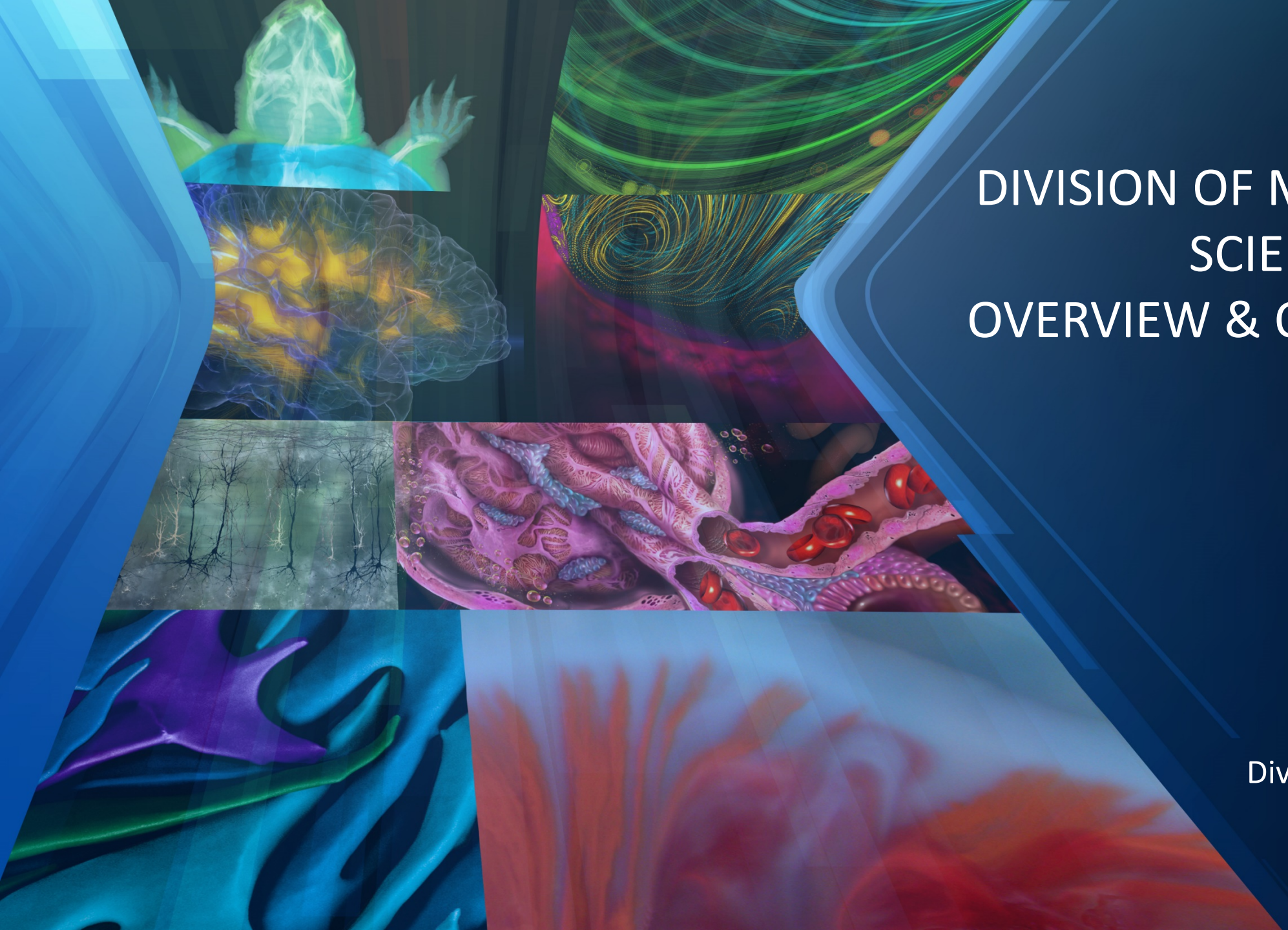


# DIVISION OF MATHEMATICAL SCIENCES: OVERVIEW & OPPORTUNITIES

Juan C. Meza
Division of Mathematical Sciences
April 2018

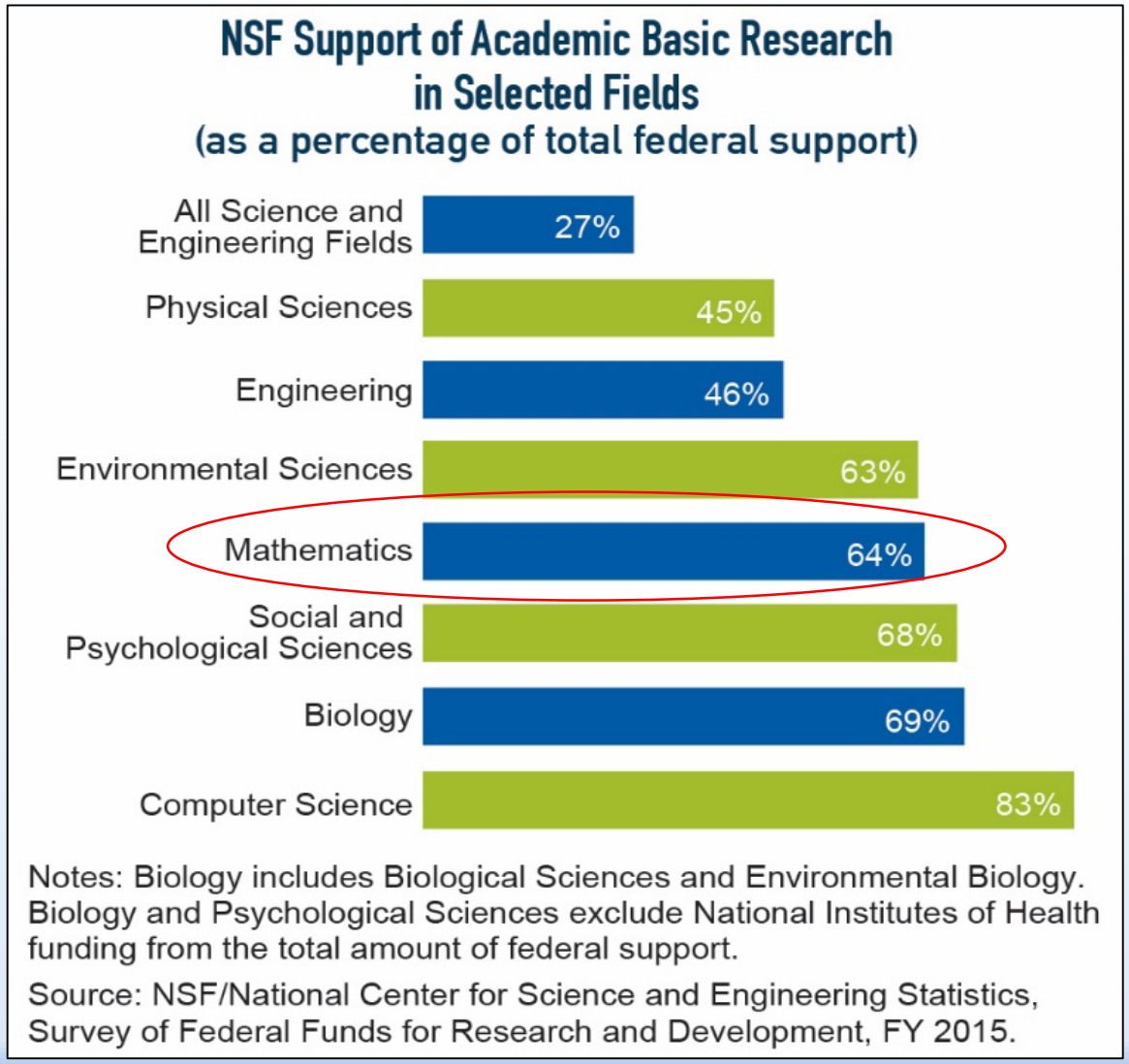
# DMS Highlights and Sample Activities

# DMS Quick Facts

| | |
|---|---|
| $233M | FY17 Budget |
| 64% | Support of US Basic Math Research |
| ~3000 | Proposals reviewed each year |
| 24% | Average Funding Rate |
| 28 | Program Directors |

# NSF/DMS FUNDS 64% OF MATHEMATICS BASIC RESEARCH IN THE US

- DMS is the predominant funder of basic mathematical sciences research in the US
- FY 2017 spending was $233M
- Majority of budget goes toward disciplinary program individual investigator awards



# DMS Major Investment Areas

Institutes & Centers

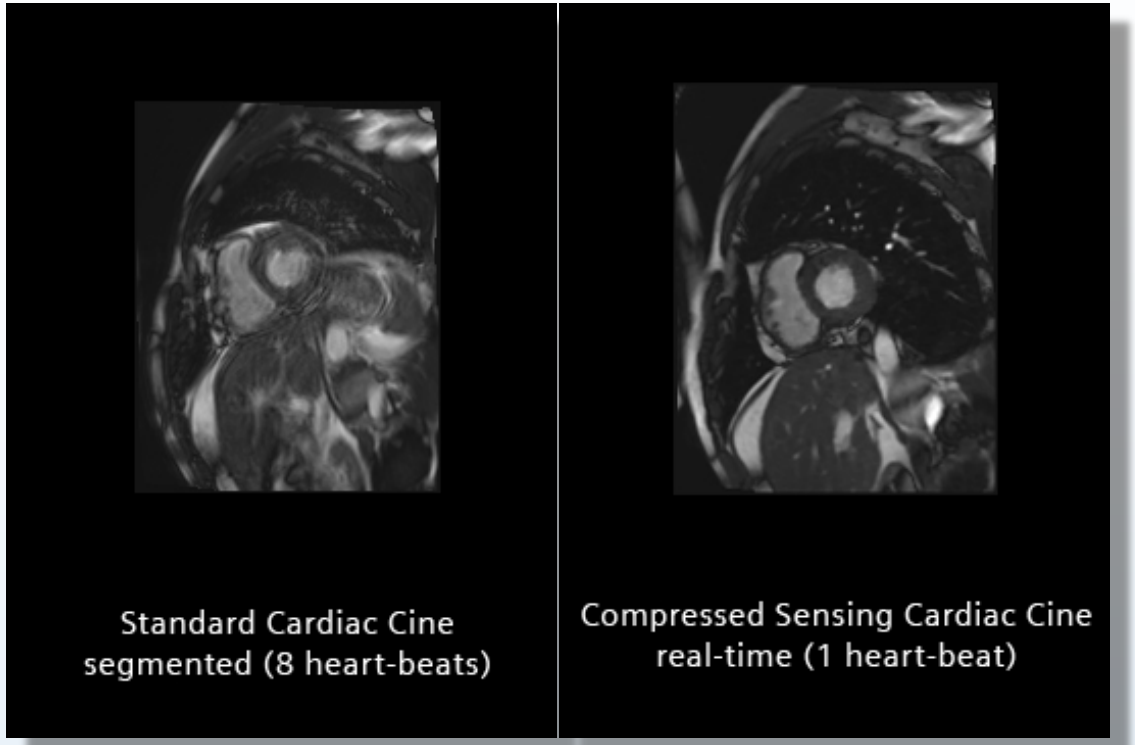
Workforce, Training, MSPRF, CAREER


New Initiatives & Special Programs

Infrastructure

# DMS Funded Research Has a BIG Impact

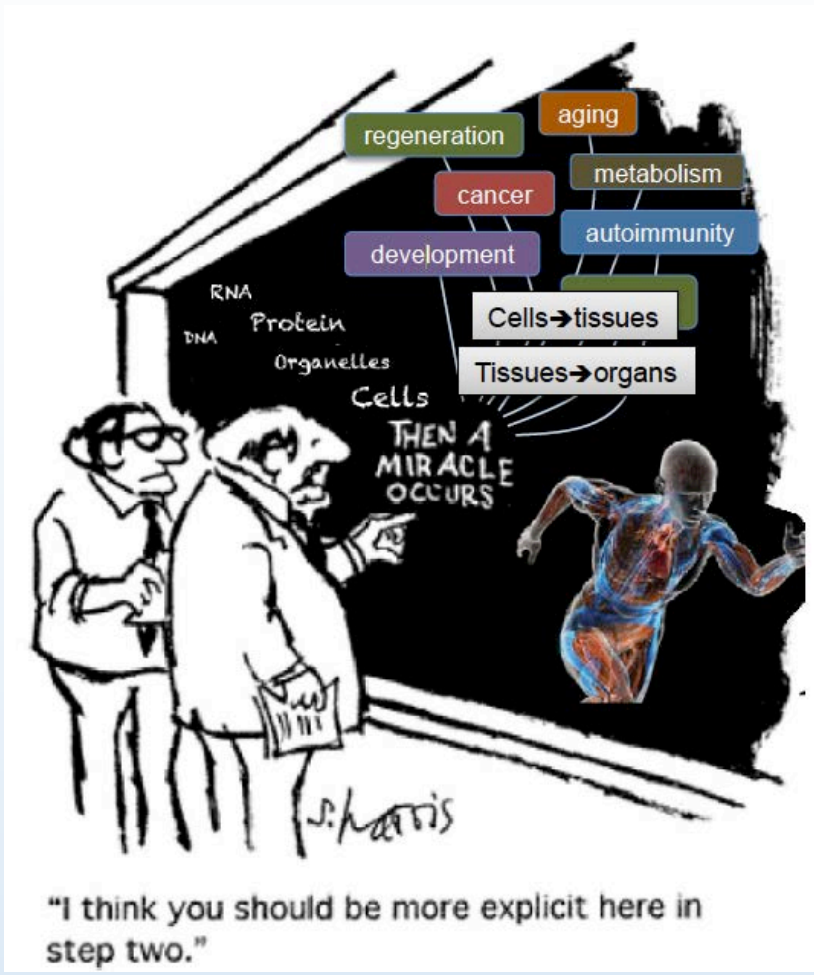
- FDA approved 2 new MRI devices that dramatically speed up scanning, **between 8 and 16 times faster** than conventional methods.
- Both products use **compressed sensing,** a breakthrough technique developed over **10 years ago** by NSF/DMS-supported mathematicians.
- The speedup will **allow more patients to be served at a lower cost per patient**, giving US taxpayers a better return on the tens of billions of dollars in annual MRI charges.




**A Focused Research Group on Multiscale Geometric Analysis – Theory, Tools, Applications.** DMS – 0140698/Donoho (Lead), DMS – 0140540/Candes, DMS – 0140587/Huo, DMS – 0140623/Jones

# NSF-Simons Research Centers for Mathematics of Complex Biological Systems

- Five year, $30M program funded equally by NSF and Simons Foundation
- 3 NSF Divisions: Mathematical Sciences, Integrative Organismal Systems, Molecular and Cellular Biosciences
- Support mathematical approaches aimed at understanding:
  - the complex causal relationships leading to emergent properties of molecular, cellular and organismal systems, or
  - to the emergent properties resulting from the complex integration across these levels of organization at different time scales
- Close, sustained collaborations between biologists and mathematical scientists that leverage their complementary expertise



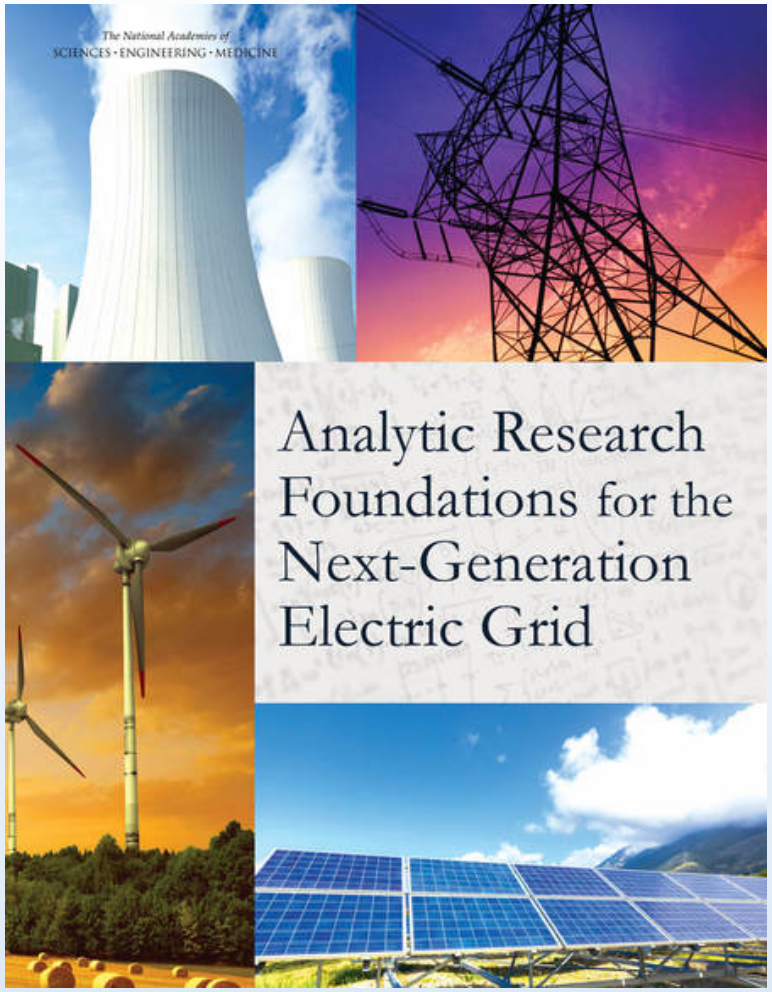
"I think you should be more explicit here in step two."

# TRIPODS - TRANSDISCIPLINARY RESEARCH IN PRINCIPLES OF DATA SCIENCE

- Joint DMS & Division of Computing and Communications Foundations
- Bring together the statistics, mathematics, and theoretical computer science communities to develop the theoretical foundations of data science through integrated research and training activities
- 12 phase I awards. Each $500K per year for three years
- First PI Meeting held in Oct. 2017

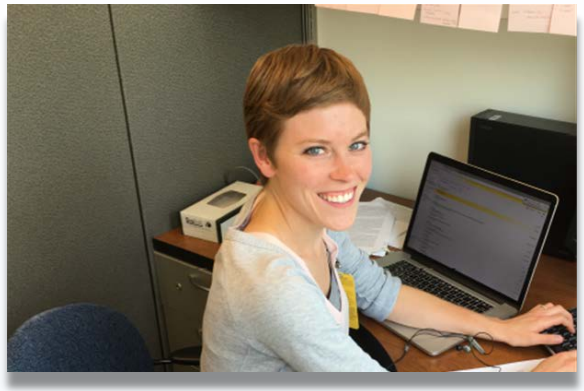
# AMPS – Algorithms for Modern Power Systems

- Collaboration with Department of Energy
- Develop the next generation of mathematical and statistical algorithms for improving the security, reliability, and efficiency of the modern power grid
- 10 projects awarded in FY 2017, PI meeting scheduled in 2018



# MATHEMATICAL SCIENCES GRADUATE INTERNSHIP

- Provide an opportunity for mathematical sciences doctoral students to participate in internships at national laboratories, industry and other approved facilities
- Aimed at students who are interested in understanding the application of advanced mathematical and statistical techniques to "real world" problems, regardless of whether the student plans to pursue an academic or nonacademic career
- 40 graduate students from 38 universities worked in 10 National Labs in the Summer of 2017

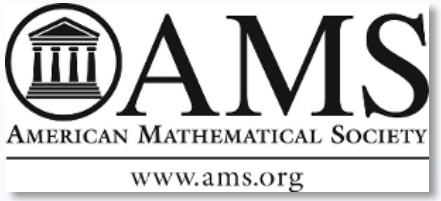


SIAM News Article (12/01/2017)

**Managed by Oak Ridge Institute for Science and Education**

# Infrastructure Serves the Entire Math Community

- Support for a broad range of conferences, especially those with a focus on broadening participation
- Involvement of students and junior investigators a DMS priority
- Support for professional societies, CBMS, National Academies (BMSA and CATS), and international conferences (ICIAM, ICM)

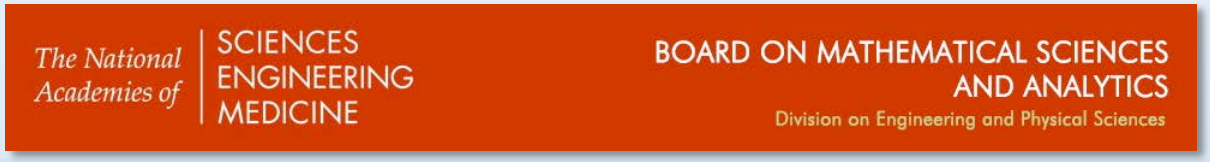












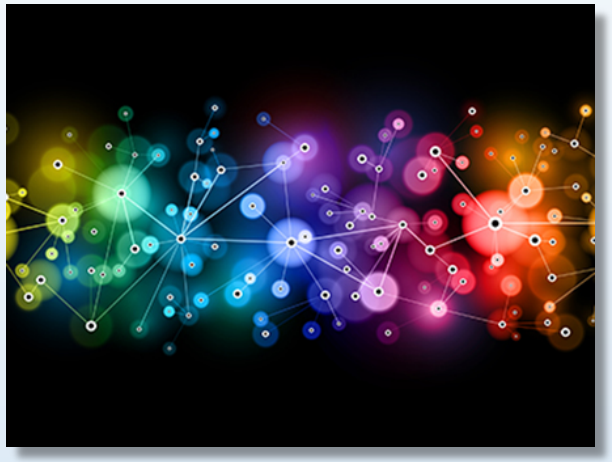
# Opportunities Looking Forward

# TEN BIG IDEAS FOR FUTURE NSF INVESTMENT RESEARCH

- Harnessing Data for 21st Century Science and Engineering
- Understanding the Rules of Life: Predicting Phenotype
- The Quantum Leap: Leading the Next Quantum Revolution
- Windows on the Universe: The Era of Multi-messenger Astrophysics
- Navigating the New Arctic
- The Future of Work at the Human-Technology Frontier

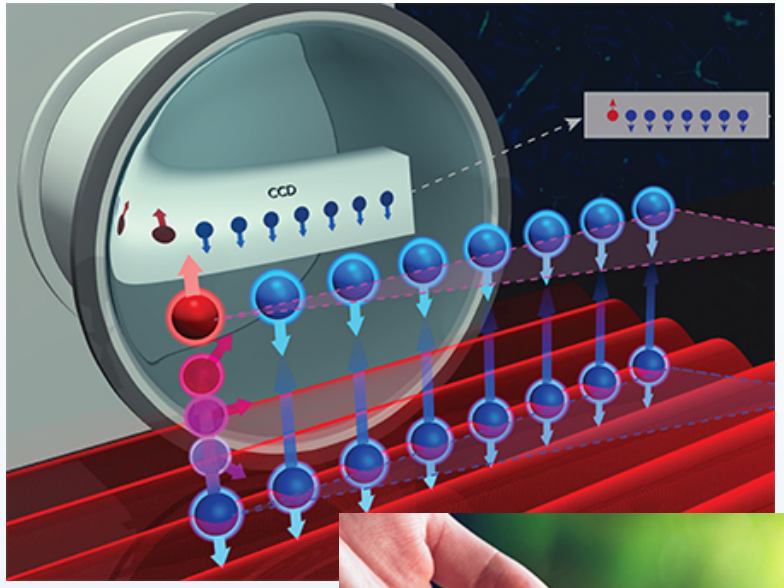
# Ten Big Ideas for Future NSF Investment Process

- Mid-scale Research Infrastructure (RFI: NSF 18-013)
- NSF INCLUDES: Enhancing Science and Engineering through Diversity (NSF 17-591 for INCLUDES Hubs)
- NSF 2026: The Integrative Foundational Funds
- Growing Convergent Research at NSF (DCL: NSF 17-065 and NSF 18-058)



# On the Horizon – Connections to Big Ideas

- Mathematical aspects of advancing fundamental understanding of quantum phenomena, materials, systems, and information processing methods (DCL NSF 18-035 )
- Define the key challenges and research imperatives to understand the organizational principles and rules of living systems. Seeking Conference, EAGER, and RAISE proposals (DCL NSF 18-031)

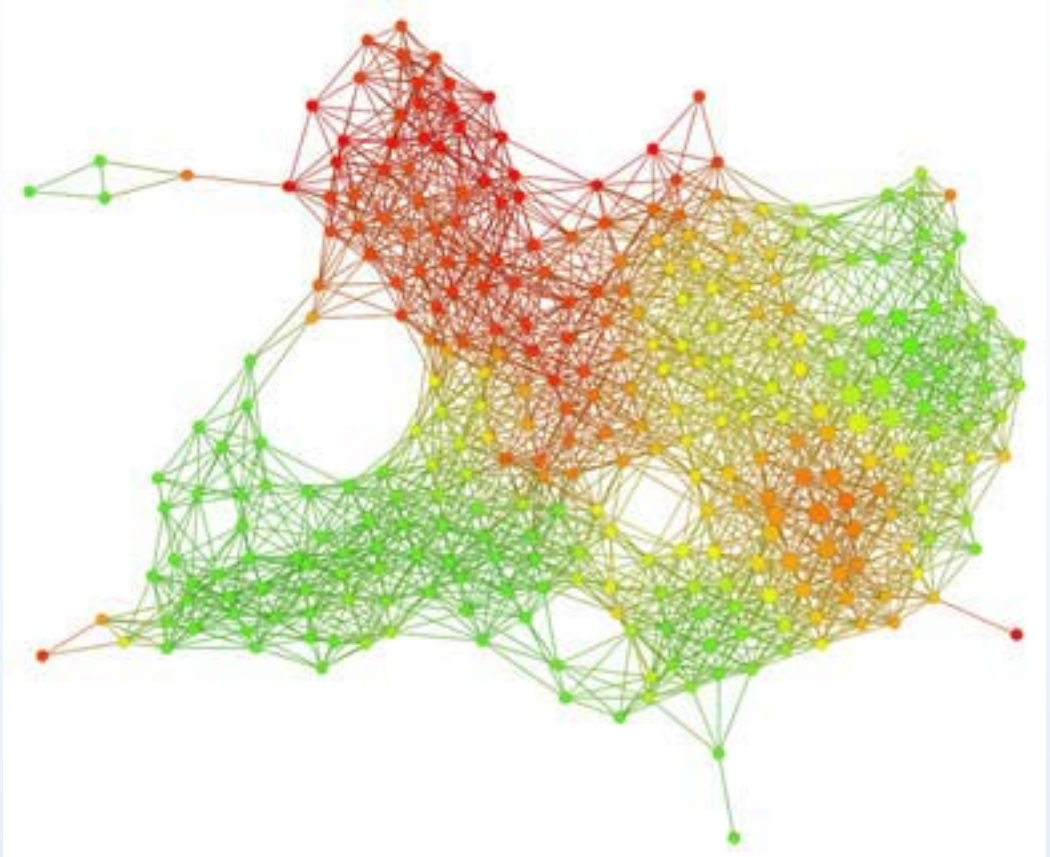



Quantum Leap

Rules of Life

# On the Horizon – Expansion of TRIPODS

- **TRIPODS+X**: Partnerships between SCI/ENG Fields and TRIPODS Institutes (NSF 18-542)
- Webinar held on March 20, 2018
- Three tracks: Research, Visioning, and Education
- **TRIPODS Phase II** in FY 2020, anticipated to call for larger Institutes for up to 5 years of funding



Topological view of CT slices for traumatic brain injury. Red nodes represent slices with intracerebral hemorrhage, while green nodes show normal features. Brock, Brown University, CCF-1740741

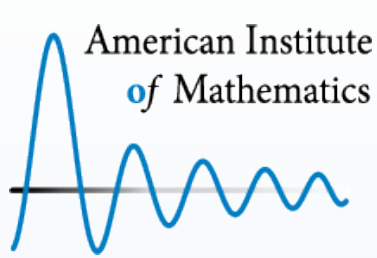
# On the Horizon – Connections to Other Agencies

- **QuBBD** supports research at the intersection of the biomedical and data sciences by encouraging inter- and multi-disciplinary collaborations
- 1 award by NSF (up to 2 more in FY18) and 7 by NIH, **total $8.5M**
- Working on new NSF/DMS and National Library of Medicine MOU for quantitative data science approaches to biomedical data **(FY2019)**

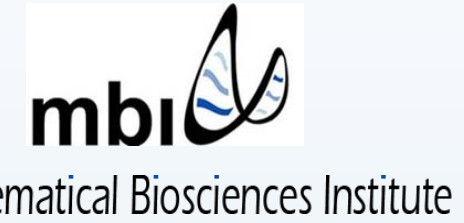
Persistent homology used to develop quantitative morphological descriptors that capture architectural features of prostate glands in pathology images, Wenk, DMS 1664848

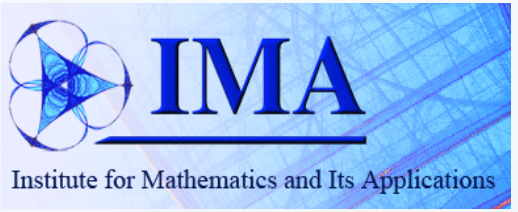
# On the Horizon – Institutes Recompete

- Mathematical Sciences Research Institutes solicitation (NSF 17-553) issued in FY 2017
- Webinar held Feb 20, 2018 with over 70 participants registered
- Proposals due **March 14, 2019**





# SUMMARY

- DMS mathematical sciences research is having a big impact in society, science, engineering
- Moving forward it will be important for DMS to play a role in NSF's 10 Big Ideas
- DMS would like to encourage input from the mathematics and statistics communities

Please help me spread the message

# THANK YOU!