

**Yunfan Huang 黄云帆, PhD Candidate**

Department of Engineering Mechanics, Tsinghua University

Date of Birth: 1997/03**Websites:** [ResearchGate](#), [Google Scholar](#), [Group](#), [LinkedIn](#), [Gitee](#)**Place of Birth:** Liao-Ning Province**Contact Info:** xungeer2311@gmail.com, yf-huang19@foxmail.com**Education Background**➤ **2019/08-2025/07** *Doctor of Philosophy* Tsinghua University Department of Engineering Mechanics

- **Major:** Power Engineering and Engineering Thermal Physics (Admission by Recommendation)
- **Field of Research:** Electrokinetic transport in liquid-liquid multiphase flow (**Supervisor:** Prof. Moran Wang)
- **Dissertation:** Spontaneous charging and electrokinetic multiphase flow of immiscible liquid-liquid interface
- **Applications:** Enhanced oil recovery with low-salinity waterflooding, Electrolyte filling in rechargeable batteries

➤ **2018/10-2019/01** *Visiting Student* Purdue University School of Mechanical Engineering

- **Project:** Optimization of the pillar array distribution for rare cell analysis (**Supervisor:** Prof. Steven T. Wereley)
- **Applications:** Reaction efficiency enhancement in point-of-care fluidics for rare cell analysis

➤ **2015/08-2019/07** *Bachelor of Engineering* Tsinghua University Department of Engineering Mechanics

- **Major:** Theoretical and Applied Mechanics (Tsien Excellence in Engineering Program, TEEP) (Ranked 6/29, GPA 3.78/4.00)
- **Field of Research:** Hydrodynamic effect in low-temperature electron transport (**Supervisor:** Prof. Moran Wang)
- **Thesis:** Electron hydrodynamics in micro/nanoscale low-dimensional materials
- **Applications:** Super-ballistic electron transport in 2D materials, Thermal management of electronic devices

Research Experiences*Research Interests*

- Electrokinetic flows, micro-/nano-fluidics, complex flows
- Hydrodynamic effect in electron and phonon transport
- Kinetic modeling and multiscale simulation of multiphysical transport

Research Projects (See [Supplementals](#) for more)➤ **2019-2025** [Doctoral dissertation, also supported by NSFC & NKRD](#) Tsinghua University

- Project: Electrokinetic multiphase flow in porous media & Multiphysical microflow simulation software development

➤ **2021/07-08** [Internship \(in Company\)](#) DORIGHT

- Project: Review and simulation of flow and heat transfer in a high-temperature air preheater with helical baffles

➤ **2017-2019** [Bachelor's thesis & Open Research for Innovative Challenges](#) TEEP

- Project: Mechanism of electron transport in two-dimensional materials based on electron hydrodynamics

➤ **2018-2019** [Senior Undergraduate Research Fellowship](#) Purdue University - TEEP

- Project: Optimization of the pillar array distribution for rare cell analysis in point-of-care diagnostics

➤ **2018/07-08** [Internship \(in Institute\)](#) Beijing CSRC

- Project: Implementation of Zoltan interface for mesh partitioning in high-precision CFD software

➤ **2017-2018** [Advanced Placement Course \(Finite element method\)](#) TEEP

- Project: Development of complex elements and multifunctional finite element programs for cable-stayed bridges

Possible Engagement

- **Physico-chemical hydrodynamics:** electrochemical energy conversion, soft matter, collective behavior of living matter
- **Quantum hydrodynamics in solids:** vortex hydrodynamics in electron transport, odd viscosity of electron fluid

Other Experiences

Academic Skills

- **Theoretical kinetic modeling**: electron-phonon transport in solids, ion-fluid coupling transport in electrolyte solutions
- **Algorithm development**: particle mesoscopic methods (LBM), PDE solvers (DOM, FVM/FEM); in Matlab/Fortran/C
- **Numerical simulation**: COMSOL, ANSYS Fluent, ABAQUS, OpenFOAM; AutoCAD, SolidWorks, Origin, ParaView
- **Experiment platform setup**: microfluidic measurement system, including design, fabrication, test and data processing
- **Engineering system design**: optimization of complex bridge / heat exchangers, electrical and control system in CMG

Academic Experiences

- 2021-2023/Fall, Teaching Assistant of *Heat and Mass Transfer* (Prof. Moran Wang), Tsinghua University
- 2018/07, Participant (1/40) in Airbus Airnovation Summer Academy, Cranfield University (UK)

Social Practices and Hobbies

- 2020/11, Technology Industry Survey of Hangzhou, TEEP, Tsinghua University
- 2017-2018/Winter, Industrial Survey of Hong Kong/Singapore, Student Association for Sci & Tech, Tsinghua University
- **Hobbies**: Music (Violin, Piano, Chorus), Sports (Badminton, Table tennis), Reading (Sci-Fi, Sci-Tech history)

Honors & Awards

In Research+

- 2024.08 Tsinghua Doctoral Travel Grant for International Conferences (Top-Tier)
- 2023.06 Tsinghua Doctoral Travel Grant for International Conferences (Grade A)
- 2019.07 Tsinghua “Future Scholar” Scholarship
- 2019.07 Bachelor’s Thesis with Honor (both in Tsinghua, and in Beijing)
- 2018.02 Honorable Mention in the Mathematical Contest in Modeling (MCM, held by SIAM)

In Education+

- 2023.12 Excellent Teaching Assistant (Eng. Mech. Dept.)
- 2021.12 Tsinghua Excellent Mentor for Undergraduate
- 2021.12 Tsinghua Comprehensive Excellence Scholarship (1st Prize)
- 2019.07 Tsinghua Outstanding Graduate (Bachelor)
- 2016.10 National Scholarship
- 2015.10 Tsinghua Xuetao Scholarship (Outstanding Innovative Talent Cultivation Program)

Supplemental materials

A. List of Publications

B. Project Details

A. List of Publications

Publications in Journal (first author)

1. **Y.F. Huang** and M. Wang*. Solvent mixing and ion partitioning effects in spontaneous charging and electrokinetic flow of immiscible liquid-liquid interface. *Physical Review Fluids*, 2024 (in press)
2. **Y.F. Huang**, M. Wang*. Merging of mechanics and mathematical physics: a brief discussion on similarity method. *Mechanics in Engineering*, **46**(4): 868-875, 2024 [in Chinese; education]
3. A. Alizadeh[#], **Y.F. Huang**[#], F.L. Liu, H. Daiguji, M. Wang*. A streaming-potential-based microfluidic measurement of surface charge at immiscible liquid-liquid interface. *International Journal of Mechanical Sciences*, **247**: 108200, 2023
4. X. Ran[#], **Y.F. Huang**[#], M. Wang*. A hybrid Monte Carlo-discrete ordinates method for phonon transport in micro/nanosystems with rough interfaces. *International Journal of Heat and Mass Transfer*, **201**: 123634, 2023
5. **Y.F. Huang** and M. Wang*. Nonnegative magnetoresistance in hydrodynamic regime of electron fluid transport in two-dimensional materials. *Physical Review B*, **104**: 155408, 2021
6. **Y.F. Huang**. Relationship between the two loci of instant center of rigid body in plane motion. *Mechanics in Engineering* **3**: 306, 2017 [in Chinese; education]
7. **Y.F. Huang** and M. Wang*. Review of spontaneous charging and electrokinetic flow at liquid-liquid interface (I): physical picture and typical phenomena. *ACIS* (in preparation)
8. **Y.F. Huang** and M. Wang*. Review of spontaneous charging and electrokinetic flow at liquid-liquid interface (II): theory, simulation and experiment. *ACIS* (in preparation)
9. **Y.F. Huang** and M. Wang*. Flow reversal effect on two-liquid streaming potential: from parallel streaming to liquid-infused surface. *PRF* (in preparation)
10. **Y.F. Huang** and M. Wang*. Hydrophobic and impurity effect in surface charging and contact angle of nonpolar oil. *Langmuir* (in preparation)

Publications in Journal (others)

11. B. Liu, **Y.F. Huang**, M. Wang*. Physics and modeling of phonon wave behaviors in nanoscale heat conduction. *Chinese Journal of Computational Physics*, 2024 (in press) [in Chinese]
12. Q.Q. Li, G. Yang, **Y.F. Huang**, X.K. Lu, J. Min and M. Wang*. Lattice Boltzmann method for particulate multiphase flow system. *International Journal of Mechanical Sciences*, **273**: 109217, 2024
13. Y.R. Li, **Y.F. Huang**, X.K. Lu, M. Wang*. Criteria of distribution transitions in dispersed multiphase systems based on an extended lattice model. *Langmuir*, **39**: 17021, 2023
14. W. Liu, **Y.F. Huang**, M. Wang*. Formation mechanism of extended space charge in electroconvective flow near ion-selective surfaces. *IJMS* (under review)
15. W. Liu, **Y.F. Huang**, M. Wang*. Instability and scaling transition triggered by strong capacitive charging in induced-charge electro-osmosis. *PRX* (in preparation)
16. Z.G. Tian, **Y.F. Huang**, Y. Wang, M. Wang*. Analytical solution of inertia effect in high-speed flows through disordered porous media. *PRF* (under review)
17. M.B. Zhang, Z.G. Tian, **Y.F. Huang**, M. Wang*. Flow regimes and criteria of gas flow in porous media by experiments. *IJMS* (under review)
18. X.K. Lu, Q.Q. Li, G. Yang, **Y.F. Huang**, M. Wang*. Inertial accumulation effect on microgel particle transport and preferential flow control in disordered media. *JFM* (under review)

Conferences

1. **Y.F. Huang**, W. Liu, M. Wang*. Electrokinetic multiphase flow at spontaneously charged liquid-liquid interface: a diffuse interface model with adsorption-induced interface charge (Oral & Long abstract). *ICTAM 2024*. Daegu, Korea. 2024.08
2. **Y.F. Huang**, A. Alizadeh, F.L. Liu, M. Wang*. Measurement of surface charge at immiscible liquid-liquid interface using streaming-potential-on-microfluidics (Oral). *InterPore 2023*. Edinburgh, UK. 2023.05
3. **Y.F. Huang**, M. Wang*. Measurement of liquid-liquid interfacial charge based on streaming potential (Oral). *NCFIuid 2022*. Xi'an, China. 2022.11 (in Chinese)
4. **Y.F. Huang**, M. Wang*. Hydrodynamics of low dimensional electron transport at micro-nanoscales (Oral & Paper). *CCTAM 2019*. Hangzhou, China. 2019.08 (in Chinese)

Patents (Chinese)

1. M. Wang, **Y.F. Huang** and F.L. Liu. A method and apparatus for measuring the charge density at the liquid-liquid interface, patent number ZL 2021 1 1448254.6, authorization number CN 114216950 B, 2024.
2. M. Wang, **Y.F. Huang**. A method, device, and system for in-situ measurement of the charge density at the immiscible liquid interface, application number 012434465, 2024.

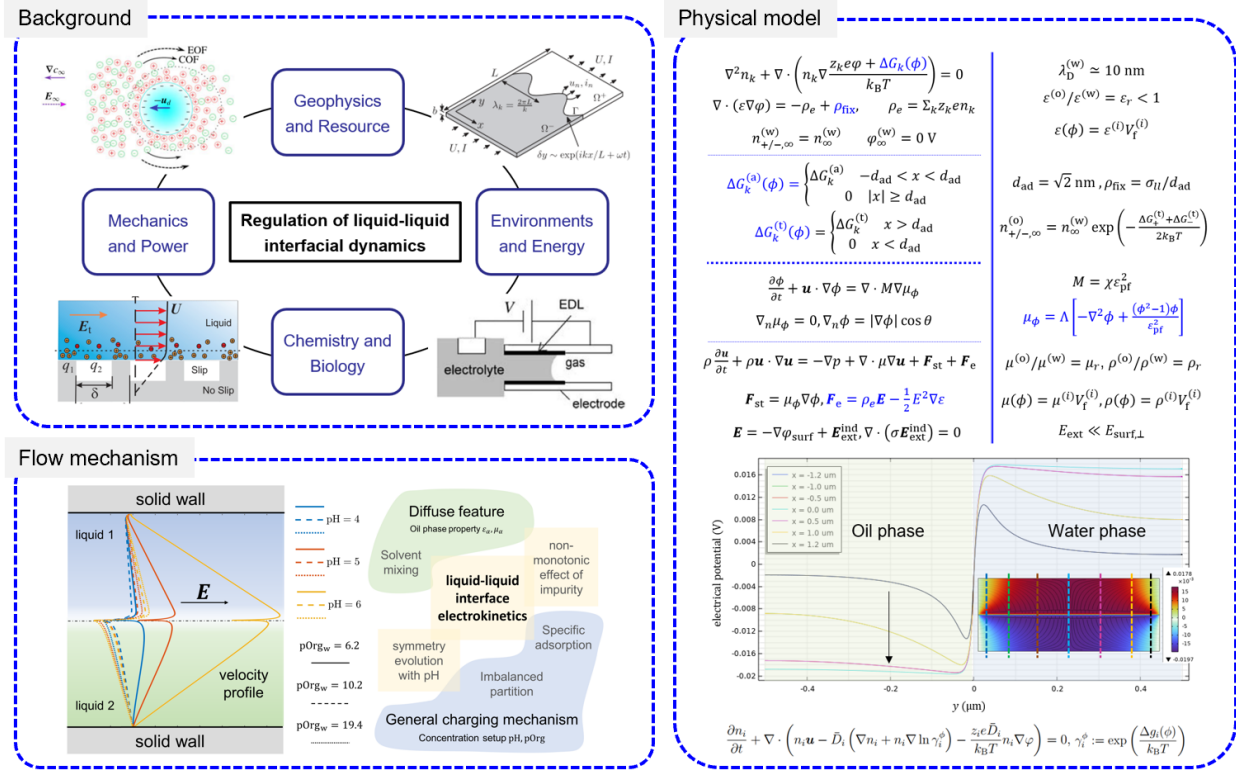
Software copyrights (Chinese)

3. M. Wang, G. Yang, H.Y. Chen, and **Y.F. Huang**. Multi-physics, multi-phase, multi-scale flow simulation software (μ^3 -Flows), registration number 2024SR0160474, 2024.

B. Project Details

Doctor dissertation ([RETURN](#)): Spontaneous charging and electrokinetic multiphase flow of immiscible liquid-liquid interface (I)

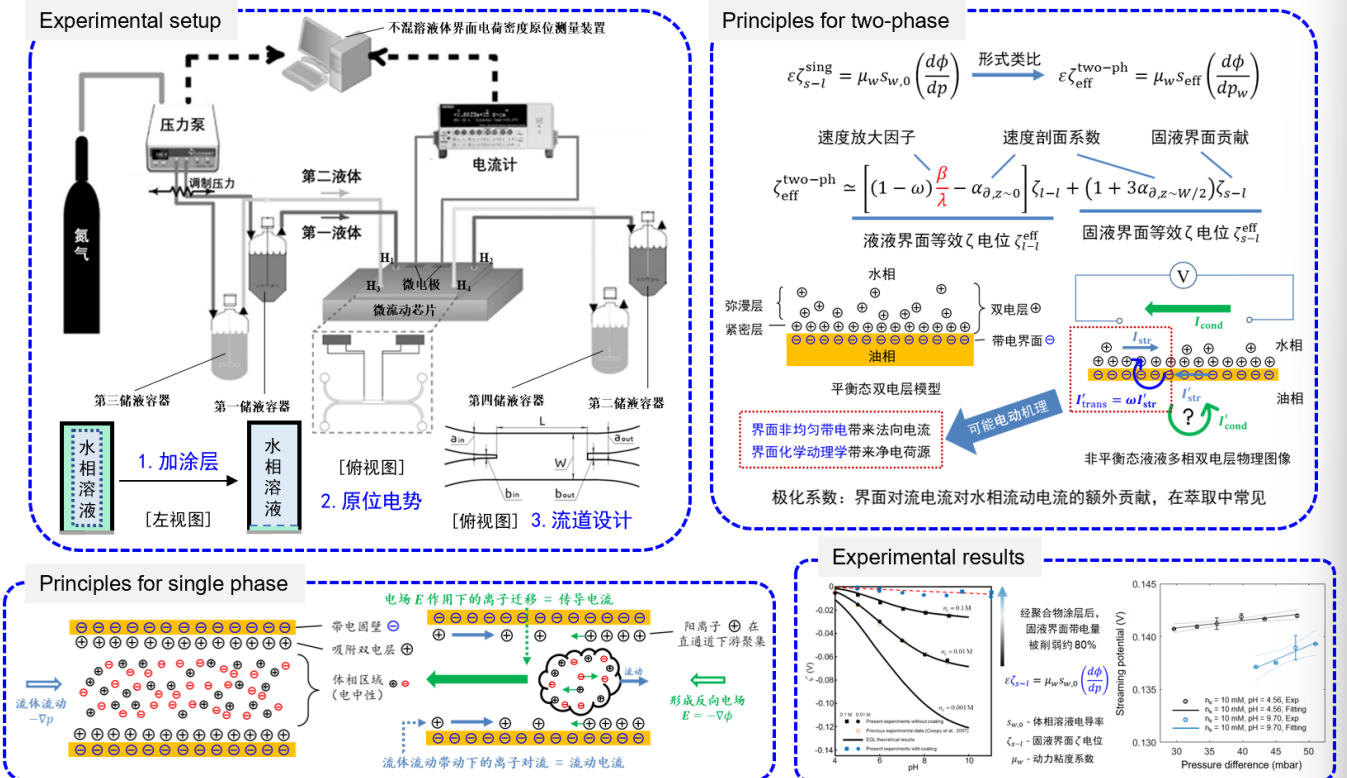
Motivation: mechanism & description of electrokinetics at soft liquid-liquid interface



Y.F. Huang and M. Wang*. *Physical Review Fluids* (in press); Software copyrights * 1 (μ^3 -Flows)

Doctor dissertation: Spontaneous charging and electrokinetic multiphase flow of immiscible liquid-liquid interface (II)

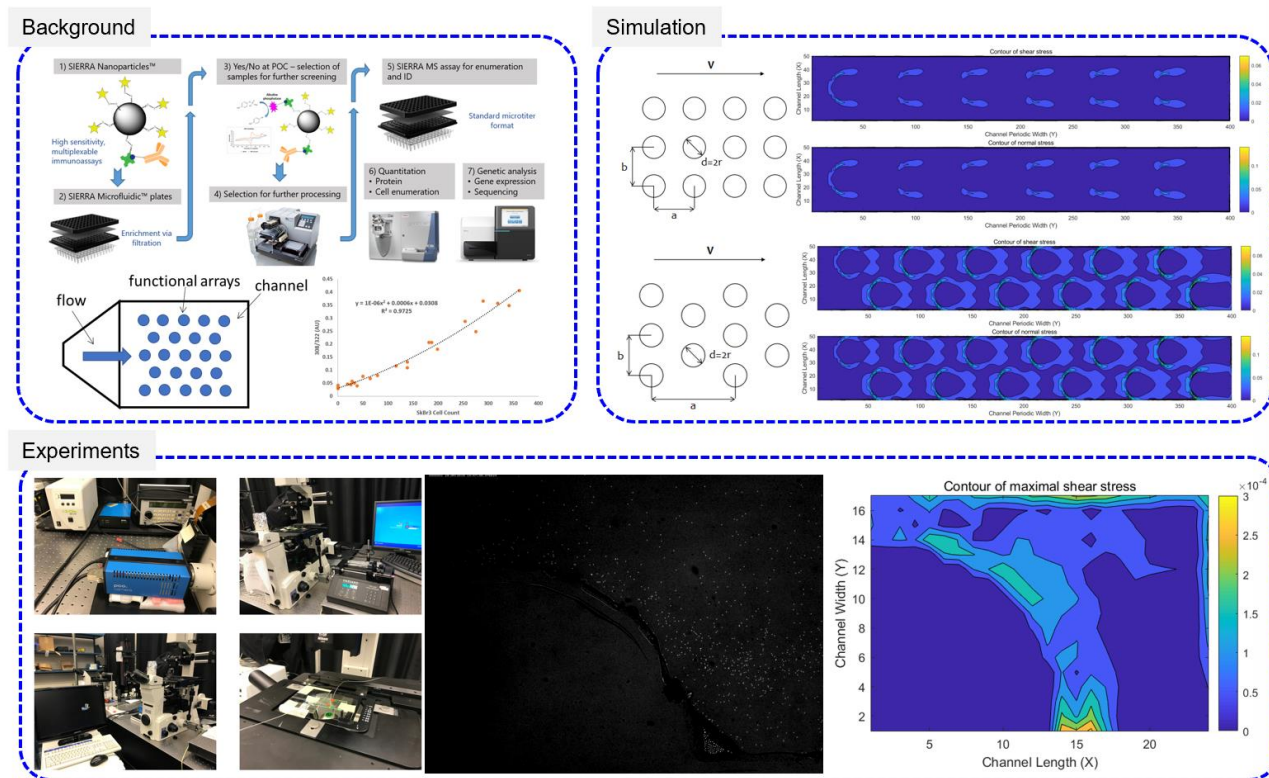
Motivation: to overcome limitations of traditional droplet electrophoresis method



A. Alizadeh[#], Y.F. Huang[#], ... and M. Wang*. *International Journal of Mechanical Sciences*, **247**: 108200, 2023; Patents * 2

TEEP-SURF (RETURN): Optimization of the pillar array distribution for rare cell analysis in point-of-care diagnostics

Motivation: to achieve better reaction efficiency by optimizing pillar array structure



TEEP-APC (RETURN): Development of complex elements and multifunctional finite element programs for cable-stayed bridges

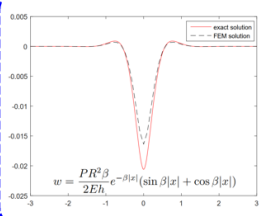
Motivation: to incorporate elements and functions into prescribed C++ program

Problem description

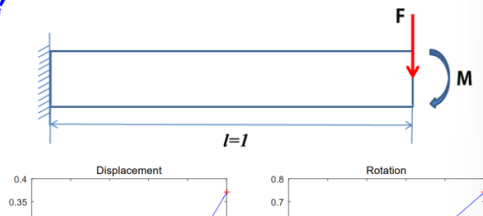
- 扩展后的STAP++程序必须能够求解给定的桥梁问题（同时包括杆单元、梁单元、六面体实体单元和板单元），并用ABAQUS进行验证

- 除以上基本要求外，各组可以自行选择增加其他功能，包括但不限于片应力恢复(SPR)、稀疏求解器、半带宽优化、无限单元、超级单元、过渡单元、模态分析、动力学响应分析和弹塑性杆单元等。

Shell element



Timoshenko beam element



Group report

经过一个月的努力，经历了9次每周五例会以及若干次不定期讨论，在小组成员配合下，本组顺利地完成了大作业的任务。以STAP++程序为主进行展示。

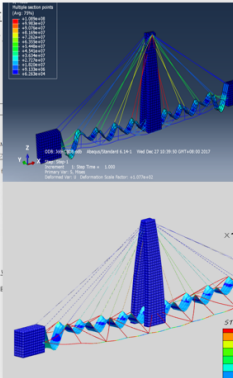
示例的具体描述与测试结果如下：

示例	NodeNo	ElemNo	SLR	CSDMR	ELU	TZFD	ELU/EL
1	4.14E3	2.48E3	4E2	1.79E3	7.04E2	20	0.27
2	3.72E4	3.04E4	2.1E3	2.65E4	1.35E3	20	2.35
3	1	2.38E5	1E4	2.3E5	2.7E3	20	25.64444
4	1.91E6	1.43E6	4E4	1.79E6	5.42E3	20	3121.10

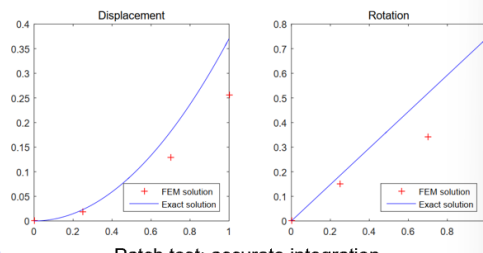
- 前后处理
 - 前：Python开发；DOF自动匹配
 - 后：Tecplot作图；基于B4的SPR功能

- 单元构造
 - 基本单元：杆单元^{1D}，六面体实体单元^{3D}，欧拉梁^{2D}
 - 其他单元：平面单元^{2D}，壳单元^{3D}，纯弯板^{2D}，铁木辛柯梁^{1D}
 - 扩展单元：过渡单元^{2D}，无限单元^{1D}

- 求解器
 - LDLT求解器
 - PARDISO稀疏求解器
- 模态分析



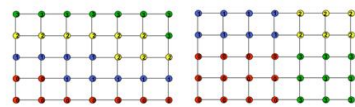
Patch test: selective reduced integration



Motivation: to embed dynamic partitioning module into compressible flow solver

Background

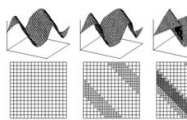
什么是好的并行网格分区(partitioning)?



Enough?

1. 负载均衡 (load balancing)
2. 减少通信 (reduce communication)

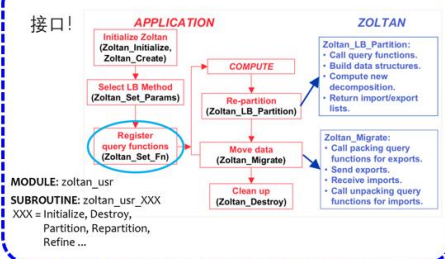
什么是好的动态并行网格分区(dynamic partitioning)?



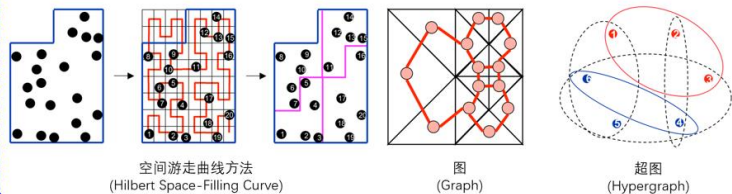
1. 负载均衡(load balancing)
2. 减少通信(reduce communication)
3. 减少迁移(reduce migration)

Programming

接口!

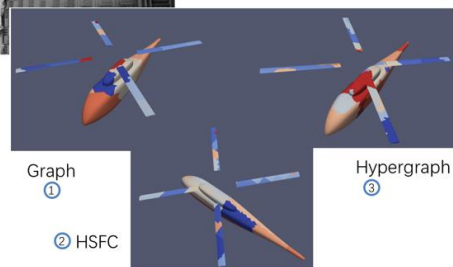
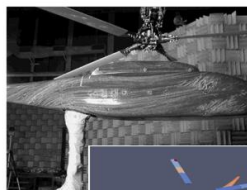


Method



Results

- 基本情况
 - NASA 标准机身模型
 - 测试直升机气动性能
- 算例选取
 - TM-2000-210286
 - TM-80051
 - TM-1999-209510
 - Goktan2007, Lee2010



Motivation: to achieve better overall performance by optimizing baffle parameters

Background

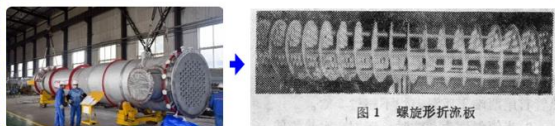
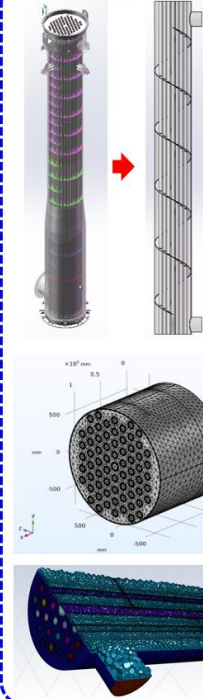


图 1 螺旋形折流板

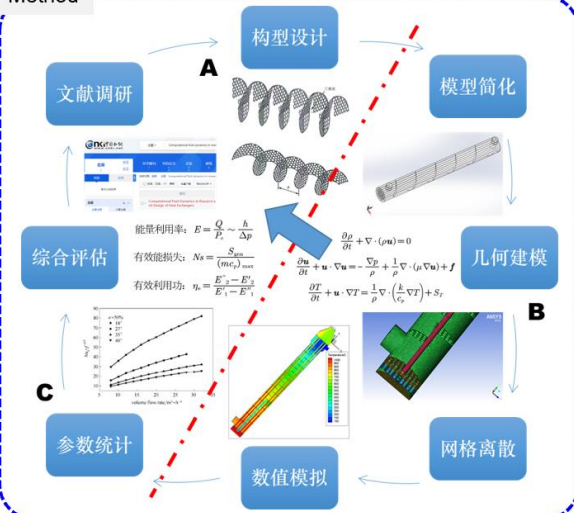
Schematics



Simulation cases

基本类型 代号 basic, 主要关注曲面连续型和弓型的综合成本对比, 为主要研究内容
 basic.wCtrTube 曲面连续型螺旋 (五周期/正三角布管), 加中心假管
 basic.segmental 弓型 (正三角布管), 折流板间距按原图纸给定, 无中心假管
 ext.wCtrTube 曲面连续型螺旋 (五周期/正三角布管), 无中心假管
 参数优化 代号 para, 主要关注曲面连续型螺旋角对流动换热性能的影响
 ext.n8/10/12.alp180 曲面连续型螺旋, 改变螺旋角, 固定转角, 无螺距梯度
 形状影响 代号 planar, 主要关注曲面连续型和平面连续型螺旋的流动换热性能比较
 ext.planarOverlapConti 平面连续型螺旋, 四分之一圆, 其余与 n8.alp180 一致

Method



Results

Case	$T_{air, in}$ (°C)	\dot{Q}_{total} (W)	Δp (Pa)	$\dot{Q}_{total}/\Delta p$ (W/Pa)	q_{air} (kg/s)	Solver
helical-alp5*	364.97	489071.9	210.83	2319.745292	1.5836	SIMPLE
helical-alp8	394.01	541437.1	571.12	948.0268505	1.5836	SIMPLEC
helical-alp10	499.18	517513.3	4063.92	127.3433778	1.0291	PISO
helical-alp12	495.71	512193.7	3616.47	141.6280703	1.1478	PISO

Case	$T_{air, in}$ (°C)	\dot{Q}_{total} (W)	Δp (Pa)	$\dot{Q}_{total}/\Delta p$ (W/Pa)	Solver
segmental-zhike	900.17	3260269	9060.2	359.8466045	SIMPLE
segmental-present	453.92	645347.4	3969.2	162.5891933	SIMPLE
helical-wctrtube	364.97	489071.9	210.83	2319.745292	SIMPLE
helical-wctrtube	437.10	614040.2	173.65	3536.07947	SIMPLE

