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#### **Summer School in PDE and Applications 2024**

Vietnam Institute for Advanced Study in Mathematics (VIASM) and Saigon University (SGU) jointly organized the Summer School in PDE and Applications 2024 at SGU in Ho Chi Minh City from July 22 to July 27, 2024.



Assoc Prof. Lê Minh Triết - Vice Director of SGU at the Opening ceremony

The summer school had more than 70 active participants, including undergraduate, graduate students, lecturers, and professors from Vietnam and abroad (USA, Indonesia, Thailand, South Korea, and the Philippines). The organizing committee sponsored 15 domestic and international participants from regions outside Ho Chi Minh City to attend the summer school.

The summer school consisted of three special topic courses with 12 lectures delivered by world leading experts in partial differential equations and applications: Prof. Suzanne Lenhart (University of Tennessee, USA), Prof. Nguyễn Tiên Khải (North Carolina State University, USA), and Prof. Trần Minh Bình (Texas A&M University, USA). The lectures at the summer school focused on many current issues in partial differential equations, including various interconnected and complementary topics:



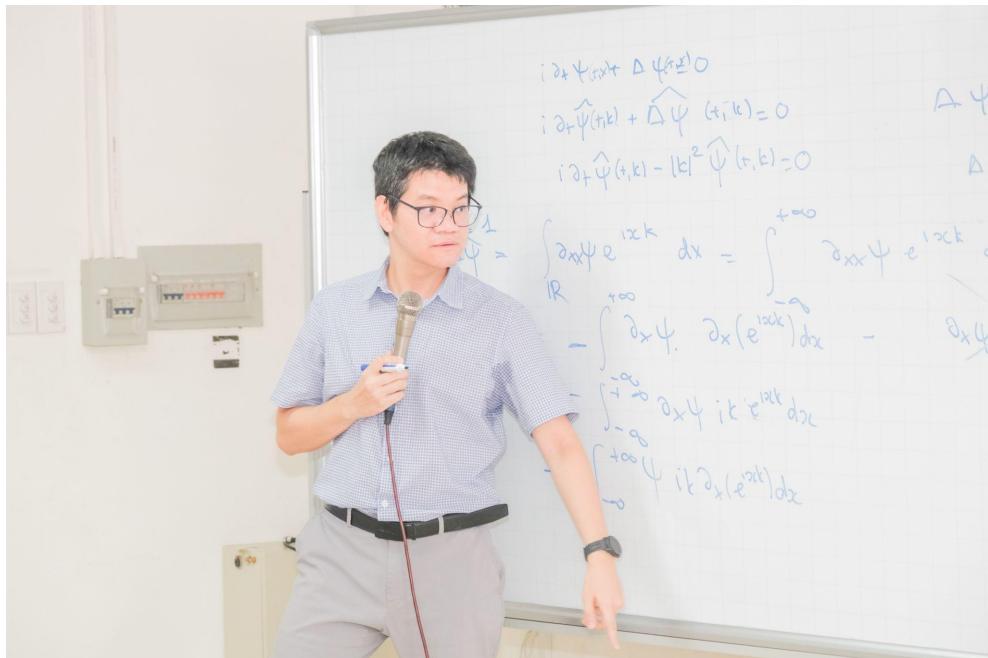
Prof. Suzanne Lenhart (University of Tennessee, USA)

Professor Lenhart taught a topic course on optimal control of ordinary differential equations, partial differential equations, and applications to biology and environment.



Prof. Nguyễn Tiến Khải (North Carolina State University, USA)

Professor Nguyễn Tiến Khải delivered a topic course on introduction to optimal control theory and Hamilton-Jacobi equations.



Prof. Trần Minh Bình (Texas A&amp;M University, USA)

Professor Trần Minh Bình gave a topic course on introduction to kinetic equations for waves.

The lectures not only provided introductory knowledge but also led students to the currently active research topics, and addressed many interesting open problems. In addition, the summer school also had two sessions of exercises and Matlab practice on optimal control for ordinary differential equations under the guidance of Prof. Phillip Andreae and Prof. Suzanne Lenhart. Furthermore, informal discussions between students and professors at the end of each day (from 3:30 p.m. to 5:00 p.m.) had a quite open atmosphere, and the contents of the topic courses as well as many related topics were discussed.



Prof. Phillip Andreae supported on the exercise

Besides the topic courses, the summer school was concluded by a workshop with four talks given by experts in partial differential equations:

First, they proved that  $u^2 + v^2 \leq 1$  in  $\mathbb{R}^N$ . This helped to carry on the moving plane method to show that  $\frac{\partial u}{\partial x_N} > 0$  and  $\frac{\partial v}{\partial x_N} < 0$  in  $\mathbb{R}^N$ .

- ▶ Second, they exploited the associated linearized equation to show that the same monotonicity holds in all directions in the  $x_N$ -direction.
- ▶ One-dimensional symmetry of  $u$  follows from a standard argument.

Results on Gross–Pitaevskii system:

Liouville type results are also proved by Farina, Serra, and Soave (2020) and Sourdis (2017) for  $0 < \Lambda \leq 1$ .

Solutions to (2) without uniform convergence (3) in any direction do exist when  $\Lambda > 1$  (see Soave (2020)).

Prof. Phuong Le (University of Economics and Law, VNUHCM, Vietnam) gave a talk titled "One-dimensional symmetry of solutions to elliptic systems with non-uniform limits".

**Warm-up in 1D: Minimizing curves - with boundary data**

Fix manifold  $\mathcal{M}$ ,  $p \in (1, \infty)$ . Find  $\gamma : [0, 1] \rightarrow \mathcal{M}$  that minimizes

$$\int_0^1 |\gamma'(t)|^p dt : \gamma : [0, 1] \rightarrow \mathcal{M}$$

subject to boundary data  $\gamma(0) = \vec{p}_0$ ,  $\gamma(1) = \vec{p}_1$ .

- ▶ Minimizer exist, end of story (bit more work if  $p = 1$ ), by the direct method of CalcVar.
- ▶ Set

$$X := \left\{ \gamma : [0, 1] \rightarrow \mathcal{M} \text{ s.t. } \inf_{[0,1]} |\gamma'(t)|^p dt < \infty, \gamma(0) = \vec{p}_0, \gamma(1) = \vec{p}_1 \right\}$$

Goal: find  $\bar{\gamma} \in X$  such that

$$\text{INF} := \inf_{[0,1]} |\bar{\gamma}'(t)|^p dt = \inf_{\gamma \in X} \int_{[0,1]} |\gamma'(t)|^p dt$$

- ▶ Take a minimizing sequence  $\gamma_k : [0, 1] \rightarrow \mathcal{M}$ ,  $\gamma_k(0) = \vec{p}_0$ ,  $\gamma_k(1) = \vec{p}_1$  such that

$$\text{INF} = \lim_{k \rightarrow \infty} \int_{[0,1]} |\gamma_k'(t)|^p dt$$

The energy is coercive, so up to subsequence convergent to some  $\bar{\gamma} : [0, 1]$ .

- ▶ Since  $\bar{\gamma} \in X$  it is the minimizer, indeed:

$$\int_{[0,1]} |\bar{\gamma}'(t)|^p dt \stackrel{l.s.c}{\leq} \lim_{k \rightarrow \infty} \int_{[0,1]} |\gamma_k'(t)|^p dt \stackrel{\text{minseq}}{\leq} \text{INF} \stackrel{\bar{\gamma} \in X}{\leq} \int_{[0,1]} |\bar{\gamma}'(t)|^p dt$$

- ▶ These minimizers are just the geodesics (shortest curves)

Prof. Armin Schikorra (University of Pittsburgh, USA) talked titled "On s-Stability of  $W^{s,n/s}$ -minimizing maps between spheres in homotopy classes".

$L^\infty(\mathbb{R}^d)$

$C^{1,\gamma}(\mathbb{R}^d)$

functionals

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Dr. Son Tu (Michigan State University, USA) delivered a talk titled "Remarks on the well-posedness of Viscosity Solutions for the One-Phase Muskat Problem".



Dr. Doanh Pham (Saigon University, Vietnam) presented a talk titled "A logarithmic Sobolev inequality for minimal hypersurfaces of the unit sphere".

The talks at the miniworkshop introduced students and participants to many current trends in the field of partial differential equations and their applications.

In addition to professional activities, the lecturers, speakers, and the scientific organizers of the summer school spent an afternoon visiting some places in Ho Chi Minh City such as Ben Thanh Market and the Ho Chi Minh City Museum of Fine Arts.

Some representative images from the summer school:









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