NATIONAL ACADEMIES Sciences Engineering Medicine

Board on Physics and Astronomy
Condensed Matter and Materials Research Committee (CMMRC)

2025 Annual CMMRC Workshop

Frontiers of Materials That Learn: A Workshop

October 2, 2025
Hybrid Meeting
In Person at the Academies Keck Building Room 100 at 500 5th St NW in Washington, DC, 20001
Online via Zoom and Livestream

THURSDAY, OCTOBER 2, 2025

OPEN SESSION

Livestream: see event page here

CLICK HERE TO JOIN

8:20 AM **Welcoming Remarks and Workshop Objectives** — **T. Arul Mozhi**
(10 minutes)
Senior Program Director, Aeronautics, Space, and Astronomy
Board Director, Board on Physics and Astronomy

M. Lisa Manning*
Chair, Workshop Planning Committee
William R. Kenan, Jr. Professor of Physics, Syracuse University

8:30 **Workshop Overview** — **Andrea Liu (NAS)***
(10 minutes)
Member, Workshop Planning Committee
Hepburn Professor of Physics at the University of Pennsylvania

8:40 AM **Session 1: Physical Learning Implemented in Physical Systems**
(20 minute presentation and 10 minutes for Q&A each)
Moderator: Stefano Martiniani, Assistant Professor, New York University

Physical Learning in Mechanical Network Materials — **Xiaoming Mao***
Professor of Physics, University of Michigan

Physical Learning in Resistor and Mechanical Networks — **Doug Durian***
Professor of Physics and Astronomy, University of Pennsylvania

Learning and Inference in Biomolecular Systems — **Erik Winfree***
Professor of Computer Science, Computation and Neural Systems, and Bioengineering, California Institute of Technology

Moderated Discussion — **Session Speakers**

10:40 AM *Break (20 minutes)*

11:00 AM **Session 2: Biological Materials as Substrates for Intelligent Behavior**
(20 minute presentation and 10 minutes for Q&A each)
Moderator: James De Yoreo, Battelle Fellow, Pacific Northwest National Laboratory

Computationally Designed Novel Protein-Protein Interfaces — **Possu Huang***
Assistant Professor of Bioengineering, Stanford University

Ultrasensitive and robust mechanoluminescent living composites — **Shengqiang Cai***
Professor, Mechanical and Aerospace Engineering
University of California, San Diego

(more schedule information on page 2) **: indicates confirmed*

	Moderated Discussion	**Session Speakers**
12:30 PM	*Working lunch (60 mins)*	
1:30 PM	**Session 3: Physical/Chemical Systems as Substrates for Intelligent Behavior** *(20 minute presentation and 10 minutes for Q&A each)* *Moderator: Varda Hagh, Assistant Professor, University of Illinois Urbana Champaign*	
	Dynamically Reconfigurable Network Materials	**Mark Tibbitt *(virtual)**** *Associate Professor of Macromolecular Engineering, ETH Zurich*
	Chemical Reaction Networks	**Bartosz Grzybowski*** *Distinguished Professor of Chemistry, IBS Korea*
	Robot Swarms	**Itai Cohen*** *Associate Professor of Physics, Cornell University*
	Moderated Discussion	**Session Speakers**
3:30 PM	*Break (10 mins)*	
3:40 PM	**Session 4: Looking Forward (Breakouts and Discussion)** *(2 hours 20 minutes)*	
	Opportunities in Industry for Materials that Learn *Moderated by Lisa Manning* *(15 minutes)*	**Discussion**
	Breakout Guidance and Discussion Prompts: *(5 minutes)*	**M. Lisa Manning**
	- What are some of the ideas discussed today that resonated with you and would be exciting directions to pursue? Based on your own expertise, are there additional directions or synergies that should be explored? - What new theoretical, computational, and experimental techniques need to be developed to push this field forward? What is currently limiting progress in this area? - What new functionalities, applications, and use-cases might emerge from discoveries in this topic area? How might discoveries in this field impact other disciplines?	
	Breakout groups *(65 minutes)*	**All in-person attendees**
	Breakout Summaries *(3 groups, 10 minutes each)*	**All attendees**
	Moderated Q&A and Discussion *(25 minutes)*	**All attendees**
6:00 PM	*Adjourn workshop*	

(more important information on page 3) **: indicates confirmed*

IMPORTANT NOTES

Presenters:

- Please do not include ITAR-controlled or sensitive information in your presentation.
- A National Academies Board staff member will ask you to sign a form before the meeting allowing us permission to use your likeness and presentation for our livestream video, which will be posted on our Board website after the meeting. Please get in touch with us before the meeting if you have any concerns about this usage.

Committee & Board Members and Presenters:

- Remote access will be provided through Zoom. This will allow you to participate in the meeting even if you can't be physically present.
- Please note that Zoom allows audio and any materials exchanged or viewed during the session to be recorded and shared.
- By participating in this activity, you agree to let your voice, likeness, and any materials you provide be recorded for use and dissemination. This includes any language, format, or media now known or later devised.
- You release the National Academies of Sciences, Engineering, and Medicine from any and all claims, liability, or damages arising from any such use. If you disagree, please do not join the session.

THANK YOU ALL FOR YOUR COOPERATION, AND WE LOOK FORWARD TO A SUCCESSFUL WORKSHOP.