



Integrity ★ Service ★ Excellence

Basic Research in Space Science at AFOSR

12 May 2015

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Air Force Office of Scientific Research

Air Force Research Laboratory

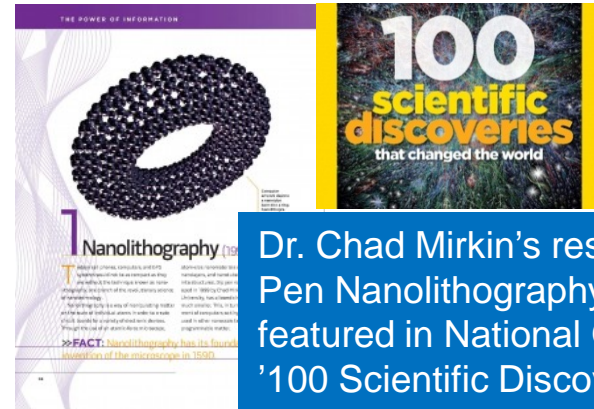
Arlington, Virginia



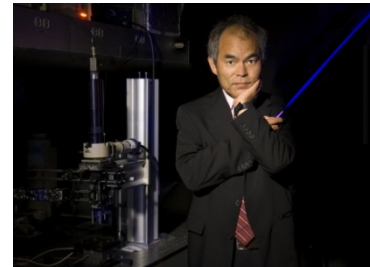
Why the Air Force Invests in Basic Research



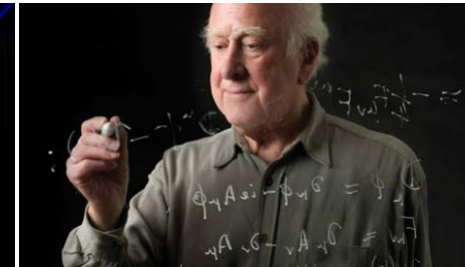
- To probe today's technology limits and ultimately lead to future technologies with DoD relevance
- Attract the most creative minds to fields of critical DoD interest
- Create a knowledgeable workforce in fields of critical DoD interest



Dr. Chad Mirkin's research on Dip Pen Nanolithography was featured in National Geographic's '100 Scientific Discoveries That Changed the World'



2014 Nobel Prize in Physics - Dr. Shuji Nakamura, Univ of California, Santa Barbara



2013 Nobel Prize in Physics – Dr. Peter Higgs, Univ of Edinburgh



AFOSR Sponsored 78 Nobel Laureates



2 AFRL scientists and 4 AFOSR-funded scientists received 2013 Nobel Prize



AFOSR Vision & Mission



- **Vision**

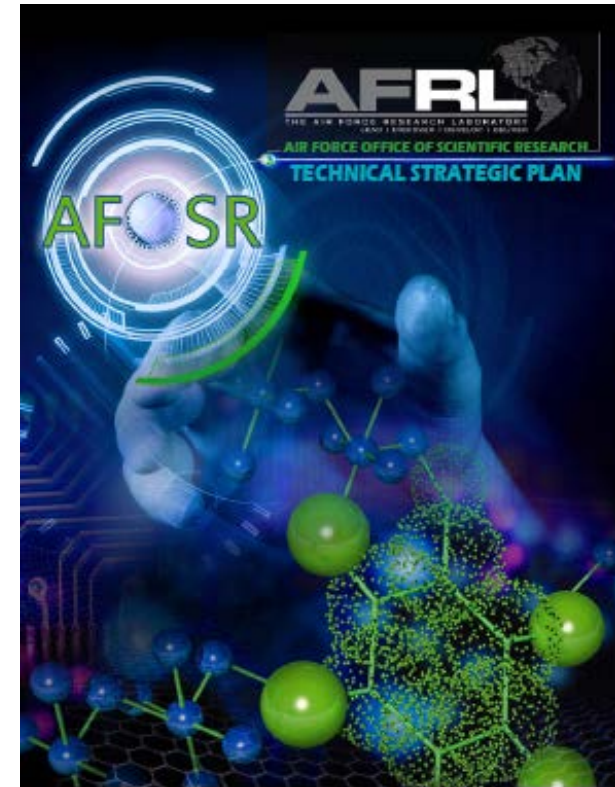
- The U.S. Air Force dominates air, space, and cyber through revolutionary basic research

- **Mission**

- Discover, shape, and champion basic science that profoundly impacts the future Air Force

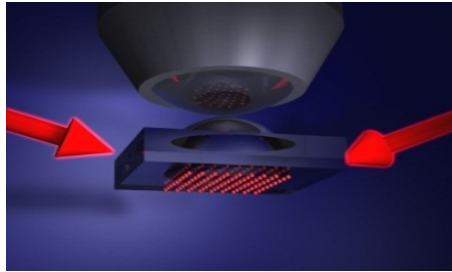
- **Scope**

- AF basic research program - \$373M in FY14, \$390M in FY15
- AF part of the OSD University Research Initiative program - \$138M in FY14, \$147M in FY15





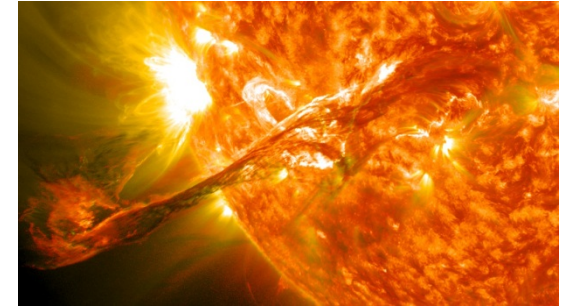
Basic Research at AFRL's Technical Directorates



RY – Develop new jam-free navigation



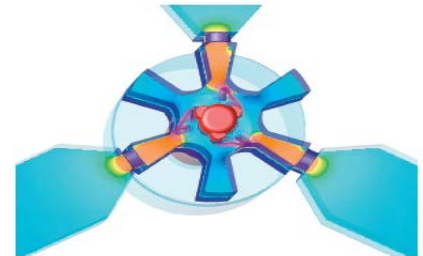
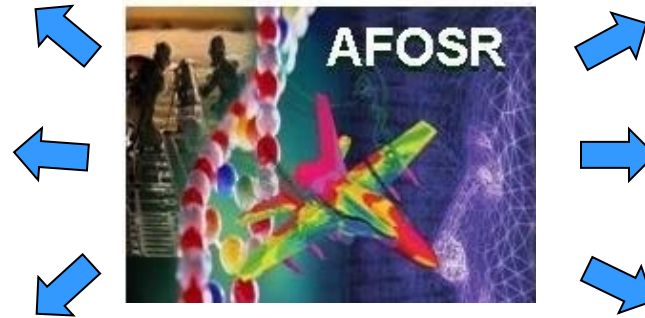
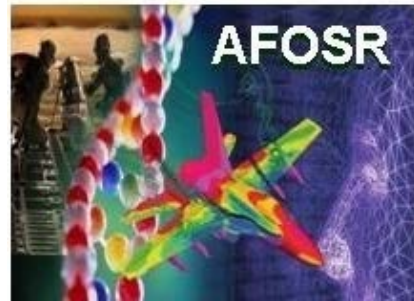
RX - Develop novel energetic materials



RV – Emphasis on ICME forecasting and modeling



RH – Human performance & complex human-machine interactions



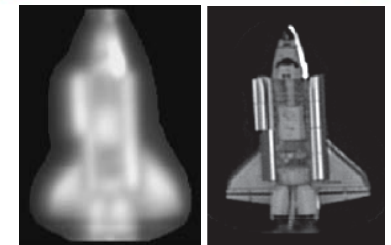
RI – Develop robust cyber command and control system



RQ – Development of Hypersonic vehicles



RW - Developing new fuse and sensors technologies



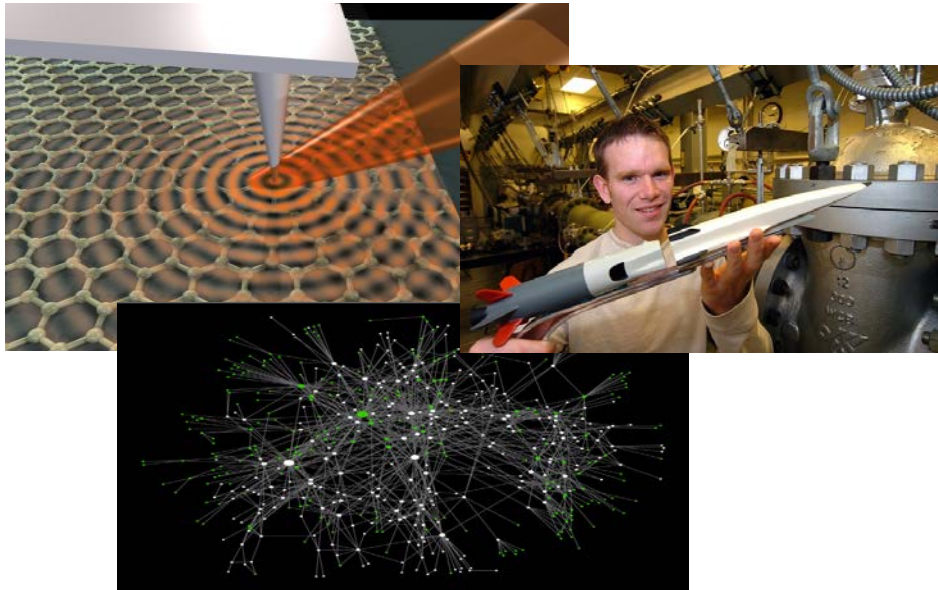
RD - Image restorations & high energy physics



Executing Our Mission



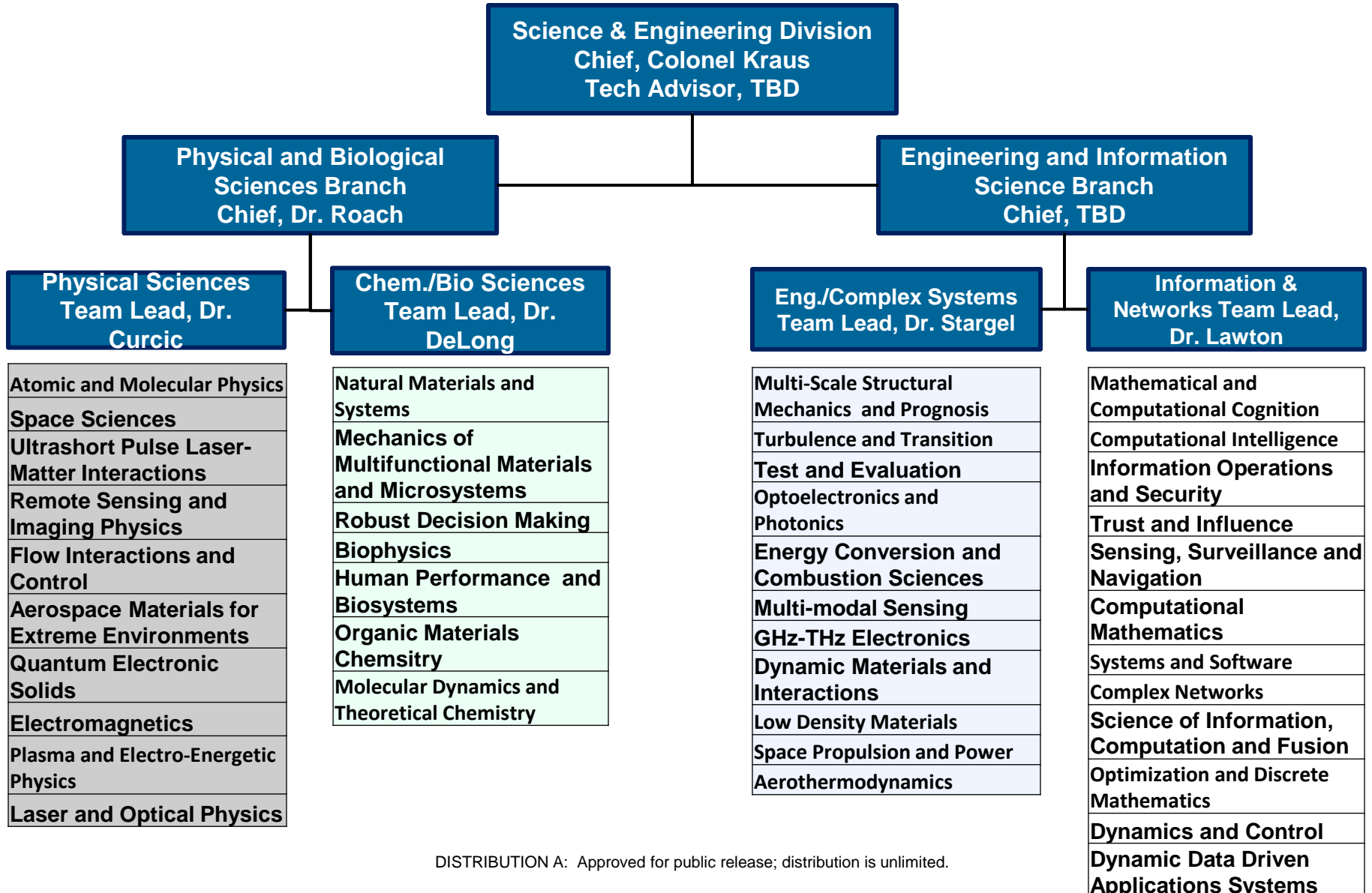
- **Intramural (AFRL) program**
(~30% of discretionary funding)
 - Lab tasks
 - Academic connections
 - International opportunities



- **Extramural (university and industry) programs**
 - Grants
 - Young Investigators
 - STTR contracts












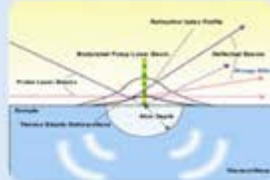

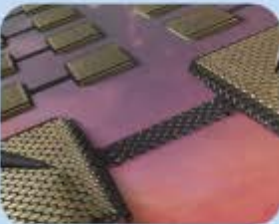

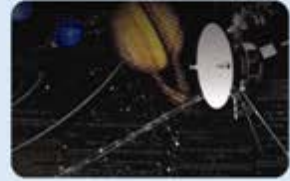



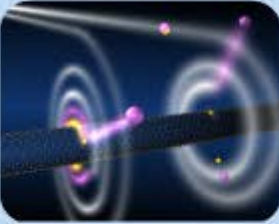
AFOSR Tech Divisions





60 Years of AFOSR Breakthroughs



1950s	1960s	1970s	1980s	1990s	2000+
 Maser/Laser	 The Computer Mouse	 Chemical Oxygen Iodine Laser (Coil)	 Low-Temperature Gallium Arsenide	 Self-healing Plastics	 Joint Percussion Airdrop System
 Stealth	 Code Division Multiple Access System for GPS	 Superplastics Forming	 Laser Diagnostics	 Dip-pen Nanolithography	 Graphene Material
 Kalman Filter	 Viterbi Decoding Algorithm	 Air Fracture Mechanics Methodology	 High-Efficiency Compressor Blades	 Laser Trapping	 Ultracold Atoms



What is Space Science?



- **Space Weather**
 - Effects of space environment on AF/DoD/Society
- **6.2/6.3 Applied Research**
 - Mitigation of adverse space weather effects
 - Forecasting space weather
 - Exploiting geospace to AF advantage
- **6.1 Research**
 - What is the science – physics, chemistry – of space weather?
 - What science enables space weather forecasting?
 - What is the science behind changes in geospace?



Portfolio Organization



- **Research Community (NSF, NASA, etc.) is organized by region.**
 - Sun
 - Solar wind
 - Magnetosphere
 - Ionosphere
 - Neutral atmosphere
- **AFRL, Applied Community is organized by application.**
 - Satellite drag, Astrodynamics
 - Communication
 - Precision Navigation and Timing
 - Satellite/astronaut survivability
 - RF Sensing and OTH radar
 - Civilian applications (i.e. power grids, GPS, radiation exposure, climate)



Portfolio Organization



- **Emphasis on Forecasting**
- **Organized by science problem:**
 - **Solar Disturbances** (Satellite survivability, Pilot radiation exposure)
 - **Magnetic field evolution in the solar wind** (Prediction of geomagnetic storms, Satellite survivability)
 - **Solar Disturbances** (Satellite survivability, Pilot radiation exposure)
 - **Ionosphere/neutral atmosphere coupling and energy flow in the polar cap** (Satellite drag, OTH Radar)
 - **Dynamic structure of the ionosphere** (OTH radar, communication, navigation)
 - **Physics and chemistry of the neutral atmosphere** (Satellite drag, re-entry)
 - **Physics of the radiation belts** (Satellite survivability)



How to select grants



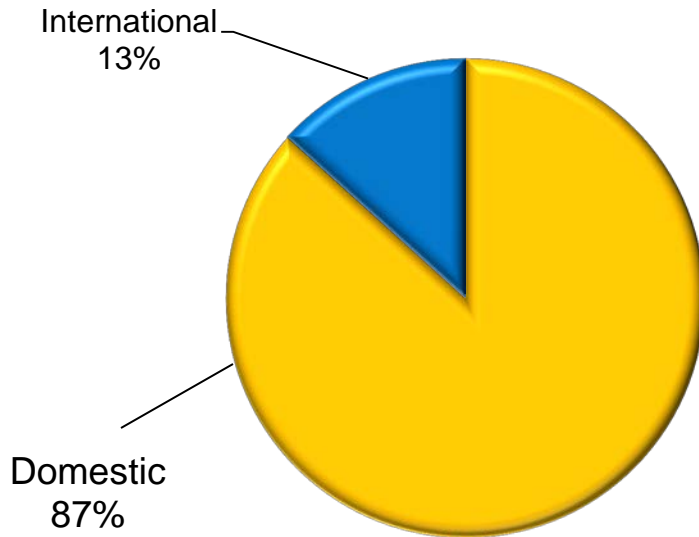
- **Select based on:**
 - **Excellence (best proposal, best idea)**
 - **Contribution to the solution of an AF problem**
 - **Leads to ability to forecast**
 - **Basic knowledge in an area not dominated by others**
 - **Funding – There are always more good ideas than money to fund them**



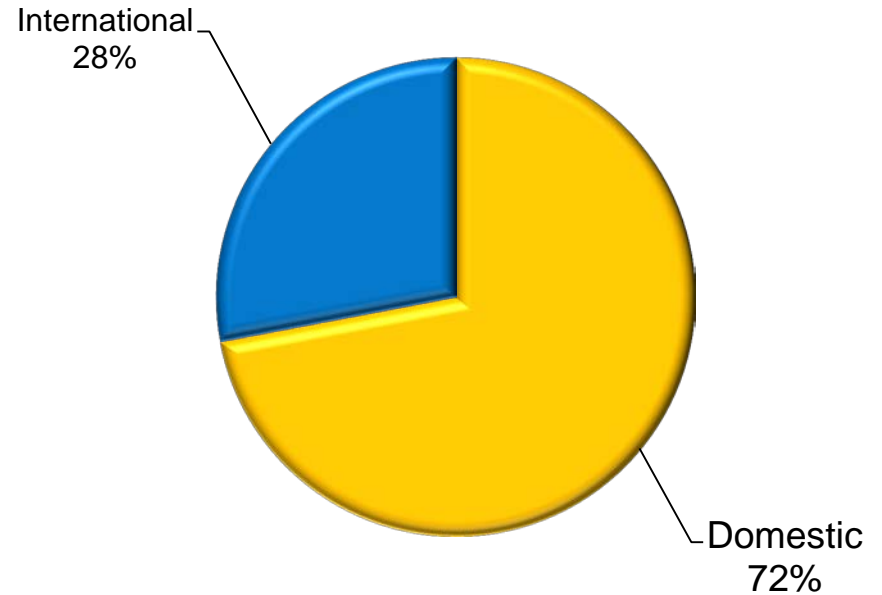
International Investment



Funding



Investigators





AFOSR Space Group



Develop and Coordinate World-wide Strategy and Investments in Basic Space Science and SSA

Members:

- Dr. Ingrid Wysong, AOARD
- LtCol Kevin Bollino, EOARD
- Dr. Tom Caudill, EOARD
- Mr. Jim Fillerup, SOARD
- Dr. Kent Miller, AFOSR
- Dr. Julie Moses, AFOSR

Share information, Monthly meetings, Documents folder:

- TD interests and research needs
- Awareness by all of existing and planned grants
- Worldwide science state-of-the-art

Develop topics for future research focus areas



International Strategy



- Fulfill mission: **awareness, engagement, relationships**
 - Awareness of international S&T activity; emerging trends
 - Engage top-notch overseas researchers & build ties to TDs, etc.
- **Align with new trends & leverage world-leaders in strategic areas**
- **Address challenges ID'ed by Nat'l policy, MAJCOM, AFRL, Other**
- **Targeted investment approach**
 - “**Complement, supplement, benchmark**” AFRL TD investment
- **Promote teaming/collaboration:**
 - i.e. in UK: MoD (Dstl), DoD (AFRL), Met Office/NOAA/AFWA
 - Teaming to provide new concepts and techniques for space weather analysis and forecasting
- **Leverage international investment**



Summary



- **The Air Force continues to discover, shape, and champion basic science that profoundly impacts the future Air Force**
- **Air Force basic research:**
 - **Probes today's technology limits and ultimately leads to future technologies**
 - **Coordinates with government and industry to ensure that leveraging opportunities are exploited for innovation**
 - **Creates a knowledgeable workforce in fields of critical interest to the Air Force**
 - **Prevents technology surprise**

Social Media



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