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Mathematics for Advancing Cardiovascular Medicine —From Hemodynamic Analysis to Clinical Application —

Friday 6 March 2026 14:00 (40 minutes)

In this talk, I discuss how mathematical structures contribute to advances in cardiovascular medicine, based on ongoing interdisciplinary collaborations with cardiovascular surgeons and cardiologists.

Starting from three-dimensional anatomical structures reconstructed from medical imaging, we perform hemodynamic analyses grounded in fluid equations and continuum mechanics. These analyses aim to provide quantitative indicators that support surgical design and clinical decision-making. As a representative example, I will introduce efforts to improve the Fontan procedure through mathematical evaluation of blood flow dynamics and energy-related measures.

Reliable hemodynamic modeling requires more than numerical computation. Its validity depends fundamentally on the mathematical formulation of governing equations, well-posedness considerations, and in particular the appropriate treatment of boundary conditions. Boundary conditions are not merely technical specifications; they determine stability, physical consistency, and interpretability of the results. I will highlight how these theoretical aspects shape clinically meaningful analysis.

Finally, I will briefly discuss how mechanically derived quantities can be connected to predictive frameworks, including AI-based approaches, while preserving mathematical coherence and interpretability.

Through these examples, I aim to demonstrate that mathematics serves not only as a computational tool but as a conceptual and structural foundation for translating medical information into reliable clinical insight.

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