数学科学学院
School of Mathematical Sciences
Eastern Institute of Technology, Ningbo

东方理工高等研究院
EASTERN INSTITUTE FOR ADVANCED STUDY
宁波东方理工大学（暂名）

东方理工计算与应用数学研讨会
Frontier Workshop on Computational and Applied Mathematics

数学科学学院
School of Mathematical Sciences
Eastern Institute of Technology, Ningbo

会议手册



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中国 · 宁波
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东方理工计算与应用数学研讨会

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宁波东方理工大学（暂名）
EASTERN INSTITUTE OF TECHNOLOGY, NINGBO

学校介绍

宁波东方理工大学（暂名）是一所由社会力量举办、国家重点支持、省市共同建设的高起点、小而精、研究型、国际化的新型研究型大学。

学校以服务国家发展、推动社会进步为使命，注重基础研究、突出前沿交叉、强化工程技术，形成以理学、工学、信息、商科为主，兼具特色人文社科的学科体系。

学校坚持志存高远、求真务实的培养理念，培养具有宽厚基础、创新能力、家国情怀、国际视野的拔尖创新人才。

办学特色

学科布局

学校以服务国家发展、推动社会进步为使命，注重基础研究、突出前沿交叉、强化工程技术，形成以理学、工学、信息、商科为主，兼具特色人文社科的学科体系。

师资队伍

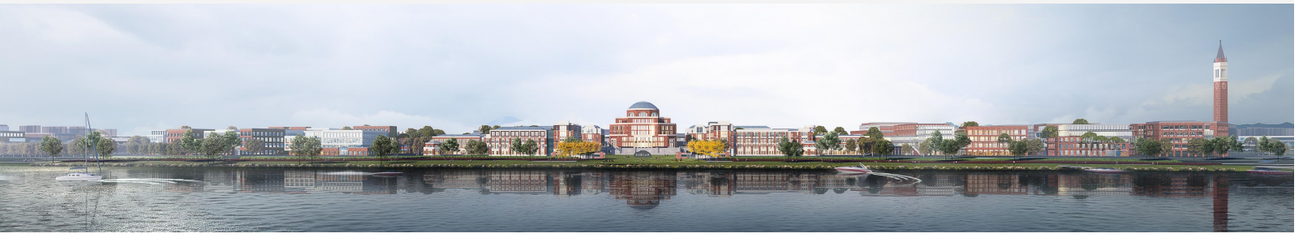
学校致力于引进世界一流高端领军人才，使用国际通用的“准聘-长聘”聘用制度，实行课题组负责人（PI）制度，激发教师尤其是青年教师的积极性和创造性。充分发挥高层次人才的支撑引领作用，创新引才、育才、留才的体制机制。

立德树人

学校坚持志存高远、求真务实的培养理念，培养具有宽厚基础、创新能力、家国情怀、国际视野的拔尖创新人才。

改革创新

学校将结合国际先进经验和中国高等教育的发展成果，积极创新现代大学制度，走出一条社会力量与政府合力共建世界一流大学的新路。



定位使命

一所社会力量举办、国家重点支持、省市共同建设的高起点、小而精、研究型、国际化的新型研究型大学

东方理工计算与应用数学研讨会
Frontier Workshop on Computational and Applied Mathematics

会议介绍

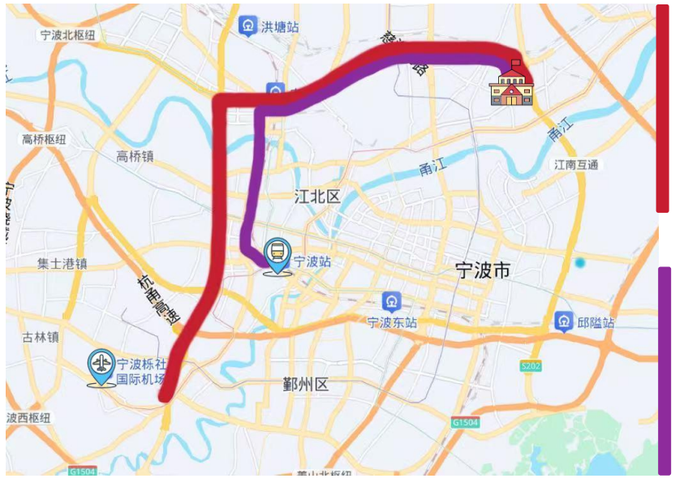
为促进计算数学各领域学者之间的交流与合作，拓展合作空间，宁波东方理工大学（暂名）数学科学学院拟于 2025 年 6 月 6 日至 6 月 8 日 在宁波举办“计算与应用数学前沿研讨会”。

本次研讨会将邀请来自国内外的 30 余位知名学者参会，会议将围绕计算数学领域的前沿研究展开深入探讨，重点聚焦于人工智能、量子计算、电子信息、复杂流体计算等国家急需和学科前沿方向。

参会人员（按姓氏首字母排序）

姓名	单位	姓名	单位	姓名	单位
包维柱	National University of Singapore	蔡智强	大湾区大学（筹）	陈景润	中国科学技术大学
陈艳萍	南京邮电大学	成娟	首都师范大学	程晋	复旦大学
高卫国	复旦大学	胡俊	北京大学	黄云清	湘潭大学
黄忠亿	清华大学	金石	上海交通大学	李培军	中国科学院数学与系统科学研究院
李若	北京大学	刘歆	中国科学院数学与系统科学研究院	明平兵	中国科学院数学雨系统科学研究院
聂玉峰	西北工业大学	邵嗣烘	北京大学	汤华中	北京大学
谢资清	湖南师范大学	徐定华	上海财经大学	徐立伟	电子科技大学
徐岩	中国科学技术大学	徐振礼	上海交通大学	许传炬	厦门大学
许学军	同济大学	杨志坚	武汉大学	张磊	北京大学
张智民	Wayne State University	郑伟英	中国科学院数学与系统科学研究院	周爱辉	中国科学院数学与系统科学研究院
周涛	中国科学院数学与系统科学研究院	MORE TO BE ANNOUNCED.....			

路线图
MAP



标识
路线　机场-酒店/过渡校区
距离　约33KM
时长　约40分钟



标识
路线　高铁站-酒店/过渡校区
距离　约24KM
时长　约30分钟

标识
路线　酒店-过渡校区
距离　约500M
时长　步行约7分钟

日程表
SCHEDULE

6月6日 星期五

地点：镇海开元名都酒店

时间	事项
13:00-21:00	报到
18:45	晚餐 Dinner

日程表
SCHEDULE

6月7日 星期六

会议地点：东方理工过渡校区1号楼MBA会议室

时间	报告题目	报告人	主持人
08:30-08:45	Opening Remark（沈捷）		王晓明
08:45-09:15	TBA	金　石	徐振礼
09:15-09:45	Image Segmentation via Variational Model based Tailored UNet: A Deep Variational Framework	黄忠亿	周　涛
09:45-10:00	茶歇 Nutrition Break		
10:00-10:30	Sharp Interface Models for Solid-State Dewetting Problems	包维柱	汤华中
10:30-11:00	非局域化建模与Wigner函数	邵嗣烘	张　磊
11:00-11:15	茶歇 Nutrition Break		
11:15-11:45	Neural Networks in Scientific Computing (SciML)	蔡智强	明平兵
11:45-12:15	TBA	TBA	陈艳萍
12:30-13:30	午餐 Lunch（镇海开元名都酒店2楼自助餐厅）		
13:30-14:00	电子结构有限元逼近的误差控制理论	周爱辉	杨志坚
14:00-14:30	The exactness of the L1 penalty function for a class of mathematical programs with generalized complementarity constraints	刘　歆	徐立伟
14:30-14:45	茶歇 Nutrition Break		
14:45-15:10	Multiscale subspaces and their relationships with preconditioners	付书彬	成　娟
15:10-15:35	New high-order consistent splitting schemes for the Navier-Stokes equations	黄富铿	聂玉峰
15:35-18:00	TBA		
18:30	晚宴 Dinner（美宴·月湖）		

日程表
SCHEDULE

6月8日 星期日

会议地点：东方理工过渡校区1号楼MBA会议室

时间	报告题目	报告人	主持人
08:30-09:00	Overlapping Schwarz Methods in H(curl)	许学军	黄云清
09:00-09:30	催化剂制备过程介尺度模型及参数反演方法	徐定华	程　晋
09:30-09:45	茶歇 Nutrition Break		
09:45-10:15	WENO格式权重映射的保序性	李　若	胡　俊
10:15-10:45	High order well-balanced numerical methods for hyperbolic balance laws	徐　岩	陈景润
10:45-11:00	茶歇 Nutrition Break		
11:00-11:30	Optimal and superconvergence error estimates of P^k-DG methods on rectangular meshes for 2D hyperbolic equations	张智民	谢资清
11:30-12:00	Stochastic inverse problems for the diffusion equations	李培军	郑伟英
12:15-14:00	午餐 Lunch（三江码头·开元广场）		
14:00-18:00	自由讨论		
18:30	晚宴 Dinner（宁海食府·开元 316包厢）		

报告题目与摘要
KEYNOTE SPEECH

（按报告时间排序）

黄忠亿

Image Segmentation via Variational Model based Tailored UNet: A Deep Variational Framework

Traditional image segmentation methods, such as variational models based on PDEs, offer strong mathematical interpretability and precise boundary modeling, but often suffer from sensitivity to parameter settings and high computational costs. In contrast, deep learning models such as UNet—which is relatively lightweight in parameters—excel in automatic feature extraction but lack theoretical interpretability and require extensive labeled data. To harness the complementary strengths of both paradigms, we propose Variational Model based Tailored UNet (VM_TUNet), a novel hybrid framework that integrates the phase field model with the deep learning backbone of UNet which combines the interpretability and edge-preserving properties of variational methods with the adaptive feature learning of neural networks. Experimental results on benchmark datasets demonstrate that VM_TUNet achieves superior segmentation accuracy and dice score compared to traditional deep learning methods, particularly in challenging scenarios which requires fine boundary delineation.

个人简介：清华大学数学科学系长聘教授、博士生导师，一直从事计算数学与科学工程计算方面的研究，2020年获国家杰出青年基金资助，2013年获优秀青年基金资助。

包维柱

Sharp Interface Models for Solid-State Dewetting Problems

In this talk, I will present sharp interface models with anisotropic surface energy for simulating solid-state dewetting and the morphological evolution of patterned islands on a substrate. We will show how to derive the sharp interface model via thermovariation dynamics, i.e. variation of the interfacial energy via an open curve with two triple points moving along a fixed substrate. The sharp interface model tracks the moving interface explicitly and it is very easy to be handled in two dimensions via arc-length parametrization. An efficient and accurate parametric finite element method (PFEM) was proposed for the sharp interface models. It is applied to study numerically different setups of solid-state dewetting including short and long island films, pinch-off, hole dynamics, semi-infinite film, tiny particle migration, etc. Our results agree with experimental results very well. In addition, extension to curved substrate and three dimensions will be discussed. Finally, we also present a reduced variational model via the Onsager's principle for small particle migration in solid-state dewetting. This is joint works with Wei Jiang, Yifei Li, David J. Srolovitz, Yan Wang and Quan Zhao.

个人简介：Professor Weizhu BAO is Provost's Chair Professor at Department of Mathematics, and Vice Dean for Graduate Studies and Academic Affairs of

Faculty of Science, National University of Singapore. He got his PhD from Tsinghua University in 1995. He has made significant contributions in modeling and simulation of Bose-Einstein condensation, solid-state dewetting and geometric flows; and multiscale methods and analysis for highly oscillatory PDEs. He was awarded the Feng Kang Prize in Scientific Computing by the Chinese Computational Mathematics Society in 2013. He was an Invited Speaker at the International Congress of Mathematicians (ICM) in 2014 and is a plenary speaker at the International Congress of Industrail and Applied Mathematics (ICIAM) in 2027. He was elected a Fellow of the American Mathematical Society (AMS Fellow), a Fellow of the Society of Industrial and Applied Mathematics (SIAM Fellow) and a Fellow of Singapore National Academy of Science (SNAS Fellow) in 2022. In 2024, he was elected as an Officer-at-Large of the ICIAM.

邵嗣烘

非局域化建模与Wigner函数

作为量子力学的另一类数学模型，Wigner函数同时以坐标和动量作为自变量，与经典力学一样定义在相空间内，其运动方程（即Wigner方程）呈现天然的非局域结构，形式上和Boltzmann方程类似，为刻画量子和经典的差别提供了工具。这是Schroedinger波函数方法所不具备的，使得近年来Wigner函数方法受到越来越多的关注，已在不同领域内得到了广泛应用。本报告将阐述Wigner方程的非局域结构在处理低正则势和奇异势方面的突出优势，并通过系列的数值试验说明它可以帮助我们得到低正则势和奇异势下高精度的Wigner量子动力学模拟。

个人简介：北京大学博雅特聘教授，主要开展面向智能、量子和计算的交叉融合研究，落脚点在基础的数学理论和高效的算法设计，强调离散数学结构的设计、分析和应用。具体研究领域包括：高维数值方法、离散建模与组合优化、计算量子力学、图谱理论及算法、微分方程数值解和计算复杂性等。

蔡智强

Neural Networks in Scientific Computing (SciML): Basics and Challenging Questions

As a new class of approximating functions, ReLU neural networks can accurately approximate discontinuous and non-smooth functions with degrees of freedom several orders of magnitude lower than those required by existing classes of approximating functions such as finite elements on quasi-uniform mesh. This talk will first use simple examples to demonstrate these properties.
For computationally challenging problems such as interface singularities, thin transitional interior or boundary layers, and discontinuities, while some existing neural network-based approaches, such as Physics-Informed Neural Networks (PINNs), attempt to incorporate physical principles, they often fail to fully preserve the underlying physics. In contrast, this talk will discuss and introduce fundamentally different approaches: Physics-Preserved Neural Networks (P2NN) methods, which rigorously enforce physical laws at the discrete level.
Despite ReLU neural network's remarkable approximation property, a major computational challenge is the inherently non-convex optimization problem they produce. This talk will conclude with a discussion of our latest advancements in overcoming this critical issue, paving the way for more efficient, robust, and physically faithful neural network-based simulations.

个人简介：Before coming to Great Bay University, he has been a faculty member in the Department of Mathematics at Purdue University since 1996. His research is on numerical solution of partial differential equations (PDEs) with applications in fluid and solid mechanics. In particular, he was interested in traditional mesh-based numerical methods, such as finite volume, finite element, and least-squares, etc., accuracy control of computer simulations, and self-adaptive numerical methods for complex systems. Currently, he is mainly working on neural network-based methods for solving PDEs that are difficult for traditional approaches.

周爱辉

电子结构有限元逼近的误差控制理论

电子结构计算特别需要误差可估计、精度可调控的计算方法。我们的研究表明自适应有限元方法满足这一需求。在本报告中，我们将扼要地介绍我们小组在这方面探索所取得的有关进展。

个人简介：中国科学院数学与系统科学研究院研究员。主要从事电子结构模型的数学理解与数值逼近，以及基础算法方面的研究。

刘　歆

The exactness of the L1 penalty function for a class of mathematical programs with generalized complementarity constraints

In a mathematical program with generalized complementarity constraints (MPGCC), complementarity relation is imposed between each pair of variable blocks. MPGCC includes the traditional mathematical program with complementarity constraints (MPCC) as a special case. On account of the disjunctive feasible region, MPCC and MPGCC are generally difficult to handle. The L1 penalty method, often adopted in computation, opens a way of circumventing the difficulty. Yet it remains unclear about the exactness of the L1 penalty function, namely, whether there exists a sufficiently large penalty parameter so that the penalty problem shares the optimal solution set with the original one. In this paper, we consider a class of MPGCCs that are of multi-affine objective functions. This problem class finds applications in various fields, e.g., the multi-marginal optimal transport problems in many-body quantum physics and the pricing problems in network transportation. We first provide an instance from this class, the exactness of whose L1 penalty function cannot be derived by existing tools. We then establish the exactness results under rather mild conditions. Our results cover those existing ones for MPCC and apply to multi-block contexts.

个人简介：中国科学院数学与系统科学研究院研究员，博士生导师，计算数学与科学工程计算研究所副所长。2004年本科毕业于北京大学数学科学学院；并于2009

年在中国科学院数学与系统科学研究院获得博士学位。主要研究方向包括流形优化、分布式优化及其在材料计算、大数据分析和机器学习等领域的应用。刘歆分别于2016年，2021年和2023年获得国家自然科学基金委优秀青年科学基金项目、杰出青年科学基金项目和科技部重点专项的资助。2024年获得中国工业与应用数学学会萧树铁应用数学奖。现担任MPC, JCM, APJOR等国内外期刊编委，《中国科学·数学》（中英文）青年编委，《计算数学》副主编；中国科学院青年创新促进会理事长；中国运筹学会常务理事；中国工业与应用数学会副秘书长，中国数学会计算数学分会常务理事。

付书彬

Multiscale subspaces and their relationships with preconditioners

In this talk, I will introduce the basic ideas of constructing multiscale subspaces and how these subspaces can be leveraged to develop efficient preconditioners. Specifically, I will discuss their applications in Darcy's flow in highly heterogeneous and fractured media, compressible flow and transport, elasticity problems, and the Helmholtz equation.

个人简介：宁波东方理工大学（暂名）助理教授，博士生导师，曾入选浙江省海外引才计划。他本科毕业于四川大学数学学院，随后在德州农工大学获得博士学位。曾在香港中文大学和威斯康星大学麦迪逊分校完成博士后训练。他的主要研究兴趣是多尺度有限元方法和模型降阶方法及其跨学科应用。主要成果发表在SIAM J. Sci. Comput., Multiscale Model. Simul., J. Comput. Phys., Comput. Methods Appl. Mech. Engrg., Water Resour. Res.和Geophys. J. Int.等期刊

黄富铿

New high-order consistent splitting schemes for the Navier-Stokes equations

The consistent splitting schemes for the Navier-Stokes equations decouple the computation of pressure and velocity. However, only the first-order version of the consistent splitting schemes is proven to be unconditionally stable for the time dependent Stokes equations. We construct a new class of consistent splitting schemes of orders two to four for Navier-Stokes equations based on Taylor expansions at time $t_{n+\beta}$ with $\beta \ge 1$. By choosing suitable k, we construct, for the first time, unconditionally stable and totally decoupled schemes of orders two to four for the velocity and pressure, and provide rigorous optimal error estimates.

个人简介：2016年本科毕业于中山大学，2021年博士毕业于普渡大学。2021-2024年任新加坡国立大学博士后研究员，2025年1月起任宁波东方理工大学（暂名）助理教授。主要研究方向包括复杂非线性耗散系统高精度算法的分析与应用，相关工作发表在SINUM, SISC, JCP, CMAME等计算数学重要期刊。

许学军

Overlapping Schwarz Methods in H(curl)

Overlapping Schwarz method is one of the most important methods for computing the large-scale discrete problems arising from partial differential equations. The previous proved-bound is $C(1+\frac{H^2}{\delta^2})$ for the condition number of the overlapping domain decomposition $\boldsymbol{H(\mathbf{curl};\Omega)}$ methods, where H and δ are the sizes of subdomains and overlaps respectively. But all numerical results indicate that the best bound is $C(1+\frac{H}{\delta})$. In this talk, we shall solve this long-standing open problem by proving that $C(1+\frac{H}{\delta})$ is indeed the best bound. Based on the overlapping Schwarz methods, we shall propose a two-level preconditioned Helmholtz subspace iterative (PHSI) method for solving algebraic eigenvalue problems resulting from edge element approximation of Maxwell eigenvalue problems. The two-level PHSI method may compute simple eigenpairs, multiple eigenpairs and clustered eigenpairs.
This is a joint work with Qigang Liang and Shangyou Zhang.

个人简介：同济大学副校长，特聘教授，国家杰出青年科学基金获得者，智能计算与应用教育部重点实验室主任。主要从事有限元，区域分解以及机器学习等方法的研究。

徐定华

催化剂制备过程介尺度模型及参数反演方法

坚持“建模-分析-计算”研究策略，分享催化剂制备过程多尺度模型（抛物型方程）和结晶-晶核生长-晶核集聚参数反演方法研究进展。

个人简介：浙江理工大学理学院二级教授，上海财经大学数学学院教授、院长。从事应用与计算数学研究与教学，开展可计算模型及反演算法、数据建模与计算研究。主持国家基金面上项目5项、重大研究计划项目1项，获中纺联科技进步二等奖。教育部高校数学类专业教学指导委员会委员、浙江省高校数学类专业教指委副主任。

李　若

WENO格式权重映射的保序性

在ENO重构的基础上，WENO重构根据光滑度指示子构造非线性的权重，加权组合ENO重构的中间结果，从而可以提升精度。基于WENO重构所得的求解双曲守恒律的格式，可以同时保持高精度和抑制数值振 荡，因而广受欢迎。然而，在长时间问题的模拟中，同时保持高精度和抑制数值振荡似乎是一个甚为不同的问题，极具挑战。过去的上十年中此问题持续受到关 注，文献中至少已发展出M族和Z族两大类方法，但仍未有明确的线索为此 问题的解决给出方向。我们发现，在加映射WENO重构的权重构造中，保持非线性 权在映射前后的相对顺序，是此问解决的关键。以此保序性为原则，无论是对现有的格式进行修正，还是设全新的格式，数值结果均可以获得显著的改进。

个人简介：2001年博士毕业于北京大学数学科学学院，现为数学学院博雅特聘教授，博士生导师，研究方向为偏微分方程数值解，特别是流体力学的数值方法，解决了有六十余年历史的玻尔兹曼方程Grad矩系统双曲性缺失的问题。曾获得国家杰出青年基金，冯康科学计算奖，吴文俊应用数学奖，获聘教育部长江特聘教授和入选中组部领军人才计划，是第九届国际工业与应用数学大会报告人。瞄准核心工具软件国产化替换的目标，目前正致力于领导和组织《北太天元》通用数值软件的开发工作。

徐　岩

High order well-balanced numerical methods for hyperbolic balance laws

This work develops a general framework for the design of the arbitrary high-order well-balanced discontinuous Galerkin (DG) method for hyperbolic balance laws with different equilibria. Not only the hydrostatic equilibrium, but our scheme is also well-balanced for the exact preservation of the moving equilibrium state for the shallow water equations, the Ripa model, and the compressible Euler equations with gravitation. The strategy adopted is to approximate the equilibrium variables in the DG piecewise polynomial space, rather than the conservative variables, which is pivotal in the well-balanced property. Our approach provides flexibility in combination with any consistent numerical flux, and it is free of the reference equilibrium state recovery and the special source term treatment. This approach also enables the construction of well-balanced methods for non-hydrostatic equilibria of two-layer shallow water equations and rotating shallow water equations. Extensive numerical examples, such as moving or isobaric equilibria, validate the high-order accuracy and exact equilibrium preservation for various flows given by hyperbolic balance laws. With a relatively coarse mesh, it is also possible to capture small perturbations at or close to steady flow without numerical oscillations.

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张智民

Optimal and superconvergence error estimates of P^k-DG methods on rectangular meshes for 2D hyperbolic equations

Optimal convergence rate of the P^k discontinuous Galerkin (DG) methods under the rectangular mesh for hyperbolic equations is a long-standing unsolved theoretical problem. Until today, the best result is $h+1/2$ for general rectangular meshes. In 2020, Liu, Shu, and Zhang proved that under a uniform rectangular mesh, the optimal convergence rate is $k+1$ for linear problems with constant coefficients. For non-constant coefficients, the optimal rate has been proved for $k=0,1,2,3$. For the nonlinear case, only $k=2,3$ have been proved. In this work, we prove the $k+1$ optimal rate of convergence under the uniform rectangular mesh for variable coefficients and nonlinear cases for all k. In addition, we discover some super-convergence phenomena for P^k-DG for the first time.

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李培军

Stochastic inverse problems for the diffusion equations

Diffusion equations play an important role in modeling complex systems across physics, geophysics, finance, biology, and engineering. In this talk, I will present our recent mathematical and computational studies on stochastic inverse problems for the diffusion equations driven by temporal, spatial, and space-time random noise. Our focus will be on theoretical aspects, including uniqueness and stability, as well as computational methods for recovering key parameters from noisy observations.

个人简介：中国科学院数学与系统科学研究院研究员，主要从事偏微分方程反问题、波动方程散射和反散射问题的理论、算法与应用研究。

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