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Mathematical Sciences in the FY 2014 Budget

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Highlights

- The **National Science Foundation's (NSF) Division of Mathematical Sciences (DMS)** budget is estimated to increase by 2.8 percent over the FY 2012 enacted budget to $245 million.
- **Department of Defense (DOD)** funding for the mathematical sciences is estimated to decrease by 10.4 percent from FY 2012 to $122 million.
- The aggregate funding for the mathematical sciences in the **Department of Energy (DOE)** is estimated to increase by 5.4 percent.

Introduction

Research in the mathematical sciences is funded primarily through the National Science Foundation (NSF), the Department of Defense (DOD, including the National Security Agency), the Department of Energy (DOE), and the National Institutes of Health (NIH). NSF is the federal agency with the largest budget for the mathematical sciences. Over 60 percent of all federal support for academic research in the mathematical sciences comes from NSF and it is the only agency that supports mathematics research broadly across all fields. The majority of research in the mathematical sciences in the U.S. is performed by academic researchers. DOD, DOE, and NIH support mathematical sciences research that contributes to their missions.

Trends in Federal Support for the Mathematical Sciences

The FY 2014 budget request increases total federal research by 7.5 percent over FY 2012. This includes a 4.5 percent increase for basic research and a 10.6 percent increase for applied research. NSF increases research by

9.8 percent, the DOE Office of Science by 5.6 percent, and DOD increases basic research by 6 percent over FY 2012. For the mathematical sciences FY 2014 increases over FY 2012 are NSF 2.8 percent, and DOE 5.4 percent. Mathematical sciences in DOD decrease by 10.4 percent from FY 2012. (see Table 1).

Table 1. Mathematical Sciences in the Federal R&D Budget
(budget authority in millions of dollars)

	FY 2012 Actual	**FY 2014 Budget**	Change FY 12-14* Amount	Percent
National Science Foundation				
Mathematical Sciences	238	**245**	7	2.8%
Department of Defense	136	**122**	-14	-10.4%
Air Force Off of Sci Res	51	**42**	-9	-17.1%
Army Research Office	18	**17**	-1	-4.4%
Def Adv Res Proj Agency	32	**30**	-2	-7.0%
Natl Security Agency	6	**5**	-1	-14.5%
Office of Naval Research	29	**27**	-2	-5.3%
Department of Energy	92	**96**	5	5.4%
Applied Math	46	**50**	4	8.7%
SciDAC 1/	46	**47**	1	2.1%

Source: Agency budget justifications and other agency communications. All figures rounded to the nearest million. Changes calculated from unrounded figures.
1/ Scientific Discovery through Advanced Computing

Research in the mathematical sciences contributes to the country's intellectual capacity and enables discovery in fields of science and engineering. Advances in many areas such as medicine, cyber security, and weather prediction depend on mathematical sciences research, and today's world of large complex data sets and powerful computing environments require continuing development of sophisticated mathematical and statistical tools.

National Science Foundation (NSF). The Division of Mathematical Sciences (DMS)[1] is housed in the NSF Directorate of the Mathematical and Physical Sciences (MPS). DMS has two modes of support: (1) research and education grants, and (2) institutes. Grants include individual-investigator awards; awards for groups of researchers, including multi-disciplinary; and educational and training awards. Approximately 53 percent of the

1 http://www.nsf.gov/div/index.jsp?div=DMS

DMS budget is available for new research grants and the remaining 47 percent is used primarily to fund continuing grants made in previous years.

The Division supports core research programs in algebra and number theory; analysis; applied mathematics; computational mathematics; geometry and topology; mathematical biology; probability; combinatorics and foundations; and various areas within statistics. In FY 2014, DMS plans to increase the number of CAREER awards and will participate in the Cyber-Infrastructure Framework for 21st Century Science, Engineering and Education (CIF21); Science, Engineering, and Education for Sustainability (SEES); Secure and Trustworthy Cyberspace (SaTC); Research Experiences for Undergraduates (REU); and, Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS). DMS will also fund work through the Cognitive Science and Neuroscience agency-wide program.

Air Force Office of Scientific Research (AFOSR). Portfolios for the mathematical sciences at AFOSR are found in the Division of Dynamical Systems and Control, Division of Quantum and Non-Equilibrium Processes, and the Division of Information, Decision, and Complex Networks. The AFOSR mathematics program includes specific portfolios in Dynamics and Control, Multi-Scale Modeling, Computational Mathematics, Mathematical and Computational Cognition, Optimization and Discrete Mathematics, Electromagnetics; Science of Information, Computation, and Fusion; and Sensing, Surveillance, and Navigation. For additional information on areas of focus within each of these portfolios, refer to the AFOSR Research Areas Webpage[2] and Broad Agency Announcement.

Army Research Office (ARO). The Mathematics Sciences Division, housed in the Information Sciences Division,[3] manages the following programs: modeling of complex systems; probability and statistics; biomathematics; and numerical analysis. The Division plays an essential role in developing the fundamental understanding that underpins the modeling, analysis, design, and control of complex phenomena and large-scale systems which are of critical interest to the Army. Areas of application include communication networks, image analysis, pattern recognition, test and evaluation of new systems, sensor networks, network science, autonomous systems, and

2 http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=8973

3 http://www.arl.army.mil/www/default.cfm?page=185

mathematics of biological systems. The Division also works closely with the Computing Sciences Division and Network Science Division of ARO to develop mathematical theory for systems control, information processing, information assurance, network design, and data fusion.

Defense Advanced Research Projects Agency (DARPA). The Defense Sciences Office (DSO)[4] and the Microsystems Technology Office (MTO) inside DARPA both have mathematics programs cutting across mathematics and its applications. Current DSO program themes include topological and geometrical methods, extracting knowledge from data, and new approaches for conducting focused research to explore fundamental interconnections between key areas of mathematics where critical insights should lead to both new mathematics and innovative applications.

National Security Agency (NSA). As the largest employer of mathematicians in the United States, NSA has a vested interest in maintaining a healthy academic mathematics community in the United States. The Mathematical Sciences Program (MSP)[5] of NSA administers a Grants Program that supports undirected fundamental research in the areas of algebra, number theory, discrete mathematics, probability, and statistics. The Grants Program also accepts proposals for conferences and workshops in these research areas, together with proposals for Research Experiences for Undergraduates and other special projects that advance the U.S. mathematics community at the college level and above. In addition to these grants, MSP supports an in-house faculty Sabbatical Program for university professors and others to perform research at NSA. The program administrators are especially interested in supporting initiatives that encourage the participation of underrepresented groups in mathematics (such as women, African-Americans, and other minorities).

Office of Naval Research (ONR). The ONR Mathematics, Computers, and Information Research Division's scientific objective is to establish rigorous mathematical foundations and analytical and computational methods that enhance understanding of complex phenomena and enable prediction and control of Naval applications in the future.[6] Basic research in the mathematical sciences is focused on analysis and computation for multi-

4 http://www.darpa.mil/default.aspx

5 http://www.nsa.gov/research/math_research/index.shtml

6 http://www.onr.navy.mil/Science-Technology/Departments/Code-31/All-Programs/311-Mathematics-Computers-Research.aspx

phase, multi-material, multi-physics problems; predictability of models for nonlinear dynamics; electromagnetic and acoustic wave propagation; data analysis and understanding; information theoretical approaches for signal processing; optimization; modeling and exploiting hybrid control of large, dynamic complex networks; and computational foundations for machine reasoning and intelligence to support autonomous decision making. Also of interest are computational frameworks and formal methods for secure and autonomic computing systems and quantum information sciences, a program that began in FY 2013.

Department of Energy (DOE). Mathematics at DOE is funded through the Office of Advanced Scientific Computing Research (ASCR),[7] one of the interdisciplinary research offices within DOE's Office of Science. Research supported by ASCR underpins computational science throughout DOE. ASCR funding for the mathematical sciences is found primarily in the Applied Mathematics program and the Scientific Discovery through Advanced Computing (SciDAC) program. The Applied Mathematics activity supports the research, development, and application of applied mathematical models, methods and algorithms to understand complex physical, chemical, biological, and engineered systems related to the Department's mission. SciDAC investments address dramatically accelerating progress in scientific computing that delivers breakthrough scientific results through partnerships between applied mathematicians, computer scientists, and scientists from other disciplines. These efforts apply results from applied mathematics and computer science core research to scientific applications sponsored by other Office of Science programs.

National Institutes of Health (NIH). NIH funds mathematical sciences research through the National Institute of General Medical Sciences (NIGMS)[8] and the National Institute of Biomedical Imaging and Bioengineering (NIBIB).[9] Mathematical sciences areas of interest are those that support the missions of NIGMS and NIBIB. The NIGMS Division of Biomedical Technology, Bioinformatics, and Computational Biology supports research for understanding complex biological systems. Research and training funded by the Division join biology with

7 http://www.science.energy.gov/ascr/

8 http://www.nigms.nih.gov/About/Overview/cbcb.htm

9 http://www.nibib.nih.gov/Research/ProgramAreas/MathModeling

computer science, engineering, mathematics, and physics. Grants in computational biology support development of modeling and simulation tools and methods for analyzing and disseminating computational models. NIBIB supports the mathematical sciences through the Mathematical Modeling, Simulation and Analysis Program Area. This program supports mathematical models and computational algorithms with potential clinical or biomedical applications. Research includes mathematical, statistical, transport, network, population, mechanical, electrical and electronic models applied to a broad range of biomedical fields. The analysis portion of this program supports the development of mathematical, statistical and signal processing methods for the analysis of complex biomedical systems, clinical diagnosis, and patient monitoring.