## 機械工学科

| キーワード | 熱マネジメント、相変化、多相流・多成分、熱輸送、冷凍サイクル |
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教授 / 博士（工学）

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### 学歴

東京工業大学　理工学研究科　原子核工学専攻　修士課程
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### 経歴

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### 相談・講演・共同研究に応じられるテーマ

製品搭載を前提とした熱マネジメント全般の基礎研究(特に固-気, 気-液 相変化の課題解決や活用)

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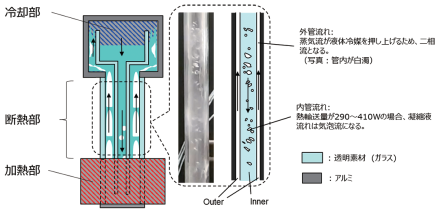
### 主な研究と特徴

## 「密閉二重管二相サーモサイホンの流動と熱輸送の現象解明」

二相サーモサイホンは高性能かつノーメンテナンスでの熱輸送の実現を期待できる。特に同軸二重管タイプはフラッディング限界が生じにくい、体積当たりの熱輸送性能が高い、また外形が単管なので設置構造の簡素化に寄与できるという特長を持つ。冷媒として水、R113、エタノール、窒素などを用いた熱輸送特性の実験と予測式の構築が進んでいるが、無可動部品装置ゆえに制御手段がないため安定動作が難しく、更なる流動現象の解明が不可欠である。そこで加熱部液面上昇を気泡ポンプ理論で表現した性能計算モデルを提案し、透明材料で製作した装置を用いて低沸点冷媒, HFE 7100による流動観察と最大熱輸送量の評価を行った。その結果、最大熱輸送量近傍でも断熱部外管内は二相流であることが確認されたが、実験値は計算値より約17%低かった。圧力測定と流動観察から、断熱部内管への気泡巻き込みが圧力分布に大きく影響することが判明し、混合を考慮したモデル改良の必要性が示唆された。





サーモサイホン概略図

### 今後の展望

サーモサイホンの熱輸送量が限界値に近づくと流動が脈動することにも注目してモデル改良しつつ、低沸点冷媒の適用によるサーバー冷却のコンパクト化、低コスト化といった応用を目指す

## Department of Mechanical Engineering

| Key words | Thermal management, Phase change, Multiphase / multicomponent flows, Heat transport, Refrigeration cycle |
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Doctor of Engineering / Professor

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### Education

Master's Program, Department of Nuclear Engineering, Graduate School of Science and Engineering, Tokyo Institute of Technology
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### Professional Background

Expert, Research and Development Center, Toshiba Corporation
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### Consultations, Lectures, and Collaborative Research Themes

Fundamental research on thermal management for product integration, particularly addressing and utilizing solid–gas and gas–liquid phase-change phenomena.

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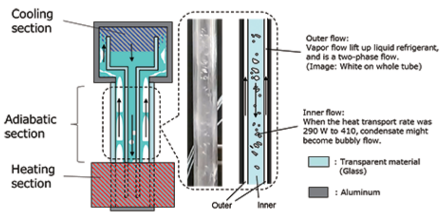
### Main research themes and their characteristics

## Study on the flow and heat transport characteristics of concentric-tube two-phase thermosyphon

Two-phase thermosyphons can transport heat from a heat source with high performance and without maintenance. In particular, the concentric-tube type is less susceptible to flooding limits and offers high heat transport capacity per unit volume. Its single-tube external form also contributes to simplifying installation structures. Although experiments using water, R113, ethanol, and nitrogen have advanced the understanding of heat transport characteristics and the development of prediction correlations, the absence of active control—due to the device having no moving parts—makes stable operation difficult. Therefore, further clarification of the flow phenomena is essential.

To address this, we proposed a performance prediction model based on bubble pump theory, which is necessary for considering the rise of the liquid level in the heating section. Using a transparent thermosyphon and HFE-7100 as a low-boiling-point working fluid, we conducted flow visualization and evaluated the maximum heat transport rate. The results showed that even near the maximum heat transport rate, the outer tube of the adiabatic section remained in a two-phase flow regime. However, the measured maximum heat transport rate was approximately 17% lower than the calculated value. Pressure measurements and flow observations revealed that bubble entrainment into the inner tube of the adiabatic section significantly affects the pressure distribution, suggesting that incorporating mixing effects would improve the model.





The sketch of flow of thermosyphon

### Future prospects

While refining the model to account for flow pulsation that occurs as the heat transport rate of a thermosyphon approaches its limit, we aim to apply low-boiling-point refrigerants to achieve more compact and cost-effective server cooling systems.