

An endorsement from the laboratory chief scientist is required before a candidate's application can be reviewed at AFOSR. Appointees have the status of visiting scientists or engineers in the laboratory and are subject to the general conditions of the laboratory. The date on which appointments begin, which may be any time during the year, is negotiated with the appointees.

For more information, contact—

URRP
AFOSR/NI
(202) 767-5013; DSN: 297-5013
FAX: (202) 767-5012

Summer Faculty Research Program (SFRP)

The SFRP provides research opportunities for qualified faculty members of U.S. colleges and universities at Air Force research facilities within the continental United States. The objectives of SFRP are to—

1. stimulate relations among faculty members and their professional peers in the Air Force;
2. enhance the research interests and capabilities of educators in scientific/engineering areas of interest to the Air Force; and
3. develop the basis for continuing research of interest to the Air Force at the faculty member's institution.

University faculty members spend 8 to 12 weeks during the summer working at an Air Force research activity. To qualify, applicants must—

1. be U.S. citizens or permanent residents;
2. be faculty members of an accredited U.S. college, university, or technical institute; and
3. have at least 2 years of teaching and/or research experience.

After completing this program, participants may submit a proposal for continuing research at their own facilities. Selected proposals are funded under the Summer Research Extension Program (SREP).

For regular summer appointments, the research is conducted for a continuous period of 8 to 12 weeks between April 1 and September 30; the start date is flexible. Under exceptional circumstances, AFOSR, a Summer Faculty Researcher, and the Air Force laboratory may arrange a research appointment during October through March.

For the research period, Fellows receive about $740 a week and an expense allowance of about $50 a day *if they live more than 50 miles from their Air Force research site.* AFOSR Fellows may visit the research sites before the research period by writing the laboratory representative ahead of time.

For more information, contact—

Research and Development Laboratories
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363 or (310) 410-1244
or

Summer Programs Manager
AFOSR/NI
(202) 767-4970; DSN: 297-4970
FAX: (202) 767-5012

Summer Faculty Research Program/ Summer Research Extension Program (SFRP/SREP)

After completing the SFRP, participants may submit proposals to continue the research at their universities. These proposals, if accepted, are funded under the SREP. To compete for the SREP award, SFRP participants must submit a complete proposal and proposed budget either during or promptly after their SFRP appointment.

Each proposal is evaluated for technical excellence, with special emphasis on relevance to continuation of the SFRP effort as determined by the Air Force laboratory or center.

The maximum award under the SFRP/SREP is $25,000, plus the amount shared by the employing institution. Employing institutions are encouraged to share costs because the SREP is designed only to initiate research. The total available funds limit the number of awards.

Proposal deadline is November 1. Funded projects start no earlier than September 1 and end no later than December 15 of the following year.

For more information, contact—

Research and Development Laboratories
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363 or (310) 410-1244
or

Summer Programs Manager
AFOSR/NI
(202) 767-4970; DSN: 297-4970
FAX: (202) 767-5012

Graduate Student Research Program (GSRP)

GSRP is an adjunct effort of the SFRP. The program provides research funds for selected graduate students to work at appropriate Air Force facilities with supervising professors who hold an SFRP appointment or with designated laboratory researchers. The objectives of GSRP are to—

1. provide a productive means for a graduate student to participate in research under the direction of a faculty member or researcher at an Air Force laboratory;
2. stimulate continuing professional association among graduate students, their supervising professors, and professional peers in the Air Force; and
3. expose graduate students to potential thesis topics in areas of interest to the Air Force.

To qualify as a Graduate Researcher in GSRP, applicants must be—

1. U.S. citizens;
2. holders of either a B.S. or an M.S. degree in the appropriate technical specialty;
3. registered in a graduate school program working toward an appropriate graduate degree at their respective institutions; and
4. willing to pursue their summer research work under the direction of a supervising professor who holds an appointment under SFRP or a designated Air Force laboratory researcher.

The research is conducted for a continuous period of 8 to 12 weeks between April 1 and September 30. The student's research period should coincide with the appointment time of the supervising professor.

A selectee receives a predetermined stipend based on educational level. Holders of a B.S. degree receive about $391 per week; holders of an M.S. degree receive about $455 per week. In addition, a daily expense allowance of about $37 is paid if the researcher lives more than 50 miles from the Air Force research location.

For more information, contact—

Research and Development Laboratories
Summer Research Program Officer
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363 or (310) 410-1244
or

Summer Programs Manager
AFOSR/NI
(202) 767-4970; DSN: 297-4970
FAX: (202) 767-5012

Laboratory Graduate Fellowship Program (LGFP)

As a means of increasing the number of U.S. citizens obtaining Ph.D. degrees in science and engineering, AFOSR annually offers about twenty-five 3-year fellowships. These fellowships are for study and research in areas of interest to the Air Force. Fellowships are limited to U.S. citizens who have received their baccalaureate degrees. Air Force laboratory graduate fellowships are tenable at any U.S. institution of higher education offering a Ph.D. in science or engineering.

Fellows receive stipends of $16,000 the first year, $17,000 the second year, and $18,000 the third year. Stipends are prorated for fellowship periods of less than 12 months; however, the duration of the fellowship will not be less than 9 months. In addition to the stipend, the Air Force pays full tuition and fees to the Fellow's institution and provides $2,000 per year to the Fellow's department.

Each Fellow is sponsored by an Air Force laboratory that assigns a mentor to the Fellow. Fellows are required to perform research at their sponsoring Air Force laboratory for at least one summer period in their first or second year of the fellowship.

For more information, contact—

Summer Programs Manager
AFOSR/NI
(202) 767-4970; DSN: 297-4970
FAX: (202) 767-5012

National Defense Science and Engineering Graduate (NDSEG) Fellowship Program

The NDSEG Fellowship Program is a Department of Defense (DOD) fellowship program sponsored by AFOSR, the Army Research Office, the Office of Naval Research, and the Advanced Research Projects Agency. The eligibility requirements and stipends paid, including tuition and fees, are the same as those for the LGFP. The DOD selects about 100 Fellows per year; the Air Force sponsors about 25 of the Fellows.

Ten percent of these awards will be set aside for applicants who are members of an ethnic minority group underrepresented in the advanced levels of the U.S. science and engineering personnel pool, i.e., American Indian, Black, Hispanic, Native Alaskan (Eskimo, Aleut), or Native Pacific Islander (Polynesian or Micronesian).

Those Fellows selected and sponsored by the Air Force will be offered the opportunity to become associated with an Air Force laboratory but are not required to spend a summer at an Air Force laboratory.

For more information, contact—

NDSEG Fellowships
AFOSR/NI
(202) 767-4970; DSN: 297-4970
FAX: (202) 767-5012

IV

Proposal Guidance

The Air Force Office of Scientific Research (AFOSR) invites proposals for basic research in support of the Air Force Defense Research Sciences Program. Proposals selected for funding may be awarded grants, cooperative agreements, or contracts. The areas of interest are covered in Section II of this pamphlet. Application procedures for programs noted in Section III are specific to each program. Information and proposal procedures can be requested from the office noted in each program description.

Our overriding purpose in supporting this research is to advance the state of the art in areas related to the technical problems the Air Force encounters in developing and maintaining a superior Air Force; in lowering the cost and improving the performance, maintainability, and supportability of Air Force weapon systems; and in creating and preventing technological surprise.

Proposals will be evaluated through a peer or scientific review process and selected for award on a competitive basis according to Public Law 98-369, Competition in Contracting Act of 1984, and 10 United States Code 2361. The three primary evaluation criteria, of equal importance, are as follows:

1. The scientific and technical merits of the proposed research.
2. The potential contributions of the proposed research to the mission of the Air Force.
3. The availability of funds.

Other evaluation criteria, which are of lesser importance than the primary criteria and of equal importance to one another, are as follows:

1. The likelihood of the proposed effort to develop new research capabilities and to broaden the research base in support of national defense.
2. The offeror's capabilities, related experience, facilities, techniques, or unique combinations of these factors that are integral to achieving the objectives.
3. The qualifications, capabilities, experience, and past research accomplishments of the proposed principal investigator, team leader, or key personnel.
4. The realism and reasonableness of proposed costs.
5. The offeror's record of past research accomplishments and past performance.

No further evaluation criteria will be used in source selection. The technical and cost information will be analyzed simultaneously during the evaluation process.

Proposals may be submitted for one or more of the topics in Section II or for a specific portion of one topic. A proposer may submit separate proposals on different topics or different proposals on the same topic. The Government does not guarantee an award in each topic area.

The cost of preparing proposals in response to this announcement is not considered an allowable direct charge to any award made under this Broad Agency Announcement (BAA) or any other award. It may, however, be an allowable expense to the normal bid and proposal indirect cost specified in the Federal Acquisition Regulation (FAR) 31.205-18, or Office of Management and Budget Circular A-21 or A-122. Only contracting officers are legally authorized to commit the Government to an award under this BAA.

Technology sharing and transfer is encouraged, and in this respect AFOSR welcomes proposals that envision university-industry cooperation. Nonindustry proposers are encouraged to specify in their proposals their interactions with industry and Air Force laboratories, including specific points of contact. Cooperation with or use of facilities in an Air Force laboratory is also encouraged. Personnel interaction (for example, university faculty or students performing research at industry or Air Force laboratory sites, or industry or Air Force staff working in university laboratories) is viewed as highly desirable.

Every effort will be made to protect the confidentiality of the proposal and of any evaluations. The submitter must mark the proposal with a protective legend in accordance with FAR 52.215-12 (modified to permit release to outside evaluators retained by AFOSR) if protection is desired for proprietary or confidential information.

Proposals should briefly address whether the research proposed will result in environmental impacts outside the laboratory and how the proposer will ensure compliance with environmental statutes and regulations.

It is Air Force policy to eliminate the use of Class I Ozone Depleting Chemicals (ODC) in all Air Force procurements. This policy implements Section 326 of the fiscal year 1993 Defense Authorization Act (Public Law 102-484). Unless a specific waiver has been authorized, Air Force procurements (1) may not include any specification, standard, drawing, or other document that requires the use of a Class I ODC in the design, manufacture, test, operation, or maintenance of any system, subsystem, item, component, or process and (2) may not include any specification, standard, drawing, or other document that establishes a requirement that can only be met by use of a Class I ODC. For the purpose of this policy, the following are Class I ODC's: (1) Halons: 1011, 1202, 1211, and 2402; (2) Chlorofluorocarbons (CFC): CFC-11, CFC-12, CFC-13, CFC-111, CFC-112, CFC-113, CFC-114, CFC-115, CFC-211, CFC-212, CFC-213, CFC-214, CFC-215, CFC-216, and CFC-217; (3) Other controlled substances: carbon tetrachloride, methyl chloroform, and methyl bromide. Proposals submitted in response to this BAA will be reviewed by the Air Force to reflect this policy. Where considered essential, specific authorization will be obtained for the use of these substances, and these authorized uses will be identified in the resulting contract. Proposers are requested to notify the Air Force if any Class I ODC will be required in the performance of any contract awarded under this BAA.

Unnecessarily elaborate brochures or presentations beyond those sufficient to present a complete and effective proposal are not desired. Proposals must be submitted as hard copy.

For additional guidance on the form and content of proposals, proposers should refer to the *AFOSR Proposer's Guide* (AFOSR Pamphlet 70-11), which can be obtained by sending a self-addressed label with the request to—

AFOSR/XPT
110 Duncan Avenue, Suite B115
Bolling AFB, DC 20332-0001

These pamphlets may also be downloaded from the Federal Information Exchange (FEDIX), an on-line information system accessible via computer and modem. Call the FEDIX computer at (800) 783–3349 (eight data bits, one stop bit, no parity). There is no charge for accessing the information. The FEDIX help line is available at (301) 975–0103 from 8:30 a.m. until 5:00 p.m. EST. Also, FEDIX is accessible via Internet at the following telnet address: "fedix.fie.com." At login, type "fedix" or Telnet to "192.111.228.33," or to web server HTTP:\\web.fie.com\.

Proposals may be submitted at any time to the appropriate AFOSR program manager or directorate (addresses are found in Section V). There will be no further solicitations. Historically Black Colleges and Universities (HBCU) and minority institutions (MI) are encouraged to apply; however, no portion of this announcement is set aside for HBCU and MI participation. In case of difficulties in determining the appropriate AFOSR addressee, proposals may be submitted to—

AFOSR/PKC
110 Duncan Avenue, Suite B115
Bolling AFB, DC 20332-0001

This announcement is AFOSR BAA 95-1 and supersedes the AFOSR Pamphlet 70-1 of 1 Oct 93, Research Interest Brochure and Broad Agency Announcement 94-1 of AFOSR. This announcement is open-ended until revised and should be referenced on all responses.

V

Directory

Organizational Directory

ORGANIZATION	ADDRESS	NAME AND TELEPHONE NUMBER
Air Force Office of Scientific Research (AFOSR)	AFOSR 110 Duncan Avenue, Suite B115 Bolling AFB, DC 20332–0001	Hellwig, Helmut, Dr., Director (202) 767–5017; DSN: 297–5017; FAX: (202) 767–6213 Haritos, George K., Col., Deputy Director (202) 767–5018; DSN: 297–5018; FAX: (202) 767–6213
Directorate of Contracts	AFOSR/PK	Hawkins, Ed, Mr., Director (202) 767–4945; DSN: 297–4945; FAX: (202) 404–7951
Directorate of Aerospace and Materials Sciences	AFOSR/NA	Chang, Jim C. I., Dr., Director (202) 767–4987; DSN: 297–4987; FAX: (202) 767–4988
Directorate of Physics and Electronics	AFOSR/NE	Wittmann, Horst R., Dr., Director (202) 767–4984; DSN: 297–4984; FAX: (202) 767–4986
Directorate of Chemistry and Life Sciences	AFOSR/NL	Berry, William O., Dr., Director (202) 767–4278; DSN: 297–4278; FAX: (202) 404–7475
Directorate of Mathematics and Geosciences	AFOSR/NM	Holland, Charles J., Dr., Director (202) 767–5025; DSN: 297–5025; FAX: (202) 404–7496
Directorate of Academic & International Affairs	AFOSR/NI	Vacant (202) 767–4969; DSN: 297–4969; FAX: (202) 767–5012
European Office of Aerospace Research and Development (EOARD)	EOARD/CC 223/231 Old Marylebone Rd. London NW1-5TH United Kingdom or EOARD/CC PSC 802, Box 14 FPO AE 09499–0200	Pletcher, John H., Jr., Col., Commander (011) 44–71–514–4950; DSN: 235–4950; FAX: (011) 44–71–514–4960
Asian Office of Aerospace Research and Development (AOARD)	AOARD Unit 45002 APO AP 96337–0007	Fujishiro, Shiro, Dr., Director (011) 81–3–5410–4409; DSN: 785–1301; FAX: (011) 81–3–5410–4407
Frank J. Seiler Research Laboratory (FJSRL)	FJSRL/CC 2354 Vandenberg Drive, Suite 6F13 U.S.A.F.A., CO 80840–6272	Neal, Parris, Lt. Col., Commander (719) 472–3120; DSN: 259–3120; FAX: (719) 472–3649
Armstrong Laboratory	AL/CA 2509 Kennedy Circle Brooks AFB, TX 78235–5118	Mohr, George, Dr., Chief Scientist (210) 536–3656; DSN: 240–3656; FAX: (210) 536–2371
Aerospace Medicine Directorate	AL/AO 2509 Kennedy Circle, Suite 117 Brooks AFB, TX 78235–5119	Miner, Judson, Dr., Chief Scientist (210) 536–3208; DSN: 241–3208; FAX: (210) 536–2042
Crew Systems Directorate	AL/CF-CA 2509 Kennedy Circle Brooks AFB, TX 78235–5118	Burton, Russell, Dr., Chief Scientist (210) 536–2446; DSN: 240–2446; FAX: (210) 536–2371
Operations & Support Directorate	AL/DO 2509 Kennedy Circle Brooks AFB, TX 78235–5118	Oertli, Ernest H., Col., Director (210) 536–3575; DSN: 240-3575 FAX: (210) 536–2371
Human Resources Directorate	AL/HR-CA 7909 Lindbergh Drive Brooks AFB, TX 78235–5352	Alley, William E., Dr., Chief Scientist (210) 536–3605; DSN: 240–3605; FAX: (210) 536–2902
Environics Directorate	AL/EQ 139 Barnes Drive, Suite 2 Tyndall AFB, FL 32403-5323	Katona, Michael, Dr., Chief Scientist (904) 283–6272; DSN: 523–6272 FAX: (904) 283–6064
Occupational & Environmental Health Directorate	AL/OE 2402 E Drive Brooks AFB, TX 78235–5114	Farrer, Donald N., Dr., Chief Scientist (210) 536–2001; DSN: 240–2001; FAX: (210) 536–2025

(DSN numbers are available only on Department of Defense telephones.)
Due to the recent restructuring of the Air Force laboratories, this preliminary list is subject to change.

Phillips Laboratory	PL/CA 3550 Aberdeen Avenue, SE Kirtland AFB, NM 87117-5776	Janni, Joseph F., Dr., Chief Scientist (505) 846-0861; DSN: 246-0861; FAX: (505) 846-5128
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Geophysics Directorate	PL/CAG 29 Randolph Road Hanscom AFB, MA 01731-3010	Hendl, Richard G., Dr., Chief Scientist (617) 377-3604; DSN: 478-3604; FAX: (617) 377-5688
Lasers & Imaging Directorate	PL/LI 3550 Aberdeen Avenue, SE Kirtland AFB, NM 87117-5776	Hogge, Charles B., Dr., Associate Chief Scientist (505) 846-9428; DSN: 246-9428; FAX: (505) 846-0873
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Space & Missile Technology Directorate	PL/VT 3550 Aberdeen Avenue, SE Kirtland AFB, NM 87117-5776	Wick, Ray, Dr., Associate Chief Scientist (505) 846-2603; DSN: 246-2603; FAX: (505) 844-5589
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