

The 8th International Conference on Nonlinear PDEs & Their Numerical Analysis

–In honor of Professor Tai-Ping Liu’s 70th birthday

Program and Abstracts



May 25-28, 2015,
Hangzhou, Zhejiang, P.R.China

Organized By:

Academy of Mathematics and Systems Science, Chinese Academy of Sciences, China
K.K. Chen Institute for Advanced Studies, Hangzhou Normal University, China

Sponsored By:

National Natural Science Foundation of China

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Invited Speakers:

Alberto Bressan (Pennsylvania State University, USA)
Alfonso Castro (Harvey Mudd College, USA)
Dongho Chae (Chung-Ang University, Korea)
Gui-Qiang Chen (University of Oxford, UK)
Shuxing Chen (Fudan University, USA)
Yinbin Deng (Central China Normal University, China)
Yi Ding (New Jersey City University, USA)
Renjun Duan (Chinese University of Hong Kong, China)
Volker Elling (Michigan University, USA)
Beixiang Fang (Shanghai Jiaotong University, China)
Daoyuan Fang (Zhejiang University, China)
Heinrich Freistuhler (University of Konstanz, Germany)
Hermano Frid (IMPA, Brazil)
James Glimm (State University of New York at Stony Brook, USA)
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Xianpeng Hu (City University of Hong Kong, China)
Yanbo Hu (K.K. Chen Institute for Advanced Studies, Hangzhou Normal University, China)
Zaihong Jiang (Zhejiang Normal University, China)
Shi Jin (University of Wisconsin, USA)
Zhen Lei (Fudan University, China)
Congming Li (University of Colorado at Boulder, USA and and SJTU, China)
Gongbao Li (Central China Normal University, China)
Hailiang Li (Capital Normal University, China)
Jing Li (Chinese Academy of Sciences, China)
Tianhong Li (Chinese Academy of Sciences, China)
Tong Li (University of Iowa, USA)
Yachun Li (Shanghai Jiaotong University, China)
Zhong Li (Zhejiang Sci-Tech University, China)
Dong Liang (York University, Canada)
Xing Liang (University of Science and Technology of China, China)
Tai-Ping Liu (Stanford University, USA)
Tao Luo (Georgetown University, USA)
Pierangelo Marcati (University of L' Aquila, Italy)
Marcelo Martins dos Santos (UNICAMP, Brazil)
Shuangjie Peng (Central China Normal University, China)
Changzheng Qu (Ningbo University, China)
Wen Shen (Pennsylvania State University, USA)
Wancheng Sheng (Shanghai University, China)
Xiaoding Shi (BUCT, China)

Zhong Tan (Xiamen University, China)
Xiangxing Tao (ZUST, China)
Athanasios Tzavaras (KAUST, Saudi Arabia)
Mingxin Wang (Harbin Institute of Technology, China)
Yaguang Wang (Shanghai Jiaotong University, China)
Yi Wang (Chinese Academy of Sciences, China)
Yong Wang (Chinese Academy of Sciences, China)
Yang Wang (Hangzhou Dianzi University, China)
Yuzhu Wang (NCWU, China)
Wei Xiang (City University of Hong Kong, China)
Chao-Jiang Xu (Rouen University, France & Wuhan University, China)
Jiang Xu (Nanjing University of Aeronautics and Astronautics, China)
Xiaozhou Yang (Chinese Academy of Sciences, China)
Hongjun Yu (South China Normal University, China)
Hairong Yuan (East China Normal University, China)
Yanni Zeng (University of Alabama Birmingham, USA)
Chengjian Zhang (Huazhong University of Sciences and Technology, China)
Pingwen Zhang (Peking University, China)
Ting Zhang (Zhejiang University, China)
Yongqian Zhang (Fudan University, China)
Huijiang Zhao (Wuhan University, China)
Huansong Zhou (Wuhan Institute of Physics and Mathematics, China)
Yi Zhou (Fudan University, China)

Below is some useful information which we would like to inform you for attention.

Arrival at Lotus Hotel

The transportations to Lotus Hotel could be found from the conference website at:

<http://lxy.hznu.edu.cn/ztzl/dbjpwffcjqszfxgjhy/>

<http://lxy.hznu.edu.cn/ztzl/dbjpwffcjqszfxgjhy/619511.shtml>

<http://lxy.hznu.edu.cn/ztzl/dbjpwffcjqszfxgjhy/619510.shtml>

Registration for Residents

The conference registration starts from May 24 at the check-in lobby of Lotus Hotel, and the registration on-desk is available for the whole day of May 24. If you arrive before May 24, please check in directly and register in May 24.

Please prepare enough **CASH** for your registration on desk in May 24, because only **CASH** can be accepted to pay registration fee and Credit Card can not be used. It is no problem for you to use Credit Card to pay your accommodation in Lotus Hotel.

No registration fee for all invited speakers.

Non-Resident and Late Registration

For participants who arrive after May 24, a Registration/Information Desk shall be open throughout the conference period in the hotel.

Internet Connection

The internet is available in Lotus Hotel, you can connect to internet via cable or wi-fi (wireless) in each room if you have a laptop.

Accommodation and Breakfast

We have made reservation for all invited speakers in Lotus hotel (Address: 72 Huancheng West Road, Xicheng District, Hangzhou, Tel. 0571-85060888) and all participants in another Hotel (Huandao Hotel Address: 92 Huancheng West Road, Xicheng District, Hangzhou, Tel. 0571-85068666). The price of each room includes one or two free breakfasts depending on the double or single room.

Lunch and Dinner

For all invited speakers and registered participants, the lunch and the dinner are free for the period May 24 (dinner only)-29 (lunch only).

Excursion

A short excursion to the Capital HangZhou Grand Canal will take place at the night of May 25. The excursion fee is not included in the registration fee. The excursion fee (80 Chinese Yuan) will be charged to all participants. Information in details shall be announced during the conference.

Conference Banquet

We are organizing a Conference Banquet to be held in the evening of May 26. The banquet fee is included in the registration fee. For accompanying persons, the banquet fee is to be charged. Information in details shall be announced during the conference.

Program

May25 (Monday)	
Time	
9:00-10:00	Registration (Lotus Hotel, First Floor)
10:00-10:15	Opening Ceremony(Lotus Hotel, Second Floor; Chair: Gui-Qiang Chen)
Time	Speakers
10:15-11:15	Tai-Ping Liu James Glimm
11:15-12:15	Gui-Qiang Chen Shuxing Chen
12:30	Lunch (Lotus Hotel, Second Floor)

May 25 (Monday)			
	Session 1(Lotus Hotel, Third Floor)		Session 2 (Huandao Hotel, 17th Floor)
Time	Chairs	Speakers	Chairs
14:30-15:10		Volker Elling	Dongho Chae
15:15-15:55	Yaguang Wang	Beixiang Fang	Pigong Han
16:00-16:40		Wei Xiang	Zheng Han
17:00	Dinner (Lotus Hotel, Second Floor)		
18:30	Excursion for The Beijing-Hangzhou Grand Canal (京杭大运河)		

May 26 (Tuesday)				
Session 1(Lotus Hotel, Third Floor)		Session 2 (Huandao Hotel, 17th Floor)		
Time	Chairs	Speakers	Chairs	Speakers
8:30-9:10	P. Marcati	H. Freistuhler	Gongbao Li	Chaojiang Xu
9:15-9:55		Yi Zhou		Ziqing Xie
10:00-10:15	Tea Break			
10:15-10:55	Yachun Li	Zhen Lei	Jiang Xu	Jing Li
11:00-11:40		Hairong Yuan		M. Martins Santos
12:30	Lunch (Lotus Hotel, Second Floor)			

May 26 (Tuesday)			
Session 1(Lotus Hotel, Third Floor)		Session 2 (Huandao Hotel, 17th Floor)	
Time	Chairs	Speakers	Speakers
14:30-15:10	Shuangjie Peng	Yaguang Wang	Wen Shen
15:15-15:55		Yong Wang	Alfonso Castro
16:00-16:15	Tea Break		
16:15-16:55	Huijiang Zhao	Xiaozhou Yang	Jiang Xu
17:00-17:40		Hailiang Li	Changzheng Qu Yuzhu Wang
17:45-18:20	Group Photo (Huandao Hotel, 17th Floor)		
18:30	Banquet (Lotus Hotel, Second Floor)		

May 27 (Wednesday)			
Session 1(Lotus Hotel, Third Floor)		Session 2 (Huandao Hotel, 17th Floor)	
Time	Chairs	Speakers	Speakers
8:30-9:10	A. Tzavaras	HermanoFrid	Pingwen Zhang
9:15-9:55		Yanni Zeng	Chengjian Zhang
10:00-10:40		Yachun Li	Dong Liang
10:45-11:00	Tea Break		
11:00-11:40	Yanni Zeng	A. Tzavaras	Congming Li
11:45-12:25		Xianpeng Hu	Tianhong Li
12:30	Lunch (Lotus Hotel, Second Floor)		

May 27 (Wednesday)					
Session 1(Lotus Hotel, Third Floor)			Session 2 (Huandao Hotel, 17th Floor)		
Time	Chairs	Speakers	Chairs	Speakers	
14:30-15:10	Wen Shen	P. Marcarti	Xianpeng Hu	Renjun Duan	
15:15-15:55		Tao Luo		Xiaoding Shi	
16:00-16:15	Tea Break				
16:15-16:55	Tao Luo	Hongjun Yu	Hailiang Li	Tong Li	
17:00-17:40		Zhong Li		Yang Wang	
18:30	Dinner (Lotus Hotel, Second Floor)				

May 28 (Thursday) (Huandao Hotel, 17th Floor)		
Time	Chairs	Speakers
9:00-10:00	James Glimm	Alberto Bressan
10:00-11:00	Hermano Frid	Gui-Qiang Chen
11:00-12:00	Alberto Bressan	Tai-Ping Liu
12:00	Closing Ceremony	
12:30	Lunch (Lotus Hotel, Second Floor)	
18:30	Dinner (Lotus Hotel, Second Floor)	

Program

——The 8th International Conference on Nonlinear PDEs and Their
Numerical Analysis,
May 25-28, 2015, Hangzhou, China

May 25 (Monday)

9:00-10:00 Registration (Lotus Hotel, First Floor)

10:00-10:15 Opening Ceremony (Lotus Hotel,
Second Floor; Chair: Gui-Qiang Chen)

10:15-11:15 Chair: Tai-Ping Liu

Speaker: James Glimm (State University of New York
at Stony Brook, USA)

Title: Numerical Models of Subgrid Physics

11:15-12:15 Chair: Gui-Qiang Chen

Speaker: Shuxing Chen (Fudan University, China)

Title: Global existence and stability of a stationary
Mach reflection

12:30 Lunch (Lotus Hotel, Second Floor)

May 25 (Monday)

Session 1 (Lotus Hotel, Third Floor)

Chair: Yaguang Wang

14:30-15:10 Speaker: Volker Elling (University of Michigan, USA)

Title: Self-similar 2d Euler solutions with vorticity of mixed sign

15:15-15:55 Speaker: Beixiang Fang (Shanghai Jiaotong University, China)

Title: Global Stability of E-H Type Regular Refraction of Shocks on the Interface between Two Media

16:00-16:40 Speaker: Wei Xiang (City University of Hong Kong, China)

Title: Shock diffraction by convex cornered wedges

May 25 (Monday)

Session 2 (Huandao Hotel, 17th Floor)

Chair: Huansong Zhou

14:30-15:10 Speaker: Dongho Chae (Chung-Ang University, Korea)

Title: Unique continuation and asymptotic properties in the Euler/Navier-Stokes equations

15:15-15:55 Speaker: Pigong Han (AMSS, China)

Title: Long time behavior for non-stationary Navier-Stokes flows in unbounded domains

16:00-16:40 Speaker: Zheng Han (Hangzhou Normal University, China)

Title: On the unconditional uniqueness for NLS in \dot{H}^s

17:00 Dinner (Lotus Hotel, Second Floor)

18:30 Excursion for The Beijing-Hangzhou Grand Canal (京杭大运河)

May 26 (Tuesday)

Session 1 (Lotus Hotel, Third Floor)

Chair: P. Marcati

8:30-9:10 Speaker: H. Freistuhler (University of Konstanz, Germany)

Title: Internal structure of dynamic phase-transition fronts in a fluid with two compressible or incompressible phases

9:15-9:55 Speaker: Yi Zhou (Fudan University, China)

Title: Global existence of radial solutions for general semilinear hyperbolic systems in 3D

10:00-10:15 Tea Break

Chair: Yachun Li

10:15-10:55 Speaker: Zhen Lei (Fudan University, China)

Title: Global Wellposedness of Incompressible Elastodynamics in 2D

11:00-11:40 Speaker: Hairong Yuan (East China Normal University, China)

Title: On Transonic shocks in steady compressible Euler flows

12:30 Lunch (Lotus Hotel, Second Floor)

Chair: Shuangjie Peng

14:30-15:10 Speaker: Yaguang Wang (Shanghai Jiaotong University, China)

Title: Stability of Three-dimensional Prandtl Boundary Layers

15:15-15:55 Speaker: Yong Wang (AMSS, China)

Title: A Justification of Diffusion limit for the Boltzmann Equation with non-trivial Profile

16:00-16:15 Tea Break

Chair: Huijiang Zhao

16:15-16:55 Speaker: Xiaozhou Yang (WIPM, China)

Title: Singular structures, formula and schemes for

global solutions of some conservation laws

17:00-17:40 Speaker: Hailiang Li (Capital Normal University, China)

Title: Spectrum structure and behaviors of Vlasov-Poisson(Maxwell)-Boltzmann equations

17:45-18:20 Group Photo (Huandao Hotel, 17th Floor)

18:30 Banquet (Lotus Hotel, Second Floor)

May 26 (Tuesday)

Session 2 (Huandao Hotel, 17th Floor)

Chair: Gongbao Li

8:30-9:10 Speaker: Chaojiang Xu (Rouen University, France and Wuhan University, China)

Title: Incompressible Navier-Stokes-Fourier Limit from The Boltzmann Equation

9:15-9:55 Speaker: Ziqing Xie (Hunan Normal

University, China)

Title: Are Normalized Line Search Rules Really Suitable for Finding Multiple Solutions of Semilinear PDEs

10:00-10:15 Tea Break

Chair: Jiang Xu

10:15-10:55 Speaker: Jing Li (AMSS, China)

Title: Large-Time Behavior of Solutions to One-Dimensional Compressible Navier-Stokes System in Unbounded Domains with Large Data

11:00-11:40 Speaker: M. Martins Santos (State University of Campinas, Brazil)

Title: The Cauchy problem for the combustion model in a porous media with two layers

12:30 Lunch (Lotus Hotel, Second Floor)

Chair: Yinbin Deng

14:30-15:10 Speaker: Wen Shen (Pennsylvania State

University, USA)

Title: Recent results on models of slow erosion by granular flow

15:15-15:55 Speaker: Alfonso Castro (Harvey Mudd College, USA)

Title: Existence of low Morse index solutions for semilinear elliptic boundary value problems

16:00-16:15 Tea Break

Chair: Changzheng Qu

16:15-16:55 Speaker: Jiang Xu (Nanjing University of Aeronautics and Astronautics, China)

Title: Optimal decay estimates on the framework of Besov spaces for hyperbolic systems with degenerate dissipation

17:00-17:40 Speaker: Yuzhu Wang (North China University of Water Resources and Electric Power, China)

Title: Global existence and asymptotic behavior of

solutions to the generalized double dispersion equation

17:45-18:20 Group Photo(Huandao Hotel, 17th Floor)

18:30 Banquet (Lotus Hotel, Second Floor)

May 27 (Wednesday)

Session 1(Lotus Hotel, Third Floor)

Chair: A. Tzavaras

8:30-9:10 Speaker: Hermano Frid(IMPA, Brazil)

Title: Some questions and results on generalized almost periodic homogenization of nonlinear PDEs

9:15-9:55 Speaker: Yanni Zeng (University of Alabama at Birmingham, USA)

Title: Some Recent Results for Hyperbolic Balance Laws

10:00-10:40 Speaker: Yachun Li (Shanghai Jiaotong University, China)

Title: Recent Progress on classical solutions for compressible isentropic Navier-Stokes equations with degenerate viscosities and vacuum

10:45-11:00 Tea Break

Chair: Yanni Zeng

11:00-11:40 Speaker: A. Tzavaras (King Abdullah University of Science and Technology (KAUST), Saudi Arabia)

Title: Kinetic models for the description of sedimenting suspensions

11:45-12:25 Speaker: Xianpeng Hu (City University of Hong Kong, China)

Title: Wellposedness of self-gravitating Hookean elastodynamics

12:30 Lunch (Lotus Hotel, Second Floor)

Chair: Wen Shen

14:30-15:10 Speaker: P. Marcati (University of

L'Aquila, Italy)

Title: On the Mathematical theory of Quantum hydrodynamics (QHD)

15:15-15:55 Speaker: Tao Luo (Georgetown University, USA)

Title: Global Solutions to the Gas-Vacuum Interface Problem with Physical Singularity for the Compressible Euler Equations with Damping

16:00-16:15 Tea Break

Chair: Tao Luo

16:15-16:55 Speaker: Hongjun Yu (South China Normal University, China)

Title: Spectrum analysis of some kinetic equations

17:00-17:40 Speaker: Zhong Li (Zhejiang University of Science and Technology, China)

Title: Geometric computation and its application

18:30 Dinner (Lotus Hotel, Second Floor)

May 27 (Wednesday)

Session 2 (Huandao Hotel, 17th Floor)

Chair: Chaojiang Xu

8:30-9:10 Speaker: Pingwen Zhang (Peking University, China)

Title: The Mathematical Problems of Isotropic-Nematic Interface

9:15-9:55 Speaker: Chengjian Zhang (Huazhong University of Sciences and Technology, China)

Title: An ADI Method for Solving Nonlinear Telegraph Wave Equations

10:00-10:40 Speaker: Dong Liang (York University, Canada)

Title: Energy-conserved S-FDTD methods for solving Maxwell's equations

10:45-11:00 Tea Break

Chair: Renjun Duan

11:00-11:40 Speaker: Congming Li (University of Colorado at Boulder, USA and SJTU, China)

Title: Qualitative analysis on solutions to Hardy-Littlewood-Sobolev type systems

11:45-12:25 Speaker: Tianhong Li (AMSS, China)

Title: Regularity property of solutions to Eikonal equation

12:30 Lunch (Lotus Hotel, Second Floor)

Chair: Xianpeng Hu

14:30-15:10 Speaker: Renjun Duan (The Chinese University of Hong Kong, China)

Title: Time-periodic solutions of the Vlasov-Poisson-Fokker-Planck system

15:15-15:55 Speaker: Xiaoding Shi (Beijing University of Chemical Technology, China)

Title: Vanishing Mean Free Path Limit for Interacting Shock Waves of Broadwell Equation

16:00-16:15 Tea Break

Chair: Hailiang Li

16:15-16:55 Speaker: Tong Li (University of Iowa, USA)

Title: Stability of Large-amplitude Traveling Waves in Hyperbolic Systems with Relaxation

17:00-17:40 Speaker: Yang Wang (Hangzhou Dianzi University, China)

Title: The population dynamics of a competition model with non-local dispersal

18:30 Dinner (Lotus Hotel, Second Floor)

May 28 (Thursday) (Huandao Hotel, 17th Floor)

9:00-10:00 Chair: James Glimm

Speaker: Alberto Bressan (Pennsylvania State University, USA)

Title: Uniqueness and generic regularity for a nonlinear wave equation

10:00-11:00 Chair: Hermano Frid

Speaker: Gui-Qiang Chen (Oxford University, UK)

Title: Shock Reflection-Diffraction, von Neumann's Detachment Conjecture, and Transonic Free Boundary Problems

11:00-12:00 Chair: Alberto Bressan

Speaker: Tai-Ping Liu (Academic Sinica, Taiwan and Stanford University, USA)

Title: Some recollections

12:00 Closing Ceremony

12:30 Lunch (Lotus Hotel, Second Floor)

18:30 Dinner (Lotus Hotel, Second Floor)

Title and Abstract

Uniqueness and generic regularity for a nonlinear wave equation

ALBERTO BRESSAN

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The talk will be concerned with the nonlinear wave equation

$$u_{tt} - c(u)(c(u)u_x)_x = 0.$$

For initial data $(u, u_t) \in H^1 \times L^2$, using a refined version of the method of characteristics, it is proved that the conservative solution is unique.

For an open dense set of C^3 initial data, the conservative solution is piecewise smooth in the t - x plane, while the gradient u_x can blow up along finitely many characteristic curves. The analysis relies on a variable transformation which reduces the equation to a semilinear system with smooth coefficients, followed by an application of Thom's transversality theorem. A detailed description of the solution profile can be given, in a neighborhood of every singular point and every singular curve.

(These results are in collaboration with Geng Chen, Tao Huang, Fang Yu, and Qingtian Zhang).

Existence of low Morse index solutions for semilinear elliptic boundary value problems

ALFONSO CASTRO

Harvey Mudd College, USA
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This lecture shall include a survey of techniques leading to the existence of solutions to semilinear elliptic boundary value problems and recent results of how to obtain the existence of solutions with Morse 3 or more.

Unique continuation and asymptotic properties in the Euler/Navier-Stokes equations

DONGHO CHAE

Chung-Ang University, Korea
donghochae@gmail.com

In this talk we discuss the unique continuation type results and the maximal decay rates at the spatial infinity for nontrivial solutions of the Euler and Navier-Stokes equations. The unique continuation type result is first studied for the stationary Schroedinger equation, and then was extended to the stationary Navier-Stokes system by some authors. The key method is the Carleman estimate. For the Euler equations in a self-similar form, without relying on the Carleman estimate, we derive unique continuation type results and the Liouville type theorems,

using the maximum principle argument. For the Navier-Stokes equations we derive new Carleman estimate to prove an improved unique continuation theorem, and combining this with the Kelvin transform we prove an asymptotic behavior of nontrivial solutions to the stationary Navier-Stokes equations.

Shock Reflection-Diffraction, von Neumann's Detachment Conjecture, and Transonic Free Boundary Problems

GUI-QIANG CHEN

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Global existence and stability of a stationary Mach reflection

SHUXING CHEN

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We prove the global existence and stability of a wave structure containing a stationary Mach configuration, which occurs when an incident shock front hits a wall with a large incident angle. Our result shows that the data of the upstream flow and the pressure at downstream part jointly determine the whole flow, as well as the wave structure. Particularly, we show that the height of the Mach stem depends not only on the data of upstream flow, but also on the pressure at downstream flow.

The flow with the assigned wave structure is governed by a free boundary value problem for the Euler system. In the problem the location of the triple point, the shock fronts and the contact discontinuity are all unknown, they are finally determined together with the solution.

Time-periodic solutions of the Vlasov-Poisson-Fokker-Planck system

RENJUN DUAN

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In this note it is shown that the Vlasov-Poisson-Fokker-Planck system in the three-dimensional whole space driven by a time-periodic background profile near a positive constant state admits a time-periodic small-amplitude solution with the same period. The proof follows by the Serrin's method on the basis of the exponential time-decay property of the linearized system in the case of the constant background profile. This is a joint work with Shuangqian Liu.

Self-similar 2d Euler solutions with vorticity of mixed sign

VOLKER ELLING

University of Michigan, USA
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We construct a class of self-similar 2d incompressible Euler solutions that have initial vorticity of mixed sign. The regions of positive and negative vorticity form algebraic spirals.

Global Stability of E-H Type Regular Refraction of Shocks on the Interface between Two Media

BEIXIANG FANG

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bxfang@sjtu.edu.cn

In this talk I will discuss the refraction of shocks on the interface for 2-d steady compressible flow. Particularly, the class of E-H type regular refraction is defined and its global stability of the wave structure is verified. The 2-d steady potential flow equations is employed to describe the motion of the fluid. The stability problem of the E-H type regular refraction can be reduced to a free boundary problem of nonlinear mixed type equations in an unbounded domain. The corresponding linearized problem has similarities to a generalized Tricomi problem of the linear Lavrentiev-Bitsadze mixed type equation, and it can be reduced to a nonlocal boundary value problem of an elliptic system. The later is finally solved by establishing the bijection of the corresponding nonlocal operator in a weighted Hölder space via careful harmonic analysis. This is a joint work with CHEN Shuxing and HU Dian.

Internal structure of dynamic phase-transition fronts in a fluid with two compressible or incompressible phases

HEINRICH FREISTUHLER

University of Konstanz, Germany
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The framework of this talk is the Navier-Stokes-Allen-Cahn system for the dynamics of a fluid whose two phases can transform into each other. It studies traveling waves that describe the internal structure of moving interfaces between the phases. A general result on the existence and bifurcation of these waves is detailed for fluids with (1) two compressible phases, (2) one incompressible and one compressible phase, (3) two incompressible phases, and (4) associated limits in which one or both of the two phases are almost incompressible. (Joint work with Matthias Kotschote)

Some questions and results on generalized almost periodic homogenization of nonlinear PDEs

HERMANO FRID

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We recall some recent results about homogenization of nonlinear partial differential equations in the context of ergodic algebras. We review the concept of two-scale Young measures in generalized almost periodic homogenization and some important applications in which its use demonstrates to be a decisive resource for the homogenization analysis, among which the porous medium equation and some correlated ones. We also discuss the relationship between generalized almost periodic homogenization and stationary ergodic stochastic homogenization, and we exemplify this with the hamilton-Jacobi and fully nonlinear elliptic and parabolic equations. Parts of this research were done in collaboration with Luigi Ambrosio, Jean Silva e Henrique Versieux.

Numerical Models of Subgrid Physics

JAMES GLIMM

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Turbulence remains a major scientific and numerical obstacle for many engineering problems of practical importance; currently planned advances in computer hardware will only marginally ameliorate this problem, and so the issue has to be addressed at an intellectual level. Commonly used Reynolds averaged Navier-Stokes (RANS) models, the workhorse of turbulent simulation, are data hungry due to their numerous underspecified parameters, and are hardly predictive unless supported by sufficient data. Data is generally expensive and otherwise not available, so that the more accurate Large Eddy Simulations (LES) are employed to fill this gap.

LES are not trouble free. In this talk we will outline some of their major weaknesses, and mitigating strategies. Unreliable results with LES can usually be traced to a failure to employ LES correctly.

In a word, the major problem with LES is the nonuniqueness of their solutions. Of course, this should be a major concern when the goal is predictive science. LES has fewer parameters than RANS and a simpler formulation. Even with this fact, the key weakness of LES lies in its parameters, both their identification and their realization in a numerical algorithm.

In this talk, we first identify at an intuitive level the origins of LES nonuniqueness. We find that the missing ingredient is the subgrid physics of fluid transport embedded in the numerical algorithm. In part the subgrid fluid transport is addressed by the addition of 'models' to the fluid equations, and with a recipe for the choice of dynamic (space-time dependent) model coefficients.

For reasons of numerical stability, (turbulent) diffusion can be added to the equations in this manner, but it cannot be subtracted. Thus we also propose a Front Tracking algorithm to control excesses of numerical diffusion. The use of this algorithm is called for in Eulerian algorithms applied to problems with a Schmidt or Prandtl number in excess of 0.3.

Finally, we address issues of technology transfer, with an API (called FTI) for front tracking, to allow its ready adaption into other physics packages. The interface and operations on it are

supported with high order accuracy. Future versions of this API will support fully conservative tracking.

Long time behavior for non-stationary Navier-Stokes flows in unbounded domains

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In this talk, we introduce some asymptotic results for non-stationary Navier-Stokes flows in the half space. Using the Stokes solution formula, we find a crucial and new estimate for the Stokes solution in L^1 , from which, the time L^1 behavior for N-S flows, including the first and second spatial derivatives, are established. In addition, we also give some recent decay results of N-S flows in exterior domains.

On the unconditional uniqueness for NLS in \dot{H}^s

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In this talk, we discuss the unconditional uniqueness of \dot{H}^s , $0 < s < 1$, solutions for the nonlinear Schrödinger equation $i\partial_t u + \Delta u + c|u|^\alpha u = 0$ in \mathbb{R}^n . We give a unified proof of the previously known results in the subcritical cases and critical cases, and we also extend these results to some previously unsettled cases. Our proof uses in particular negative order Sobolev spaces (or Besov spaces), general nonhomogeneous Strichartz estimates, and the improved regularity property for the difference of two solutions.

Wellposedness of self-gravitating Hookean elastodynamics

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This talk is devoted to the wellposedness issue for the self-gravitating Hookean elastodynamics in dimension three. The solution is constructed near an equilibrium.

Global Wellposedness of Incompressible Elastodynamics in 2D

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We will report our recent result on the 2D incompressible elastodynamics, and review the history on the study of long time existence for quasilinear wave equations and elastodynamics.

Qualitative analysis on solutions to Hardy-Littlewood-Sobolev type systems

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This presentation is centered around the well-known Hardy-Littlewood- Sobolev type systems:

$$\begin{cases} (-\Delta)^{\frac{\gamma}{2}} u = v^q, & u > 0, \text{ in } R^n, \\ (-\Delta)^{\frac{\gamma}{2}} v = u^q, & v > 0, \text{ in } R^n, \end{cases}$$

These are also sometimes called Lane-Emden type systems. We give a brief survey on some important known results, a short introduction of some of our recent results, and also a brief description of some basic problems that we are interested. Beyond the basic qualitative properties such as the existence, non-existence, and classification of positive solutions, we are also interested in the integrability, asymptotic at infinite, and symmetries of positive solutions.

Spectrum structure and behaviors of Vlasov-Poisson(Maxwell)-Boltzmann equations

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We present the recent results on the spectrum structures of the Vlasov-Poisson(Maxwell)-Boltzmann equations and justify the influences of the electrostatic potential force, Lorentz force, and/or the mutual interaction between charged particles of different type. It is joint with Mingying Zhong and Tong Yang.

Large-Time Behavior of Solutions to One-Dimensional Compressible Navier-Stokes System in Unbounded Domains with Large Data

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Abstract?We study the large-time behavior of solutions to the initial and initial boundary value problems with large initial data for the compressible Navier-Stokes system describing the one-dimensional motion of a viscous heat-conducting perfect polytropic gas in unbounded domains. The temperature is proved to be bounded from below and above independently of both time and space. Moreover, it is shown that the global solution is asymptotically stable as time tends to infinity. Note that the initial data can be arbitrarily large. This result is proved by using elementary energy methods.

Regularity property of solutions to Eikonal equation

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Eikonal equation has many applications in geometric optics, optimal control, path planing and etc. It is a Hamilton-Jacobi equation with Hamiltonian $H(p) = |p|$. H is not smooth and strictly convex. No matter how smooth initial data are, the solutions to Eikonal equation in general are not in C^1 . In this talk, we consider C^2 initial data and study the regularity of solutions.

Stability of Large-amplitude Traveling Waves in Hyperbolic Systems with Relaxation

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We study the linear and nonlinear exponential stability of traveling wave solutions for a system of quasi-linear hyperbolic equations with relaxation. By applying C_0 -semigroup theory and detailed spectral analysis, we prove the linear exponential stability of the traveling waves for the quasilinear systems and nonlinear exponential stability of the waves for semilinear systems, i.e., the Jin-Xin relaxation models, in some exponentially weighted spaces without assuming that the wave strengths are small.

This is a joint work with Yaping Wu.

Recent Progress on classical solutions for compressible isentropic Navier-Stokes equations with degenerate viscosities and vacuum

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In this talk I first present our recent progress on the local existence of classical solutions for compressible isentropic Navier-Stokes equations with density dependent viscosities in a power law when allowing vacuum, which is a long-standing open problem due to the very high degeneracy caused by vacuum for this system. The formation of singularities and the vanishing viscosity limit are also involved. This talk is the joint work with Yongcai Geng, Ronghua Pan, and Shengguo Zhu).

Geometric computation and its application

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In this talk, I will introduce some progresses in geometric computation and give some applications in garment computer aided design and bio-informatics.

Energy-conserved S-FDTD methods for solving Maxwell's equations

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Maxwell's equations, which are a set of partial differential equations describing the relation of electric and magnetic fields, have been widely used in computational electromagnetics. They have been playing an important role in many applications such as the radio-frequency, microwave, antennas, aircraft radar, integrated optical circuits, wireless engineering, and the design of CPU in microelectronic, etc. During the propagation of electromagnetic wave in lossless media without sources, the electromagnetic energy keeps constant for all time, which explains the physical feature of conservation of electromagnetic energy in long term behaviour. It is significantly important to preserve this invariance in time, for developing efficient numerical schemes for Maxwell's equations and specially for a long term computation of electromagnetic fields. In this talk, we will present our new progress on energy-conserved S-FDTD methods, including high-order energy-conserved schemes for Maxwell's equations and new energy-conserved schemes in metamaterials. We will talk theoretical results on energy conservation, stability and convergence and will give numerical examples to show their performance. Applications in metamaterials will also be introduced in the talk.

Some recollections

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Global Solutions to the Gas-Vacuum Interface Problem with Physical Singularity for the Compressible Euler Equations with Damping

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In this talk, the result for the global existence and large time convergence to the Barenblatt self-similar solution to the gas-vacuum inter-face problem with physical singularity for the compressible Euler equations with damping will be discussed. This is a joint work with Huihui Zeng.

On the Mathematical theory of Quantum hydrodynamics (QHD)

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QHD appears in many relevant situations as the physics of superfluids (Landau Kapitsa), superconductors (Feynman), Bose Einstein condensation and in the modeling of semiconductors devices at nanoscale. The classical WKB approach or Modeling transformations relates the QHD approach to the Schroedinger picture. The presence of vacuum is the source of many mathematical difficulties. We introduce a new tool which is the polar decomposition for the wave functions and prove its stability in H^1 , which allows, due to cancellation phenomena, to control quadratic nonlinearities despite the lack of smoothness and a priori bounds. The solutions are approximated via a semigroup splitting method then energy estimates, Strichartz estimates and local smoothing are sufficient to get compactness. Non uniqueness and ill posedness are obtained in a result which extends DeLellis and Szkelyhidi theory to Euler Korteweg fluids. Finally we show some recent advances on MQHD, the Landau Kapitsa 2 fluid model and a beginning of analysis of quantum turbulence.

The Cauchy problem for the combustion model in a porous media with two layers

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We prove the existence of a global solution to the Cauchy problem for a nonlinear reaction-diffusion-convection system coupled with a system of ordinary differential equations. The system models the propagation of a combustion front in a porous medium with two layers, as derived by J.C. da Mota and S. Schechter in *Combustion fronts in a porous medium with two layers*, Journal of Dynamics and Differential Equations, **18** (3) (2006), 615–665. For the particular case, when the fuel concentrations in both layers are known functions, the Cauchy problem was solved by J.C. da Mota and M.M. Santos in *An application of the monotone iterative method to a combustion problem in porous media*, Nonlinear Analysis: Real World Application, **12** (2010), 1192–1201). For the full system, in which the fuel concentrations are also unknown functions, we construct an iterative scheme, that contains a sequence which converges to a solution of the system, locally in time, under the conditions that initial data are Hölder continuous and bounded functions. We also show the existence of a global solution, if the initial data are also in a L^p space, for some $p \in (1, \infty)$. Our proof of the local existence relies on a careful analysis of the construction of the fundamental solution for parabolic equations obtained by the parametric method. In particular, we show the continuous dependence of the fundamental solution for parabolic equations with respect to the coefficients. To obtain the global existence, we employ the “method of auxiliary functions” as used by O.A. Oleinik and S.N. Kruzhkov in *Quasi-linear second-order parabolic equations with many independent variables*, Russian Mathematical Surveys, **16** (5) (1961), 105–146, and we need to control the growth of the local solution at infinity, in space, so the hypothesis of the initial data in a L^p space.

This is a joint work with J.C. da Mota and R.A. Santos.

Recent results on models of slow erosion by granular flow

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In this talk we present recent results on models of slow erosion by granular flow. The model is an integro-differential equation, which is a conservation law where the flux function contains an integral term of a nonlinear function of the conserved quantity. We will present results on various models which lead to various properties in the solution, in particular when the profile develops vertical jumps. Recent results include existence of global BV solutions via front tracking approximation, existence of semi-group solutions, existence and local stability of traveling waves, uniqueness and stability of the semi-group solution, and existence and uniqueness for slow erosion of rough geological layers.

Vanishing Mean Free Path Limit for Interacting Shock Waves of Broadwell Equation

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In this talk, we present our recent work about the vanishing mean free path limit for interacting shock waves of Broadwell equation. Given any entropy solution of Broadwell model system which consists of two different families of shocks interacting at some positive time, we show that such solution is the vanishing mean free path limit of a family of smooth global solution for the Broadwell model system.

Kinetic models for the description of sedimenting suspensions

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I review some works on modeling and the mathematical theory for dilute suspensions of rigid rods. Such problems appear in modeling sedimentation of suspensions of particles. Similar in spirit models are also used for modeling swimming micro-organisms. Here, we focus on a class of models introduced by Doi and describing suspensions of rod-like molecules in a solvent fluid. They couple a microscopic Fokker-Planck type equation for the probability distribution of rod orientations to a macroscopic Stokes flow. One objective is to compare such models with traditional models used in macroscopic viscoelasticity as the well known Oldroyd model.

In particular: (i) We show that steady states can have discontinuous solutions analogous to the ones studied in the context for macroscopic viscoelastic models (e.g. for Oldroyd-B models) and spurt phenomena or shear bands in that context. (ii) For the problem of sedimenting rods under the influence of gravity we discuss the instability of the quiescent flow and the derivation of the collective response in the diffusive regime. We derive a reduced model for the description of the collective flow that amounts to a flux-limited Keller-Segel model.

Stability of Three-dimensional Prandtl Boundary Layers

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In this talk, we shall study the stability of the Prandtl boundary layer equations in three space variables. First, we give an instability criterion on the shear flow of the three-dimensional Prandtl boundary layers. Both of linear and nonlinear stability are considered. This criterion shows that the monotonic shear flow is linearly stable for the three dimensional Prandtl equations if and only if the tangential velocity field direction is invariant with respect to the normal variable. Second, we obtain a well-posedness result of the three-dimensional nonlinear Prandtl

equations for a special flow, which avoids the appearance of the complicated secondary flow in boundary layers. This is a joint work with Chengjie Liu and Tong Yang.

The population dynamics of a competition model with non-local dispersal

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Equations with non-local dispersal have been widely used as models in biology. In this talk we focus on logistic models with non-local dispersal, for both single and two competing species. We show the global convergence of the unique positive steady state for the single equation and investigate the effects of dispersal rates and interspecific competition coefficients in a shadow system for a two-species competition model. Our results illustrate that the effect of dispersal in spatially heterogeneous environments can be quite different from that in homogeneous environments.

A Justification of Diffusion limit for the Boltzmann Equation with non-trivial Profile

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Under the diffusion scaling and a scaling assumption on the microscopic component, a non-classical fluid dynamic system was derived in Bardos-Levermore-Ukai-Yang(2008) that is related to the system of ghost effect derived in Sone(2006) in different settings. This paper aims to justify this limit system for a non-trivial background profile with slab symmetry. The result reveals not only the diffusion phenomena in the temperature and density, but also the flow of higher order in Knudsen number due to the gradient of the temperature. Precisely, we show that the solution to the Boltzmann equation converges to a diffusion wave with decay rates in both Knudsen number and time.

Global existence and asymptotic behavior of solutions to the generalized double dispersion equation

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In this paper, we study the initial value problem for the generalized double dispersion equation in n -dimensional space. Under small condition on the initial data, we prove the global existence and asymptotic decay of solutions for all space dimensions. Moreover, when $n=2$, we show that the solution can be approximated by the linear solution as time tends to infinity. When $n=3$, we show that as time tends to infinity, the solution approaches the superposition of nonlinear diffusion waves which are given explicitly in terms of the self-similar solution of the viscous Burgers equation. This is a joint work with S. Kawashima, M. Kato.

Shock diffraction by convex cornered wedges

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In this talk, I would like to present one of our current research projects, that is on the mathematical analysis of shock diffraction by convex cornered wedges for the potential flow. The existence of the regular configuration is established for any cornered wedges when the upcoming shocks are weak.

Are Normalized Line Search Rules Really Suitable for Finding Multiple Solutions of Semilinear PDEs

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It is well known that the global convergence of the iteration methods for nonlinear problems is a very important but difficult topic. Inspired by the work in Zhou and Li (SISC, 2001,2002) and the line search strategies in optimization theory in R^n aiming at the global convergence, in this talk we propose a modified Local Minimax Method (LMM) based on a normalized Goldstein line search rule to find multiple minimax-type solutions. It extends the classical Goldstein linear search rule in the optimization theory into nonlinear iteration methods for solving nonlinear PDEs and prevents step-size from being too small and not terminating to ensure that an algorithm makes reasonable progress and then a large-scope convergence is attained. The feasibility of our approach is provided and its corresponding convergence is proven. Finally, our approach is implemented to solve several typical semilinear elliptic boundary value problems on a square for multiple saddle points and the numerical results indicate that our approach is efficient.

Incompressible Navier-Stokes-Fourier Limit from The Boltzmann Equation

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The global classical solution to the incompressible Navier-Stokes-Fourier equation with small initial data in the whole space is constructed through a zero Knudsen number limit from the solutions to the Boltzmann equation with general noncutoff collision kernels. The key point is the uniform estimate of the Sobolev norm on the global solutions to the Boltzmann equation. This is a collaboration with N. Jiang (Tsinghua University) and H. Zhao (Wuhan University).

Optimal decay estimates on the framework of Besov spaces for hyperbolic systems with degenerate dissipation

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We give a decay framework for linearized dissipative hyperbolic system and hyperbolic-parabolic composite system, which enables us to pay less attention on the traditional spectral analysis. New ingredients lie in the high-frequency and low-frequency decompositions of a pseudo-differential operator and an interpolation inequality related to homogeneous Besov spaces of negative order. Furthermore, we develop the Littlewood-Paley pointwise energy estimates and time-weighted energy approaches in terms of the high-frequency and low-frequency decompositions, which lead to the optimal decay estimates in spatially critical Besov spaces for hyperbolic system of balance laws. This is a joint work with Professor Shuichi Kawashima.

Singular structures, formula and schemes for global solutions of some conservation laws

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In this talk, we will present several results of new singular structures for solutions of some multi-dimensional conservation laws, we will also present formula and converged numerical scheme for a class of solutions of one dimensional combustion equations. Joint with my students Gaowei Cao and Chunlong Yang.

Spectrum analysis of some kinetic equations

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We analyze the spectrum structure of some kinetic equations by using semi-group theory and linear operator perturbation theory. The models include the classical Boltzmann equation for hard potentials with or without angular cutoff and the Landau equation with $\gamma > 2$. As an

application, we show that the solutions to these two fundamental equations are asymptotically equivalent (mod time decay $t^{5/4}$) as $t \rightarrow \infty$ to that of the compressible Navier-Stokes equations for initial data around an equilibrium state.

On Transonic shocks in steady compressible Euler flows

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I will review some recent results on the mathematical studies of steady compressible Euler flows that containing transonic shocks, and introduce our new result on the problem of stability of spherical transonic shocks for the three-dimensional steady full compressible Euler systems. It is a free boundary problem of a multi-dimensional first-order system of conservation laws of elliptic-hyperbolic composite-mixed type, and we employed some tools from differential geometry to reveal that this nonlinear problem could be decomposed equivalently into six coupled sub-problems, which include a Venttsel problem of a second order elliptic equation containing a non-integral type nonlocal term, a div-curl system on 2-sphere, and several Cauchy problems of transport equations. The talk is based upon joint works with many collaborators.

Some Recent Results for Hyperbolic Balance Laws

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In this talk we discuss some recent results for a general system of hyperbolic balance laws. We consider the Cauchy problem near an equilibrium state. Under a set of assumptions, which include an entropy function and the Shizuta-Kawashima dissipation condition, we obtain the existence of global solution and large time behavior. We also discuss the consequence of the removal of the Shizuta-Kawashima condition, as happens in the dynamics of real gasses.

An ADI Method for Solving Nonlinear Telegraph Wave Equations

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In this talk, a new three-level compact alternating direction implicit (ADI) difference scheme is presented for solving nonlinear telegraph wave equations. It is shown by the energy method that the numerical solution is conditionally convergent with an order of $\mathcal{O}(\Delta t^2 + h_x^4 + h_y^4)$ in H^1 - and L^∞ -norms. Based on three time-grid parameters, a Richardson extrapolation formula is

given to obtain numerical solution of fourth-order accuracy in both time and space. Several numerical experiments further illustrate the effectiveness of the algorithms and the corresponding theoretical results.

The Mathematical Problems of Isotropic-Nematic Interface

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Liquid crystals represent a vast and diverse class of anisotropic soft matter materials which are intermediate between isotropic liquids and crystalline solids. The various liquid crystal phases can be characterized by the type of ordering one of the most common liquid crystal phases is the isotropic phase, another is the nematic phase.

In this talk, a wide spectrum of mathematical problems of isotropic-nematic interface will be considered. One set of problems to be considered is the relationship between these different levels of modeling, for example how one can make a rigorous passage from molecular/statistical descriptions to continuum theories. Special consideration will be given to the existence, uniqueness and regularity of the solutions of the Landau-de Gennes theory.

Global existence of radial solutions for general semilinear hyperbolic systems in 3D

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We study the well-posedness of radial solutions for general nonlinear hyperbolic systems in three dimensions. We give a proof of the global existence of radial solutions for general semilinear hyperbolic systems in 3D under null condition, with small scaling invariant $W^{2,1}(\mathbb{R}^3)$ data. We obtain a bilinear estimate that is effective to the hyperbolic systems which do not have any time decay. It allows us to achieve the boundedness of the weighted BV norm of the radial solution. This work is a joint work with Silu Yin.