

成果一.

常晋源研究员与合作者的论文 EDGE DIFFERENTIALLY PRIVATE ESTIMATION IN THE β -MODEL VIA JITTERING AND METHOD OF MOMENTS 被 ANNALS OF STATISTICS 接收发表。

摘要：A standing challenge in data privacy is the trade-off between the level of privacy and the efficiency of statistical inference. Here, we conduct an in-depth study of this trade-off for parameter estimation in the β -model (*Ann. Appl. Probab.* **21** (2011) 1400–1435) for edge differentially private network data released via jittering (*J. R. Stat. Soc. Ser. C. Appl. Stat.* **66** (2017) 481–500). Unlike most previous approaches based on maximum likelihood estimation for this network model, we proceed via the method of moments. This choice facilitates our exploration of a substantially broader range of privacy levels—corresponding to stricter privacy—than has been to date. Over this new range, we discover our proposed estimator for the parameters exhibits an interesting phase transition, with both its convergence rate and asymptotic variance following one of three different regimes of behavior depending on the level of privacy. Because identification of the operable regime is difficult, if not impossible in practice, we devise a novel adaptive bootstrap procedure to construct uniform inference across different phases. In fact, leveraging this bootstrap we are able to provide for simultaneous inference of all parameters in the β -model (i.e., equal to the number of nodes), which, to our best knowledge, is the first result of its kind. Numerical experiments confirm the competitive and reliable finite sample performance of the proposed inference methods, next to a comparable maximum likelihood method, as well as significant advantages in terms of computational speed and memory.

论文链接：<http://dx.doi.org/10.1214/24-AOS2365>

成果二.

黄飞敏研究员与合作者的论文 UNIQUENESS OF COMPOSITE WAVE OF SHOCK AND RAREFACTION IN THE INVISCID LIMIT OF NAVIER-STOKES EQUATIONS 被 SIAM JOURNAL ON MATHEMATICAL ANALYSIS 接收发表。

摘要：The uniqueness of entropy solution for the compressible Euler equations is a fundamental and challenging problem. In this paper, the uniqueness of a composite wave of shock and rarefaction of one-dimensional compressible Euler equations is proved in the inviscid limit of compressible Navier-Stokes equations. Moreover, the relative entropy around the original Riemann solution consisting of shock and rarefaction under the large perturbation is shown to be uniformly bounded by the framework developed in [M. J. Kang and A. F. Vasseur, *Invent. Math.* **224** (2021), pp.

55-146]. The proof contains two new ingredients: (1) a cut-off technique and the expanding property of rarefaction are used to overcome the errors generated by the viscosity related to inviscid rarefaction; (2) the error terms concerning the interactions between shock and rarefaction are controlled by the compressibility of shock, the decay of derivative of rarefaction, and the separation of shock and rarefaction as time increases.

论文链接: <http://dx.doi.org/10.1137/23M156584X>

成果三.

李特副研究员与合作者的论文 Nonlinear Asymptotic Stability and Transition Threshold for 2D Taylor-Couette Flows in Sobolev Spaces 被 COMMUNICATIONS IN MATHEMATICAL PHYSICS 接收发表。

摘要:

In this paper, we investigate the stability of the 2-dimensional (2D) Taylor–Couette (TC) flow for the incompressible Navier–Stokes equations. The explicit form of velocity for 2D TC flow is given by $u = (Ar + \frac{B}{r})(-\sin \theta, \cos \theta)^T$ with $(r, \theta) \in [1, R] \times \mathbb{S}^1$ being an annulus and A, B being constants. Here, A, B encode the rotational effect and R is the ratio of the outer and inner radii of the annular region. Our focus is the long-term behavior of solutions around the steady 2D TC flow. While the laminar solution is known to be a global attractor for 2D channel flows and plane flows, it is unclear whether this is still true for rotating flows with curved geometries. In this article, we prove that the 2D Taylor–Couette flow is asymptotically stable, even at high Reynolds number ($Re \sim \nu^{-1}$), with a sharp exponential decay rate of $\exp(-\nu^{\frac{1}{3}} |B|^{\frac{2}{3}} R^{-2} t)$ as long as the initial perturbation is less than or equal to $\nu^{\frac{1}{2}} |B|^{\frac{1}{2}} R^{-2}$ in Sobolev space. The powers of ν and B in this decay estimate are optimal. It is derived using the method of resolvent estimates and is commonly recognized as the enhanced dissipative effect. Compared to the Couette flow, the enhanced dissipation of the rotating Taylor–Couette flow not only depends on the Reynolds number but also reflects the rotational aspect via the rotational coefficient B . The larger the $|B|$, the faster the long-time dissipation takes effect. We also conduct space-time estimates describing inviscid–damping mechanism in our proof. To obtain these inviscid–damping estimates, we find and construct a new set of explicit orthonormal basis of the weighted eigenfunctions for the Laplace operators corresponding to the circular flows. These provide new insights into the mathematical understanding of the 2D Taylor–Couette flows.

论文链接: <http://dx.doi.org/10.1007/s00220-024-05022-6>

成果四.

罗德军研究员与合作者的论文 ON THE BOUSSINESQ HYPOTHESIS FOR A STOCHASTIC PROUDMAN-TAYLOR MODEL 被 SIAM JOURNAL ON MATHEMATICAL ANALYSIS 接收发表。

摘要: We introduce a stochastic version of the Proudman-Taylor model, a 2D-3C fluid approximation of the 3D Navier-Stokes equations, with the small-scale turbulence modeled by a transport-stretching noise. For this model we may rigorously take a scaling limit leading to a deterministic model with additional viscosity on large scales. In certain choice of noises without mirror symmetry, we identify an anisotropic kinetic alpha (AKA) effect. This is the first example with a 3D structure and a stretching noise term.

论文链接: <http://dx.doi.org/10.1137/23M1587944>

成果五.

盛赢助理研究员与合作者的论文 Sequential Data Integration Under Dataset Shift 被 TECHNOMETRICS 接收发表。

摘要: With the rapidly increasing availability of large-scale and high-velocity streaming data, efficient algorithms that can process data in batches without requiring expensive storage and computation resources have drawn considerable attention. An emerging challenge in developing efficient batch processing techniques is dataset shift, where the joint distribution of the collected data varies across batches. If not recognized and addressed properly, dataset shift often leads to erroneous statistical inferences when integrating data from different batches. In this article, two shift-adjusted estimation procedures are developed for updated estimation of the parameter in the presence of dataset shift. Under prior probability shift, we can obtain parameter estimation and assess the degree of dataset shift simultaneously. We study the asymptotic properties of the proposed estimators and evaluate their performance in numerical studies. The proposed methodologies are illustrated with an analysis of the Ford GoBike docked bike-sharing data.

论文链接: <http://dx.doi.org/10.1080/00401706.2024.2350436>

成果六.

夏建明研究员与合作者的论文 Equilibrium Portfolio Selection for Smooth Ambiguity Preferences 被 MATHEMATICS OF OPERATIONS RESEARCH 接收发表。

摘要: This paper investigates the equilibrium portfolio selection for smooth ambiguity preferences in a continuous -time market. The investor is uncertain about the risky asset's drift term and updates the subjective belief according to the Bayesian rule. A verification theorem is established, and an equilibrium strategy can be decomposed into a myopic demand and two hedging demands. When the prior is Gaussian, we provide an equilibrium solution in closed form. Moreover, a puzzle in the numerical results is interpreted via an alternative representation of the smooth ambiguity preferences.

论文链接: <http://dx.doi.org/10.1287/moor.2023.0112>

成果七.

张波研究员与合作者的论文 Reconstruction of inhomogeneous media by an iteration algorithm with a learned projector 被 INVERSE PROBLEMS 接收发表。

摘要: This paper is concerned with the inverse problem of reconstructing an inhomogeneous medium from the acoustic far-field data at a fixed frequency in two dimensions. This inverse problem is severely ill-posed (and also strongly nonlinear), and certain regularization strategy is thus needed. However, it is difficult to select an appropriate regularization strategy which should enforce some a *priori* information of the unknown scatterer. To address this issue, we plan to use a deep learning approach to learn some a *priori* information of the unknown scatterer from certain ground truth data, which is then combined with a traditional iteration method to solve the inverse problem. Specifically, we propose a deep learning-based iterative reconstruction algorithm for the inverse problem, based on a repeated application of a deep neural network and the iteratively regularized Gauss-Newton method (IRGNM). Our deep neural network (called the learned projector in this paper) mainly focuses on learning the a *priori* information of the *shape* of the unknown contrast with a normalization

technique in the training processes and is trained to act like a projector which is helpful for projecting the solution into some feasible region. Extensive numerical experiments show that our reconstruction algorithm provides good reconstruction results even for the high contrast case and has a satisfactory generalization ability.

论文链接: <http://dx.doi.org/10.1088/1361-6420/ad4f0b>

成果八.

张波研究员与合作者的论文 UNIFORM FAR-FIELD ASYMPTOTICS OF THE TWO-LAYERED GREEN FUNCTION IN TWO DIMENSIONS AND APPLICATION TO WAVE SCATTERING IN A TWO-LAYERED MEDIUM 被 SIAM JOURNAL ON MATHEMATICAL ANALYSIS 接收发表。

摘要: In this paper, we establish new results for the uniform far-field asymptotics of the two-layered Green function (together with its derivatives) in two dimensions in the frequency domain. To the best of our knowledge, our results are the sharpest yet obtained. The steepest descent method plays an important role in the proofs of our results. Further, as an application of our new results, we derive the uniform far-field asymptotics of the scattered field to the acoustic scattering problem by buried obstacles in a two-layered medium with a locally rough interface. The results obtained in this paper provide a theoretical foundation for our recent work, where direct imaging methods have been developed to image the locally rough interface from phaseless total-field data or phased far-field data at a fixed frequency. It is believed that the results obtained in this paper will also be useful on its own right.

论文链接: <http://dx.doi.org/10.1137/22M1525910>

成果九.

朱湘禅研究员与合作者的论文 Surface quasi-geostrophic equation perturbed by derivatives of space-time white noise 被 MATHEMATISCHE ANNALEN 接收发表。

摘要:

We consider a family of singular surface quasi-geostrophic equations

$$\partial_t \theta + u \cdot \nabla \theta = -\nu(-\Delta)^{\gamma/2} \theta + (-\Delta)^{\alpha/2} \xi, \quad u = \nabla^\perp (-\Delta)^{-1/2} \theta,$$

on $[0, \infty) \times \mathbb{T}^2$, where $\nu \geq 0$, $\gamma \in [0, 3/2)$, $\alpha \in [0, 1/4)$ and ξ is a space-time white noise. For the first time, we establish the *existence of infinitely many non-Gaussian*

- probabilistically strong solutions for every initial condition in C^η , $\eta > 1/2$;
- ergodic stationary solutions.

The result presents a single approach applicable in the subcritical, critical as well as supercritical regime in the sense of Hairer (Invent Math 198(2):269–504, 2014). It also applies in the particular setting $\alpha = \gamma/2$ which formally possesses a Gaussian invariant measure. In our proof, we first introduce a modified Da Prato–Debussche trick which, on the one hand, permits to convert irregularity in time into irregularity in space and, on the other hand, increases the regularity of the linear solution. Second, we develop a convex integration iteration for the corresponding nonlinear equation which yields non-unique non-Gaussian solutions satisfying powerful global-in-time estimates and generating stationary as well as ergodic stationary solutions.

论文链接: <http://dx.doi.org/10.1007/s00208-024-02881-1>