

2019 年度研究実績

- 1) 外界との物質及び熱移動を伴う、単純な非平衡開放系の熱力学に関して、時間依存系の非線形かつ非ホロノミックな力学系の枠組みで変分的定式化が可能となることを示した。
- 2) 非平衡開放熱力学系の幾何学的構造が、拡張された熱力学的相空間に付随するポントリヤーギンバンドル上のディラック構造として、時間依存の非ホロノミックなディストリビューションから誘導できることを示した。
- 3) 接バンドル上に誘導されたディラック構造が存在することを示し、それに関連して接バンドル上のラグランジュ・ディラック力学系を提案した。また、その力学系に付随する一般化ハミルトンの原理を提案した。
- 4) 流速ベクトル場に摂動を伴う 2 次元レイリー・ベナール対流に関する実験を行い、そこに現れる流体輸送構造としてのラグランジュ・コヒーレント構造を実験的に見出した。
- 5) Ho:YAG レーザーによって誘起されたキャビテーションクラウドの 2 次元非定常流れに関する SPH 法による数値解析を行い、クラウドの生成から成長、圧壊までの素過程を明らかにした。

Research Report 2019

1. We have shown the variational structure of the simple open nonequilibrium thermodynamics in the context of time-dependent nonlinear nonholonomic mechanics.
2. We have clarified the geometric structure of simple open nonequilibrium thermodynamics by time-dependent Dirac structures on the Pontryagin bundle over an extended thermodynamic phase space.
3. We have developed an induced Dirac structure on the tangent bundle together with the associated Lagrange-Dirac dynamical systems. We have also developed the associated extended Hamilton principle for the associated Lagrange-Dirac dynamical systems.
4. We have made an experimental study for two dimensional Rayleigh-Benard Convection with and detected Lagrangian coherent structures associated with the Lagrangian transports.
5. We have examined numerical analysis of unsteady behaviors appeared in cloud cavitation induced by Ho:YAG laser and clarified the elementary process from its inception to collapse.

2019年度 論文リスト

1. Francois Gay-Balmaz and Hiroaki Yoshimura, Dirac structures in nonequilibrium thermodynamics, *J. Math. Phys.* 59, 012701–29, 2019. (査読有)
2. Hiroaki Yoshimura, Dirac structures and Lagrangian systems on tangent bundles, *Symmetry and Singularity of Geometric Structures and Differential Equations*, RIMS Kokyuroku No.2137, 12 pages, 2019. (査読無)
3. Hiroaki Yoshimura and Francois Gay-Balmaz, Dirac structures in open thermodynamics, *Geometric Science and Information*, Proc. 4th International conference GSI 2019 at Toulouse in France, August 27–28. *Lecture Notes in Computer Science*, Springer Nature Switzerland AG, pp.199–208, 2019. (査読有)
4. Francois Gay-Balmaz and Hiroaki Yoshimura, Proc. 4th International conference, GSI(Geometric Science and Information) 2019 at Toulouse in France, August 27–28. *Lecture Notes in Computer Science*, Springer Nature Switzerland AG. pp.209–217, 2019. (査読有)
5. Francois Gay-Balmaz and Hiroaki Yoshimura, From Lagrangian mechanics to nonequilibrium thermodynamics: A variational perspective, *Entropy*, 21(1):8, doi: 10.3390/e21010008, 2019. (査読有)
6. Hiroaki Yoshimura and Francois Gay-Balmaz, Dirac structures and port-Lagrangian systems in thermodynamics, Proc. 3rd IFAC Workshop on Thermodynamic Foundations for a Mathematical Systems Theory, July 3–5, 2019, Louvain-la-Neuve, Belgium. 8 pages. (査読有)
7. Francois Gay-Balmaz and Hiroaki Yoshimura, From variational to bracket formulations in nonequilibrium thermodynamics of simple systems, Proc. 3rd IFAC Workshop on Thermodynamic Foundations for a Mathematical Systems Theory, July 3–5, 2019, Louvain-la-Neuve, Belgium. 8 pages. (査読有)
8. Yu Tanaka, Hiroaki Yoshimura and Yasuhiro Kawakatsu, Design of low energy escape trajectory and delta-V reduction, Proc. 70th International Astronautical Congress (IAC), Washington D. C., United States, Oct. 21–25, 2019. Paper IAC-19-E2.2.52655, 6 pages. (査読無)
9. Kazutoshi Takemura, Nicola Baresi, Yasuhiro Kawakatsu, Hiroaki Yoshimura, Low energy escape using tube dynamics associated with quasi-Halo orbit, *Advances in the Astronautical Sciences*, vol. 168, pp. 701–711, 2019. Conference paper of 29th AAS/AIAA Space Flight Meeting. EID: 2-s2.0-85072990750. (査読無)

2019年度 国際会議発表

1. Hiroaki Yoshimura, Dirac geometry, variational principles and dynamical systems in nonequilibrium thermodynamics, *Workshop on Poisson Geometry and Related Topics*,

Ritsumeikan University, December 14, 2019.

2. Takahiro Ushioku, Masaki Kunishima, Takashi Imamura and Hiroaki Yoshimura, Experimental observations of single bubble dynamics and induced shock waves, 4th International Conference on Recent Advances in Nonlinear Mechanics (RANM 2019), Lodz, Poland, May 7-10, 2019.
3. Masahito Watanabe and Hirokai Yoshimura, Chaotic mixing in two-dimensional Rayleigh-Benard convection with periodic perturbations, 4th International Conference on Recent Advances in Nonlinear Mechanics (RANM 2019), Lodz, Poland, May 7-10, 2019.
4. Hiroaki Yoshimura and Francois Gay-Balmaz, Continuous and discrete variational formulations in nonequilibrium thermodynamics. AMS Spring Central and Western Joint Sectional Meeting, Special Session on Geometric Approaches to Mechanics and Control IV, University of Hawaii at Manoa, March 22-24, 2019.
5. Francois Gay-Balmaz and Hiroaki Yoshimura, Dirac structures and dynamical systems in nonequilibrium thermodynamics. AMS Spring Central and Western Joint Sectional Meeting, Special Session on Geometric Approaches to Mechanics and Control IV, University of Hawaii at Manoa, March 22-24, 2019.
6. M. Watanabe and H. Yoshimura, Chaotic Mixing in Two-dimensional Rayleigh-Benard Convection with Periodic Perturbations, Fourth International Conference on Recent Advances in Nonlinear Mechanics, p. 49-52, Lodz, Poland, May 7, 2019.
7. T. Ushioku, M. Kunishima, T. Imamura, H. Yoshimura, Experimental Observations of Single Bubble Dynamics and Induced Shock Waves, Fourth International Conference on Recent Advances in Nonlinear Mechanics, Lodz, Poland, May 10, 2019.