

*The Department of Mechanical Engineering presents:*

# **The Ph.D. Dissertation Defense of Qingan Cai**

**Wednesday, September 14, 2022, 10AM Pacific  
Bourns Hall A341**

## **Effects of Temperature and Pressure on the Lattice Dynamics in Tungsten Diselenide**

Doctor of Philosophy, Graduate Program in Mechanical Engineering  
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Dr. Chen Li, Chairperson

Tungsten Diselenide ( $\text{WSe}_2$ ), one valuable member of transition metal dichalcogenides, has attracted intensive attentions and emerged as promising candidates for advanced applications as field-effect transistors and light-emitting diodes. Understanding the microscopic lattice dynamics is essential for regulating the thermal properties of  $\text{WSe}_2$  to enhance the functionality and stability of  $\text{WSe}_2$ -based devices. Here, by combining inelastic X-ray scattering and first-principles calculations, the lattice dynamics of  $\text{WSe}_2$  was investigated comprehensively. We performed the first measurements of the temperature-dependent phonon dispersions and the mode Grüneisen parameters of bulk  $\text{WSe}_2$ , which are found to be in better agreement with the calculations on the monolayer system than those of the bulk. This observation indicates that lattice dynamics in bulk  $\text{WSe}_2$  hold the characterization of monolayers. We also performed the high-pressure IXS measurements on acoustic phonon in bulk  $\text{WSe}_2$  and observed the significant pressure-induced phonon stiffening. The pressure-dependent lattice dynamics are very useful to study the strain effects on the van der Waals interactions and anisotropic thermal conductivity in layered materials.