Department of Mechanical Systems Engineering
Energy Systems Engineering Control of Heat Transfer Lab.

# Biwa Shoji Lab.

# New heat engine and heat control technologies

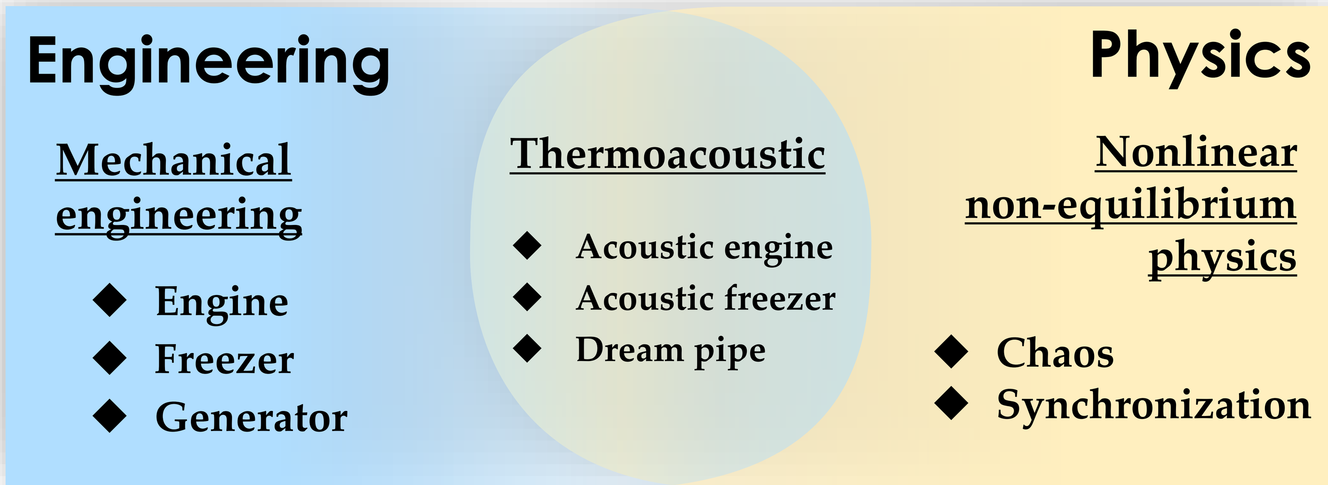
There is a vast amount of low-temperature and low-energy density heat sources such as industrial waste heat and solar energy. Our laboratory is working on development of new thermal devices that can produce useful power from these unutilized heat sources. The key is a natural engine technology based on thermoacoustic phenomena. Through establishment of the basic experimental techniques, we aim at understanding and application of the energy conversion and transfer mechanisms in natural engines.

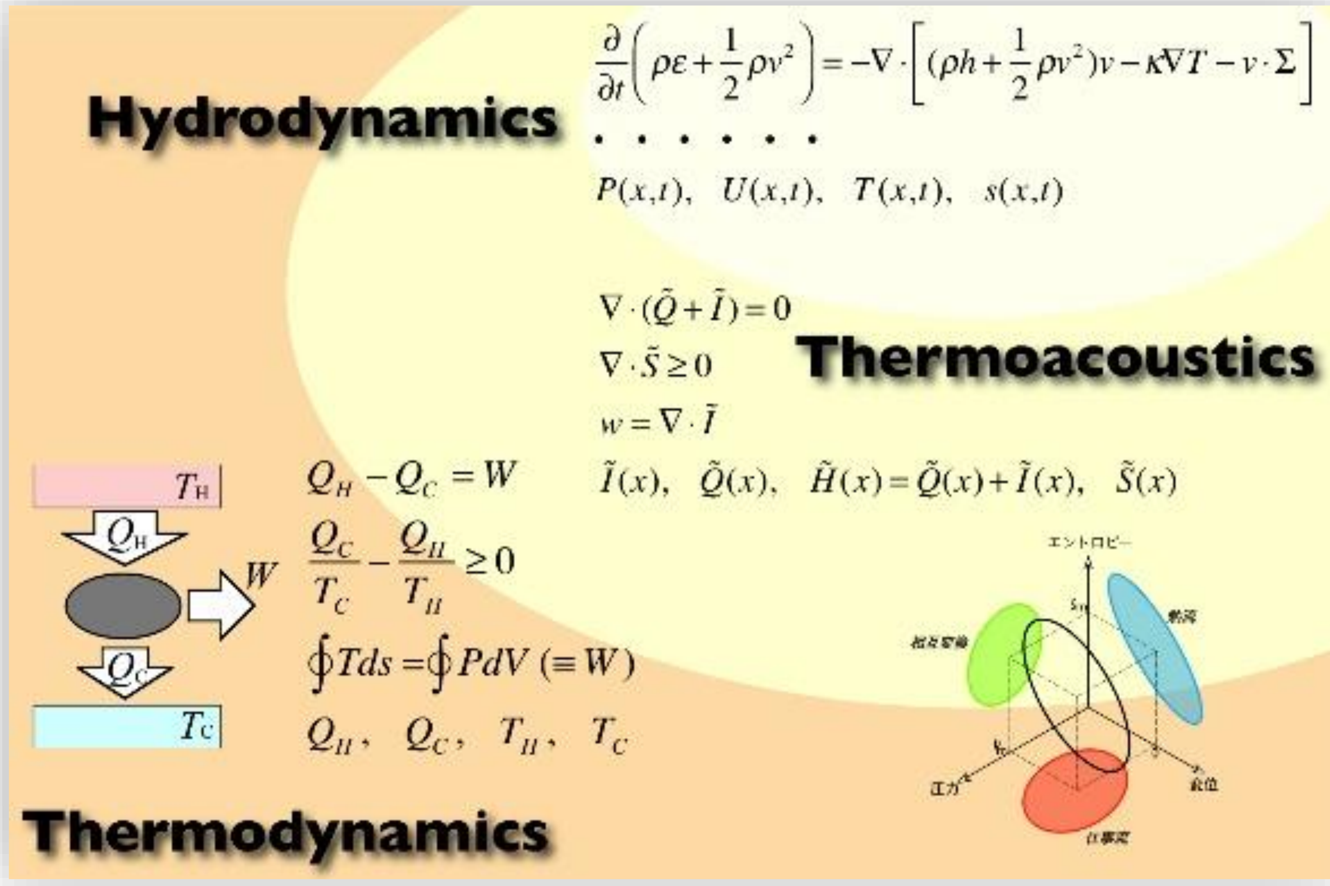
## Natural engine technology

A natural engine is a thermal device that can operate with no mechanical parts. Essential to the engine are various thermoacoustic phenomena, including generation of intense acoustic gas oscillation by heat, creation of low temperatures by sound waves and enhancement of heat transport by oscillating fluid flow. By focusing on thermodynamic aspects of oscillating gas/liquid flow, we try to develop new heat engines and thermal control devices.

### Advantages of Natural Engine

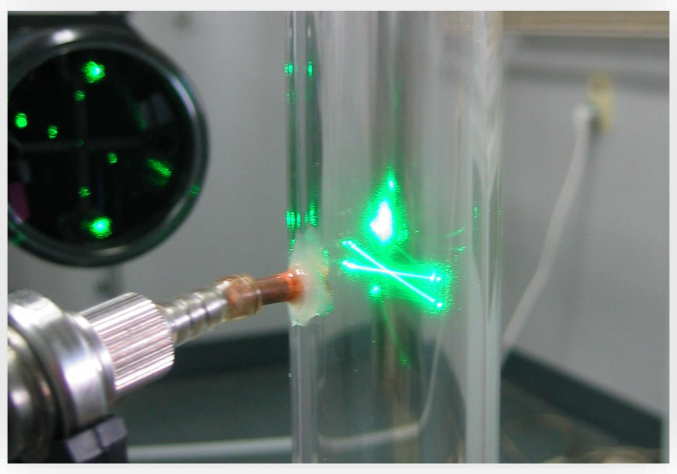
- Various heat sources can be used
  (industrial waste heat and solar power can be used)
- Simple structure (low cost, long lifetime)
- Free from global warming gases or special materials
- Execution of Stirling thermodynamic cycle (reversible cycle)

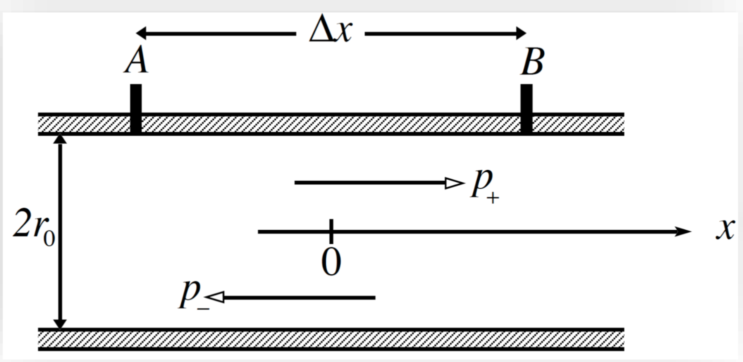


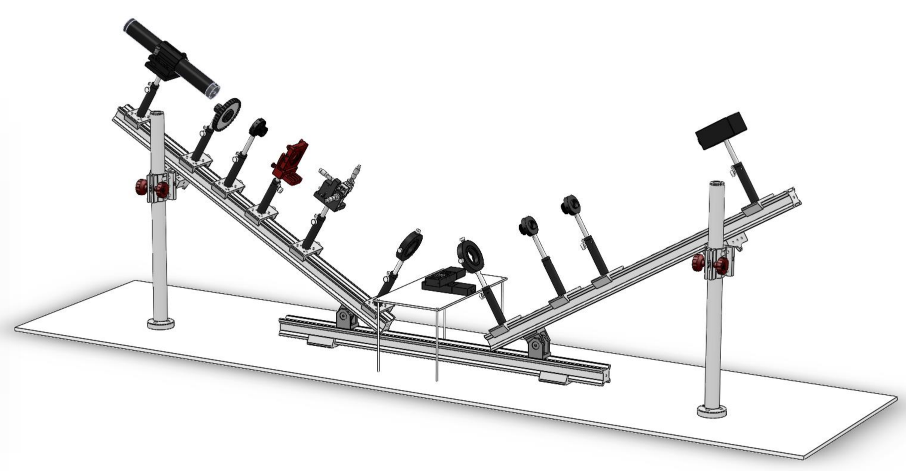

## Development of fundamental experimental techniques

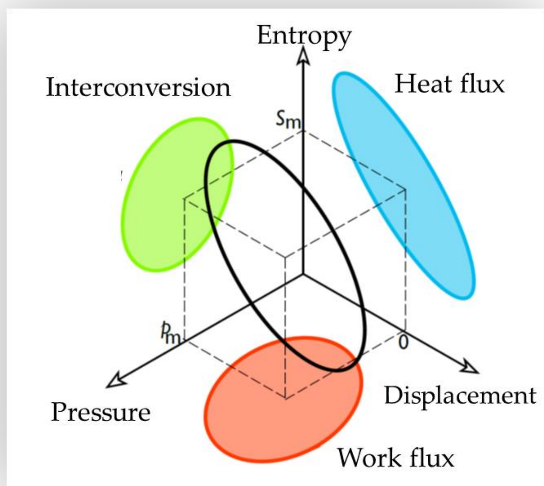
We are developing fundamental experimental techniques for simultaneous measurements of pressure, velocity, temperature, and density. These are necessary to gain a multidimensional understanding of complex thermal phenomena of gas and liquid systems.


Laser Doppler velocimetry



two-sensor method

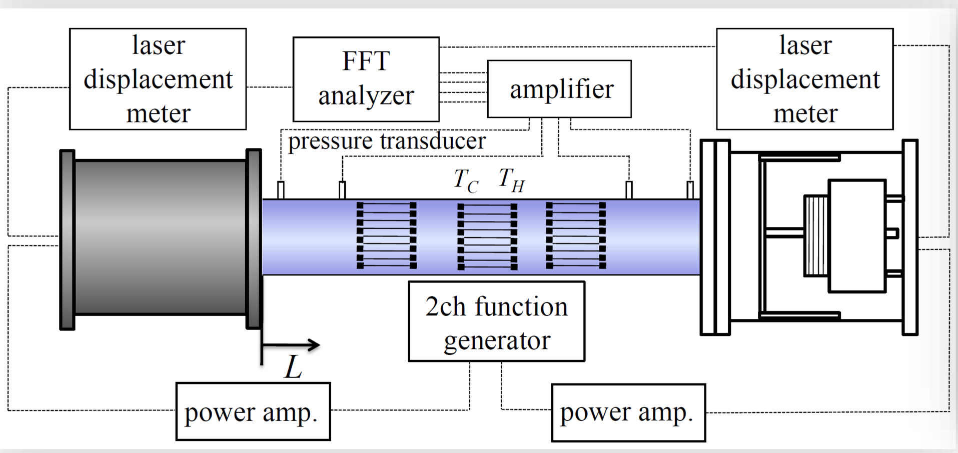

Optical measurement

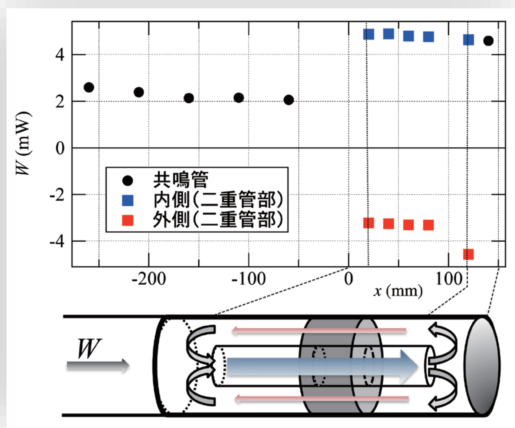


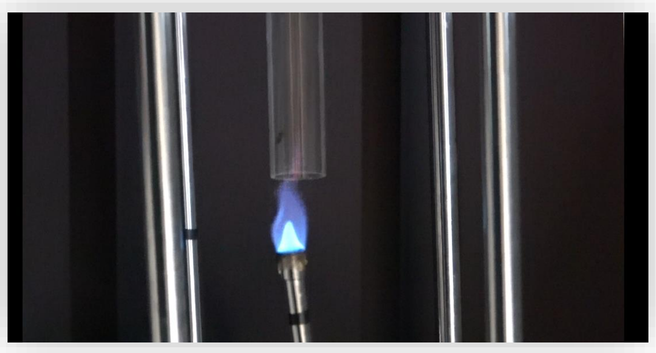
Understanding of energy conversion mechanism

## Development of novel thermal control devices

We have been designing, building, and testing new energy conversion systems and thermal control devices based on thermoacoustic phenomena. Novel nonlinear phenomena such as thermoacoustic shock waves, thermoacoustic chaos, and synchronization that were discovered through our research works led us to propose a simple and reliable suppression method of combustion oscillations.




Proposal of a simple method to suppress combustion oscillations

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