BROAD AGENCY ANNOUNCEMENT

OVERVIEW INFORMATION

The Air Force Office of Scientific Research, hereafter generally referred to as "we, us, our, or AFOSR," manages the basic research investment for the U.S. Air Force. As a part of the Air Force Research Laboratory (AFRL), our technical experts discover, shape, and champion research within the Air Force Research Laboratory, universities, and industry laboratories to ensure the transition of research results to support U.S. Air Force needs. Using a carefully balanced research portfolio, our research managers seek to foster revolutionary scientific breakthroughs enabling the Air Force and U.S. industry to produce world-class, militarily significant, and commercially valuable products.

To accomplish this task, we solicit proposals for basic research through this general Broad Agency Announcement outlining the U.S. Air Force Defense Research Sciences Program. We invite unclassified proposals that do not contain proprietary information for research in many broad areas. We expect to fund only fundamental research. Our research areas of interest are described in detail in section A. Program Description.

We anticipate many awards in the form of grants, cooperative agreements, or contracts. We reserve the right to select and fund for award all, some, part, or none of the proposals received. There is no guarantee of an award. Please review the entire announcement for full details.

SUMMARY FUNDING OPPORTUNITY INFORMATION

1. FEDERAL AWARDING AGENCY NAME

Air Force Office of Scientific Research
875 North Randolph Street, STE 325, Room 3112
Arlington, VA 22203

2. FUNDING OPPORTUNITY TITLE

Research Interests of the Air Force Office of Scientific Research

3. ANNOUNCEMENT TYPE

Amendment 3

4. ANNOUNCEMENT NUMBER

BAA-AFRL-AFOSR-2016-0007

5. CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER

12.800 Air Force Defense Research Sciences Program

6. KEY DATES

This announcement remains open until superseded. We review and evaluate proposals as they are received. You may submit proposals at any time; however, some specific topic instructions may recommend submission by specific dates that align with funding expectations. Funding is limited. We commit the bulk of our funding by the fall of each year.

TABLE OF CONTENTS

A. PROGRAM DESCRIPTION

The Air Force Office of Scientific Research "we, us, our, or AFOSR" manages the basic research investment for the U.S. Air Force. As a part of the Air Force Research Laboratory (AFRL), our technical experts discover, shape, and champion research within the Air Force Research Laboratory, universities, and industry laboratories to ensure the transition of research results to support U.S. Air Force needs. Using a carefully balanced research portfolio, our research managers seek to foster revolutionary scientific breakthroughs enabling the Air Force and U.S. industry to produce world-class, militarily significant, and commercially valuable products.

Our focus is on research areas that offer significant and comprehensive benefits to our national warfighting and peacekeeping capabilities. These areas are organized and managed in two scientific Branches:

- Engineering and Information Sciences (RTA)
- Physical and Biological Sciences (RTB)

The research activities managed within each Branch are summarized below:

1. ENGINEERING AND COMPLEX SYSTEMS (RTA1)

The Engineering and Complex Systems team within the Engineering and Information Science Branch leads the discovery and development of the fundamental and integrated science that advances future air and space flight. The broad goal of the team is to discover and exploit the critical fundamental science and knowledge that will shape the future of aerospace sciences. A key emphasis is the establishment of the foundations necessary to advance the integration or convergence of the scientific disciplines critical to maintaining technological superiority.

A wide range of fundamental research addressing electronics, fluid dynamics, materials, propulsion, and structural mechanics are brought together in an effort to increase performance and achieve unprecedented operational capability. The team carries out its ambitious mission through leadership of an international, highly diverse and multidisciplinary research community to discover, shape, and champion new scientific discoveries that will ensure novel innovations for the future U.S. Air Force.

The central research direction for this team focuses on meeting the basic research challenges related to future air and space flight by leading the discovery and development of fundamental science and engineering in the following research areas.

The Engineering and Complex Systems (AFOSR/RTA1) Program Officers and topics are:

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.1.a.	Dynamic Materials and Interactions	Dr. Martin Schmidt
A.1.b.	GHz-THz Electronics and Materials	Dr. Kenneth C. Goretta
A.1.c.	Energy, Combustion, and Non-Equilibrium Thermodynamics	Dr. Chiping Li

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.1.d.	Unsteady Aerodynamics and Turbulent Flows	Dr. Douglas R. Smith
A.1.e.	High-Speed Aerodynamics	Dr. Ivett A. Leyva
A.1.f.	Low-Density Materials	Dr. Jaimie S. Tiley (acting)
A.1.g.	Multiscale Structural Mechanics and Prognosis	Dr. Jaimie S. Tiley
A.1.h.	Space Propulsion and Power	Dr. Mitat A. Birkan
A.1.i.	Test Science for Test and Evaluation	Dr. Michael J. Kendra

Our research areas of interest are described in detail below:

a. Dynamic Materials and Interactions

Program Description: The objective of the Dynamic Materials and Interactions portfolio is to develop fundamental scientific knowledge of the dynamic chemistry and physics of complex materials, particularly energetic and reactive materials. The portfolio focuses on energetic materials science and dynamics of heterogeneous materials.

Research supported by this portfolio seeks to discover, characterize, and leverage (1) fundamental chemistry, physics, and materials science associated with energetic and reactive materials; and (2) fundamental dynamics, shock physics, and materials science associated with complex, heterogeneous materials. The research will be accomplished through a balanced mixture of experimental, numerical, and theoretical efforts. This is required for revolutionary advancements in future Air Force weapons and propulsion capabilities including increased energy density and survivability in harsh environments. Research areas of interest emphasize the characterization, prediction, and control of critical phenomena which will provide the scientific foundation for game-changing advancements in munitions development and propulsion.

Basic Research Objectives: Research proposals are sought in all aspects of the chemistry and physics of energetic and reactive materials with particular emphasis placed on chemistry-microstructure relationships and the exploitation of fundamental dynamics in heterogeneous materials. Efforts that leverage recent breakthroughs in other scientific disciplines to foster rapid research advancements are also encouraged.
Topics of interest include, but are not limited to, the following:

- Mesoscale experiments, and associated models, to understand initiation in energetic materials;
- Predictive processing-structure-property relationships in energetic materials, including reactive materials by design;
- Detonation physics, particularly the steady state reacting front propagating in energetic materials;
- High strain rate and shock response of polymers, composites, and geologic

materials;

- Ability to tailor dynamic stress waves through microstructure;
- Shock loading and mechanical response of energetic crystals;
- High energy density materials that overcome the CHNO limitations, including scale-up techniques required for gram-scale characterization of materials;
- Modeling of microstructural damage evolution for energetic/reactive and other heterogeneous materials under dynamic loading conditions, as well as diagnostic techniques for damage evaluation;
- Bridging length scales in energetic and other heterogeneous materials.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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b. GHz-THz Electronics and Materials

Program Description: This program seeks scientific breakthroughs in materials, heterostructures, and devices that can lead to game-changing capabilities in RF sensing and amplification, transmit/receive functions, wideband operation, reconfigurability, and novel functionality. The primary frequencies of interest range from GHz to THz.

Basic Research Objectives: The focus of the portfolio is on understanding and exploiting fundamental interactions of electrons and quasiparticles with each other and their host materials in all regions of device operation. Technical challenges include understanding and controlling (1) interactions between particles/quasiparticles and the host lattices, boundaries, and defects, including thermal effects and changes over time that limit lifetime and performance; (2) carrier velocity; (3) dielectric properties and electric field distributions within the dielectrics; and (4) new methods of device operation that do not rely solely on conventional transistors or transport mechanisms such as drift, diffusion, and tunneling. Included are carrier transport and properties in regimes in which transport is not limited by scattering mechanisms. Efficiency, volume, and raw speed matter, but other figures of merit, such as speed or energy of computation, are also of interest. A subarea of interest comprises ultrawide-bandgap materials as enablers for high-power electronics, with focus on the unique properties of these materials and heterostructures as basic building blocks for devices. Research into reconfigurable electronics, including those based on materials that perform multiple electronic, magnetic, and possibly mechanical functions, is another subarea interest. It is expected that in order to fully understand the various new phenomena and device configurations, novel techniques to study and control nanoscale structures, defects, and operations may be required.

Proposers are highly encouraged to contact the Program Officer prior to developing a full proposal, preferably by email, to briefly discuss the current state of the art, how your research would advance it, and the approximate cost for a three (3) to five (5) year

effort.

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c. Energy, Combustion and Non-Equilibrium Thermodynamics

Program Description: This portfolio addresses energy needs for Air Force propulsion systems and their supporting sub-systems. The portfolio emphasizes its three foundational elements: Fundamental, Relevant, and Game-Changing: starting from establishing fundamental understanding and rate-controlling processes, focusing on Air Force interests and relevant conditions, encouraging multi-disciplinary collaborations/interactions and unconventional/innovative thinking, leading to game-changing concepts and predictive capabilities in Air Force relevant regimes.

You are strongly encouraged to submit a pre-proposal less than four pages long by email prior to developing a full proposal. Your pre-proposal should describe the innovative nature of the proposed effort (how to advance the state of art), clearly presenting the underlying approach logic and scientific foundation for your proposed research. Researchers with promising pre-proposals will be encouraged to submit full proposals. Full proposals are evaluated based on their strength in fundamental scientific merits, relevant to Air Force needs and game-changing potential using the section E.1. Criteria.

Basic Research Objectives: Research topics in this portfolio include all aspects of energy conversion relevant to Air Force needs, combustion and otherwise, with the following emphases:

(1) **Turbulent Combustion:** Combustion is the primary energy conversion process in most Air Force propulsion systems such as jet engine, rocket, hypersonic and UAV systems. In those systems, combustion occurs at highly turbulent conditions. The key turbulent combustion attributes are critical in determining operability, performance, size and weight of such systems. However, these combustion attributes are also least understood areas in basic combustion research with rather large model/prediction uncertainties. In this sub-area, proposals will be considered with priority in the following topics:

- Understanding key turbulent combustion attributes: including but not limited to: flame propagation and burning rate, flame structure, dynamics and stability/ instability, flammability, extinction and ignition. Understanding, quantifying and controlling turbulence conditions of the underlying flow are essential. Those conditions should be relevant to Air Force interests, with especial emphases on highly-turbulent, high-pressure, multiphase and trans-/super-critical conditions relevant to future Air Force propulsion systems.
- Based on the first principle consideration and experimental observation/data (physical and numerical), establishing understanding and knowledge foundation and key model assumptions that are consistent to

and representative of the underlying phenomena to be modeled. Based on these foundation and assumptions, developing physics-based predictive turbulence combustion models, with a particular emphasis on understanding and quantifying impacts of combustion and fluid processes at sub-grid scales on those at LES resolvable scales, leading to scientifically developed sub-grid turbulence combustion (LES) models and logically constructed model validation procedures;

- Diagnostics for turbulent combustion: (1) game-changing signal generating processes and spectroscopic approaches for key physical and chemical properties in chemically reacting flows; (2) High-frequency, 3-d (volumetric or scanning 2-d) imaging for transient, turbulent flame and flow structures at required temporal and spatial scales/resolutions. In the both above (1) and (2), there are strong interests in diagnostics at high pressure multiphase and trans-/super-critical conditions relevant to future Air Force propulsion systems;
- Numerical algorithms and methods for (1) Addressing specific needs arising from the turbulent reactive flow simulation due to its complex multi-physics and multi-scale nature and (2) Combined experimental-numerical approaches using simulations directly coupled with experimental data to reduce the simulation uncertainty and to obtain quantitative information which is otherwise not available through experimental measurements alone.

(2) **Combustion Chemistry:** It governs the underlying molecular system changes from high-energy states to lower ones through the combustion process. In this sub-area, research focuses on developing physics-based approaches for identifying rate-controlling reaction pathways and, based on these pathways, building combustion chemistry models of quantifiable and acceptable uncertainty with reasonable size for the turbulent, reactive flow simulations. Emphasized topics are:

- Physics based (experimental, theoretical and computational) approaches to understand the combustion process of complex molecular systems such as real HC fuels, including jet fuels consisting of many molecular components, focusing on identifying, describing and quantifying key stochastic reaction pathways in those complex combustion chemical reaction systems and developing a new generation of accurate and computationally efficient combustion chemistry models based on these key reaction pathways. There are strong interests to understand, describe and establish physics-based modeling foundation for the chemical reaction process and underlying physical and chemical properties within at high-pressure, multiphase and trans-/super-critical conditions relevant to future Air Force propulsion systems;
- Experimental techniques and diagnostics: (1) Ultra-fast (e.g., using ultra-short pulse laser) and other optical approaches for quantitatively observing histories of species, temperature and properties in key parts of the combustion processes such as those in the initial break-up of fuel molecules crucial to identifying key reaction pathways in the jet fuel combustion (2) Other necessary experiments for identifying reaction

pathways and quantifying reaction model parameters. Again, diagnostics applicable to high-pressure conditions are of strong interest

- Quantifying the uncertainty of research approaches in combustion chemistry and resulted models, especially in the following aspects: (1) Uncertainties due to the empiricism and ad hoc features with the purpose of minimizing such empiricism and ad hoc features, (2) Understanding relationship between the model size and model uncertainty and (3) Uncertainties in combustion chemistry experiments;
- Ab initio constrained approaches for optimization and reduction of combustion chemistry models.

(3) **Special Thermodynamics Topics:** Thermodynamics provides insights of energy conversion process and practical systems using energy. It also establishes the framework to analyze the efficiency and operating limit of such process and systems ranging from combustion in aviation engines to information processing in computers. The following topics are of particular interest:

- Theoretical framework of thermodynamics for non-equilibrium physical and chemical processes, especially for ones being applicable to unconventional energy conversion processes that potentially offer higher than normal efficiency and other favorable attributes;
- Non-thermal, reduced-thermal and hybrid energy conversion processes, possibly of non-equilibrium nature, for future propulsion and subsystems.
- Innovative thermal-dynamic cycles, particularly for UAVs;
- Thermodynamics foundation for information processing systems.

(4) New Energy Conversion Concepts and Multi-Functions Energy Conversion Processes: Potential areas include but not limited to:

- Combustion at extreme (short and long) time-scales such as detonation and flameless/ mild combustion;
- Multi-functional energy conversion processes: (1) new innovative/unconventional energy conversion processes serving multiple system needs including but not limited to that of propulsion and supporting subsystems for resource supply, control, sensing, guidance and navigation as well as information processing (2) Approaches and algorithms for minimizing the energy consumption of those sub-systems;
- Multi-functional fuels: (1) Endothermic fuels and systems and (2) Aviation fuels and energy systems with favorable source characteristics;
- Innovative and unconventional approach to study the formation mechanism of large- or extra-large carbon based molecules/compounds/clusters at combustion, thermal or other interesting conditions, relevant to Air Force propulsion, energy and other interests.

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d. Unsteady Aerodynamics and Turbulent Flows

Program Description: The Unsteady Aerodynamics and Turbulent Flows portfolio supports basic research into the dynamics and control of aerodynamic shear flows including the interactions of these flows with rigid and flexible surfaces in motion. The portfolio is interested in aerodynamic flows arising in both internal and external configurations and extending over a wide range of Reynolds numbers. The portfolio emphasizes the characterization, modeling, prediction, and control of flow instabilities, turbulent flows, and aerodynamic interactions. A focus on the understanding of the fundamental flow physics is motivated by an interest in developing physically-based predictive models and innovative control concepts for these flows.

Basic Research Objectives: Research in this portfolio is motivated, in part, by the unique fluid-structure interactions that are found in nature, by vortex and shear layer flows, by the aerodynamic performance of novel configurations, and by enduring questions on transitional and turbulent flows. The portfolio maintains an interest in the dynamic interaction between unsteady fluid motion, linear and nonlinear structural deformations, and aerodynamic control effectors for a wide range of flight regimes.

The portfolio seeks to advance fundamental understanding of complex, time-dependent flow interactions by integrating theoretical, numerical, and experimental approaches: studies integrating these elements to improve understanding are strongly encouraged. Flow control studies are expected to involve an approach based on a fundamental insight into the flow dynamics. In cases where that insight may not exist, studies examining fundamental flow physics with a path to enabling control of the flow may be of interest. Flow control efforts integrating modeling, control theory, and advanced sensor and/or actuator technology for application to a flow of interest are encouraged.

Prior to developing a full proposal, prospective researchers are highly encouraged to contact the Program Officer to briefly discuss the current state-of-the-art in his/her area of interest, how the proposed research would advance it, and the approximate cost for a three (3) year effort. Note that basic research of the variety typically funded by the portfolio may not yet have a clear transition path to an application, but nevertheless should be relevant to U.S. Air Force interests.

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e. High-Speed Aerodynamics

Program Description: The flow field around a high-speed vehicle strongly influences its size, weight, lift, drag and heating loads. Therefore, research in this area is critical to the U.S. Air Force's interest in rapid global and regional response and space operations. This portfolio aims to lay the scientific foundation, through discovery, characterization, prediction and control of critical phenomena, for game-

changing advancements in our understanding of high-speed, high temperature non-equilibrium flows around flying vehicles. External and internal transitional and turbulent wall-bounded flows are critical to the cadre of problems studied. Such understanding is a pre-requisite to making hypersonic flight routine.

Basic Research Objectives: Proposals are encouraged which leverage recent breakthroughs in other scientific disciplines and foster rapid research advancements in high-speed aerodynamics. It is encouraged that proposed efforts contain a balanced combination of experiments, computations and theoretical efforts. Flight experiments may be sought for obtaining data that cannot be obtained in ground facilities or by state-of-the-art computations. For any experiments proposed, explain how they capture the most sensitive variables for the problem being studied and how they can be used for validation of numerical models. For any numerical efforts explain which the hardest variables to accurately predict are and how the results will be validated with relevant measurements.

Innovative research is sought in all aspects of high Mach number (preferably M>5), high temperature, non-equilibrium flows with particular interest in (not in order of priority):

- Shock/Boundary Layer, Shock/Shock, and Shock/Separation interactions and unsteadiness for both external surfaces, and at the inlet and isolators for scramjets
- Turbulence - structure and growth, unsteady flow field characterization, effects of micro/macro particles in free stream, wall roughness, curvature, angle of attack, etc.
- Transition - Initial value and Eigen value approaches for transition prediction, stability analysis for different modes and multimode transition
- Diagnostics - to measure both the shock layer and the free stream disturbances
- Flow-structure interactions at hypervelocity conditions
- Development of physics-based models for air ro-vibrational-dissociation and ro-vibrational-translational processes that can: 1) be incorporated in CFD solvers without incurring orders of magnitude more time to solve a given problem. Experiments to validate the above models are also sought.
- Characterization of fundamental processes occurring between non-equilibrium flows and ablative surfaces
- Characterization of naturally occurring disturbances in the atmosphere at high altitudes
- Energy transfer mechanisms within high enthalpy flows
- Identification and characterization of high L/D shapes
- Flight experiments to realize basic science advancement in any of the above areas might be sought.

Ideas that don't strictly fall into the categories above, but are germane to high speed aerodynamics, are also welcome. You are highly encouraged to contact our Program Officer prior to developing a full proposal, in any sub-area, to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to four (4) year effort.

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f. Low-Density Materials

Program Description: Reducing the weight of aerospace platforms, while improving robustness and reliability, reduces costs and emissions and increases payload capacity and overall performance. The Low-Density Materials portfolio supports transformative, basic research in materials design and processing to enable weight reductions with concurrent enhancements in performance and function. Such materials can transform the design of future U.S. Air Force aerospace and cyber systems for applications, which include airframes, space vehicles, satellites, and a multitude of load-bearing components and systems. Key scientific areas supported by the program include: materials discovery, processing and characterization; nanotechnology; integrated computational material science and engineering; composite and hybrid materials processing; and interface/interphase science.

Among the routes to achieving game-changing improvements in low-density materials currently emphasized within the program are: (1) materials discovery and processing to increase properties and performance of structural materials, e.g., matrix resins, coatings, and reinforcing fibers and nanoparticulates; (2) multiscale modeling of material degradation mechanisms to improve material life prediction capability and minimize overdesign of load-bearing structures; (3) understanding the impact of nanoscale porosity on mechanical properties and engineering of porous composites; and (4) the creation and interfacial understanding of hybrid structures that combine materials of different classes, scales, and properties to provide synergistic and tailorable performance.

Basic Research Objectives: Proposals are sought that advance our understanding of hierarchical or hybrid materials and our ability to design, model, and fabricate multi-material, multiscale, multifunctional material systems with a high degree of precision and efficiency. Fundamental research targeting composites that evince multifunctionality, such as high strength plus efficient electrical and thermal transport properties and/or adaptivity to enable active aerospace structures, is also a keen program interest. Material classes may be polymeric, ceramic, or metallic.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

We are currently searching/hiring a new Program Officer, but there is a temporary custodian until a new PO is selected. Emails sent to the email address below will go to the temporary custodian:

(ACTING) DR. JAIMIE S. TILEY, AFOSR/RTA1
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(703) 588-8316

g. Multiscale Structural Mechanics and Prognosis

Program Description: This fundamental basic research program addresses the U.S. Air Force needs in the following application areas: 1) New and revolutionary flight structures, 2) Multiscale modeling and prognosis and 3) Structural dynamics under non-stationary conditions and extreme environments. Other game-changing and revolutionary structural mechanics problems relevant to the U.S. Air Force are also of interest.

The structural mechanics program encourages fundamental basic research that will generate understanding, models, analytical tools, numerical codes, and predictive methodologies validated by carefully conducted experiments. The program seeks to establish the fundamental understanding required to design and manufacture new aerospace materials and structures and to predict their performance and integrity based on mechanics principles.

Basic Research Objectives: Fundamental basic research issues for new and revolutionary flight structures include: revolutionary structural concepts and unprecedented flight configurations; hybrid structures of dissimilar materials (metallic, composite, ceramic, etc.) with multi-material joints and/or interfaces under dynamic loads, and extreme environments; controlled-flexibility distributed-actuation smart structures. The predictive analysis and durability prognosis of hybrid-material structures that synergistically combine the best attributes of metals, composites, and ceramics, while avoiding their inherit shortcomings are of great interest.

Fundamental basic research issues of interest for multiscale modeling and prognosis include: physics-based models that quantitatively predict the materials performance and durability of metallic and composite flight structures operating at various regimes; modeling and prediction of the structural flaws distribution and service-induced damage on each aircraft and at fleet level; structural analysis that accounts for variability due to materials, processing, fabrication, maintenance actions, changing mission profiles; novel and revolutionary on-board health monitoring and embedded non-destructive evaluation (NDE) concepts.

Fundamental basic research issues for structural dynamics include: control of dynamic response of extremely flexible nonlinear structures; control of unsteady energy flow in nonlinear structures during various flight conditions; nonlinear dynamics and vibration control of thin-wall structures of functionally graded hybrid materials with internal vascular networks under extreme loading conditions.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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h. Space Propulsion and Power

Program Description: Research activities are focused as multi-disciplinary, multi-physics, multi-scale approach to complex problems, and fall into four areas: Coupled Material and Plasma Processes far from Equilibrium, Nanoenergetics, High Pressure Combustion Dynamics, and Energy Storage.

Basic Research Objectives: Research in the first area is to significantly advance the state-of-the-art in our ability to understand the fundamental aspects of a coupled plasma/material system in non-equilibrium states, for a variety of potential applications. The typical conditions of interest are characterized by critical phenomena in small spatial and temporal scales which affect the behavior over a much wider range of scales. Detailed understanding and control of non-equilibrium and multiscale effects have the potential to overcome the limitations of traditional plasma in thermodynamic equilibrium, leading to improved system designs; preventing or leveraging dynamic features such as instabilities, coherent structures, and turbulence; and realizing chemical pathways, structural changes or electromagnetic processes for novel devices with unprecedented level of control. Research in second area is the ability to possess smart, functional nano-energetics for propulsion purposes only. There has been tremendous progress in the synthesis and fabrication of nanosized reactive materials. With significant advances in quantum chemistry and molecular dynamics over the last decade, as well as a broader understanding of the properties of nanomaterials, it may now be feasible to design a priori nanostructured reactive materials to perform a given function and then produce them in the laboratory according to the design, in order to avoid simply reacting in an uncontrolled fashion. Smart nano-energetics may be activated by temperature, pressure, the presence of a particular chemical compound, or external electromagnetic stimuli, such as an electrical field or light. By smart, it may be desirable to initiate a reaction at a particular temperature, to release a particular compound at a particular temperature, to turn on or turn off a reaction, have tailored ignition properties, or to accelerate or slow a reaction with time or location. Research in the third area is to allow the Air Force to capitalize on the higher efficiencies, and increased performance options made possible by taking rocket and other propulsion systems to increasingly extreme pressures. As this necessarily pushes materials and structures to correspondingly extreme limits, it becomes essential to take into consideration the dynamics of combustion processes, because higher pressures lead to increasing coherent dynamic aero thermochemical events that convert thermal energy to thrust in a wider spectrum of time scales. Mathematical and experimental analysis also leads to a "big data" problem. It becomes necessary to combine and dynamically integrate multi-fidelity simulations and experimental probing or monitoring to systematically perform modeling, analytics, stochastic modeling, and dynamic data driven validation for chemical propulsion. Research in fourth area involves to address both as electrochemical and mechanical needs in a single multifunctional unit in which an energy storage unit simultaneously manages mechanical stress. Other concepts that can increase energy density will also be investigated.

All fundamental research ideas relating to space propulsion and power are of interest

to this program in addition to the examples given above, but researchers should also consult the programs in Plasma and Electro-Energetic Physics, Aerospace Materials for Extreme Environments, Theoretical Chemistry and Molecular Dynamics, Mechanics of Multifunctional Materials and Microsystems, Computational Mathematics, and other programs as described in this announcement to find the best match for the research in question. Researchers are highly encouraged to consult: https://community.apan.org/wg/afosr/w/researchareas/7459.space-power- and-propulsion/ for the latest information.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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i. Test Science for Test and Evaluation (T&E)

Program Description: The Test Science for Test and Evaluation (T&E) program supports basic research which will build the foundation for future revolutionary capabilities that address the identified needs of the T&E community. As new technologies emerge, the ability to test new capabilities as they are assimilated into applied R&D is a critical part of the development process. The Test Science for T&E program sponsors basic research in areas that enable such testing and areas that allow the correct and comprehensive interpretation of test results. Fast and effective Test Science and Test Engineering lead to: improved ability to identify problems, understand causes, and recommend solutions; reduced product development time; improved quality; improved performance; better acquisition program decisions; increased acquisition program flexibility; meeting schedule deadlines; reduce test-and-fix cycle costs; reaching or exceeding performance goals; and superior products. The current The Test Science for T&E program encompasses five broadly-defined, overlapping thrust areas: Hypersonics, Aeroelasticity and Aerodynamics, Sensors and Electromagnetics, Information and Data Management and Fusion, and Enabling Materials. The Program is closely aligned with many other AFOSR program interests, but with special emphasis on aspects of basic research that lead to revolutionary advances in areas such as metrology and test science.

Basic Research Objectives: The Test Science for T&E program is closely engaged with technical experts at the Air Force Test Center (AFTC) organizations located at Edwards, Arnold, and Eglin Air Force Bases, who help advise the program on basic research objectives. Basic research in areas that advance the science of testing is broadly defined and spans mathematics as well as most disciplines in engineering and the physical sciences. Areas include:

- Novel measurement techniques, materials, and instruments that enable accurate, rapid, and reliable test data collection of physical, chemical, mechanical, and flow parameters in extreme environments, such as those encountered during transonic flight, hypersonic flight, and the terminal

portion of weapons engagement

- Accurate, fast, robust, integratable models of the aforementioned that reduce requirements to test or help provide greater understanding of test results
- Advanced algorithms and computational techniques that are applicable to new generations of computers, including massively parallel, quantum, and neuromorphic machines
- Advanced algorithms and test techniques that allow rapid and accurate assessment of devices and software to cyber vulnerability
- New processes and devices that increase bandwidth utilization and allow rapid, secure transfer of test data to control facilities during test, with special emphasis on telemetry
- Advanced mathematical techniques that improve design of experiment or facilitate confident comparison of similar but disparate tests
- Advanced models of test equipment and processes that improve test reliability and efficiency
- New or advanced technologies that enable the test process
- Basic research in other T&E technical areas that advances the science of test and contributes to the development of knowledge, skills, and abilities of the established or emerging AF T&E workforce.

You are highly encouraged to contact our Program Officer prior to developing full proposals to briefly discuss program alignment. You should be prepared to explain why your proposed effort should be considered basic research, how it is unique to Test Science, and demonstrate an awareness of the Air Force T&E process. Collaborative efforts with the Air Force Test Center and Air Force Research Laboratory are encouraged, but not required.

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2. INFORMATION AND NETWORKS (RTA2)

The Information and Networks Team within the Engineering and Information Science Branch is organized to support many U.S. Air Force priority areas including autonomy, space situational awareness, and cyber security. The research programs within this team lead the discovery and development of foundational issues in mathematical, information and network oriented sciences. They are organized along three themes: Information, Decision Making, and Networks.

The information theme addresses the critical challenges faced by the U.S. Air Force which lie at the intersection of the ability to collect, mathematically analyze, and disseminate large quantities of information in a time critical fashion with assurances of operation and security.

Closely aligned with the mathematical analysis of information is the need for autonomous decision making. Research in this theme focuses on the discovery of mathematical laws, foundational scientific principles, and new, reliable and robust algorithms, which underlie

intelligent, mixed human-machine decision-making to achieve accurate real-time projection of expertise and knowledge into and out of the battle space.

Information analysis and decision making rarely occur in the context of a single source. The networks theme addresses critical issues involving how the organization and interaction among large collections of information providers and consumers contributes to an understanding of the dynamics of complex information systems.

The Information and Networks (AFOSR/RTA2) Program Officers and topics are:

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.2.a.	Computational Cognition and Machine Intelligence	Dr. James H. Lawton
A.2.b.	Computational Mathematics	Dr. Jean-Luc Cambier
A.2.c.	Dynamics and Control	Dr. Frederick Leve
A.2.d.	Dynamic Data Driven Applications Systems (DDDAS)	Dr. Erik Blasch
A.2.e.	Information Assurance and Cybersecurity	Dr. Tristan N. Nguyen
A.2.f.	Optimization and Discrete Mathematics	Dr. Jean-Luc Cambier (acting)
A.2.g.	Science of Information, Computation, Learning, and Fusion	Dr. Richard D. (Doug) Riecken
A.2.h.	Systems and Software	Dr. James H. Lawton (acting)
A.2.i.	Trust and Influence	Dr. Benjamin A. Knott

Our research areas of interest are described in detail below:

a. Computational Cognition and Machine Intelligence

Program Description: This program supports innovative basic research on the fundamental principles and methodologies needed to enable intelligent machine behavior, particularly in support of mixed-initiative (i.e., human-machine teaming) systems. The overall vision of this program is that future computational systems will achieve high levels of performance, adaptation, flexibility, self-repair, and other forms of intelligent behavior in the complex, uncertain, adversarial, and highly dynamic environments faced by the U.S. Air Force. This program covers the full spectrum of computational and machine intelligence, from cognitively plausible reasoning processes that are responsible for human performance in complex problem-solving and decision-making tasks, to non-cognitive computational models of intelligence necessary to create robust intelligent systems. Robustness in this context is the ability to achieve high performance given at least some or all of the following factors: uncertainty, incompleteness or errors in knowledge; limitations on sensing; real-world complexity and dynamic change; adversarial factors; unexpected events including

system faults; and out-of-scope requirements on system behavior. In the midst of this spectrum are the technologies explicitly needed to seamlessly incorporate intelligent computational systems into mixed human-machine teams. The program is divided into three sub-areas that span the full spectrum of computational and machine intelligence. They are: Computational Cognition, Human-Machine Teaming and Machine Intelligence.

The program encourages cross-disciplinary teams with collaboration including computer scientists, neuroscientists, cognitive scientists, mathematicians, statisticians, operation and management science researchers, information scientists, econometricians and game theoreticians, etc., especially when the research pertains to common issues and when collaboration is likely to generate bidirectional benefits. This program is aggressive, accepts risk, and seeks to be a pathfinder for U.S. Air Force research in this area. Proposals that may lead to breakthroughs or highly disruptive results are especially encouraged.

Basic Research Objectives: The Computational Cognition sub-area supports innovative basic research on high-order cognitive processes that are responsible for good human performance in complex problem solving and decision-making tasks – we only want to model the things people excel at. The sub-area also seeks to support research on building computational systems that derive from and/or integrate cognitive and biological models of human and animal intelligence. The overall objective is to understand and exploit these processes to create computational models that perform as well as or better than the reasoning systems they emulate. This sub-area seeks basic research that pertains to exploiting the capabilities of the mind and brain (human or animal) for creating more intelligent machines, as well as cognitively plausible mechanisms inspired by human (or animal) reasoning. This includes computational models based on human and animal performance in perception, attention, memory, learning, reasoning, and decision making in order to improve machine performance. This sub-area does NOT, however, support statistical approaches to machine learning (e.g., "Deep Learning"), or related variants, as fundamental science in that area is addressed by the Science of Information, Computation, Fusion and Learning program described elsewhere in this BAA.

The Machine Intelligence sub-area supports innovative basic research on fundamental principles and methodologies of computational intelligence necessary to create robust intelligent systems. These methodologies may be cognitively inspired, or non-cognitive in nature, taking full advantage of the strengths embodied in mathematical and computational systems, such as the ability to reason with complex formal logic. This sub-area encourages research enabling the creation of computational systems that embody intelligent behavior based on cognitively inspired or purely mathematical approaches. Proposals that lead to advances in the basic principles of machine intelligence for memory, reasoning, planning, scheduling, and cognitively-inspired learning (i.e., NOT "Deep Learning" or other statistical means), action, and communication are desired insofar as these contribute directly towards robustness as defined above.

The Human-Machine Teaming sub-area is primarily concerned with the machine-side

of mixed human-machine decision-making, which appears at all levels of U.S. Air Force operations and pervades every stage of U.S. Air Force missions. To that end, new theoretical and empirical guidance is needed to prescribe maximally effective mixtures of human and machine decision making in environments that are becoming increasingly complex and demanding as a result of the high uncertainty, complexity, time urgency, and rapidly changing nature of military missions. This sub-area seeks new empirical and theoretical basic research that enables intelligent machines to perform as true "teammates," adapting their behavior to accommodate changes in the environment, as well as augmenting the performance of human teammates when needed. This includes basic science in collaborative human-machine teams to aid the machine-side of inference, analysis, prediction, planning, scheduling, and decision making.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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b. Computational Mathematics

Program Description: This program seeks to develop innovative mathematical methods and fast, reliable and scalable algorithms aimed at making radical advances in computational science and large-scale engineering and design. Research in computational mathematics underpins the fundamental understanding of complex physical phenomena and leads to predictive simulation capabilities that are crucial to the design and control of future U.S. Air Force systems, and their lifetime expectancy. Proposals to this program should focus on fundamental scientific and mathematical innovations, and should have the potential to address some of the most important computational challenges in science and engineering. Additionally, it is desirable to frame the basic research ideas in the context of applications relevant to the U.S. Air Force, which can serve simultaneously to focus the research and to provide avenues for transition of basic research outcomes into practice. Applications of current Air Force interest include, but are not limited to, quantum physics and quantum information systems, plasma dynamics, turbulence (e.g., in fluids, combustion, plasma), lasers and directed energy, aero-thermo-dynamics, information science, data analysis (including machine learning), biophysics, and material and structural sciences.

Basic Research Objectives: Research under this program has traditionally emphasized schemes that address the discretization and numerical solution of complex systems of equations, generally partial differential equations derived from physical models. However, alternative computational approaches are of keen interest, particularly in connection with emerging and multidisciplinary applications. Increased emphasis in this portfolio is placed on approaches that can handle a very

high number of dimensions, uncertainty and stochasticity for non-Markovian processes, far from equilibrium conditions, and/or a wide range of scales (space, time, physical parameters, or complexity). Research areas of particular interest currently include:

- Innovative methods for quantum many-body physics, especially strongly correlated systems and environmental interactions; of special interest are approaches based on concepts derived from high-energy physics, and the exploration of relationships with information processing by neural networks.
- Mathematical methods for complexity reduction of high-dimensional, non-linear and multiscale problems, e.g., via projection-based methods and/or new machine-learning concepts. Such systems may have continuous, discrete or mixed representations, and may reside on graphs with evolving topology.
- Mathematical approaches to the modeling of non-equilibrium statistical processes and turbulent dynamics with multiple physical interactions and large parameter spaces; of special interest are methods which effectively allow bi-directional transfer of information across scales, and can simultaneously reduce the computational burden while preserving the correct physics of interaction, including conservation laws and instability regimes.
- Highly efficient and accurate methods for high-dimensional, nonlinear and stochastic dynamics with constraints. In particular, we are seeking revolutionary approaches to solving Hamilton-Jacobi-Bellman equations, optimal transport problems, and inverse problems for highly complex conditions. Of particular interest are applications in large-scale game theory, self-organized criticality and cascades, and the prediction of rare and extreme events.
- Traditional computational methods involving high-order spatial and temporal algorithms remain of interest, if they have the potential for significant breakthrough and are able to meet the formidable computational challenges associated with current and future engineering problems of interest to the U.S. Air Force.

The list above is not exhaustive and other approaches can be suggested to the Program Officer, who can then determine if a proposal is warranted and of potential interest. All proposed methods must be innovative, have quantifiable measures of fidelity, efficiency and adaptivity, must be based on rigorous analysis and preferably demonstrated on canonical challenge and grand challenge problems.

You are encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-1411

c. Dynamics and Control

Program Description: This program emphasizes the interplay of dynamical systems and control theories with the future aim of developing innovative synergistic strategies for the design and analysis of controlled systems that enable radically enhanced capabilities, including performance and operational efficiency for future U.S. Air Force systems. Proposals should focus on the fundamental science and mathematics first, but should also include possible connectivity to appropriate Air Force applications of the future. These applications currently include information systems, as well as autonomous/semi-autonomous aerial vehicles, munitions, and space vehicles.

The dramatic increase in complexity of Air Force systems provides unique challenges for the Dynamics and Control Program. Meeting these challenges may require interdisciplinary approaches as well as deeper studies within single disciplines.

Lastly, note that the Dynamics and Control Program places special emphasis on mathematically rigorous techniques addressing realistic treatment of applications, complexity management, semi-autonomous systems, and real-time operation in stochastic and adversarial environments.

Basic Research Objectives: Current research interests include: methods of dynamical analysis of complex systems for the purpose of real-time control, control of ensemble and infinite dimensional systems, deterministic time and/or real-time reachability set calculation and verification and validation of hybrid systems, distributed and decentralized decision making and control for coordinated autonomous/semi-autonomous aerospace vehicles considering constraints, uncertain, information rich, dynamically changing, networked environments with time-varying topologies; understanding how to optimally account for humans in the design space; novel schemes that enable challenging multi-agent aerospace tracking in complex, cluttered scenarios; robust and adaptive non-equilibrium (e.g., set-based) control of nonlinear processes where the primary objective is enhanced operability rather than just local stability; new methods for understanding and mitigating the effects of uncertainties in dynamical processes where uncertainty distribution is non-Gaussian; novel theory for control of hybrid systems that can intelligently manage actuator, sensor, and processor communications in a complex, spatially distributed and evolving system of systems; sensor rich, data driven adaptive control; and applying control concepts motivated by studies of biological systems. In general, interest in the control of large complex, multi-scale, hybrid, highly uncertain nonlinear systems is increasing. Further, new mathematics in clear support of dynamics and control is of fundamental importance.

In this regard, some areas of interest include, but are not limited to, hybrid dynamical systems theory, geometric and algebraic methods of dynamics and control, stochastic and adversarial systems, control of cyber physical systems, emerging areas of control theory, graph theoretic control theory over nonlinear dynamics, partial and corrupted information, max-plus and idempotent methods, nonlinear control and estimation, and novel computational techniques specifically aimed at control of systems with large data.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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d. Dynamic Data Driven Applications Systems (DDDAS)

Program Description: The DDDAS concept entails the ability to dynamically incorporate additional data into an executing application, and in reverse, the ability of an application to dynamically steer the measurement (instrumentation and control) components of the application system. DDDAS is a key concept for improving modeling of systems under dynamic conditions, more effective management of instrumentation systems, and is a key concept in architecting and controlling dynamic and heterogeneous resources, including, sensor networks, networks of embedded controllers, and other networked resources. DDDAS transformative advances in computational modeling of applications and in instrumentation and control systems (and in particular those that represent dynamic systems) require multidisciplinary research, and specifically need synergistic and systematic collaborations between applications domain researchers with researchers in mathematics and statistics, researchers computer sciences, and researchers involved in the design/ implementation of measurement and control systems (instruments, and instrumentation methods, and other sensors and embedded controllers).

Basic Research Objectives: Individual and multidisciplinary research, technology development, and cyber Infrastructure software frameworks needed for DDDAS applications and their environments are sought, integrating key science and technology frontiers.

Applications modeling: DDDAS applications and simulations must be able to accept data at execution time and be dynamically steered by such dynamic data inputs. Research advances in application models should describe the application system at different levels of detail and modalities; dynamically invoke appropriate models as needed by the dynamically injected data; and include interfaces of applications to measurements and other data systems. DDDAS will, for example, engender an integration of large scale simulation with traditional controls systems methods, thus provide an impetus of new directions to traditional controls methods.

Advances in Mathematical and Statistical Algorithms: Designed methods include stable and robust convergence properties under perturbations induced by dynamic data inputs; algorithmic stability under dynamic data injection/streaming; multiple scales and model reduction; enhanced asynchronous algorithms with stable communication; and multimodal modeling and uncertainty quantification. Dynamically invoked models require fast methods of uncertainty quantification and uncertainty propagation. Such aspects push to new levels of challenges the traditional computational math approaches.

Application Measurement Systems and Methods: Improvements and innovations in instrumentation platforms require means and methods for collecting data, focusing on relevant measurements, controlling sampling rates, multiplexing multisource information fusion, and determining the architecture of heterogeneous and distributed sensor networks and/or networks of embedded controllers. The advances will create

new instrumentation and control capabilities.

Advances in Systems Software: Architectures are sought that provide runtime support and infrastructures to support the execution of applications whose computatio nal systems resource requirements are dynamically dependent on dynamic data inputs, and include: dynamic selection at runtime of application components embodying algorithms suitable for the kinds of solution approaches depending on the streamed data, the underlying resources, and dynamic workflow driven systems. Efforts are sought for coupling domain specific workflow for interoperation with computationa l software, general execution workflow, and software engineering techniques. The systems software environments required are those that can support execution in dynamically integrated platforms ranging from the high-end to the real-time data acquisition and control - cross-systems integrated. Software infrastructures and other systems software (OS, data-management systems and other middleware) services to address the "real time" coupling of data and computations across a wide area heterogeneous dynamic resources and associated adaptations while ensuring correctness, consistency, and satisfying time and policy constraints. Specific features include the ability to process large volume, high rate data from different sources including sensor systems, archives, other computations, instruments, etc.; interfaces to physical devices (including sensor systems and actuators), and dynamic data management requirements.

Areas of interest to the AF and which can benefit from DDDAS transformat ive advances, include areas driven by the AF Technology Horizons, Energy Horizons, and Global Horizons reports, such as: (a) autonomy (e.g., mission planning, complex adaptive resilient autonomy, collaborative/cooperative control, reasoning and learning); (b) agility (e.g., sensor-based processing, ad-hoc, agile networks, multi-sca le simulation, coupled multi-physics simulations, decision support systems with the accuracy of full scale models); (c) multi-domain coupling (e.g., high-performa nce aircraft health monitoring, space situational awareness, ground operations); and (d) robustness (e.g., materials stresses and degradation; embedded diagnostics, verification and validation for complex adaptive systems, cognitive performance augmentat ion, human-machine interfaces).

DDDAS provides new approaches for combining computational, theoretical, and instrumentation data sets for high interactive testing of multiple physical and engineering hypotheses. Programmatic activities that will be launched under this initiative will support research in individual areas, but mostly in the context of multidisciplinary research across at least two of the four components under Basic Area Objectives above.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-7311

e. Information Assurance and Cybersecurity

Program Description: Securing cyberspace, defending against and preventing cyber-attacks are not new but have become increasingly pressing in the light of technological advancements. Software and protocols are only becoming more complex to meet application demands. More flexible computing environments such as distributed systems need new ways of thinking to ensure secure end-to-end functionalities even though components are only known to be individually secure. The emergence of nanoscale devices and quantum information processing and communication portends new technological challenges for cybersecurity. By the same token, these new technologies potentially offer unparalleled security solutions to the existing or future problems.

Although engineering practices continue to provide short-term and temporary relieves to these pressing needs, new scientific ideas are required to address insecurity and hostility in cyberspace, especially, taking into account of emerging technologies. Many fundamental concepts are still eluding precise formulation and awaiting rigorous responses. The goal of this Basic Research program is to explore novel, promising concepts and methodologies that can establish a firm scientific foundation for cybersecurity and potentially tackle the difficult technical hurdles put forth in the previous paragraph.

Basic Research Objectives: Recent developments and advances in the following research areas of computer science and mathematics are expected to provide valuable insights into various cybersecurity problems: dependent type theory, cryptographic protocols for interactive computation and communication, interactive and automated theorem proving, language-based techniques in software and hardware for formal specification and verification, secure protocols, game theory with strong security content, obfuscation and fully homomorphic encryption, model categories, formalized mathematics. Broadly speaking, cross-fertilization of mathematical formalisms and logical constructs will likely continue to play a central role in the construction and verification of security invariants, and in the study of security models or security principles.

These scientific advances are expected to contribute fresh ideas to a number of fundamental cybersecurity topics: composition of security properties and protocols in distributed interactive systems without the need of trusted third parties; rigorous techniques to enable persistent and secure operations on unsecure or untrusted systems; information flow security and noninterference in dynamic and distributed settings; new security invariants that can readily be computed and interpreted, especially for systems endowed with rich geometric dynamics; rigorous proofs and construction of obfuscation techniques for programs and circuits to enhance security; formal verification and certification of the correctness of complex large-scale mathematical proofs and critical computer systems.

Aside from software and secure protocols, nanoscale material properties and quantum effects should offer added security capabilities for future computing devices that cannot be realized by today's technologies. They potentially enable physical

construction of cryptographic primitives that are traditionally described by algorithms and typically implemented by software. Random Number Generators and Physical Unclonable Functions are simplest examples of such construction. At the same time, securing future unconventional technologies will require the introduction of new security principles and security models that may substantially deviate from the traditional approaches. In fact, various concepts in quantum information science and quantum computation such as quantum resources (entanglement, non-locality, contextuality, etc.) and quantum computational complexity are highly relevant to security of future communication and computing systems in which classical and quantum devices interact.

Research areas of interest to this program include, but are not limited to, the methodologies and topics described above. Highest priority will be given to projects with novel scientific ideas that potentially deliver new DoD/Air Force capabilities.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-7796

f. Optimization and Discrete Mathematics

Program Description: The program goal is the development of mathematical methods for the optimization of large and complex models that will address future decision problems of interest to the U.S. Air Force. Areas of fundamental interest include resource allocation, planning, logistics, engineering design, and scheduling. Increasingly, the decision models will address problems that arise in the design, management and defense of complex networks, in robust decision making, in performance, operational efficiency, and optimal control of dynamical systems, and in artificial intelligence and information technology applications.

Basic Research Objectives: There will be a focus on the development of new nonlinear, integer, and combinatorial optimization algorithms, including those with stochastic components. Techniques designed to handle data that are uncertain, evolving, incomplete, conflicting, or overlapping are particularly important.

As basic research aimed at having the broadest possible impact, the development of new computational methods will include an emphasis on theoretical underpinnings, on rigorous convergence analysis, and on establishing provable bounds for (meta-) heuristics and other approximation methods.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

We are currently searching/hiring a new Program Officer, but there is a temporary custodian until a new PO is selected. Emails sent to the email address below will go to the temporary custodian:

(ACTING) DR. JEAN-LUC CAMBIER, AFOSR/RTA2
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g. Science of Information, Computation, Learning, and Fusion

Program Description: The U.S. Air Force collects vast amounts of data through various modes at various times in order to extract and derive needed "information" from these large and heterogeneous (mixed types) data sets. Some data, such as those collected from magnetometers, register limited information content which is more identifiable at the sensor level but beyond human's sensory reception. Other types of data, such as video cameras or text reports, possess more semantic information that is closer to human cognition and understanding. Nevertheless, these are instances of disparate data which encapsulate different types of "information" pertained to, perhaps, the same event(s) captured by different modalities through sensing and collection.

In order to understand and interpret information contained in various data sources, it is necessary to extract relevant pieces of information from these datasets and to make inferences based on prior knowledge and probabilities. This bottom-up processing direction needs conceptually driven reasoning to integrate or fuse the previously extracted snippets of information by leveraging domain knowledge. Furthermore, the top-down processes can offer causal explanation or causal inference, generate new hypotheses, verify or test hypotheses in light of observed datasets. Between the data-driven and conceptually-driven ends, there may reside different levels of abstraction in which information is partially extracted and aggregated based on the nature of applications.

Basic Research Objectives: With the rationale and guiding principles outlined in the above paragraph, this program seeks fundamental research that potentially leads to scientific advancements in informatics, computation, and learning that can support processing and making sense of complex disparate information sources. After all, information processing can formally and fundamentally be described as computing and reasoning on various knowledge representations. Successes in addressing the research sub-areas stated below would give the U.S. Air Force new capabilities to: (1) shift emphasis from sensing to information awareness; (2) understand the underpinning of autonomy; (3) relieve human's cognitive overload in dealing with the data deluge problem; (4) enhance human-machine interface in information processing.

To accomplish the research objectives, this program focuses on, but is not limited to, new techniques in mathematics, computing science, statistics and logic which have potentials to: (1) cope with various complex disparate data/information types; (2) integrate a diversity of unique reasoning and learning components collaborating simultaneously (e.g., multi-strategy reasoning and learning); (3) bridge correlational with causal discovery; (4) determine solutions or obstructions to local-to-global data-fusion problems; (5) mechanize reasoning/learning and computing in the same computational environment; (6) yield provably efficient procedures to enable or

facilitate data analytics; (7) deal with high-dimensional and massive datasets with provably guaranteed performance.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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h. Systems and Software

Program Description: The AF's mission is to "fly, fight, and win in air, space, and cyberspace." In order to accomplish its mission, the AF invests in Systems & Software, which is the keystone of all advanced technology. The Systems & Software program actively searches for ideas with respect to two submissions: 1) Improving current AF systems, and; 2) Introducing cutting-edge research to expand the field of knowledge. Improving current AF systems is needed; the AF's use of legacy systems is well known, along with the detrimental issues of legacy system use. There are many AF systems which have extremely long life cycles (such as combat system software). In order to ensure that these legacy systems are up-to-date, new systems infrastructures are investigated. Additionally, new areas of Systems & Software are encouraged to ensure that the AF continues to be on the cutting-edge of technology; novel areas include entirely new directions that will have significant impact in the future. Overall examples of areas include operating systems, compilers, virtual memory, multi-core platforms, etc. AFOSR is looking for research that will drastically improve current AF systems and help to develop new S&T for the benefit of the nation.

Basic Research Objectives: As stated above, Systems & Software addresses two issues – both the new and the old: 1) New Technology Research (such as, but not limiting to, multi-core and many-core systems), and; 2) Legacy System Research (concerning existing AF systems such as, but not limiting to, operating systems, software, etc.). Since Systems & Software direction is continually changing, i.e., technology life-span of approximately three years or less, specific subareas are not specifically stated within this announcement; instead, due to the topical nature of the field, the specific area of research is open to the proposer, as long as the research addresses either issue – New Technology Research or Legacy System Research – in Systems & Software. Any new ideas of either of the two issues are welcomed.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

We are currently searching/hiring a new Program Officer, but there is a temporary custodian until a new PO is selected. Emails sent to the email address below will go to the temporary custodian:

(ACTING) DR. JAMES H. LAWTON, AFOSR/RTA2

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i. Trust and Influence

Program Description: The Trust and Influence program is motivated by recent technological advances in the area of unmanned and autonomous systems, and the strategic environment that the U.S. Air Force is expected to face in the future; a significant departure from that which has dominated most of its history. The Air Force is facing a broader range of threats that are less predictable, with many conflicts occurring in failed or failing states that include radical extremists and a wide range of non-state actors. Moreover, the rapid advances and proliferation of advanced autonomous systems are expected to fundamentally change the way the Air Force operates. To address these challenges, the Trust and Influence program invests in the development of the theoretical and empirical foundations of reliance and contemporary influence. Specifically, we are concerned with investigating the mechanisms by which humans establish, maintain, and repair trust in other agents, both human and machine. The science of influence or persuasion will expand our understanding for how we might shape the behaviors, attitudes and beliefs of others. The resulting portfolio directly enhances the Air Force's technology development programs, and will impact policies and operations related to national security. Trust and Influence invests in the discovery of the foundational concepts of effective influence, deterrence, trust-building, trust calibration, and counter-terrorism operations. Multi-disciplinary approaches are encouraged, to include cognitive science, neuroscience, anthropology, sociology, linguistics, economics, computer science and mathematics. Research designs that incorporate laboratory studies, modeling or field research leading to transformative novel theories are also encouraged.

Basic Research Objectives: The basic research interests under this program can be defined broadly by three areas: trust in autonomous systems, cross-cultural trust, and socio-digital influence. In the area of trust in autonomous systems there is particular interest in (1) empirical studies to examine drivers of trust between humans and intelligent, autonomous or robotic agents, (2) laboratory and field studies to examine the impact of socially-designed cues or physical features such as appearance, voice, personality, and other social elements on human trust and system performance, (3) development of trust metrics and other relevant constructs in human-machine teaming with a particular focus on real-time and dynamic assessment, and (4) modeling of human-machine teaming that supports adaptive and continuous improvement of joint performance in complex environments. In the area of cross-cultural trust, there is interest in (1) developing theories of interpersonal and organization trust that account for various cultural constructs and characteristics, (2) revealing the antecedents of trust in cross-cultural interactions, and (3) cultural differences in complex human-machine interaction. In the area of socio-digital influence there is a need for (1) laboratory and field studies to reveal sources of influence and persuasion in social media and across different cultural groups, (2) social, cognitive, and neural mechanisms of influence and persuasion (3) modeling and measuring the relationship

between online and real-world behaviors, (4) empirical studies to discover new theories of influence as it pertains to the cyber domain, and (5) understanding the behavioral effects of influence tactics such as foreign policies or developmental activities.

You are encouraged to contact our Program Officer prior to developing a full proposal to discuss alignment of your ideas with our program goals, your proposed methods, and the scope of your proposed effort.

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3. PHYSICAL SCIENCES (RTB1)

The Physical Sciences Team leads the discovery and transition of foundational physical science to enable air, space, and cyber power. Research in physics generates the fundamental knowledge needed to advance U.S. Air Force operations, from the perspective of sensing, characterizing, and managing the operational environment as well as developing advanced devices that exploit novel physical principles to bring new capabilities to the warfighter. Research directions are categorized in the following four broad areas, with the focus on advancing our basic understanding of the physical world: (1) quantum matter and devices; (2) plasma and high-energy-density physics; (3) optics, photonics, and electromagnetics; and (4) aerospace materials.

The Physical Science (AFOSR/RTB1) Program Officers and topics are:

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.3.a.	Aerospace Materials for Extreme Environments	Dr. Ali Sayir
A.3.b.	Atomic and Molecular Physics	Dr. Grace D. Metcalfe
A.3.c.	Electromagnetics	Dr. Arje Nachman
A.3.d.	Laser and Optical Physics	Dr. Gernot S. Pomrenke (acting)
A.3.e.	Optoelectronics and Photonics	Dr. Gernot S. Pomrenke
A.3.f.	Plasma and Electro-Energetic Physics	Dr. Jason A. Marshall
A.3.g.	Quantum Electronic Solids	Dr. Harold Weinstock
A.3.h.	Quantum Information Sciences	Dr. Grace D. Metcalfe
A.3.i.	Remote Sensing	Dr. Stacie E. Williams
A.3.j.	Space Science	Dr. Julie J. Moses
A.3.k.	Ultrashort Pulse Laser-Matter Interactions	Dr. Riq Parra

Our research areas of interest are described in detail below:

a. Aerospace Materials for Extreme Environments

Program Description: Aerospace Materials for Extreme Environments program aims to provide the fundamental knowledge required to enable revolutionary advances in future U.S. Air Force technologies through the discovery and characterization. Extreme environments are combination of heat-, stress-, magnetic-, electric-, microwave-, and acoustic fields. Materials of interest are ceramics, metals, hybrid systems including inorganic composites that exhibit superior structural, functional and/or multifunctional performance.

Basic Research Objectives: The following research concentrations areas are selected to highlight the philosophy about function, environment and state of the materials that could create disruptive source of transformations.

Computational Materials Science: The aim of this research concentration area is to explore the possibility for the quantification of microstructure through reliable and accurate descriptions of grain and particle shapes, and identifying sample distributions of shape descriptors to generate and predict structures which might revolutionize the design and performance. The quality of computerized representation of microstructures and models will be measured by its (a) geometric accuracy, or faithfulness to the physical landscape, (b) complexity, (c) structure accuracy and controllability (function), and (d) amenability to processing and high level understanding. In order to satisfy these metrics, the approaches may require development of an accurate methodology for the quantification of 3-dimensional shapes in both experimental and theoretical microstructures in heterogeneous systems, and to establish a pathway for an accurate comparison tools (and metric).

Synthesis Science and Response Far from Equilibrium: The transformative breakthrough has not originated from the investigations of materials in equilibrium state but in contrary at the margins of the disciplines. In this context, this program embraces materials and processing science approaches that are far from the thermodynamic equilibrium domain; i.e., materials for quantum sciences, adaptive oxides, multiferroics, frustrated structures (layered structured materials), highly doped polycrystalline laser materials, and other non-equilibrium materials. This area requires understanding of supersaturation of lattice-structure and manipulation of lattice substructure by understanding elastic softening of a lattice containing a critical amount of dopants, which could lead to an order disorder transition with further supersaturation. The intent is to elucidate complex interplay between phase transitions for electronic/magnetic phase separation and untangle the interdependence between structural, electronic, photonic and magnetic effects.

Hypersonic Material: This topic area includes a wide range of activities of hypersonic that require understanding and managing the non-linear response of materials to combined loads (i.e., thermal, acoustic, chemistry, shear or pressure fields) under high energy density non-equilibrium extremities. The ultimate goal is to exploit these phenomena and design future materials, sensors and components for hypersonic environments.

Combined External Fields: This subtopic also stresses a fundamental understanding of external fields and energy through the materials microstructure at a

variety of time scales and in a variety of conditions of extreme fields; i.e., dielectric breakdown at high temperatures. The aim is to link an effective property to relevant local fields weighted with certain correlation functions that statistically exemplify the structure and demonstrate scientific pathway to design new materials with tailorable properties.

Researchers are highly encouraged to contact the Program Manager prior to developing full proposals to briefly discuss the current state-of-the-art, how the proposed effort would advance it, and the approximate yearly cost for a three (3) to five (5) year effort.

DR. ALI SAYIR, AFOSR/RTB1
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(703) 696-7236

b. Atomic and Molecular Physics

Program Description: This program encompasses fundamental experimental and theoretical Atomic and Molecular Physics research that is primarily focused on studies of cold and ultra-cold quantum gases, precision measurement, matter-wave optics, and non-equilibrium quantum dynamics. These research areas support technological advances in application areas of interest to the U.S. Air Force, including precision navigation, timekeeping, remote sensing, metrology, and novel materials for the U.S. Air Force needs in the future.

Basic Research Objectives: AMO (Atomic, Molecular and Optical) physics today offers an unprecedented level of coherent control and manipulation of atoms and molecules and their interactions, allowing for significant scientific advances in the areas of cold and ultracold matter and precision measurement. Specific research topics of interest in this program include, but are not limited to, the following: physics of quantum degenerate atomic and molecular gases; strongly-interacting quantum gases; new quantum phases of matter; non-equilibrium dynamics of cold quantum gases; cold/ultracold plasmas; ultracold chemistry; precision spectroscopy; novel clocks; and high-precision techniques for navigation, guidance, and remote sensing.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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c. Electromagnetics

Program Description: This portfolio supports research in Electromagnetics (EM) whose objective is the interrogation (modeling/simulation) of linear/nonlinear Maxwell's equations together with research in the general area of signal processing.

Basic Research Objectives: Basic research to produce conceptual descriptions of electromagnetic properties of novel materials/composites (such as photonic band gap media, negative index media, Parity-Time symmetry media, etc.) and the simulation of their uses in various operational settings is encouraged. Also of interest is temporal modulation of physical parameters of various components. Such a dynamically induced nonreciprocity can lead to a new generation of compact and energy efficient isolators, circulators, phase shifters, and other non-reciprocal optical and microwave devices. Basic research in inverse scattering theory in order to promulgate new methods which recognize and track targets or upgrade efforts to pursue Nondestructive Evaluation is encouraged. Efforts to identify suitable wideband radar waveforms to penetrate foliage, clouds, buildings, the ionosphere, or other dispersive/random/turbulent media as well as to notionally design transmitters to produce such waveforms are also supported. Research which develops the mathematical underpinning for computational electromagnetic simulation codes (both frequency domain and time domain) that are rapid and whose claims of accuracy are accompanied by rigorous error estimates/controls is encouraged. In the area of nonlinear Maxwell's equations, commonly called nonlinear optics, research pursues descriptions of nonlinear EM phenomena such as the propagation of Ultrashort laser pulses through air, clouds, etc. and any possible exploitation of these pulses is supported. Such mathematical descriptions are anticipated to be a coupled system of nonlinear partial differential equations. Basic research in other nonlinear EM phenomena include the dynamics of the EM field within solid state laser cavities (particularly the modeling/simulation of non-equilibrium carrier dynamics within semiconductor lasers) and fiber lasers, the propagation of light through various nonlinear crystals (including Graphene), as well as other nonlinear optical media. All such modeling/simulation research is complementary to the experimental portfolios within AFOSR. As regards the signal processing component, an outstanding need in the treatment of signals is to develop resilient algorithms for data representation in fewer bits (compression), image reconstruction/enhancement, and spectral/frequency estimation in the presence of external corrupting factors. These factors can involve deliberate interference, noise, ground clutter, and multi-path effects. This component searches for application of sophisticated mathematical methods, including time-frequency analysis and generalizations of the Fourier and wavelet transforms, that deal effectively with the degradation of signaling transmission across a channel. These methods hold promise in the detection and recognition of characteristic transient features, the synthesis of hard-to-intercept communications links, and the achievement of faithful compression and fast reconstruction for video and multi-spectral data. New combinations of asset location and navigation are being sought, based on analysis and high-performance computation that bring a force-multiplier effect to command/control capabilities. Continued upgrade and reliance on Global Positioning System makes it critical to achieve GPS-quality positioning in situations where GPS by itself is not sufficient. Ongoing research in non-Inertial navigation methods (including optical flow and use of signals of opportunity) will bring location precision and reliability to a superlative level.

You are highly encouraged to contact our Program Officer prior to developing a full

proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

DR. ARJE NACHMAN, AFOSR/RTB1
E-mail: electromagnetics@us.af.mil
(703) 696-8427

d. Laser and Optical Physics

Program Description: The program goal is to advance the science of laser devices, laser materials, laser matter interaction, nonlinear optical phenomena and devices, and unique applications of these to solving scientific and technological problems of interest to the Air Force. Novel light sources are also an objective of this program, particularly in regions of the spectrum otherwise not easily accessible. Theoretical, computational, and experimental research is encouraged.

Basic Research Objectives: This U.S. Air Force program seeks innovative approaches and novel concepts that could lead to transformational advances in high peak and average power lasers for future applications related to directed-energy and standoff sensing, while supporting fundamental science in novel lasing processes in solids, liquids, gases, and plasma. Research that enhances the power, energy, and waveform stability of lasers across the wavelength spectrum is especially encouraged. Examples include novel processing techniques for high quality solid-state laser materials with control over spatial distributions of dopants and index of refraction, and processing methods for achieving low loss lasers. New ideas for high average power fiber lasers are of interest, including new materials, and large mode area structures, novel ways of mitigating nonlinear instabilities, and studies of coupling multiple fiber lasers which can withstand very high average power. Of particular interest are new light generating materials systems that are from the thermodynamics equilibrium, such as highly doped polycrystalline materials, and layered semiconducting laser structures. Novel, compact, particularly tunable or wavelength flexible, infrared lasers are of interest for countermeasures and sensing applications, as are compact novel sources of monochromatic x-rays and gamma rays. More broadly, the Laser and Optical Physics program will consider any novel and potentially transformational ideas, and is especially interested in inter-disciplinary research, within the broad confines of its portfolio title. With this in mind, researchers should also consult the programs in Ultrashort Pulse Laser-Matter Interactions, Plasma and Electro-Energetic Physics, and Remote Sensing and Imaging Physics described in this Broad Area Announcement. New concepts for the computational modeling of light and laser devices, including thermal effects, are also of interest. Combined theory, simulation, and experimental efforts designed to verify and validate innovative models are welcome.

Researchers are highly encouraged to contact the Program Officer prior to developing full proposals to briefly discuss the current state-of-the-art, how the proposed effort would advance it, and the approximate yearly cost. Collaborative efforts with the researchers at the Air Force Research Laboratory are encouraged, but not required.

We are currently searching/hiring a new Program Officer, but there is a temporary

custodian until a new PO is selected. Emails sent to the email address below will go to the temporary custodian:

(ACTING) DR. GERNOT S. POMRENKE, AFOSR/RTB1
E-mail: laser.optics@us.af.mil
(703) 696-8426

e. Optoelectronics and Photonics

Program Description: This program supports Air Force requirements for information dominance by increasing capabilities in image and data capture, processing, storage, and transmission for applications in surveillance, communications, computation, target discrimination, and autonomous navigation. Important considerations for this program are the airborne and space environment in which there is a need to record, read, and change digital data at extremely high speeds with low power, low weight, and small sized components. Five major areas of interest include Integrated Photonics (including Silicon Photonics); Nanophotonics (including Plasmonics, Photonic Crystals, Metamaterials, Metaphotonics and Novel Sensing); Reconfigurable Photonics (including all-optical switching and logic, and optoelectronic computing); Nanofabrication, 3-D Assembly, Modeling and Simulation Tools for Photonics; and Quantum Computing using Optical Approaches.

Basic Research Objective: The major objective is to push the frontiers of optics and explore new fundamental concepts in photonics; understand light-matter interactions at the sub-wavelength and nanoscale; investigate novel optoelectronic materials; improve the fundamental understanding of photonic devices, components, and architectures; and enable discovery and innovation in advancing the frontier of nanophotonics with the associated nanoscience and nanotechnology.

The thrusts in Integrated Photonics include investigations in two affiliated areas: (1) the development of optoelectronic devices and supportive materials and processing technology, and (2) the insertion of these components into optoelectronic computational, information processing and imaging systems. Device exploration and architectural development for processors are coordinated; synergistic interaction of these areas is expected, both in structuring architectural designs to reflect advancing device capabilities and in focusing device enhancements according to system needs. Research in optoelectronic or photonic devices and associated optical material emphasizes the insertion of optical technologies into computing, image-processing, and signal-processing systems. To this end, this program continues to foster interconnection capabilities, combining arrays of sources or modulators with arrays of detectors, with both being coupled to local electronic or potentially optical processors. Understanding the fundamental limits of the interaction of light with matter is important for achieving these device characteristics. Semiconductor materials, insulators, metals and associated electromagnetic materials and structures are the basis for the photonic device technologies. Numerous device technology approaches (such as silicon photonics, tin based Group IV photonics, Graphene and related 2D materials and novel III-V optoelectronics) are part of the program as are

techniques for optoelectronic integration.

The program is interested in the design, growth and fabrication of nanostructures that can serve as building blocks for nano-optical systems. The research goals include integration of nanocavity lasers, filters, waveguides, detectors and diffractive optics, which can form nanofabricated photonic integrated circuits. Specific areas of current interest include nanophotonics, use of nanotechnology in photonics, exploring light at the nanoscale, nonlinear nanophotonics, plasmonics and excitonics, sub-wavelength components, photonic crystal and negative index materials, optical logic, optical signal processing, reconfigurable nanophotonics, nanophotonics enhanced detectors, chip scale optical networks, integrated nanophotonics and silicon-based photonics. Coupled somewhat to these areas are optoelectronic solutions to enable practical quantum computing schemes, quantum plasmonics and quantum Metamaterials, plus novel approaches to ultra-low power optoelectronic devices.

To support next generation processor architectures, image processing and capture and new multi-media application software, computer data buffering and storage research is needed. As devices are being developed that emit, modulate, transmit, filter, switch, and detect multi-spectral signals, for both parallel interconnects and quasi-serial transmission, it is important to develop the capability to buffer, store, and retrieve data at the rates and in the quantity anticipated by these devices. Architectural problems are also of interest that include, but are not limited to, optical access and storage in memory devices to obviate capacity, access latency, and input/output bandwidth concerns. Of interest has been the ability to slow, store, and process light pulses. Materials with such capabilities could be used for tunable optical delay lines, optical buffers, high extinction optical switches, novel image processing hardware, and highly efficient wavelength converters.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-8426

f. Plasma and Electro-Energetic Physics

Program Description: The objective of this program is to understand and control the interaction of electromagnetic energy and charged particles to produce useful work in a variety of arenas, including directed energy weapons, sensors and radar, electronic warfare, communications, and novel compact accelerators. While the focus of this effort is the generation and collective interaction of electromagnetic fields and plasmas, advances in the enabling technology of compact pulsed power, including innovative dielectric and magnetic materials for high-density energy storage, switching devices, and non-linear transmission lines are also of fundamental interest. This portfolio will also consider research increasing the scientific understanding required to predict heat transfer across a broad range of temporal and spatial scales, both in plasmas, in the connection of plasma to energy supplying electrodes, and in

advanced materials facing the extreme environments associated with energy dense materials.

Basic Research Objectives: Ideas for advancing the state-of-the-art in the following areas are strongly encouraged: ultra-cold and other strongly coupled plasmas, including novel approaches to study the physics of complex and/or dusty ionospheric plasmas, and those that address open questions of how plasmas involving potential states such as plasma "liquids," "glasses," and "crystals," come to equilibrium and partition their energy between various thermodynamic states, laser plasma/matter interaction, and particle-field interaction physics. Also of primary interest are highly efficient electron-beam-driven sources of high-frequency microwave, millimeter-wave, and sub-millimeter coherent radiation (high power microwaves [HPM] and/or vacuum electronics), high-power amplifiers, novel dispersion engineering via metamaterials and photonic band gap structures, novel sources of relativistic particle beams, compact pulsed power, and power efficient methods to generate and maintain significant free-electron densities in ambient air. New concepts for the theory, modeling, and simulation of these physical phenomena are of interest, and combined experimental/theoretical/simulation efforts that verify and validate innovative models are highly encouraged. Researchers should also consult the program in Aerospace Materials for Extreme Environments as described in this announcement to find the best match for research concerning thermal physics and other areas of potential overlap. Ideas relating to plasmas and electro-energetic physics in space are of interest to this program, but researchers should also consult the programs in Space Power and Propulsion and in Space Sciences as described in this announcement to find the best match for the research in question. Additionally, laser plasma/matter interaction, while of interest to this portfolio, is generally limited to the non-equilibrium physics of plasmas; other concepts related to laser-matter interactions should consult the Ultrashort Pulse Laser-Matter Interactions or Laser and Optical Physics programs as described in this announcement. Innovative science that combines plasma and electro-energetic physics with the high-energy density associated with nuclear forces (e.g., nuclear batteries where radiation produces currents in semiconductors and propulsion plasmas sustained via fusion), while not a primary focus of the portfolio, may be considered. Nuclear fission or fusion for large-scale energy production is not of prime interest to this portfolio.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

Collaborative efforts with researchers at the Air Force Research Laboratory are encouraged when appropriate, but are not required.

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g. Quantum Electronic Solids

Program Description: This program focuses on materials that exhibit cooperative quantum electronic behavior. The primary emphasis is on superconductors, meta-materials, and on nanoscopic electronic components and devices based upon 2D materials such as graphene, transition metal dichalcogenides (TMDs) and other forms of these materials with low power dissipation and the ability to provide denser non-volatile memory, logic and/or sensing elements that have the potential to impact future U.S. Air Force electronic systems.

Basic Research Objectives: The superconductivity portion of this program is mainly devoted to a search for new classes of superconducting materials that either have higher transition temperatures, higher critical magnetic fields or have isotropic superconducting properties at temperatures in the range of the transition temperatures of the cuprates, e.g., YBCO. While the 2008 discovery of iron-pnictide superconductors has provided new insights, these materials are not sufficiently promising. This emphasis is part of a coordinated activity that is multidisciplinary in nature, and proposals that address both the physics and chemistry of potential new types of superconductors are welcome. This program is primarily an experimental one, but theorists who interact with experimental groups constructively are welcome. The primary goal of this part of the program is to uncover superconducting materials that can be made into forms that are amenable to U.S. Air Force applications.

The metamaterials portion of this program is devoted to the production of meta-materials that operate over a wide swath of the electromagnetic spectrum, from microwaves, to IR and the visible. The long-term goal is to produce materials that improve the efficiency and selectivity of, and reduce the size of communications system components such as antennas, filters and lenses. Another important aspect is to study the ability to create sub-wavelength, near-field (and possibly far-field) imaging. These desired properties could lead to denser information storage and retrieval.

A relatively new area of interest involves thin-film, oxide-based materials that are critical for the development of devices with new functionalities that will lead to useful, reprogrammable, controllable and active systems at the nanoscale with properties difficult to attain by other means. The utilization of oxides for revolutionary technologies critically relies on acquiring fundamental understanding of the physical processes that underlie spin, charge and energy flow in these nanostructured materials. The oxides to be considered are generally complex, multi-element materials that can be synthesized in unusual nanostructured geometries that exhibit strong electronic correlations.

A relatively minor part of this program is the inclusion of nanoscopic techniques to fabricate, characterize and manipulate atomic, molecular and nanometer-scale structures (including graphene and TMDs), with the aim of producing a new generation of improved communications components, sensors and non-volatile, ultra-dense memory, resulting in the ultimate miniaturization of analog and digital circuitry. This aspect of the program includes the use of polarized electrons to produce nuclear magnetic polarization as a basis for dense, non-volatile memory, with possible application to quantum computing at room temperature.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

DR. HAROLD WEINSTOCK, AFOSR/RTB1
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(703) 696-8572

h. Quantum Information Sciences

Program Description: This program encompasses fundamental experimental and theoretical research in the field of Quantum Information Science (QIS). The primary focus is on understanding, controlling, and exploiting non-classical phenomena for developing novel capabilities for the Air Force beyond those possible with classical systems in the areas including, but not limited to, quantum networks, and complex materials.

Basic Research Objectives: Quantum mechanics provides the opportunity to utilize non-classical physical resources to develop beyond-classical capabilities in imaging, sensing and precision measurements, ultra-secure transmittal of information, or simulation and discovery of complex materials. Specific research topics of interest in this program include, but are not limited to, the following: quantum communication; quantum simulation; open quantum systems and dissipative engineering; and fundamental studies in support of this research area, such as fundamental investigations of creation and manipulation of entanglement and squeezing, quantum control techniques, and coherent state transfer between different types of qubits.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-9740

i. Remote Sensing

Program Description: This program addresses fundamental research in remote sensing with applications to space situational awareness and combat identification. This includes, but is not limited to, theoretical and experimental approaches to expand the basic physical understanding in propagation of electromagnetic radiation, the interaction of radiation with matter, image formation, smart sensor tasking, data fusion, remote target detection and identification, and the effect of the atmosphere or space environment on sensing systems. Proposals are sought in all areas of ground, air, and space-based remote sensing with applications to tracking, detecting, and characterizing. Technological advances are driving the requirement for innovative methods to detect, identify, and predict trajectories of smaller and/or more distant objects in space at further standoff distances and under both day and night conditions. New optical capabilities to include active approaches that complement the current state of the art, as well as increased resolution and sensitivity, are of particular

interest.

Basic Research Objectives: Research goals include, but are not limited to:

- Theoretical foundations of remote sensing, both active and passive
- Enhancement of remote sensing capabilities, including novel solutions to system limitations such as limited aperture size, time of day, imperfections in the optics, and irregularities in the optical path
- Novel tracking and image processing algorithms
- Propagation of coherent and incoherent electromagnetic radiation through a turbulent atmosphere
- Innovative methods of remote target location, characterization, and tracking, as well as non-imaging methods of target identification
- Understanding and predicting dynamics of space objects as it relates to space object identification and space situational awareness
- Rigorous theory and models to describe the spectral, thermal and polarimetric signature from targets of interest using basic material physical properties with the goal of providing better understanding of the physics of the reflection and/or emission from objects in space and the instrumentation requirements for next generation space surveillance systems
- Remote sensing signatures and backgrounds of both ground-based and space-based observations
- The interaction of U.S. Air Force imaging systems and sensors with the space atmosphere environment. This includes the understanding of conditions that affect target identification, such as environmental changes and surface aging or weathering
- Theoretical and mathematical aspects of remote sensing may also align with the Electromagnetics portfolio. Please address questions on the Electromagnetics portfolio to Dr. Arje Nachman.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) effort. Collaborative efforts with the researchers at the Air Force Research Laboratory are encouraged, but not required

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(703) 588-8213

j. Space Science

Program Description: The AFOSR Space Science program supports basic research on the solar-terrestrial environment extending from the Sun through Earth's magnetosphere and radiation belts to the mesosphere and lower thermosphere region. This geospace system is subject to solar radiation, particles, and eruptive events, variable interplanetary magnetic fields, and cosmic rays. Perturbations to the system can disrupt the detection and tracking of aircraft, missiles, satellites, and other targets; distort communications and navigation signals; interfere with global command,

control, and surveillance operations; and negatively impact the performance and longevity of U.S. Air Force space assets.

Fundamental research focused on improving understanding of the physical processes in the geospace environment is encouraged. Particular goals are to improve operational forecasting and specification of solar activity, thermospheric neutral densities, and ionospheric irregularities and scintillations. Activities that support these goals may include validating, enhancing, or extending solar, ionospheric, or thermospheric models; investigating or applying data assimilation techniques; and developing or extending statistical or empirical models. An important aspect of the physics is understanding and represents the coupling between regions, such as between the solar corona and solar wind, between the magnetosphere and ionosphere, between the lower atmosphere and the thermosphere/ionosphere, and between the equatorial, middle latitude, and Polar Regions.

Basic Research Objectives: Research goals include, but are not limited to:

- The structure and dynamics of the solar interior and its role in driving solar eruptive activity;
- The mechanism(s) heating the solar corona and accelerating it outward as the solar wind;
- The triggers of coronal mass ejections (CMEs), solar energetic particles (SEPs), and solar flares;
- The coupling between the solar wind, the magnetosphere, and the ionosphere;
- The origin and energization of magnetospheric plasma;
- The triggering and temporal evolution of geomagnetic storms;
- The variations in solar radiation received at Earth and its effects on satellite drag;
- The impacts of geomagnetic disturbances on the thermosphere and ionosphere;
- Electron density structures and ionospheric scintillations;
- Ionospheric plasma turbulence and dynamics;
- The effects of neutral winds, atmospheric tides, and planetary and gravity waves on the neutral atmosphere densities and on the ionosphere;

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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k. Ultrashort Pulse Laser-Matter Interactions

Program Description: The Ultrashort Pulse Laser-Matter Interactions program is focused on the most fundamental process in nature, the interaction of light with the

basic constituents of matter. The objective of the program is to explore and understand the broad range of physical phenomena accessible via the interaction of ultrashort pulse (USP) laser sources with matter in order to further capabilities of interest to the U.S. Air Force, including directed energy, remote sensing, communications, diagnostics, and materials processing. The portfolio explores research opportunities accessible by means of the three key distinctive features of USP laser pulses: high peak power, large spectral bandwidth and ultrashort temporal duration.

Basic Research Objectives: The Ultrashort Pulse Laser-Matter Interactions program seeks innovative science concepts in the research focus areas of high-field laser physics, frequency combs and attosecond science described below:

High-field laser physics: Over the last two decades, progress in laser pulse amplification techniques has resulted in a six order of magnitude increase in achieved focused intensities. The interaction of such intense radiation with matter results in rapid electron ionization and a rich assortment of subsequent interaction physics. Topics of interest in this area include, but are not limited to, techniques for ultrafast-laser processing (e.g., machining, patterning), mechanisms to control dynamics of femtosecond laser propagation in transparent media (e.g., filamentation), concepts for monochromatic, tunable laser-based sources of secondary photons (e.g., extreme ultraviolet, terahertz, x-rays) and particle beams (e.g., electrons, protons, neutrons), laser-based compact particle accelerators and concepts for high peak power laser architectures and technology that efficiently scale up to high repetition rates and/or new wavelengths of operation.

Optical frequency combs: The large coherent spectral bandwidths intrinsic to USP lasers make them especially suitable for applications requiring high temporal and spectral precision such as telecommunications, optical clocks, time and frequency transfer, precision spectroscopy and arbitrary waveform generation. Research topics in this thrust area include, but are not limited to, dispersion management techniques to increase the spectral coverage to exceed an octave while maintaining high powers per comb, new concepts to extend frequency combs from the extreme ultraviolet into the mid-wave and long-wave infrared spectral regimes, development of novel resonator designs (e.g., micro-resonator based) and ultra-broadband pulse shaping.

Attosecond science: The development of intense light pulses with attosecond durations has resulted in stroboscopic probes with the unprecedented ability to observe atomic-scale electron dynamics with attosecond temporal resolution. This highly exploratory thrust of the program is interested in developing research aimed at resolving attosecond electron dynamics in complex systems of interest to DOD (i.e., such as solid-state semiconductor, magnetic, and plasmonic systems). If successful, such understanding would have a broad and direct impact on future materials research, moving us closer to designing materials with carefully engineered electronic properties. Topics of interest in this area include, but are not limited to, new concepts

for improved attosecond sources (e.g., increased efficiency, higher flux, shorter pulses, and higher photon energy), development of pump-probe methods that investigate interactions with systems ranging from isolated atoms / molecules to condensed matter, attosecond pulse propagation, novel concepts for attosecond experiments and fundamental interpretations of attosecond measurements.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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4. CHEMISTRY AND BIOLOGICAL SCIENCES (RTB2)

The Chemistry and Biological Sciences Team is responsible for research activities in chemistry and biological sciences. A wide range of fundamental chemistry, biology, mechanics, and biophysics research is supported to provide the Air Force with novel options to increase performance and operational flexibility. Research carried out within this team will help usher in revolutionary new technologies that will fundamentally change the way future Air Force weapon systems are designed and implemented.

This research effort will endeavor to identify chemical and biological mechanisms, structures, and systems with the potential to inspire future technology in all Air Force systems. Understanding these mechanisms, structures and systems at a fundamental level will accelerate advances in energy technology, control of complex systems, sensors and sensory systems, and materials engineering.

The focus is on complex materials, microsystems and structures and well as systems of a biological natural by incorporating hierarchical design of mechanical and functional properties from the nanoscale through the mesoscale, ultimately leading to controlled well-understood chemistry/biochemistry, and material or structural behavior capable of dynamic functionality and/or performance characteristics to enhance mission versatility. In addition to research into underlying materials/biomaterials and fundamental physical/biophysical processes, this area considers how they might be integrated into new classes of devices and pursues a fundamental understanding of materials that are not amenable to conventional computational means.

Finally, the energy extraction and storage efforts addresses the characterization, synthesis, and utilization of fundamental energy sources, ranging from novel molecular configurations to photoelectric stimulated mitochondria and solid rocket motor propellants infused with performance improving nano-energetic particles.

The Chemistry and Biological Sciences (AFOSR/RTB2) Program Officers and topics are:

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.4.a.	Biophysics	Dr. Sofi Bin-Salamon
A.4.b.	Human Performance and Biosystems	Dr. Patrick O. Bradshaw
A.4.c.	Mechanics of Multifunctional Materials and Microsystems	Dr. Byung-Lip (Les) Lee
A.4.d.	Molecular Dynamics and Theoretical Chemistry	Dr. Michael R. Berman
A.4.e.	Natural Materials, Systems, and Extremophiles	Dr. Sofi Bin-Salamon (acting)
A.4.f.	Organic Materials Chemistry	Dr. Kenneth C. Caster

Our research areas of interest are described in detail below:

a. Biophysics

Program Description: This program encompasses fundamental experimental and theoretical Biophysics research that is primarily focused on studies of bio-molecular and atomic imaging below the diffraction limit, bioelectricity, electromagnetic stimulation, and quantum biology. We are concerned then, with the study of physical biology with the aim of answering fundamental and basic physics questions through the application of the principles and methods of physical sciences to achieve novel and innovative solutions in biology and physics. The relatively recent emergence of biophysics as a scientific discipline may be attributed to the spectacular success of biophysical tools born out of physics that have allowed us to unravel the complex atomic/molecular structures found in DNA and RNA. More recently areas of interest in Biophysics include, but are not limited to bio-molecular imaging while preserving structure and functionality, optogenetics, electromagnetic bioeffects and quantum biology. These research areas are selected for their potential to support technological advances in application areas of interest to the United States Air Force including biologically inspired new innovative and novel materials, autonomy, human performance, Directed Energy, and enhanced computational development for future Air Force needs.

Basic Research Objectives: This is a multidiscipline collaborative basic research effort that meets scientifically meritorious rigor in the area of Biophysics. We seek to directly or indirectly support the efforts of the Air Force Research Laboratories ongoing in house research in Biophysics and Human Performance. We seek to explore new areas in applied mathematics, physics, optics and biology by working in the sub-areas of bio-molecular imaging, optogenetics, electromagnetic bioeffects, and quantum biology.

As examples, the new emerging technology area of optogenetics is beginning to

enable precise excitation modulation of distinct atoms and molecules associated with living material to track activity of molecular processes; for controlling cellular signaling processes. Functional projections of intracellular signal pathways at the atomic/molecular level within mammalian cells, with high temporal accuracy and reversible neuromodulation are of fundamental interest in this portfolio. Electromagnetic bioeffects associated with Directed Energy Weapons remains at the forefront of Air Force science and technology interest associated with emerging new technologies, development, and deployment. The interest here is to understand fundamental atomic/molecular mechanisms associated with electromagnetic perturbation that occur below damage thresholds and may give insight into new novel means of human performance enhancement, biological control, and man machine interface. Recent work has found that rapid change in temperature from the IR laser stimulation reversibly alters the electrical capacitance of the plasma membranes of a cell and depolarization of the membrane can results in real measurable action potentials. This capacitance is established by the spatial distributions of ions near the plasma membrane surface and underlies the mechanism responsible for the voltage waves in the Soliton theory of action potentials. Finally, this program coordinates multi-disciplinary experimental research with mathematical, neuromorphic, and computational modeling to develop the basic scientific foundation to understand and emulate sensory information systems in natural acoustic, visual, and sensorimotor systems.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

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(703) 696-8411

b. Human Performance and Biosystems

Program Description: The U.S. Air Force is currently interested in improving human capabilities through the development of advanced human-machine interfaces and the establishment of direct methods used to augment human performance. The primary goal for this program is to gain a better understanding of the biophysical, biochemical, and physiological mechanisms responsible for the behavioral, genetic, cellular, tissue and systems changes resulting from various forms of perturbation. Additionally, a sensory systems focus has been added to this program and the emphasis is on developing the basic scientific foundation to understand and emulate sensory information systems. Emphasis is on (a) acoustic information analysis, especially in relation to human auditory perception, and (b) sensory and sensorimotor systems that enable 3-D airborne navigation and control of natural flight, e.g., in insects or bats, especially in relation to capabilities of autonomous biological systems not yet emulated in engineered flight.

Basic Research Objectives: This program is interested in defining the mechanisms (biological, cognitive, genetic, neural, physiological, etc.) associated with enhancing

human capabilities as well as understanding the associated biomarkers, bio-circuits, bioelectric and connection pathways involved with increasing performance capabilities especially as they relate to aircrew member performance. In addition, this program aims to explore natural and synthetic processes, mechanisms and/or pathways for understanding energy production in Biosystems. We are also interested in understanding the variables of fatigue and toxicology as they relate to performance decrement in the aviation environment, i.e., exploring the bio-circuitry, biochemical and molecular pathways and processes that generate signals associated with fatigue or performance changes. We wish to define and understand the biomarkers and genetic changes associated with human performance after the administration of toxicological agents, specific interest in toxicology mechanisms that may or may not exhibit toxic effects at a minimal dose level and toxicological effects of flight line equipment. Proposals aimed at understanding synthetic biological processes as they relate to energy production in Biosystems will be accepted. We have a specific interest in understanding organelles, cells, tissues or systems perturbed with Acoustic, Photo, Electric or Magnetic energy.

For the sensory systems portion of the portfolio a goal is to pursue new capabilities in acoustic analysis, to enhance the intelligibility and usefulness of acoustic information. The primary approach is to discover, develop, and test principles derived from an advanced understanding of cortical and sub-cortical processes in the auditory brain. Included are efforts to model and control effects of noise interference and reverberation, understand the psychoacoustic basis of informational masking, develop new methods for automatic speech detection, classification, and identification, and enable efficient 3-D spatial segregation of multiple overlapping acoustic sources. Signal analysis methods based upon purely statistical or other conventional "blind source" approaches are not as likely to receive support as approaches based upon auditory system concepts that emphasize higher-level neural processes not yet fully exploited in engineered algorithms for acoustic information processing. Applicants are encouraged to develop collaborative relationships with scientists in the Air Force Research Laboratory (AFRL).

Another program goal is to deepen the scientific understanding of the sensory and sensorimotor processes that enable agile maneuvering and successful spatial navigation in natural flying organisms. Emphasis is on the discovery of fundamental mechanisms that could be emulated for the control of small, automated air vehicles, yet have no current analogue in engineered systems. Recent efforts have included investigations of information processing in wide field-of-view compound eye optics, receptor systems for linear and circular polarization sensing, and mathematical modeling of invertebrate sensorimotor control of path selection, obstacle avoidance

and intercept/avoidance of moving targets. All of these areas link fundamental experimental science with neuromorphic or other mathematical implementations to generate and test hypotheses. Current efforts also include innovations in control science to explain and emulate complex behaviors, such as aerial foraging and swarm cohesion, as possible outcomes of simpler sensory-dominated behaviors with minimal cognitive support.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

DR. PATRICK O. BRADSHAW, AFOSR/RTB2
E-mail: biosystems@us.af.mil
(703) 588-8492

c. Mechanics of Multifunctional Materials and Microsystems

Program Description: The main goals of this program are (a) to promote the utilization of newly emerging materials, nano-devices and microsystems in multifunctional design of advanced structures for higher system efficiency, (b) to bridge the gap between the viewpoints from materials science on one side and structural engineering on the other in forming a scientific basis for the materials development and integration criteria, and thereby (c) to establish safer, more maneuverable aerospace vehicles and platforms with unprecedented performance characteristics.

Basic Research Objectives: Specifically, the program seeks to establish the fundamental understanding required to design and manufacture new aerospace materials, nano-devices and microsystems for multifunctional structures and to predict their performance and integrity based on mechanics principles. The multifuctionality implies coupling between structural performance and other as-needed functionalities (such as electrical, magnetic, optical, thermal, chemical, biological, and so forth) to deliver dramatic improvements in system-level efficiency. Structural performance includes the ability to carry the load, durability, reliability, survivability and maintainability in response to the changes in surrounding environments or operating conditions.

Among various visionary contexts for developing multifuctionality, the concepts of particular interest are: (a) “autonomic” structures which can sense, diagnose and respond for adjustment with minimum external intervention, (b) “adaptive” structures allowing reconfiguration or readjustment of functionality, shape and mechanical properties on demand, and (c) structural integration of power harvesting / storage / transmission capabilities for “self-sustaining” system. This program thus focuses on the development of new design criteria involving mechanics, physics, chemistry, biology, and information science to model and characterize the integration and performance of multifunctional materials and microsystems at multiple scales from atoms to continuum.

Projected U.S. Air Force applications require material systems and devices which often consist of dissimilar constituents with different functionalities. Interaction with Air Force Research Laboratory researchers is encouraged to maintain relevance and enhance technology transition.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

DR. BYUNG-LIP (LES) LEE, AFOSR/RTB2
E-mail: mmmm@us.af.mil
(703) 696-8483

d. Molecular Dynamics and Theoretical Chemistry

Molecular Dynamics

Program Description: This program seeks a molecular-level description of reaction mechanisms and energy transfer processes related to the efficient storage and utilization of energy. The program supports cutting-edge experimental and joint theory-experiment studies that address key, fundamental questions in these areas. There are four major focus areas in the program: Catalytic Reactivity and Mechanisms; Novel Energetic Material Concepts; Dynamics of Energy Transfer and Transport; and Chemistry in Extreme Environments.

Basic Research Objectives: The molecular dynamics program seeks to understand, predict, and control the reactivity and flow of energy in molecules in many areas of interest to the U.S. Air Force. Thus, the program encourages novel and fundamental studies aimed at developing basic understanding and predictive capabilities for chemical reactivity, bonding, and energy transfer processes. Some of the program's current interests focus on molecular clusters and nanoscale systems in catalysis, and as building blocks for creating novel materials. Understanding the catalytic mechanisms needed to produce storable fuels from sustainable inputs and to improve propulsion processes are also topics of interest, as are novel properties and dynamics of ionic liquids. Work in this program addresses areas in which control of chemical reactivity and energy flow at a detailed molecular level is of importance. These areas include hyperthermal and ion-chemistry in the upper atmosphere and space environment, plasma-surface interactions, the identification of novel energetic materials for propulsion systems, and the discovery of new high-energy laser systems. The coupling of chemistry and fluid dynamics in high-speed reactive flows, and in particular, dynamics at gas-surface interfaces, is also of interest. The program is also interested in utilizing plasmonics, and laser excitation to control reactivity.

Theoretical Chemistry

Program Description: The theoretical chemistry program supports research to develop new methods that can be utilized as predictive tools for designing new materials and improving processes important to the U.S. Air Force. These new methods can be applied to areas such as the structure and stability of molecular systems that can be used as advanced propellants; molecular reaction dynamics; and the structure and properties of nanostructures and interfaces. We seek new theoretical and computational tools to identify novel energetic molecules or catalysts for their formation, investigate the interactions that control or limit the stability of these systems, and help guide synthesis by identifying the most promising synthetic reaction pathways and predicting the effects of condensed media on synthesis.

Basic Research Objectives: The program seeks new methods in quantum chemistry to improve electronic structure calculations to efficiently treat increasing larger systems with chemical accuracy. These calculations will be used, for example, to guide the development of new catalysts and materials of interest. New approaches to treating solvation and condensed phase effects will also be considered. New methods are sought to model reactivity and energy transfer in molecular systems. Particular interests in reaction dynamics include developing methods to seamlessly link electronic structure calculations with reaction dynamics, understanding the mechanism of catalytic processes and proton-coupled electron transfer related to storage and utilization of energy, and using theory to describe and predict the details of ion-molecule reactions and electron-ion dissociative recombination processes relevant to ionospheric and space effects on U.S. Air Force systems. Interest in molecular clusters, nanostructures and materials includes work on catalysis and surface-enhanced processes mediated by plasmon resonances. This program also encourages the development of new methods to simulate and predict reaction dynamics that span multiple time and length scales.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

DR. MICHAEL R. BERMAN, AFOSR/RTB2
E-mail: mdtc@us.af.mil
(703) 696-7781

e. Natural Materials, Systems, and Extremophiles

Program Description: The goals of this multidisciplinary program are to study, use, or alter how living systems accomplish their natural functions. This program is very biomaterials centric but doesn't cover mimicking of biomaterials properties in non-biomaterials. It looks at existing biomaterials and synthetic biomaterials to understand how nature's sensors are so exquisite and technologically superior to our current capabilities. For example nature has used evolution to build materials and sensors that outperform current sensors such as a spider's haircells capable of

detecting air flow at low levels even in a noisy background. Nature is very good at solving the problem of working in a noisy environment. The intent of this program is to study/understand the mechanism of existing natural sensory systems, to utilize existing biomaterials, or to add additional capabilities to current systems. The research will encompass four general areas: biomimetics, biomaterials (non-medical only), biointerfacial sciences, and extremophiles.

Basic Research Objectives: Biomimetics research attempts to study the mechanisms and design rules of novel systems that organisms use in their daily lives, and to learn engineering processes and mechanisms for understanding and control of those systems. The intent of this program is to study: natural chromophores and photoluminescent materials (found in microbial and protein-based systems), sensor denial systems, (active and passive camouflage, structural coloration), and protective systems developed in certain organisms to more fully address the predator-prey mechanisms.

The non-medical Biomaterials area is focused on understanding how organisms synthesize materials and their properties. The intent is to understand the properties and structural relationship within the biomaterial to enable synthetic methods to be developed or to modify existing biomaterials genetically. Additionally, we would like to understand how organisms disrupt or deny a material's function or synthesis.

The Biointerfacial Sciences area is focused on the fundamental science at the biotic and abiotic interface of a biomaterial or organism with a non-natural material such as with proteins and metals (i.e., biotemplating). The nanotechnology and mesotechnology sub-efforts under this area are focused on surface structure and new architectures using nature's idea of directed assembly at the nanoscale to mesoscale to create desired effects, such as quantum electronics or three dimensional power structures. The use of these structures is in the design of patterned and templated surfaces, new catalysts, and natural materials based-optics/electronics (biophotonics).

The Extremophiles area is focused on understanding the way nature protects biosystems from the extremes of environment such as radiation, heat, cold, acid, pressure, and vacuum. The program wants to understand the mechanism involved in these protective schemes and to try to transfer some of those properties to other biosystems that don't have that protective scheme present.

You are highly encouraged to contact our Program Officer prior to developing a full proposal to briefly discuss the current state-of-the-art, how your research would advance it, and the approximate cost for a three (3) to five (5) year effort.

We are currently searching/hiring a new Program Officer, but there is a temporary custodian until a new PO is selected. Emails sent to the email address below will go to the temporary custodian:

(ACTING) DR. SOFI BIN-SALAMON, AFOSR/RTB2
E-mail: afosr.nature@us.af.mil
(703) 696-8411

f. Organic Materials Chemistry

Program Description: The goal of this research area is to achieve unusual properties and behaviors from polymeric and organic materials and their inorganic hybrids through a better understanding of their chemistry, physics, and processing conditions. This understanding will lead to development of advanced organic and polymeric materials for future U.S. Air Force applications. This program's approach is to study the chemistry and physics of these materials through synthesis, processing control, characterization, and establishment of structure-property relationships of these materials. There are no restrictions on the types of properties to be investigated but heavy emphases will be placed on unusual, unconventional, and novel properties. Research concepts that are novel, high risk with potential high payoff are encouraged. Both functional properties and properties pertinent to structural applications will be considered. Materials with these properties will provide capabilities for future Air Force systems to achieving global awareness, global mobility, and space operations.

Basic Research Objectives: Proposals with innovative material concepts that will extend our understanding of the structure-property relationship of these materials, discover previously unknown properties and/or achieve significant property improvement over current state-of-the-art materials are sought. Current interests include photonic polymers and liquid crystals, polymers with interesting electronic properties, and polymers with novel properties achieved through nanostructures. Applications of polymers in extreme environments, including space operation environments, are of interests. Material concepts for power management, power generation, and storage applications are of interest. In the area of photonic polymers, research emphases are on materials whose refractive index can be actively controlled. These include, but are not limited to, third order nonlinear optical materials, electro-optic polymers, liquid crystals, photorefractive polymers and magneto-optical polymers. Examples of electronic properties of interest include conductivity, charge mobility, stretchable electronic materials, electro-pumped lasing and solar energy harvesting. Controlled growth and/or self-assembly of nanostructures into well-defined structures (e.g., carbon nanotubes with specific chirality) or hierarchical and complex structures are encouraged. Material concepts that will provide low thermal conductivity but high electrical conductivity (thermoelectric), or vice versa, (thermally conductive electrical insulator) are of interest. Research aimed at being able to control/tune two or more material properties independently through creative, precision chemistry is of interest. Nanotechnology approaches are encouraged to address all the above-mentioned issues. Approaches based on biological systems or other novel approaches to achieve material properties that are difficult to attain through conventional means are encouraged. Concepts of excited state engineering to control the flow of energy within a material or molecule are of interest. Concepts of single molecules that combined different moieties with various functionalities to perform complex functions, as in a rudimentary electronic or photonic circuit for novel applications, are welcome.

You are highly encouraged to contact our Program Officer about your research ideas

by submitting one or more idea paragraphs (4-5 sentences plus a title and descriptive figure) that describe the fundamental science to be investigated. Alternatively, a two-page pre-proposal can be submitted prior to developing a full proposal. Your two-page description should include the objective and approach of the proposed effort, a benchmark of the targeted results with the current state-of-the-art, a brief rationale why the approach can achieve the target, and the approximate yearly cost for a three (3) to five (5) year effort.

DR. KENNETH C. CASTER, AFOSR/RTB2
Email: organic@us.af.mil
(703) 588-8487

5. STUDENT EXCHANGE PROGRAM

Program Description: The International Student Exchange Program is a new opportunity for the Air Force Office of Scientific Research (AFOSR) Program Officers (POs) to give a funded Principal Investigator's (PI) graduate student the opportunity to work with an overseas collaborator for a short term, or the opportunity for an overseas collaborator to send their graduate student to work with the AFOSR funded PI here for a short term. It would have to enhance the PO's grant with something like unique equipment access, sharing/learning new techniques, etc. which could further enable significant advances towards Air Force Science & Technology (AF S&T) objectives and could further help identify advances in emerging opportunities within the international scientific community. This program could also further assist AFOSR leadership a means to evaluate highly promising new international research, and direct additional funding towards areas of strategic AF importance.

If your future grant might benefit from additional funding from this program, it would be prudent to indicate so in your grant proposal. Applications to supplement an existing project with this additional funding may be considered on a case-by-case basis post-award.

We anticipate not more than $15,000 in additional funding per selected project, and any overhead or administrative costs will impact the ability to maximize the exchange collaboration. Such charges will be evaluated in determining project feasibility. The $15,000 in additional funding will not be further supplemented to compensate for overhead and administrative costs.

If you intend to utilize this opportunity, your proposal must include details on how the collaborative effort will benefit your research, enable significant advances toward Air Force science and technology objectives, and/or identify advances in emerging opportunities (e.g., provide access to unique equipment, share new technologies, or identify potential new international research opportunities). Also, your budget and budget justification must be provided. **The exchange proposal is considered an optional funding item and must be self-contained and stand on its own in the event the government chooses not to fund the exchange program element of your proposal.**

Your supplemental student exchange program funding request will be evaluated using the section E.1. Criteria for proposals submitted under this announcement.

We reserve the right to request proposals on previously awarded grants and cooperative agreements, subject to funds availability and agency approval of the proposal. These additional funding proposals will be evaluated on a case-by-case basis using the evaluation and selection criteria from the broad agency announcement associated with that award, and the benefit it provides as stated above.

6. OTHER INNOVATIVE RESEARCH CONCEPTS

Program Description: We are always looking for new basic research ideas and are open to considering unique and revolutionary concepts. If you have an exciting idea that doesn't seem to fit within one of the more specific topic descriptions of this announcement detailing our current technical programs, you may submit it under this section of the announcement. Pre-coordination with the point of contact listed below is strongly encouraged before submitting a proposal.

Basic Research Objective(s): Our goal is to create revolutionary scientific breakthroughs. This announcement seeks to invest in high payoff science and to identify challenging fundamental scientific problems relevant to the U.S. Air Force in the 21st century. We expect your proposals will describe cutting-edge efforts on basic scientific problems. Proposed research should investigate truly new and unique approaches and techniques that may enable revolutionary concepts with potentially high payoff relevant to the U.S. Air Force mission.

(ACTING) DR. KENNETH C. GORETTA, AFOSR/RT
E-mail: specialtopics@us.af.mil
(703) 426-7349

B. FEDERAL AWARD INFORMATION

In fiscal year 2015, AFOSR managed funding support for approximately 1,400 grants, cooperative agreements, and contracts to about 400 academic institutions, non-profit organizations and industrial firms. This included grants, cooperative agreements and contracts to academic institutions, non-profit organizations, and industry. Of the 1,400 grants managed, approximately one-third were made within the past fiscal year.

The following table summarizes our fiscal year 2015 new assistance award activity under the Catalog of Domestic Federal Assistance Program 12.800 Air Force Defense Research Sciences:

DESCRIPTION	DOMESTIC	FOREIGN	ALL RECIPIENTS
New Awards	385	168	553
Total Award Value*	$235,925,900	$19,183,600	$255,109,500
Mean Award Total*	$612,800	$114,200	$463,300
Median Award Total*	$438,900	$58,300	$360,000
Median Award Duration*	36 months	12 months	36 months
Largest Award & Duration	$7,500,000 / 60 mo.	$782,796 / 36 mo.	$7,500,000 / 60 mo.
Smallest Award & Duration	$9,000 / 6 mo.	$3,200 / 6 mo.	$3,200 / 6 mo.

SOURCE: Usaspending.gov

**Total award value, mean, and median values are rounded to the nearest $100.*

About $220 million is anticipated to be available for support of actions awarded under this announcement, subject to availability of funds. Research proposals funded between $200,000 and $400,000 per year are encouraged. Most of our awards are three (3) years in duration. Awards may be proposed for not more than five (5) years.

All applications received under this announcement will be considered applications for new awards, including any application marked renewal. Applications to supplement an existing project with additional funding may be considered on a case-by-case basis post-award, but are not anticipated to compete with new award funding.

Awards may start any time during the year. The actual start date is determined at the time of award, and may be different than the date you propose. We discuss this more in section F. Federal Award Administration Information.

Awards are made under the authority of 10 U.S.C. 2358 in the form of grants, cooperative agreements, or contracts. We rely on discretionary appropriated funds for this program. We can only make awards if enough funds are made available.

We select what kind of award instrument we can use based on requirements in the Federal Grant and Cooperative Agreement Act 31 U.S.C. 6301 – 31 U.S.C. 6308.

- A grant or cooperative agreement award may be made to U.S. institutions of higher education (IHE) or nonprofit organizations as described in 2 CFR 25.345, including foreign public entities and foreign organizations operated primarily for scientific,

educational, service, charitable, or similar purposes in the public interest. We do not award grants to organizations with a for-profit organization type.

- A cost-reimbursement contract may be awarded to applicants with a for-profit organization type as described in 2 CFR 25.325, or to any applicant that requests a fee or profit.

We reserve the right to select and fund for award all, some, part, or none of the proposals received in response to this announcement. There is no guarantee of an award.

C. ELIGIBILITY INFORMATION

1. ELIGIBLE APPLICANTS

a. General

All qualified, responsible organizational applicants from academia, the non-profit sector, and industry are eligible to submit research proposals. This includes University Affiliated Research Centers unless precluded from submitting a proposal by their Department of Defense operating contract.

b. We review your application, proposal, and Office of Management and Budget (OMB) designated repositories of government-wide public and non-public data, including comments you have made, as required by 31 U.S.C. 3321 and 41 U.S.C. 2313 and described in 2 CFR 200.205 and 32 CFR 22.410 to assess risk posed by applicants, and confirm applicants are qualified, responsible, and eligible to receive an award. If we cannot determine you or your organization qualified and responsible, you are not eligible to receive an award.

c. Ineligible Entities

None of the following entity types are eligible to submit proposals as primary award recipients under this announcement.

(1) Federally Funded Research and Development Centers (FFRDCs)

(2) Individual persons or people

(3) Federal agencies

2. COST SHARING

We do not require cost sharing for proposals under this announcement. Cost sharing is not an evaluation or selection criterion.

3. OTHER

a. Acknowledgement of Support and Disclaimer Requirements

You must include the F.3.d. Acknowledgement of Research Support on all materials created or produced under our awards.

You must include the F.3.e. Disclaimer Language on materials as required.

Our award document may provide additional instructions about specific distribution statements to use when you provide research materials to us. You are not eligible to submit a proposal if you cannot accept these terms.

b. Expectation of Public Dissemination of Research Results

We expect research funded by this announcement will be fundamental. We expect public dissemination of research results if you receive an award. This is a basic requirement for unclassified research results.

We intend, to the fullest extent possible, to make available to the public all unclassified, unlimited peer-reviewed scholarly publications and digitally formatted scientific data arising from research and programs funded wholly or in part by the DoD as described in the OUSD, AT&L Memorandum, *"Public Access to Department of Defense-Funded Research"* dated 09 Jul 2014.

We follow DoD Directive 5230.24 and DoD Instruction 5230.27 policies and procedures to ensure broad dissemination of unclassified research results to the public and within the Government. The DoD Instruction 5230.27 policy and procedures allowing publication and public presentation of unclassified fundamental research results will apply to all research proposed under this competition unless the Program Officer gives you an explicit, written exclusion to these policies with the Grants or Contracting Officer's advice and consent. All exclusions must be authorized or required by law, and must cite a valid legal authority.

You must provide a copy of all peer-reviewed publications developed or produced from research conducted with Air Force funds to our Program Officer.

You are not eligible to submit a proposal if you cannot accept these terms.

c. Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements

You must complete the "Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements" provided with the Grants.gov package. We provide more specific information about this requirement in section D.3.b.

We cannot determine you are eligible for funding unless we receive this form.

d. Conflict of Interest

(1) General Requirement for Disclosure

You and your organization must disclose any potential or actual scientific or non-scientific conflict of interest(s) to us. You must also disclose any potential or actual conflict(s) of interest for any subrecipient you include in your proposal. You must provide enough information for us to evaluate your disclosure. We may have to ask you more questions if we need more information.

At our discretion, we may ask you for a conflict of interest mitigation plan after you submit your proposal. Your plan is subject to our approval.

(2) Scientific Conflict of Interest

Scientific collaborations on research and development projects are generally the result of close collaboration prior to the submission of applications for support. Accordingly, virtually all of these collaborations might be considered to include a potential conflict of interest. The potential conflict is mitigated by the disclosure of these collaborations, and the list of current and pending support you provide for senior and key researchers.

D. APPLICATION AND SUBMISSION INFORMATION

1. ADDRESS TO REQUEST APPLICATION PACKAGE

All the application forms you need are available electronically on Grants.gov. From the "View Grant Opportunity" page, you can click on the "Application Package" tab to download the application package.

You can find the electronic application package on Grants.gov by searching for the announcement number shown on page one or by using this link: http://www.grants.gov/web/grants/search-grants.html?keywords=BAA-AFRL-AFOSR-2016-0007. We will not issue paper copies of this announcement.

Please contact us at afosr.baa@us.af.mil to request a reasonable accommodation for any accessibility requirements you may have.

2. CONTENT AND FORM OF APPLICATION SUBMISSION

a. Pre-proposal Inquiries and Questions

If you need help with technical matters, you should email the individual listed for your topic of interest in section A. Program Description. We provide a list of all the programs and Program Officers listed in this announcement again in section G.1. Technical Inquires and Questions.

If you have general questions about this announcement or administrative matters, you must submit your question in writing by email to the contact listed in section G.2. General Inquiries and Questions.

The Program Officer does not have the authority to make commitments for us. Grants and Contracting Officers acting within their warranted capacity are the only people authorized to make commitments for the Government.

b. The Application as a Whole

You must submit your proposal electronically through Grants.gov. We will not accept or evaluate any proposal submitted by any means other than through Grants.gov.

You must use the electronic Standard Form (SF) 424 Research and Related (R&R) Form Family, OMB Number 4040-0001. The SF 424 (R&R) Application for Federal assistance form must be your cover page. No pages may precede the SF 424 (R&R).

You may submit a proposal for one or more topics, or for a specific portion of a topic. You may submit different proposals on any number of topics, or different proposals on the same topic. We may not make awards in every topic area.

You must mark your application with the announcement number.

A summary of what is required for a complete proposal is summarized below:

- We require the forms and attachments in bold text with all applications
- *Some applications* require the attachments in *italic*
- We provide more instructions in D.3. Component Pieces of the Application

R&R FORM, OMB No. 4040-0001	FIELD	ATTACHMENT
SF 424 (R&R) Application for Federal Assistance, including an authorized signature	**18.**	**Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements**
	18.	*SFLLL Disclosure of Lobbying Activities*
R&R Other Project Information Form	**7.**	**Project Summary / Abstract**
	8.	**Project Narrative**
	9.	**Bibliography & References Cited**
	10.	*Facilities and Other Resources*
R&R Other Project Information Form	*11.*	*Equipment*
	12.	*Other Attachments*
R&R Senior / Key Person Profile Form		**Biographical Sketch**
		Current & Pending Support
R&R Budget Form		**Budget Justification**
R&R Subaward Budget Attachments Form		*Subaward Budget Justification*

R&R FORM, OMB No. 4040-0001	FIELD	ATTACHMENT
R&R Project / Performance Site Locations Form		**None**
R&R Personal Data (Optional)		None

The SF 424 (R&R) must include the signature of an authorized representative from your organization. The signature is affixed electronically by Grants.gov upon submission. This signature is considered the signature for the application as a whole.

c. Proposal Format

- Paper Size – 8.5 x 11-inch paper
- Margins – 1 inch
- Spacing – Single, 1.5, or 2.0-line spacing
- Font – Times New Roman or Garamond, 10, 11, or 12 point
- Page Limitation – None. However, unnecessarily elaborate or lengthy proposals are not desirable
- Attachments – Electronic Portable Document Format (PDF)
- Content – As described below

d. Proposal Length

We do not limit the length of your proposal for this competition; however, you must not include elaborate brochures, reprints, or presentations beyond those sufficient to present a complete and effective proposal.

e. Marking Requirements for Confidential or Proprietary Information

You must mark your proposal and proposal sections that contain proprietary or confidential information. You must use the protective legend found at FAR 52.215-1(e) Instructions to Offerors -- Competitive Acquisition (Jan 2004) modified to permit release to our outside evaluators.

We make every effort to protect the confidentiality of proposals, including any proposal evaluations; however, under Freedom of Information Act (FOIA) requirements, some or all proposal information may be subject to release.

Your entire proposal, or any portions thereof, without protective markings or otherwise identified as requiring protection will be considered voluntarily furnished to us without restriction, and will be treated as such for all purposes.

f. Electronic Form and Proposal Attachments

Your application and proposal attachments must be in electronic file formats. You should use the Portable Document Format (PDF) for your attachments. DO NOT password protect any attachments. The website http://www.grants.gov/web/grants/applicants/adobe-software-compatibility.html provides additional important instructions.

g. Advance Preparation for Electronic Submission through Grants.gov

Your proposal must be submitted electronically through Grants.gov. Your organization must complete several one-time actions before electronic submission. Registration with Grants.gov may take up to twenty-one (21) days.

You should verify that the person authorized to submit proposals for your organization has completed Grants.gov registration well in advance of the submission deadline. Grants.gov electronic proposal submissions cannot be accomplished before your organization is fully registered.

(1) A Grants.gov getting started checklist is available at: http://www.grants.gov/web/grants/learn-grants/grants-101/getting-started-checklist.html.

(2) Guidance for registering with Grants.gov as an organization may be found at: http://www.grants.gov/web/grants/applicants/organization-registration.html.

(3) Questions relating to the Grants.gov registration process, system requirements, how an application works, or the proposal submittal process can be answered by email at support@grants.gov, telephone at (800) 518-4726 or (606) 545-5035, or at http://www.grants.gov/web/grants/support.html.

(4) An active System for Award Management (SAM) registration and an active Dun and Bradstreet Data Universal Numbering System (DUNS) number are required to register through Grants.gov. Section D.5 provides more information.

3. COMPONENT PIECES OF THE APPLICATION

a. SF 424 (R&R) Application for Federal Assistance

The SF 424 (R&R) Application for Federal assistance form must be your cover page. No pages may precede the SF 424 (R&R).

Complete all required fields in accordance with the "pop-up" instructions on the SF 424 (R&R) form. The completion of most fields is self-explanatory. You can turn on Grants.gov "Help Mode" to provide additional instructions for forms. "Help Mode" is turned on by the icon with the pointer and question mark at the top of the form.

We have special instructions for completion of several SF 424 (R&R) form fields in your application.

Our instructions are:

FIELD	INSTRUCTION
2.	You may leave "Applicant Identifier" blank
3.	You may leave "Date Received by State" and "State Application Identifier" blank
9.	You must list Air Force Office of Scientific Research as the reviewing agency if Grants.gov has not pre-populated this answer

FIELD	INSTRUCTION
16.	You should check "No." and "Program is Not Covered by Executive Order 12372"
17.	Select "I Agree" to: ▪ Provide the certification regarding lobbying that is required by 31 U.S.C. 1352 as implemented by DoD 32 CFR Part 28. *The full text of this certification may be found at http://www.ecfr.gov or we will provide you a copy if you ask for one.* ▪ Certify that all statements in the proposal, your Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements are true, complete, and accurate to the best of your knowledge. *See section F.3. Administrative and National Policy Requirements for more information and links to the full text of these items.*
18.	You must attach the completed D.3.b. Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements. You may have to attach the completed D.3.c. SFLLL Disclosure of Lobbying Activities if you have lobbying activity that you must disclose.

b. Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements

You must attach this representation to field 18 of the SF 424 (R&R).

You must complete and attach the "Representation for Tax Delinquency, Felony Conviction, and Internal Confidentiality Agreements" provided with the Grants.gov package. We cannot fund an award if this information is not provided.

If you answer "is" a corporation with a felony conviction and/or "is" a corporation with a felony conviction on this representation, you may not be eligible for an award if your proposal is selected. You should contact us right away to discuss your situation to find out if you can submit your application.

If you do not attach this form to the SF 424, we may request the representation after you submit your application, but we are not required to do so. We may deem your application ineligible for selection by citing an authority listed or referenced in FAR 52.209-11, and make an award to another applicant. This applies to all applicants.

c. SFLLL Disclosure of Lobbying Activities

When required, attach this disclosure to field 18 of the R&R Other Project Information Form.

If you have lobbying activity that you must disclose under 31 U.S.C. 1352 as implemented by the DoD in 32 CFR Part 28, you must attach the completed SFLLL Disclosure of Lobbying Activities. You can find instructions for completing this form at http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf. The full text of this certification may be found at http://www.ecfr.gov or we will provide you a copy if you ask for one.

d. R&R Other Project Information Form

Complete this form as indicated. You must include all necessary attachments.

FIELD	INSTRUCTION
1, 1a.	You must address all prospective human subject involvement by answering these questions. Additional documentation pursuant to National Policy and U.S. Air Force standards is required for all proposals with human use or involvement. Your inquiries about our requirements should be sent by email directly to our Research Protections Officer at afosrharpo@us.af.mil with a copy to the Program Officer for the announcement topic.
2, 2a.	You must address all prospective animal subject and/or recombinant deoxyribonucleic acid (rDNA) involvement by answering these questions. Additional documentation pursuant to National Policy and U.S. Air Force standards is required for all proposals with animal or rDNA use or involvement. Your inquiries about our requirements should be sent by email directly to our Research Protections Officer at afosrharpo@us.af.mil with a copy to the Program Officer for the announcement topic.
4a.	For any proposal that has an actual or potential impact on the environment, answer yes and provide the answers and attachments required for fields 4b, 4c, and 4d. Additional documentation in accordance with National Policy and U.S. Air Force standards is required for any proposal with an actual or potential impact on the environment.
7.	Attach your D.3.e. Publicly Releasable Abstract
8.	Attach your D.3.f. Project Narrative
9.	Attach your D.3.g. Bibliography and References Cited
10.	Attach a Facilities and Other Resources description document here if you need to supplement your D.3.f. Proposal Narrative facilities and resources section.
11.	You may supplement your D.3.j. Budget Justification by attaching an Equipment Justification here. Do not duplicate information included on your budget justification. If you attach an Equipment Justification, make sure you reference the attachment in your budget justification.

FIELD	INSTRUCTION
12.	Attach the D.3.k R&R Subaward Budget Attachments Form if applicable and not attached elsewhere. You should have budgets for all subawards proposed attached within this form before attachment. Attach all D.3.l Subaward Budget Justifications as applicable Attach your D.3.o Data Management Plan here if applicable

e. Publicly Releasable Project Summary / Abstract

You must attach the Project Summary / Abstract to field 7 of the R&R Other Project Information form.

You must provide a concise abstract of 300 words or less with your proposal. You must mark this abstract publically releasable. Your abstract should use terms the public can understand to describe the research objective, technical approach, anticipated outcome, and potential impact of the specific research.

Your abstract header should include the Program Officer's name and office symbol from section G.1. Technical Inquiries and Questions below.

If you receive an award, we must publish your abstract to a searchable website available to the general public in accordance with Public Law 113-235. The website address is https://dodgrantawards.dtic.mil/grants/#/home.

f. Project Narrative

You must attach the Project Narrative to field 8 of the R&R Other Project Information Form. The narrative must be complete and self-contained to qualify for review.

You must clearly describe your research, including your research objective and approach. Your project narrative will be evaluated using the section E.1. Criteria. You should show strength in as many of the evaluation and selection areas as practicable to demonstrate maximum competitiveness.

You must describe any environmental impacts of your research outside the laboratory in any appropriate narrative section, including how you will ensure compliance with environmental statutes and regulations.

Your narrative should include the following elements:

(1) Statement of Objectives

You must summarize your proposed research on a single page titled "Statement of Objectives." We may decide to incorporate your statement of objectives into the award as a description of the work instead of incorporating the whole technical proposal.

You should use active verbs when you prepare the statement of objectives, e.g., "conduct" research in a subject area, "investigate" a problem, "determine" to test a hypothesis.

(2) Research Effort

(a) You should describe the research you plan in detail. State the research objectives and approach, and the relationship and comparable objectives to research progress elsewhere. Describe your research team's knowledge in the field, and provide a bibliography and list of literature citations. Discuss the nature of the expected results.

(b) The adequacy of this information will influence the overall evaluation in accordance with the criteria and procedures specified in section E. Application Review Information below.

(3) Principal Investigator (PI) and Senior Personnel Time

(a) You must provide estimate of time the principal investigator and other senior professional personnel will devote to the research. Your estimate must include information pertaining to the proportion of time anticipated devoted to this research, to other research, and to other commitments of time such as sabbatical, extended leave, and teaching duties.

(b) State the number of graduate students for whom each senior staff member is responsible.

(c) If your principal investigator or other key personnel have current, pending, or expected research supported by other sponsors or agencies during the period you seek our support, state the title of the other research, the proportion of time to be devoted to it, the amount of support, name of agency, dates, etc.

You must attach a list of Current and Pending Support for each person listed on the D.3.h. R&R Senior / Key Person Profile Form. Each abstract should include research title, objectives, approach, and budget for both present and pending research projects. Send any changes as they become known.

(4) Your Facilities

(a) Describe the facilities available for performing the proposed research, and any additional facilities or equipment the organization proposes to acquire at its own expense for the work.

(b) Indicate any government-owned facilities that will be used. Indicate any government-owned equipment possessed presently that will be used. The facilities contract number, or in absence of a facilities contract, the specifics of the facilities or equipment, and the number of the award under which they are accountable are required.

(c) Government Furnished Equipment

You may list any special Government-owned property or test equipment required to complete the research. When possible and practicable, give a description or title for each item, the current location, and an estimated cost as

applicable. If you do not have information about individual items, group items you require by class and provide an estimate of values.

(5) High Performance Computing Requirements

You may be eligible to use DoD high performance computing resources at no cost to your research. You should address utilization of this program if you need high performance computing cycles to meet the needs of your research. This program provides access to a range of state-of-the-art high performance computing assets and user training opportunities that can be used in some of our awards; special terms and conditions apply. You can review the details, capabilities, and requirements of the program at http://www.hpcmo.hpc.mil.

Our Program Officers will help you establish an account if your proposal is selected for an award, and can answer questions before you submit your proposal.

g. Bibliography and References Cited

You must attach your narrative Bibliography and References to field 9 of the R&R Other Project Information Form.

h. R&R Senior / Key Person Profile Form

You must attach a short biographical sketch and list of significant publications (vitae) for each Senior / Key Person. You must also attach a list of current and pending support as discussed in Principal Investigator (PI) and Senior Personnel Time.

You must list all key persons proposed for the research on the R&R Senior/Key Person Profile Form. Key persons are generally the PI, any Co-PIs, and senior staff. We use this information to evaluate the qualifications of you and your research team.

i. R&R Budget Form

You must provide all information requested. You must estimate the total research project cost. You must categorize funds by year and provide separate annual budgets for projects lasting more than one year. A budget justification must be attached.

You must include enough budget related information in your proposal to support your costs as reasonable and realistic, and in compliance with 2 CFR 200 Subpart E - Cost Principles.

Not having enough information in your proposal to understand if your costs are reasonable and realistic is the most common reason awards are delayed.

j. Budget Justification

You must provide a detailed budget justification for each year that clearly explains the need for each item. The entire budget justification and supporting documentation must be combined into a single file and attached to field K of the R&R Budget Form.

(1) You should itemize travel. State the purpose of each trip proposed, the number of trips, the number of travelers, the destination, the duration, and the basis for calculating costs such as airlines and hotels.

(2) You should itemize materials, supplies, and equipment. List all material/equipment by type and kind with associated costs. Indicate what your costs are based on, such as vendor quotes, historical data and/or engineering estimates. You should include vendor quotes and/or catalog pricing data.

(3) If you have any subaward(s), you should describe how you determined subaward costs were determined fair and reasonable. Your business office usually makes this determination.

(4) If you use a Government rate agreement to propose indirect cost rates and/or fringe benefit rates, you should attach a copy of the agreement you used.

(5) Helpful Cost Principle Reference Information

(a) Grant Applicants

(i) 2 CFR 200, Subpart E – Cost Principles

(ii) General Provisions for Selected Items of Cost in 2 CFR 200.420 through 2 CFR 200.475

(b) Contract Applicants

(i) FAR Part 31 Contract Cost Principles and Procedures

(ii) FAR 31.205 Selected Costs

(iii) FAR Subpart 30.2 CAS Program Requirements if your organization does not have an exemption to CAS as described in FAR 9903.201-1 CAS applicability

k. R&R Subaward Budget Attachments Form

You must attach all subaward budgets to field 12 of the R&R Other Project Information Form.

You must provide a budget at the same level of detail as your D.3.i. prime budget for each proposed subaward. A subaward budget justification must be attached.

l. Subaward Budget Justification

You must attach all subaward budget justifications to field 12 of the R&R Other Project Information Form.

You must provide a subaward budget justification at the same level of detail as your D.3.j. prime budget justification for each proposed subaward.

m. R&R Project / Performance Site Locations Form

You must complete all information as requested. You must include the ZIP+4 for each performance location you list.

n. R&R Personal Data Form (Optional)

You can decide if you want to include the R&R Personal Data form with your proposal. We use this form to understand demographic information about senior and key persons identified in applications. We do not consider information on this form as part of our evaluation or selection process.

o. Data Management Plan (Optional)

You can decide if you want to include a Data Management Plan with your application. If you do, attach your Data Management Plan to field 12 of the R&R Other Project Information Form.

Your "Data Management Plan" should be two (2) pages or less in length and discuss:

(a) The types of data, software, and other materials to be produced in the course of the project, and include a notation marking items that are publicly releasable;

(b) How the data will be acquired;

(c) Time and location of data acquisition if they are scientifically pertinent;

(d) How the data will be processed;

(e) The file formats and the naming conventions that will be used;

(f) A description of the quality assurance and quality control measures during collection, analysis, and processing;

(g) If existing data are to be used, a description of their origins;

(h) A description of the standards to be used for data and metadata format and content;

(i) Plans and justifications for archiving the data;

(j) The timeframe for preservation; and

(k) If for legitimate reasons the data cannot be preserved, the plan must include a justification citing such reasons.

4. INFORMATION YOU MUST SUBMIT IF SELECTED FOR POSSIBLE AWARD

We may request additional necessary information from you during negotiations, or as required for award considerations. You must respond promptly.

If you not fully comply with our information requests by the time we are ready to make an award, we may determine that you are not qualified to receive an award and use that determination as a basis for making an award to another applicant.

If your proposal includes human, animal, or rDNA use or involvement you must submit all documentation requested during negotiations or you may not receive an award.

Foreign recipients must complete a payment information form to receive wire transfer payments.

If selected for a contract award, a Section K Representations, certifications, and other statements of offerors or respondents will be provided for your completion, signature, and return. The document will include representations and certifications that your organization has not completed as part of the SAM registration, representations and certifications required by DoD Class Deviation(s), or that must be requested with each acquisition. The completed Section K will be incorporated into any resultant contract.

5. DUNS UNIQUE ENTITY IDENTIFIER, CAGE, AND SYSTEM FOR AWARD MANAGEMENT (SAM)

a. SAM Registration Required

As required in 2 CFR 25.110 all applicants, unless exempted, must:

(1) Be registered in SAM.gov before submitting its application;

(2) Provide a valid DUNS unique entity identifier; and

(3) Continue to maintain an active SAM registration with current information at all times any Federal award is active, or any application is under consideration by a Federal awarding agency.

A Commercial and Government Entity (CAGE) code is obtained or specified as part of the SAM registration process. A CAGE code is required.

b. SAM Exemption or Exceptions Not Available Under This Announcement

We will not issue an Agency level exemption to SAM registration under 2 CFR 25.110(d)(1) for applicants under this announcement.

You must comply with SAM registration requirements and include a DUNS and CAGE code on your application or we cannot make an award.

c. Questions about SAM Registrations and Updates

You can get questions about SAM registration and entity updates answered by live chat at https://www.fsd.gov/fsd-gov/home.do and telephone at (866) 606-8220 or (324) 206-7828. Top help topics for SAM.gov are available at https://www.fsd.gov/fsd-gov/learning-center-system.do?sysparm_system=SAM.

d. Consequences of Non-Compliance with SAM Registration Requirements

We cannot make an award to you unless you comply with SAM requirements. If you are non-compliant, we may determine you are not qualified to receive an award, and use that determination to make an award to someone else as authorized by 2 CFR 25.205(b). You cannot receive payments without an active SAM record and CAGE.

6. SUBMISSION DATES AND TIMES

a. Proposal Submission

This announcement remains open until superseded. We review and evaluate proposals as they are received. You may submit proposals at any time; however, some specific topic instructions may recommend submission by specific dates that align with funding expectations. Funding is limited. We commit the bulk of our funding appropriation by the fall of each year.

b. How Proposal Submission Time is Determined

We use the system-generated Grants.gov time stamp to determine when you submitted your successfully validated proposal and the announcement your submission was associated with. Grants.gov policies and procedures for application submission and processing apply. We will only accept applications submitted electronically through Grants.gov.

c. Grants.gov Tracking Number is Application Receipt

Grant.gov generates a confirmation page when you submit your application. A second confirmation is provided by email when your application has passed Grants.gov validations and the status is updated from received to validated.

The confirmation page includes a system-generated Grants.gov tracking number; this serves as your receipt. You should keep a copy of all confirmations.

You can verify the submission time and application status with your tracking number through Grants.gov at http://www.grants.gov/web/grants/applicants/track-my-application.html.

d. Effect of Superseding Announcement

This announcement is open until superseded. We generally allow approximately thirty (30) days for you to submit a proposal started under the announcement that is superseded before we close the previous announcement.

Grants.gov will not accept your proposal after we close a superseded announcement.

7. INTERGOVERNMENTAL REVIEW

N/A - This program is excluded from coverage under Executive Order (E.O.) 12372.

8. FUNDING RESTRICTIONS

a. Proposal Preparation Costs

Your proposal or application preparation costs are not considered an allowable direct charge to any award under this announcement. Your costs are, however, an allowable expense to the normal bid and proposal indirect cost as specified in 2 CFR 200.460 Proposal costs if you receive a grant or cooperative agreement, or FAR 31.205-18 Independent Research and Development and Bid and Proposal Costs for contracts.

b. Pre-Award Costs for Grants

You must request our prior approval if your research requires a specific date pre-award costs become allowable, or if you need more than ninety (90) days pre-award cost authorization as described in 2 CFR 200.308(d)(1) and 2 CFR 200.458. Your business office must provide this request in writing. You must document why pre-award costs are necessary and essential for the research in the request, and identify a specific date for our Grants Officer to consider. We will only consider approval of a specific date or more than ninety days pre-award costs before an award is made.

Our grants include up to ninety (90) calendar days pre-award costs; however, the actual date costs become allowable is not final until an award is made. We recommend you ask for a specific date as described above to prevent misunderstandings.

All costs incurred before a grant or cooperative agreement award are at the recipient's risk as described in 2 CFR 200.308(d)(2). We are under no obligation to reimburse your costs if for any reason you do not receive an award, or if your award is less than anticipated and inadequate to your pre-award costs.

c. Pre-Contract Costs under FAR Cost-Reimbursement Contract Awards Not Available

Federal awards made using a 2 CFR 200.38(a)(2) cost-reimbursement contract instrument under the Federal Acquisition Regulations (FAR) do not allow for reimbursement of pre-contract costs. You will not get reimbursed for any costs you incur before the effective date of a contract award.

d. Air Force Office of Scientific Research No-cost Extension (NCE) Policy

We require prior written approval to extend the period of performance, without additional funds, beyond the expiration date of the grant. We only grant no-cost extensions when they are truly warranted and properly documented. For an extension to be granted, you must provide notice in writing, including the supporting reasons, and revised expiration date, at least thirty (30) days prior to the expiration of the award. You must include your most recent SF 270 Request for Advance or Reimbursement or SF 425 Federal Financial Report with your request. We use this information to evaluate the business aspects of your request. In no event will the period of performance be extended merely for the purpose of using unobligated balances.

You should make every effort to ensure work is completed on time. If you and your business office deem a no-cost extension is truly warranted, your business office must submit your request to your Program Officer for initial review and a recommendation.

9. OTHER SUBMISSION REQUIREMENTS

If Grants.gov rejects your electronic application submission for any reason, you must correct all errors and resubmit your application.

E. APPLICATION REVIEW INFORMATION

1. CRITERIA

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

You should show strength in as many of the evaluation and selection areas as practicable to demonstrate maximum competitiveness.

a. Principal Evaluation and Selection Criteria

Our two (2) principal evaluation and selection criteria are specified in 32 CFR 22.315(c). Our principal selection criteria are of equal importance to each other. The combined principal selection criteria are more important than the additional evaluation and selection criteria.

Our principal evaluation and selection criteria are:

(1) The technical merits of the proposed research and development; and,

(2) Potential relationship of the proposed research and development to Department of Defense missions.

b. Additional Evaluation and Selection Criterion

Our sole additional evaluation and selection criterion for research proposals, which is of lesser importance than the primary evaluation and selection criteria combined is:

(1) The applicant's capabilities integral to achieving U.S. Air Force objectives. This includes principal investigator's, team leader's, or key personnel's qualifications, related experience, facilities, or techniques or a combination of these factors integral to achieving U.S. Air Force objectives, and the potential risk of this effort to the U.S. Air Force.

c. No further evaluation criteria or criterion will be used for proposal selection

2. REVIEW AND SELECTION PROCESS

a. Merit-based, Competitive Procedures

Proposals will be subjected to a peer or programmatic review. The peer review will use external reviewers to assess technical merit and Air Force relevance of the proposal.

The programmatic review assesses the technical quality of the proposal, relevance of the proposed research to the portfolio descriptions in this BAA, relevance of the work to Air Force and DOD needs, and the potential of the research balanced against the available funding resources of a given portfolio. Selection for award consideration will be made based on the outcome of these reviews

We select proposals for possible funding on a competitive basis according to Public Law 98-369, the Competition in Contracting Act of 1984, 10 USC 2361, and 10 USC 2374 using the merit-based, competitive procedures described in 32 CFR 22.315, incorporated here by reference.

b. Cost Analysis

If your proposal is selected for possible award, we will analyze the cost of the work for realism and reasonableness. The cost of your proposal is considered, but is not an evaluation factor or criterion.

We must make sure the costs you propose reasonable, realistic, and allocable to this work before we can make an award. All costs must be allowable to be reasonable. We may analyze your technical and cost information at the same time.

3. DISCLOSURE OF ADMINISTRATIVE PROCESSING BY CONTRACTOR PERSONNEL

We use support contractor personnel to help us with administrative proposal processing. Our contractor personnel are employees of commercial firms that have a contract with us. We make sure all of our support contracts include nondisclosure agreements that prohibit disclosure of any information you submit to other parties.

4. NO GUARANTEED AWARD

We do not guarantee that any award will be made under this competition.

F. FEDERAL AWARD ADMINISTRATION INFORMATION

1. SELECTION NOTICES

a. Electronic Notification

If your proposal is selected for possible award, an email will be sent to the principal investigator.

b. Selection for Possible Award Does Not Authorize Work

Our selection notice is not an authorization to start work, and is not an award guarantee. We will contact your business office to get answers to any questions we have about your proposal, and negotiate specific award terms.

2. AWARD NOTICIES

a. Federal Award Document

A grant or contract signed by a warranted Grants or Contracting Officer is the only official notice that an award has been made.

b. Electronic Federal Award Distribution

We send award documents to your business office by email. This is called award distribution. We always ask your business office to forward the award to the Principal Investigator indicated on the award document.

3. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

a. Reporting of Matters Related to Recipient Integrity and Performance

You must report recipient integrity and performance information as required by Appendix XII to 2 CFR Part 200 – Award Term and Condition for Recipient Integrity and Performance Matters, incorporated here by reference. You should read the full text of this award term now using the link above to make sure you understand our requirements. You can also find this term at http://www.ecfr.gov.

b. Agency Reviewof Risk Posed by Applicants

(1) We must review information available about you and entities included in your proposal through the Office of Management and Budget (OMB) designated repositories of government-wide eligibility qualification and financial integrity information. Our risk review is required by 31 U.S.C. 3321 and 41 U.S.C. 2313, and includes both public and non-public information. You must be qualified and responsible as described at 32 CFR 22.415 Standards to receive a grant award. Contract applicants must be responsible based on the requirements in FAR Subpart 9.1 Responsible Prospective Contractors.

(2) We must consider the non-public segment of the Federal Awardee Performa nc e and Integrity Informatio n System (FAPIIS) for all awards exceeding the current simplified acquisition threshold of $150,000.

(3) At a minimum, the information in the system for a prior Federal award recipient must demonstrate a satisfactory record of executing programs or activities under Federal grants, cooperative agreements, or procurement awards; and integrity and business ethics. We will consider any comments you provide, in addition to the other information in the designated integrity and performance system, when making our risk judgment about your integrity, business ethics, and record of performance under Federal awards.

(a) We may make an award to a recipient who does not fully meet our standards as described at 2 CFR 200.205(a)(2) if it is determined that the information is not relevant to the current Federal award under consideration or there are specific conditions that can appropriately mitigate the effects of the non-Federal entity's risk in accordance with 2 CFR 200.207 Specific conditions.

(4) We must comply with the guidelines on government-wide suspension and debarment described in 2 CFR 200.213, and must require you to comply with these provisions for all work we fund.

These provisions restrict Federal awards, sub-awards and contracts with certain parties that are debarred, suspended or otherwise excluded from or ineligible for participation in Federal programs or activities.

c. Cross-Cutting National Policy Requirements

You must comply with all applicable national policy requirements as a condition of award. Key national policy requirements may be found in the DoD Research and Development General Terms and Conditions, July 2016 (DoD T&C); and,

Appendix B to 32 CFR Part 22 – Suggested Award Provisions for National Policy Requirements that Often Apply, incorporated here by reference.

d. Acknowledgement of Research Support

You must acknowledge support provided by the Government in all materials based on or developed under our awards. The requirement extends to copyrighted and non-copyrighted materials published or displayed in any medium.

The following language must be used unless the award document provides different instructions:

"This material is based upon work supported by the Air Force Office of Scientific Research under award number ."

You must require any subrecipients or subcontractors under your award to include this acknowledgement too.

e. Disclaimer Language for Research Materials and Publications

Some materials based on or developed under our awards must include special disclaimer language. You must to include this language in all materials except scientific articles or papers published in scientific journals unless your award document provides different instructions:

"Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Defense."

You must require any subrecipients or subcontractors under your award to include this acknowledgement too.

f. Grants and Cooperative Agreements - Uniform Administrative Requirements, Cost Principles, and Audit Requirements

Our grants are governed by the guidance in Title 2, Code of Federal Regulations (CFR) Part 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards" as modified and supplemented by the Department of Defense's (DoD) interim implementation in 2 CFR Part 1103 [79 FR 76047, December 19, 2014] and 2 CFR Part 1125. Provisions of Chapter 1, Subchapter C of Title 32, CFR, "DoD Grant and Agreement Regulations" other than parts 32 and 33 continue to be in effect and apply as stated.

These regulations are incorporated by reference into this announcement.

g. Domestic Grants and Cooperative Agreements - DoD Research and Development General Terms and Conditions

Our domestic grants are subject to the "DoD Research and Development General Terms and Conditions, July 2016" (DoD T&C) found at https://www.onr.navy.mil/Contracts-Grants/submit-proposal/grants-

proposal/~/media/Files/Contracts-Grants/docs/DoD-Research-Terms-Conditions-JUL2016.ashx. These terms and conditions are incorporated by reference into this announcement. We can provide a generic model grant or cooperative agreement upon request.

If we publish updated terms and conditions, the updated terms and conditions may apply to any grant made under this announcement.

h. Foreign Grants and Cooperative Agreements – Terms and Conditions

Our foreign grants and cooperative agreements are governed by award-specific terms and conditions that implement and supplement the section F.3.f. Uniform Administrative Requirements, Cost Principles, and Audit Requirements. We can provide a generic model grant or cooperative agreement upon request.

i. Contract Award Terms and Conditions

Our cost reimbursement contracts incorporate FAR, DFARS, and AFFARS clauses plus descriptive text tailored to the particulars of each procurement that combine as the terms and conditions of the contract. We can provide a generic model contract upon request.

When required by 2 CFR 200.100 or 200.101, our contracts may reference guidance in 2 CFR Part 200, "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards" as modified and supplemented by the Department of Defense's (DoD) interim implementation of Guidance in 2 CFR part 1103 [79 FR 76047, December 19, 2014].

j. Conditions of Award for Recipients Other Than Individuals

You must agree to comply with the requirements at 2 CFR Part 182, Subpart B "Requirements for Recipients Other Than Individuals" as a condition of award.

k. Contract Solicitation Provisions and Clauses Incorporated by Reference

The full text of FAR, DFARS, and AFFARS provisions and clauses may be accessed using the website at http://farsite.hill.af.mil/vfdfara.htm. The full text of Department of Defense (DoD) Class Deviations from the FAR and DFARS may be accessed at http://www.acq.osd.mil/dpap/dars/class_deviations.html. Any contract award will include all clauses required by FAR, DFARS, and AFFARS at the time of award.

We always include the full text of DFARS 252.227-7017 Identification and Assertion of Use, Release, or Disclosure Restrictions in your Section K. We have to understand any data restrictions before negotiations.

You should read the full text of this provision now at http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/dfars/dfars252_227.htm#P1183_92447.

52.209-11 Representation by Corporations Regarding Delinquent Tax Liability or a Felony Conviction under any Federal Law (Feb 2016)

252.203-7994 Prohibition on Contracting with Entities That Require Certain Internal Confidentiality Agreements – Representation (Deviation 2017-0001) (Nov 2016)

252.203-7995 Prohibition on Contracting with Entities That Require Certain Internal Confidentiality Agreements (Deviation 2017-0001) (Nov 2016)

252.204-7007 Alternate A, Annual Representations and Certifications (Jan 2015)

252.209-7004 Subcontracting with Firms that are Owned or Controlled by the Government of a Country that is a State Sponsor of Terrorism (Oct 2015)

252.227-7013 Rights in Technical Data--Noncommercial Items (Feb 2014)

252.227-7017 Identification and Assertion of Use, Release, or Disclosure Restrictions (Jan 2011)

252.235-7010 Acknowledgement of Support and Disclaimer (May 1995)

252.235-7011 Final Scientific or Technical Report (Jan 2015)

252.244-7001 Contractor Purchasing System Administration-Basic (May 2014)

l. Foreign Entities and For-Profit Organizations Not Generally Eligible for Equipment Vesting

We cannot vest title to equipment with for-profit organizations, foreign public entities, or foreign organizations unless there is a specific statutory or regulatory authority that allows us to do so.

- If you are applying for a contract award, you should contact us before you propose purchasing equipment.
- If you are applying as a foreign public entity or foreign organization, please contact the Program Officer listed with your topic before you propose equipment.

m. Minimum Record Retention Requirements

You must keep records related to our awards for at least three years after completion and the final Federal Financial Report is submitted. This requirement is described further in 2 CFR 200.333, incorporated here by reference. For grant or cooperative agreement awards, the DoD T&C OAR Article II. Records retention and access describes additional requirements. Contract awards have similar requirements.

Sometimes records must be retained for more than three years.

4. REPORTING

a. Monitoring and Reporting Program Performance

All of our awards require at least annual and final technical performance reports as required in 2 CFR 200.328. The DoD T&C REP Article I. Performance reporting will apply to grant or cooperative agreement awards. Some of our awards require more frequent technical reports.

You must provide your reports on time. Our awards include a schedule specifying the latest date for submission of each required report.

You may use a SF 298 Report Documentation Page for interim progress reports.

You must use a completed SF 298 Report Documentation Page as the first page of the final report. You can download an electronic SF 298 from http://www.gsa.gov/portal/forms/download/116146.

b. Technical Performance Report Format

(1) ANSI Standard Z39.29-2005

We recommend the American National Standard Institute (ANSI) Standard Z39.18-2005 Scientific and Technical Reports – Preparation, Presentation, and Preservation Format Guidelines for your final report unless your award states different requirements. You can download the Z39.29-2005 standard from http://www.kirtland.af.mil/shared/media/document/AFD-140129-070.pdf.

(2) Institutional Formats for Thesis and Dissertations

If your institution has a format for thesis and dissertations, you can use that format unless your award states different requirements.

(3) Pending Federal-wide Research Progress Performance Report (RPPR) Format

We are working on a Federal-wide Research Progress Performance Report (RPPR) for interim, annual, and final research performance reports. You do not have to use the RPPR right now. DoD plans to use the report in the future.

We may issue an award modification that requires you to use the Government-wide RPPR after a final notice is issued in the Federal Register.

c. Department of Defense (DD) Form 882 Report of Inventions and Subcontracts

(1) Invention Reports

(a) You must provide at least a final invention report on DD Form 882. We may ask for annual reports. Our award documents specify the due date. You can get the form at http://www.dtic.mil/whs/directives/forms/eforms/dd0882.pdf.

(b) You must submit invention reports even if you do not have a patent to report.

(2) Sub-Award and Subcontract Reporting

You must use the DD Form 882 to tell us about any subawards or subcontracts. Your award will provide specific instructions. You can get the form at http://www.dtic.mil/whs/directives/forms/eforms/dd0882.pdf.

d. Standard Form (SF) 425 Federal Financial Report

Our awards require a final SF 425 Federal Financial Report. You can get the form at http://www.whitehouse.gov/sites/default/files/omb/assets/grants_forms/SF-425.pdf.

(1) If you request any advance payment(s) under your award or have scheduled payments, you must submit quarterly SF 425 reports for the life of the award. Our awards include specific instructions.

(2) You do not have to submit quarterly SF 425 reports if you only request payments by reimbursement.

e. Electronic Payment Requests and Electronic Payment

You must submit payment requests electronically using the Invoicing, Receipt, Acceptance, and Property Transfer (iRAPT) application unless your award specifies different instructions. Domestic grant payments must be made using the electronic funds transfer (EFT). We prefer to make foreign payments by wire transfer.

To submit electronic payment requests you must register to use iRAPT in the Wide Area Workflow (WAWF) e-Business Suite at https://wawf.eb.mil. The website includes registration instructions.

If you have WAWF or iRAPT questions or problems, you can get help by telephone at (866) 618-5988 or (801) 605-7095, by electronic mail at disa.ogden.esd.mbx.cscassig@mail.mil, or the website https://wawf.eb.mil/xhtml/unauth/web/homepage/vendorCustomerSupport.xhtml.

f. Property Reports

If we furnish any property owned by the Government under an award, you must submit periodic property status reports as described in 2 CFR 200.329 and further implemented for grants by the DoD T&C REP Article III. Reporting on Property. Contract awards have similar property reporting requirements.

g. Other Reports

Our Program Officers may ask for informal technical reports as needed. We use these informal reports for program purposes, such as preparation for meetings and other technical purposes. We highly recommend you provide this information in a timely manner by electronic mail directly to the Program Officer.

h. Electronic Submission of Reports

You must plan on submitting reports electronically. You can submit most reports through the internet application at http://afosr.reports.sgizmo.com/s3/. Some reports must be sent using electronic mail. Our award documents provide specific instructions that you must follow.

G. AGENCY CONTACTS

1. TECHNICAL INQUIRES AND QUESTIONS

You should submit your questions in writing by electronic mail to the Program Officer responsible for your topic(s) of interest from section A. Program Description. You should include the announcement number in the subject line.

The technical contacts for this announcement by program description are as follows:

SECTION	PROGRAM DESCRIPTION	PROGRAM OFFICER
A.3.a.	Aerospace Materials for Extreme Environments	Dr. Ali Sayir
A.3.b.	Atomic and Molecular Physics	Dr. Grace Metcalfe
A.4.a.	Biophysics	Dr. Sofi Bin-Salamon
A.2.a.	Computational Cognition and Machine Intelligence	Dr. James H. Lawton
A.2.b.	Computational Mathematics	Dr. Jean-Luc Cambier
A.2.d.	Dynamic Data Driven Applications Systems (DDDAS)	Dr. Erik Blasch
A.1.a.	Dynamic Materials and Interactions	Dr. Martin Schmidt
A.2.c.	Dynamics and Control	Dr. Frederick Leve
A.3.c.	Electromagnetics	Dr. Arje Nachman
A.1.b.	GHz-THz Electronics and Materials	Dr. Kenneth C. Goretta
A.1.c.	Energy, Combustion, and Non-Equilibrium Thermodynamics	Dr. Chiping Li
A.1.d.	Unsteady Aerodynamics and Turbulent Flows	Dr. Douglas Smith
A.1.e.	High-Speed Aerodynamics	Dr. Ivett A. Leyva
A.4.b.	Human Performance and Biosystems	Dr. Patrick O. Bradshaw
A.2.e.	Information Assurance and Cybersecurity	Dr. Tristan N. Nguyen
A.3.d.	Laser and Optical Physics	Dr. Gernot S. Pomrenke (acting)
A.1.f.	Low Density Materials	Dr. Jaimie Tiley (acting)
A.4.c.	Mechanics of Multifunctional Materials and Microsystems	Dr. Byung-Lip (Les) Lee
A.4.d.	Molecular Dynamics and Theoretical Chemistry	Dr. Michael R. Berman
A.1.g.	Multi-Scale Structural Mechanics and Prognosis	Dr. Jaimie Tiley
A.4.e.	Natural Materials, Systems, and Extremophiles	Dr. Sofi Bin-Salamon (acting)
A.2.f.	Optimization and Discrete Mathematics	Dr. Jean-Luc Cambier (acting)
A.3.e.	Optoelectronics and Photonics	Dr. Gernot S. Pomrenke
A.4.f.	Organic Materials Chemistry	Dr. Kenneth Caster
A.6.	Other Innovative Research Concepts	Dr. Kenneth C. Goretta (acting)
A.3.f.	Plasma and Electro-Energetic Physics	Dr. Jason A. Marshall
A.3.g.	Quantum Electronic Solids	Dr. Harold Weinstock
A.3.h.	Quantum Information Sciences	Dr. Grace Metcalfe
A.3.i.	Remote Sensing	Dr. Stacie E. Williams

A.2.g.	Science of Information, Computation, Learning, and Fusion	Dr. Richard D. (Doug) Riecken
A.1.h.	Space Propulsion and Power	Dr. Mitat A. Birkan
A.3.j.	Space Science	Dr. Julie J. Moses
A.2.h.	Systems and Software	Dr. James H. Lawton (acting)
A.1.i.	Test Science for Test and Evaluation	Dr. Michael J. Kendra
A.2.i.	Trust and Influence	Dr. Benjamin A. Knott
A.3.k.	Ultrashort Pulse Laser-Matter Interactions	Dr. Riq Parra

If you submit a question by telephone call, fax message, or other means you may not receive a response.

2. GENERAL INQUIRIES AND QUESTIONS

You must send all general questions about this announcement to us by email. Your questions will generally be consolidated with other questions and posted on Grants.gov so everyone gets the same information. We may provide an individual response by email if your question does not apply to anyone else.

KING C. NWOHA, AFOSR/PKC
Procurement Analyst
Email: afosr.baa@us.af.mil

KYLE R. BLAKE, AFOSR
Contract Specialist
Email: afosr.baa@us.af.mil

H. OTHER INFORMATION

1. OMBUDSMAN

(a) An ombudsman has been appointed to hear and facilitate the resolution of concerns from offerors, potential offerors, and others for this acquisition. When requested, the ombudsman will maintain strict confidentiality as to the source of the concern. The existence of the ombudsman does not affect the authority of the program officer, grants officer, contracting officer, or source selection official. Further, the ombudsman does not participate in the evaluation of proposals, the source selection process, or the adjudication of protests or formal grant or contract disputes. The ombudsman may refer the party to another official who can resolve the concern.

(b) Before consulting with an ombudsman, interested parties must first address their concerns, issues, disagreements, and/or recommendations to the grants or contracting officer for resolution. Consulting an ombudsman does not alter or postpone the timelines for any other processes (e.g., agency level bid protests, GAO bid protests, requests for debriefings, employee-employer actions, contests of OMB Circular A-76 competition performance decisions).

(c) If resolution cannot be made by the grants or contracting officer, concerned parties may contact the AFRL Ombudsman: Ms. Barbara G. Gehrs HQ AFRL/PK, Wright-

Patterson AFB OH. Telephone: (937) 904-4407; Email: barbara.gehrs@us.af.mil.

(d) Concerns, issues, disagreements, and recommendations that cannot be resolved at the MAJCOM/DRU or AFISRA level, may be brought by the concerned party for further consideration to the U.S. Air Force ombudsman, Associate Deputy Assistant Secretary (ADAS) (Contracting), SAF/AQC, 1060 Air Force Pentagon, Washington DC 20330-1060, phone number (571) 256-2397, facsimile number (571) 256-2431.

(e) The ombudsman has no authority to render a decision that binds the agency.

(f) Do not contact the ombudsman to request copies of the solicitation, verify offer due date, or clarify technical requirements. Such inquiries shall be directed to the grants or contracting officer.

2. GRANTS AND CONTRACTING OFFICERS AUTHORITY

Grants and Contracting Officers acting within their warranted capacity are the only individuals legally authorized to make commitments or bind the Government.

No other individuals are authorized to make commitments or otherwise bind us.

3. ADDITIONAL FUNDING OPPORTUNITIES

We post new funding opportunities throughout the year looking for today's breakthrough science for tomorrow's Air Force. You can find more information about Air Force Office of Scientific Research interests and funding opportunities on our website at http://www.wpafb.af.mil/afrl/afosr.

Thank you for your interest in this announcement.