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Florian Beyer	*Fuchsian PDEs and applications to the Big Bang stability problem of the Einstein-matter equations*
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Andreia Chapouto	*Pathwise well-posedness of stochastic nonlinear dispersive equations with multiplicative noises*
Yu Deng	*Long time derivation of Boltzmann equation from hard sphere dynamics*
Moritz Doll	*Microlocal analysis of the Klein–Gordon equation*
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Chun-Yen Shen	*Size estimates for polynomial images*
Mitsuru Sugimoto	*Strichartz estimates for 3D hyperbolic equations*
Hideo Takaoka	*Large-time existence results for the nonlocal nonlinear Schrödinger equation around ground state solutions*
Hong Wang	*Kakeya sets in* $\mathbb{R}^3$
Xuecheng Wang	*Nonlinear stability of the Vlasov-Poisson system in* $\mathbb{T}^d$ *and* $\mathbb{R}^3$
Liangchuan Wu	*Hoeffding inequalities, almost orthogonalities and square functions*
Shengrong Wu	*Naked Singularity and Inner Cauchy Horizon for the Einstein-Scalar Field System*
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II. Talks: Titles & Abstracts

1. **Xinliang An, National University of Singapore**

   Title: On Kerr Black Hole Formation and a New Approach Toward Penrose Inequality

   Abstract: Black hole formation is a central question in mathematical general relativity, involving nonlinear wave equations, geometric analysis, and mathematical physics. In this talk I will present a recent joint work with Taoran He. For the 3+1 dimensional Einstein vacuum equations, we extend Christodoulou's celebrated trapped surface formation theorem to a black hole formation result. Without time-symmetric assumption, we further introduce a new approach and prove the spacetime Penrose inequality in perturbative regimes of sub-extremal Kerr black holes.

2. **Pascal Auscher, Université Paris-Saclay**

   Title: Kinetic embeddings and applications

   Abstract: The kinetic Kolmogorov-Fokker-Planck (KFP) equations are the linearized versions for Boltzmann model (non-local integro-differential) or Landau model (local differential). These were introduced by Kolmogorov and were exhibited by Hörmander as the main example for his theory of hypoelliptic equations based on commutator information. But the structure of kinetic spaces is still not well-understood. To draw a parallel, the kinetic spaces are for the KFP equations what the Sobolev spaces are for elliptic equations. They form a scale of spaces in which functions (distributions) f of time t, position x and velocity v have regularity along the transport field $\partial_t + v \cdot \nabla_x$ and the velocity field ∇_v, according to the scaling of the equation. We prove that these two informations imply precise regularity in time and position. Our estimates are sharp and scale invariant, improving on earlier works of Hörmander and Bouchut for the regularity with respect to position and in the spirit of the Lions embedding theorem for parabolic equations. They cover the optimal expected range of exponents. The methods rely on Fourier transform estimates. This allows us to give structural information about kinetic spaces (density, completeness and isomorphisms, embeddings...), to precisely describe the distributional solutions to the FKP equations with constant diffusion, to obtain well-posedness for weak solutions when the FKP equations come with rough diffusion and to define their fundamental solutions, and more. This is based on joint works with C. Imbert and L. Niebel.

3. **Florian Beyer, University of Otago**

   Title: Fuchsian PDEs and applications to the Big Bang stability problem of the Einstein-matter equations

   Abstract: I discuss recent results on the Fuchsian approach to global existence, stability, and asymptotics for solutions of quasilinear symmetric hyperbolic PDE systems. I also present recent applications to the Big Bang stability problem for the Einstein-matter equations. This is joint work with Todd Oliynyk (Monash University).

4. **Myeongju Chae, Hankyong National University**

   Title: Uniform in time propagation of chaos for two-type particles

   Abstract: We study uniform-in-time propagation of chaos for a two-type interacting particle system in which particles change type at prescribed rates. The type dynamics admit two equivalent representations, either as a Poisson jump process or as a spin-flip dynamics, and we exploit both viewpoints to implement a coupling approach. The key ingredient for obtaining long-time control is a reflection coupling with respect to a modified Wasserstein distance, following the framework developed by A. Eberle et al. for McKean–Vlasov type equations.

5. **Andreia Chapouto, Monash University**

   Title: Pathwise well-posedness of stochastic nonlinear dispersive equations with multiplicative noises

   Abstract: Over the last decades, the well-posedness issue of stochastic dispersive PDEs with multiplicative noises has been extensively studied. However, this study was done primarily from the viewpoint of Ito solution theory, and pathwise well-posedness remained completely open. In this talk, I will present the first pathwise well-posedness results for stochastic nonlinear wave equations (SNLW) and stochastic nonlinear Schrodinger equations (SNLS) with multiplicative white-in-time/coloured-in-space noise. Here, we combine the operator-value controlled rough paths adapted to dispersive flows, together with random tensor estimates, and the Fourier restriction norm method adapted to controlled rough paths.

6. **Yu Deng, The University of Chicago, Zoom talk**

   Title: Long time derivation of Boltzmann equation from hard sphere dynamics

   Abstract: We present recent works with Zaher Hani and Xiao Ma, in which we derive the Boltzmann equation from the hard sphere dynamics in the Boltzmann-Grad limit, for the full time range in which the (strong) solution to the Boltzmann equation exists. This is done in the Euclidean setting in any dimension $d \geq 2$, and in the periodic setting in dimensions $d \in \{2, 3\}$. As a corollary, we also derive the corresponding fluid equations from the the hard sphere dynamics. This executes the original program, proposed in Hilbert's Sixth Problem in 1900, pertaining to the derivation of hydrodynamic equations from colliding particle systems, via the Boltzmann equation as the intermediate step.

7. **Moritz Doll, Macquarie University**

   Title: Microlocal analysis of the Klein–Gordon equation

   Abstract: We consider the Klein-Gordon equation on asymptotically Minkowski space with a class of space-time potentials that decay sufficiently fast in spatial directions and approach a limiting potential as $t \to \infty$. Building on previous work of Vasy for many-body scattering problems, we show that the Klein-Gordon operator admits a description as a non-elliptic Fredholm operator as a map between anisotropic Sobolev spaces. We prove the global existence of both the causal propagators as well as the Feynman propagator. The talk is based on joint work with Dean Baskin and Jesse Gell-Redman.

8. **Kai Dong, National University of Singapore**

   Title: The Past Stability of Kasner Singularities for the $3+1$-Dimensional Einstein Vacuum Spacetime under Polarized $U(1)$-Symmetry

   Abstract: In this talk, we will provide a new proof to a past stability result established in Fournodavlos-Rodnianski-Speck [FRS23], for Kasner solutions of the $(3+1)$-dimensional Einstein vacuum equations under polarized $U(1)$-symmetry. Our method, inspired by Beyer-Oliynyk-Olvera-Santamaría-Zheng [BOOS21], [BOZ25], relies on a newly developed $(2+1)$ orthonormal-frame decomposition and a careful symmetrization argument, after which the Fuchsian techniques can be applied.

   We show that the perturbed solutions are asymptotically pointwise Kasner, geodesically incomplete and crushing at the Big Bang singularity. They are achieved by reducing the $(3+1)$ Einstein vacuum equations to a Fuchsian system coupled with several constraint equations, with the symmetry assumption playing an important role in the reduction. Using Fuchsian theory together with finite speed of constraint propagation, we obtain global existence and precise asymptotics of the solutions up to the singularities.

9. **Yihong Du, University of New England**

   Title: On the principal eigenvalue of asymmetric nonlocal diffusion operators and associated propagation dynamics

   Abstract: Let $\lambda^c(l)$ denote the principal eigenvalue of a nonlocal diffusion operator with a non-symmetric kernel function J(x) and a drifting term with coefficient c over an interval of the form $(-l, l)$. We obtain a formula for the limit of $\lambda^c(l)$ as l goes to infinity. We then make use of this formula to obtain a rather good description of the propagation dynamics of the associated KPP model whose dispersal is determined by a nonlocal diffusion operator with such a non-symmetric kernel function J(x). Our result on the propagation dynamics improves some recent ones with asymmetric nonlocal diffusion, and the method used in this approach is very different from those in the literature.

10. **Chenjie Fan, Chinese Academy of Sciences**

    Title: On Strichartz estimates for Schrödinger equations

    Abstract: We will present several Strichartz estimates on 2d wave guide, including bilinear estimates for Schrodinger, and linear Strichartz for hyperbolic Schrodinger. In some sense, all those estimates are obtained by studying the Euclidean space in a right way.

11. **Justin Forlano, Monash University**

Title: The intermediate nonlinear Schrödinger equation

Abstract: In this talk, I will discuss recent results regarding the intermediate nonlinear Schrödinger equation (INLS). Analytically speaking, INLS is a one-dimensional completely integrable nonlinear Schrödinger equation with a cubic derivative nonlinearity and is L^2-critical. A limiting form of INLS is the continuum Calogero-Moser equation (CCM), which is also completely integrable. Interestingly, CCM keeps the Hardy space L^2_+ invariant, and, under this assumption, tools from complete integrability have recently resolved the well-posedness problem for CCM in L^2_+. I will discuss progress on the well-posedness for INLS and CCM (not relying on complete integrability), outside of the Hardy space and in low-regularity. Our approach combines a gauge transformation, bilinear Strichartz estimates and a refined decomposition for smooth solutions. This is based on joint work with A. Chapouto (CNRS, UVSQ) and T. Laurens (UW-Madison).

12. **Emanuel József Godfried, The University of Melbourne**

Title: Mean first escape times of Brownian motion

Abstract: Calculating the mean first escape time of a random particle confined to a domain through a small window is a well-known problem in molecular biology. Mathematically, the mean first escape time of a Brownian particle is modelled by an elliptic boundary value problem with mixed boundary conditions depending on some parameter ϵ approaching 0. The goal is to provide the asymptotics of the solution u_ϵ of the boundary value problem as the parameter ϵ approaches 0. Difficulty comes from the need to find the asymptotics of the full Cauchy data of the solutions u_ϵ. In this talk we discuss the mean first escape time of Brownian motion on asymptotically hyperbolic surfaces and gas giant surfaces. We show using boundary layer techniques, that for each fixed $x \in M$, the mean first escape time $u_\epsilon(x)$ satisfies the estimate $u_\epsilon(x) = -\log \epsilon + \mathcal{O}(1)$ as $\epsilon \to 0$ if M is asymptotically hyperbolic and $u_\epsilon(x) = \mathcal{O}(1)$ if M is gas giant. This is joint work with Jesse Gell-Redman, Emanuel József Godfried, Justin Tzou, Leo Tzou.

13. **Taoran He, Institut des Hautes Études Scientifiques**

Title: Stability of Big Bang singularity for the Einstein-Maxwell-scalar field-Vlasov system in the full strong sub-critical regime

Abstract: In this talk, I will present our recent work on the stability of Kasner solutions for the Einstein-Maxwell-scalar field-Vlasov system in 1+3 dimensions. This system incorporates gravity, electromagnetic, weak and strong interactions for the initial stage of our universe. The inclusion of the Vlasov field introduces several new challenges. By observing detailed mathematical structures and designing new delicate arguments, we identify a new strong sub-critical regime and prove the nonlinear stability with Kasner exponents lying in this entire regime. Our results extend the work of Fournodavlos-Rodnianski-Speck from the Einstein-scalar field system to the physically more complex system with the Vlasov field. This is joint work with Xinliang An and Dawei Shen.

14. **Yougnhun Hong, Chung-Ang University**

Title: Semi-classical limit of scattering states for the nonlinear Hartree equation

Abstract: Abstract: The semi-classical limit from quantum to classical models is one of the central topics in mathematical physics, as it provides a rigorous foundation for the quantum-classical correspondence. In this talk, we focus on this correspondence principle in the context of the long-time dynamics of a large number of interacting particles. Specifically, we consider the nonlinear Hartree equation in the Heisenberg picture, and show that small-data solutions satisfy dispersion bounds and scatter. These bounds and smallness conditions are independent of the small parameter $\hbar \in (0, 1]$, which represents the reduced Planck constant. Then, in the semi-classical limit as $\hbar \to 0$, we prove that the Wigner transforms of such quantum scattering states converge to the corresponding classical scattering states of the Vlasov equation. This talk is based on joint work with Sonae Hadama (Kyoto).

15. **Xianpeng Hu, The Hong Kong Polytechnic University**

Title: Effects of viscosities of compressible fluid flows

Abstract: We will discuss the effects of shear viscosity and bulk viscosity on the stability of Cauchy problems for compressible fluid flows near constant equilibrium. The large bulk viscosity forces the pressure wave disappear and the global convergence to the limit system around an equilibrium is justified with nonnegative shear viscosity. A set of analytical tools, such as Green's functions, vector fields, and the ghost weight method are applied to overcome difficulties.

16. **Qiuye Jia, The Australian National University**

Title: Strichartz and dispersive estimates on asymptotically conic manifolds

Abstract: Asymptotically conic manifolds is a class of manifolds that are natural generalizations of Euclidean spaces. In this talk I will discuss the relationship between Strichartz/dispersive estimates on asymptotically conic manifolds and the geodesic flow on it, also with the presence of scaling critical magnetic fields. We give a non-negative integer valued quantity that quantifies the focusing effect of the geodesic flow and this will be proportional to the decay rate in dispersive estimates.

17. **Kihyun Kim, Seoul National University**

Title: Rigidity results in multi-bubble dynamics for non-radial energy-critical heat equation

Abstract: In this talk, I will present my recent joint work with Frank Merle (IHES and CY Cergy-Paris University) on the classification of asymptotic behaviors in multi-bubble dynamics for energy-critical heat equations (NLH) in large dimensions $N \geq 7$ without symmetry. Although (NLH) is a parabolic equation, this type of problem arises from a more general class of evolutionary equations including dispersive PDEs; this multi-bubble dynamics appears naturally at least for a sequence of times in view of soliton resolution. We assume each bubble is given by the scalings and translations of $\pm W$ with (localized) non-colliding conditions for a sequence of times, where W is the ground state. The case of one soliton was previously established and in particular there is no blow-up. We consider the case of $J \geq 2$ solitons, where we expect only infinite-time blow-up. We are able to identify three different scenarios, where we have a continuous-in-time resolution with an unexpected universal blow-up speed.

18. **Nobu Kishimoto, Kyoto University**

Title: Well-posedness for the intermediate NLS in a Zhidkov-type space

Abstract: The intermediate nonlinear Schrödinger equation models quasi-harmonic internal waves in two-fluid layer system, and admits dark solitons, that is, solutions with non-vanishing boundary conditions at spatial infinity. These solutions fall outside existing well-posedness theories. We establish local and global well-posedness in a Zhidkov-type space naturally suited to such non-trivial boundary conditions, and extend these results to a generalized defocusing equation. This talk is based on joint work with T. Akahori (Sizuoka University), R. Badreddine (UCLA), and S. Ibrahim (University of Victoria).

19. **Sanghyuk Lee, Seoul National University**

Title: Estimates for oscillatory integrals with damping factors

Abstract: Let σ be the surface measure on a smooth hypersurface $\mathcal{H} \subset \mathbb{R}^{d+1}$. A fundamental subject in harmonic analysis is to determine the decay of $\widehat{\sigma}$. For nondegenerate $\mathcal{H}$, the stationary phase method yields the optimal decay, while sharp bounds in the degenerate case are known only in limited situations. In this talk, we are concerned with the oscillatory estimate

$$|(\kappa^{1/2}\sigma)^\wedge(\xi)| \leq C|\xi|^{-d/2},$$

for convex analytic surfaces $\mathcal{H}$, where κ is the Gaussian curvature. The damping factor $\kappa^{1/2}$ is expected to recover the optimal decay, as suggested by the stationary phase expansion, but the work of Cowling–Disney–Mauceri–Müller shows that such bounds fail in general for $d \geq 5$ even when the surface is convex and analytic. However, it has remained open whether the estimate holds in lower dimensions $2 \leq d \leq 4$. We establish it for $d = 2, 3$, and with a logarithmic loss for $d = 4$. Our approach is inspired by the stationary set method of Basu–Guo–Zhang–Zorin-Kranich. We also discuss applications to convolution, maximal, and adjoint restriction operators. This is joint work with Sewook Oh.

20. **Jiakun Liu, The University of Sydney**

Title: Free boundary problems in optimal transportation

Abstract: In this talk, I will present some recent results on the regularity of free boundaries in optimal transportation, including higher-order regularity, global regularity, and a model case involving multiple targets. These results are based on a series of joint works with Shibing Chen, Xianduo Wang and Xu-Jia Wang.

21. **Sylvie Monniaux, Aix-Marseille Université**

Title: A Leibniz-type magic formula

Abstract: In this talk, I will show how to estimate terms of the form $\operatorname{curl}(u \times b)$ in L^r with the norms of u, ∇u, b, $\operatorname{div} b$ and $\operatorname{curl} b$. This estimate is very useful when dealing with the magnetohydrodynamical system where the term $\operatorname{curl}(u \times b)$ appears as a non linear coupling in the magnetic equation (the induction equation), where b denotes the magnetic field and u the velocity field. Although this is a 3D question, I will present its n-dimensional version for $n \geq 2$.

22. **Chun-Yen Shen, National Taiwan University**

Title: Size estimates for polynomial images

Abstract: In this talk, I will first briefly review the history of sum-product estimates in the discrete setting and mention the applications of sum-product type problems. Then I will start introducing the celebrated result of Bourgain about the discretized sum-product estimates and their applications. Finally I will talk about our recent results about expanding polynomials in terms of Lebesgue measure and Hausdorff dimension.

23. **Mitsuru Sugimoto, Nagoya University**

Title: Strichartz estimates for 3D hyperbolic equations

Abstract: Strichartz estimates for wave equations have been extensively studied and effectively applied to nonlinear problems, yet much less is known for general hyperbolic equations. In this talk, we discuss how these estimates depend on certain geometric properties of the characteristics and demonstrate that, in three spatial dimensions, they allow one to extract detailed information about the underlying dynamics. This is based on speaker's series of works and recent development by Isroil Ikromov (Samarkand).

24. **Hideo Takaoka, Kobe University**

Title: Large-time existence results for the nonlocal nonlinear Schrödinger equation around ground state solutions

Abstract: We will discuss the dynamics of solutions of a nonlocal nonlinear Schrödinger equation near a soliton orbit:

$$i\partial_t u(t,x) - \partial_x^2 u(t,x) = u(t,x)^2 u^\star(t,x), \quad (t,x) \in \mathbb{R}^2,$$

where $u^\star(t,x) = \overline{u(t,-x)}$. Notice that the equation possesses a two-parameter family of soliton solutions:

$$u_{\alpha,\beta}(t,x) = \frac{\sqrt{2}(\alpha+\beta)}{e^{i\alpha^2 t+\alpha x} + e^{i\beta^2 t-\beta x}}, \quad \alpha, \beta > 0,$$

which blows up at the time $T_{\alpha,\beta} = \pi/(\alpha-\beta)$ at the origin. We examine that the solution remains close to the orbit of the soliton for a large-time, if the initial data is close to the ground-state solitons. The proof uses the hyperbolic dynamics near ground state, which exhibits properties of local structural stability of solutions with respect to the flows of the nonlocal nonlinear Schrödinger equation, in conjunction with bootstrap argument. We also give numerical results showing this phenomenon. This is a joint work with Toshihiro Tamaki, Kobe University.

25. **Hong Wang, New York University**

Title: Kakeya sets in $\mathbb{R}^3$

Abstract: A Kakeya set is a compact subset of $\mathbb{R}^n$ that contains a unit line segment pointing in every direction. Kakeya set conjecture asserts that every Kakeya set has Minkowski and Hausdorff dimension n. We prove this conjecture in $\mathbb{R}^3$ as a consequence of a more general statement about union of tubes.

This is joint work with Josh Zahl.

26. **Xuecheng Wang, Tsinghua University**

Title: Nonlinear stability of the Vlasov-Poisson system in $\mathbb{T}^d$ and $\mathbb{R}^3$

Abstract: We consider the global stability problem for the Vlasov-Poisson system in $\mathbb{T}^d$ and $\mathbb{R}^3$ around the spatially homogeneous nontrivial equilibrium. (i) For the periodic case, i.e., in $\mathbb{T}^d$, we prove the nonlinear stability in the sharp Gevery-3 space and the existence of nonlinear scattering operator. (ii) In $\mathbb{R}^3$, we give linear stability for a class of general equilibrium and nonlinear stability for a special equilibrium, which is the so-called Poisson equilibrium. This talk is based on joint works with A. Ionescu (Princeton University), B. Pausader (Brown University), and K. Widmayer (University of Zurich and University of Vienna).

27. **Liangchuan Wu, An Hui University**

Title: Hoeffding inequalities, almost orthogonalities and square functions

Abstract: In this talk, we present joint work with Ji Li and Jill Pipher on multi-parameter Hoeffding inequalities. By introducing a new square function and developing an iterative scaling algorithm, we establish sharp inequalities for sums of almost-orthogonal atomic functions. Building on this, we resolve the multi-parameter theory for the Chang–Wilson–Wolff theorem and prove sharp square function estimates in higher dimensions. The talk will conclude with a discussion of recent applications.

28. **Shengrong Wu, National University of Singapore**

Title: Naked Singularity and Inner Cauchy Horizon for the Einstein-Scalar Field System

Abstract: This work constructs naked singularity solutions for the 3+1-dimensional Einstein scalar-field equations (ESE) with no symmetric assumption. The global existence of a new class of perturbed Christodoulou's (spherically symmetric) naked singularity solutions is established. The resulting spacetime is globally defined in the exterior region and lacks a complete future null infinity. We further analyze the structure of the resulting inner Cauchy horizon and prove C^1 inextendibility. This rigorously demonstrates a stability feature of the inner Cauchy horizon of the naked singularity against small, close-to self-similar perturbations. This talk is based on joint work with Xinliang An.

29. **Lixin Yan, Sun Yat-sen University**

Title: Sharp L^p-estimates for wave equation on $ax+b$ groups

Abstract: Let G be the group $\mathbb{R} \ltimes \mathbb{R}^n$ endowed with Riemannian symmetric space metric d and the right Haar measure $d\rho$ which is of $ax+b$ type, and L be the positive definite distinguished left-invariant Laplacian on G. Let $u = u(t,\cdot)$ be the solution to $u_{tt} + Lu = 0$ with initial conditions $u|_{t=0} = f$ and $u_t|_{t=0} = g$. We show that for a fixed $t \in \mathbb{R}$ and every $1 < p < \infty$,

$$\|u(t,\cdot)\|_{L^p(G)} \le C_p \left((1+|t|)^{2|1/p-1/2|} \|f\|_{L^p_{\alpha_0}(G)} + (1+|t|)\, \|g\|_{L^p_{\alpha_1}(G)} \right)$$

if and only if

$$\alpha_0 \ge n\left|\frac{1}{p} - \frac{1}{2}\right| \quad \text{and} \quad \alpha_1 \ge n\left|\frac{1}{p} - \frac{1}{2}\right| - 1.$$

This gives an endpoint result for $\alpha_0 = n|1/p - 1/2|$ and $\alpha_1 = n|1/p - 1/2| - 1$ with $1 < p < \infty$ that was conjectured in Remark 8.1 due to Müller and Thiele [Studia Math. 179(2007)].

30. **Xiao Zhang, Chinese Academy of Sciences**

Title: Massless Majorana spinors in the Kerr spacetime

Abstract: Majorana spinors are predicted to exist, but not detected yet in the universe. Under a separation of variables, we show that existence of Majorana spinors lead to vanishing of coupled magnetic charge and the coupled electric charge in Kerr-Newman, or Kerr-Newman-(A)dS spacetimes. Furthermore, we show that massive Majorana spinors do not exist if they are t-dependent or ϕ-dependent in Kerr, or Kerr-(A)dS spacetimes. For massless Majorana spinors in the non-extreme Kerr spacetime, the Dirac equation can be separated into radial and angular equations, parameterized by two complex constants ϵ_1, ϵ_2. If at least one of ϵ_1, ϵ_2 is zero, massless Majorana spinors can be solved explicitly. If ϵ_1, ϵ_2 are nonzero, we prove the nonexistence of massless time-periodic Majorana spinors in the non-extreme Kerr spacetime which are L^p outside the event horizon for $0 < p \le \frac{6}{|\epsilon_1|+|\epsilon_2|+2}$. We then provide the Hamiltonian formulation for massless Majorana spinors and prove that the self-adjointness of the Hamiltonian leads to the angular momentum $a = 0$ and spacetime reduces to the Schwarzschild spacetime, moreover, the massless Majorana spinor must be ϕ-independent. Finally, we show that, in the Schwarzschild spacetime, for initial data with L^2 decay at infinity, the probability of the massless Majorana spinors to be in any compact region of space tends to zero as time tends to infinity. The talk is based on the joint works with Tianyuan Cai and Hequn Zhang.