JOHNS HOPKINS
Center for Environmental
& Applied Fluid Mechanics

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3:00 PM, 132 Gilman Hall

"*The Physics of Heart Murmurs and Implications for Non-Invasive Diagnosis via Auscultation*"

Presented by Dr. Chi Zhu
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Cardiac auscultation with a stethoscope has served as the primary method for qualitative screening of cardiovascular conditions for over a century. However, using automated cardiac auscultation to quantitatively diagnose heart diseases remains a challenge due to a lack of understanding of the flow mechanism(s) responsible for the generation of the murmurs and the effect of intervening tissues on the propagation of these murmurs. In this study, we use multiphysics computational modeling to tackle these issues.

Here, we focus on the aortic stenosis as the disease condition of choice, since it is the most common valvular disease and is known to create a very distinct systolic murmur. We use a one-way coupled hemodynamic-acoustic approach to investigate the generation and propagation of murmurs associated with the aortic stenosis from first principles. Direct numerical simulation is used to explore the hemodynamics of the post-stenotic jets. Key flow structures that are responsible for the murmur generation are isolated, and a characteristic frequency induced by a periodic vortex shedding is identified.

Subsequently, the propagation of the murmurs through a tissue-like material is resolved by a high-order linear viscoelastic wave solver, and results from the flow simulations are fed into the solver as the source. Two source localization methods are proposed and demonstrated to be able to non-invasively determine the murmur source accurately. The implications of these results for cardiac auscultation are discussed.