Mathematical Sciences in the FY 2013 Budget

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Highlights

- The National Science Foundation's (NSF) Division of Mathematical Sciences (DMS) budget is estimated to increase by 3.0 percent over FY 2012 to $245 million.
- Department of Defense (DOD) funding for the mathematical sciences is estimated to grow by 7.3 percent over FY 2012 to $129 million.
- The aggregate funding for the mathematical sciences in the Department of Energy (DOE) is estimated to increase by 18.3 percent.

Introduction

Research in the mathematical sciences is funded primarily through the National Science Foundation, the Department of Defense (including the National Security Agency), the Department of Energy, and the National Institutes of Health (NIH). NSF is the federal agency with the largest budget for the mathematical sciences. Sixty-four 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 United States is performed by academic researchers. DOD, DOE, and NIH support mathematical sciences research that contributes to their missions.

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This article originally appeared as a chapter about funding in the mathematical sciences in AAAS Report XXXVII: Research & Development FY 2012, *published by the American Association for the Advancement of Science. The report is available at* http://www.aaas.org/spp/rd/rdreport2012.

DOI: http://dx.doi.org/10.1090/noti913

Trends in Federal Support for the Mathematical Sciences

Even in the current economic and political climate, the FY 2013 Budget Request increases federal total research by 3.3 percent over FY 2012. This includes a 1.5 percent increase for basic research and a 5.0 percent increase for applied research. NSF increases research by 4.2 percent, the DOE Office of Science by 4.5 percent, and DOD by 0.2 percent. These amounts translate into increases for the mathematical sciences in these agencies: NSF (3.0 percent), DOE (18.3 percent), and DOD (7.3 percent). See Table 1.

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 essentially two modes of support: (1) research and education grants, and (2) institutes. Grants include individual investigator awards; awards for groups of researchers, including multidisciplinary; and educational and training awards. Each year typically 60 percent of the DMS budget is available for new research grants, and the remaining 40 percent is used primarily to fund continuing grants made in previous years.

The division supports core research programs in algebra and number theory, analysis,

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

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

	FY 2011 Actual	FY 2012 Budget	**FY2013 Estimate**	Change Amount	FY 12–13 Percent
National Science Foundation					
Mathematical Sciences	240	238	245	7	3.0
Department of Defense	118	121	129	9	7.3
Air Force Off. of Sci. Res.	58	47	52	4	9.3
Army Research Office	16	16	16	0	0.0
Def. Adv. Res. Proj. Agency	16	28	28	0	0.0
Natl. Security Agency	6	6	7	0	7.3
Office of Naval Research	22	24	28	4	16.7
Department of Energy	98	90	106	16	18.3
Applied Mathematics	46	46	50	4	8.6
SciDAC*	53	44	57	13	28.3

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

applied mathematics, computational mathematics, geometry and topology, mathematical biology, probability, combinatorics and foundations, and various areas within statistics. In FY 2013, through the OneNSF Framework, DMS will participate in the Cyber-Infrastructure Framework for the 21st Century Science and Engineering (CIF21); Cyber-enabled Materials Manufacturing, and Smart Systems (CEMMSS); Science, Engineering, and Education for Sustainability (SEES); Secure and Trustworthy Cyberspace (SaTC); and Expeditions in Education (E^2). Additionally, DMS will take part in the Research at the Interface of Biological, Mathematical, and Physical Sciences (BioMaPS) program.

Air Force Office of Scientific Research (AFOSR). Portfolios for the mathematical sciences at AFOSR are found in the Directorate of Mathematics, Information, and Life Sciences and the Directorate of Physics and Electronics. The AFOSR mathematics program includes specific portfolios in dynamics and control; multiscale modeling; computational mathematics; mathematical modeling of cognition and decision; optimization and discrete mathematics, electromagnetics; and sensing, surveillance, and navigation. For additional information on focus areas within each of these portfolios, refer to the AFOSR Research Areas webpage.[2]

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 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 programs include Focus Areas in Theoretical Mathematics, Knowledge Enhanced Compressive Measurement, Sensor Topology for Minimal Planning, 23 Mathematical Challenges, Protein Design Processes, and Algorithms.

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

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

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

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

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 for naval applications in the future.[6] Basic research in the mathematical sciences is focused on analysis and computation for multiphase, multimaterial, multiphysics 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 framework and formal methods for secure and autonomic computing systems and quantum information sciences, a new start-up program 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 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 Discovery Science and Technology Division research program area, Mathematical Modeling, Simulation and Analysis.

[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

[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