*Fundamental Quantum Science Program*
*Seminar series No.6*

●Date & Time : **Wednesday 25th September 2024 16:00-17:30**
●Venue : # Room309, Frontier Research Laboratory

# Prof. John M. Doyle

**Department of Physics, Harvard University**

## " Cold and ultra-cold molecules for quantum science "

Polar molecules, due to their intrinsic electric dipole moment and their controllable complexity, are a powerful platform for precision measurement searches for physics beyond the standard model (BSM) and, potentially, for quantum simulation/computation. This talk will discuss the arc of research efforts using cold and ultracold molecules for BSM searches. Starting with an update on the ACME experiment and ending with proposed experiments using ultracold polyatomic molecules with octupole deformed nuclei, the goal is to place in the status of our work in technical context. The possible discovery of BSM physics has led to many experimental efforts to cool and control molecules at the single quantum state level. Polyatomic molecules have attracted new focus as potential novel quantum resources with distinct advantages - and challenges - compared to both atoms and diatomic molecules. I will discuss features of polyatomic molecules can be used in the search for BSM physics, as well as quantum simulation/computation and ultracold chemistry. I will discuss our results on the laser cooling of molecules into the ultracold regime, including the laser cooling of the polyatomic molecules SrOH, YbOH, CaOH and CaOCH3. Finally, if time permits, I will discuss a new type of MOT that increases molecular density by an order of magnitude – important for mode matching MOT clouds of ultracold molecules to conservative optical traps for precision measurements.

・Hosted by : Dr. Naoto Nagaosa
(Fundamental Quantum Science Program)

# Short Biography

John Doyle, Henry B. Silsbee Professor of Physics, Harvard University, grew up in the U.S. and received his bachelor's (1986) and Ph.D. (1991) degrees from the Massachusetts Institute of Technology (M.I.T.). After being a postdoc at M.I.T., he joined Harvard University as an assistant professor of physics in 1993. John Doyle's research centers on using cold molecules for science including particle physics, collisions, and quantum information. Starting with the development a new technique for producing heavy, polar radical molecules in an intense cold beam, he launched with collaborators searches for physics beyond the Standard Model (BSM) through probing for the electron electric dipole moment. His group is a pioneer in the cooling and trapping of molecules, studying collisional processes in atoms and molecules and developing tools to achieve full quantum control over increasingly complex molecular systems. They pioneered the laser cooling of polyatomic molecules and are working to realize new techniques to trap and study interactions in polyatomic molecules. John Doyle is the co-Director of the Harvard Quantum Initiative, director of the Japanese Undergraduate Research Exchange Program (JUREP), and he co-founded the Harvard/MIT Center for Ultracold Atoms, where for twenty years he was co-director. He has published papers in the areas of ultracold atoms, molecules, spectroscopy, precision measurement, ultracold neutrons, respiratory disease transmission mitigation, and dark matter detection and supervised the PhDs of over thirty students. He is a Humboldt, Fulbright, and American Physical Society (APS) Fellow and is currently president-elect of the American Physical Society (president in 2025). He is winner of the Broida and Ramsey prizes.