# CONFERENCE PROGRAM

## The Asian Aerospace and Astronautics Conference (AAAC 2023)

## 亚洲航空航天会议

**Wuhan, Hubei, China| September 15-17, 2023**

**中国 湖北 武汉| 2023 年 9 月 15-17 日**

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# WELCOME ADDRESS

Dear Attendees,

Welcome to The Asian Aerospace and Astronautics Conference (AAAC 2023), which is to be held in Wuhan, Hubei, China from September 15-17, 2023, where participants will gain detailed insights into the state of the art of aerospace and astronautics, and enjoy the exchange with other enthusiasts from all over the world who are interested in this highly relevant and constantly growing area.

AAAC 2023 is sponsored by Science and Engineering Institute (SCIEI), Huazhong University of Science and Technology, co-sponsored by The Hong Kong Polytechnic University, Nanjing University of Science and Technology, York University, etc.

After several rounds of rigorous review, the program committee not only indicated acceptance but also provided ratings on those papers accepted for publication in the AAAC conference proceedings. We wish to express our sincere appreciation to all individuals who have contributed to AAAC 2023 conference in various ways. Special thanks are extended to our colleagues in the program committee for their review of all the submissions, which is vital to the success of the conference, and also to the members in the organizing committee and other volunteers who had dedicated their time and efforts in planning, promoting and organizing the conference.

We have four keynote and invited speakers to give us report on their related research. They are Zheng Hong Zhu, from York University, Canada; Chih-Yung Wen, from The Hong Kong Polytechnic University, Hong Kong, China; Yan Wang, from Nanjing University of Aeronautics and Astronautics, China; Lei Shi, from Northwestern Polytechnical University, China. And there are four oral sessions in this conference. The topics include new propulsion technology based on combustion mode, system design and safety analysis in aerospace engineering, aircraft structural design and wing aerodynamic analysis, and aviation system and engine performance simulation and evaluation. One best presentation will be selected from each session, which will be evaluated based on originality, applicability, technical merit, quality of PPT and communication skill. The best one will be announced at the end of each Session.

We believe that these works will lay the foundation for further research and the interactions during the conference will lead to much improved version of the extended papers.

Have a nice communication on the conference!

AAAC 2023 Organizing Committees
September, 2023

THE ASIAN AEROSPACE AND ASTRONAUTICS CONFERENCE
AAAC
For and on behalf of

# CONFERENCE COMMITTEES

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Linyuan Jia, Northwestern Polytechnical University, China
Rui Zhao, Beijing Institute of Technology, China
Fengnian Tian, Huazhong University of Science and Technology, China

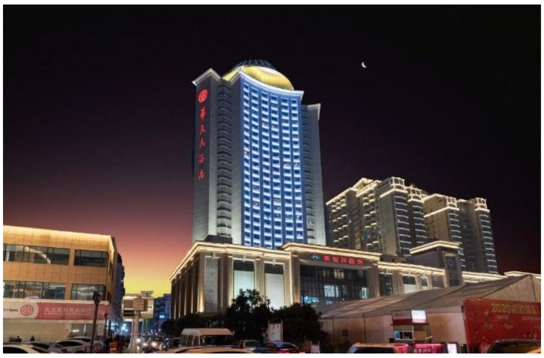
# CONFERENCE VENUE

## ❖ Conference Venue(会议地点)

華天大酒店
HUATIAN HOTEL

武汉华天大酒店（武汉徐东地铁站店）
Huatian Hotel (Wuhan Xudong Metro Station)

地址：湖北省武汉市洪山区徐东大街徐东路 7 号
Address: No. 7, Xudong Road, Xudong Street, Hongshan District, Wuhan, Hubei, China



酒店地处武汉市徐东金融商业圈，坐揽武汉三镇，眺观长江美景，门口直通公交站及地铁 8 号线，尽享交通便捷。酒店楼宇恢宏，建造风格独特，融合湘楚地域风情，充满现代文明气息，是广大商务、会议、旅行宾客之优选。这是由湖南华天集团按高星级标准投资兴建的高端酒店，酒店主楼高达 34 层，建筑面积 52057.2 平方米，拥有各类豪华客房两百余间/套、多个大型会议及宴会厅，是集住宿、餐饮、娱乐和会务服务于一体的多功能、高标准商务会议型酒店。

## ❖ Time Zone

**Beijing Time: UTC +8**

## ❖ Conference Room

| **Level** | 3 F (3 楼) | **Meeting Room** | Hall A Wuchang (武昌 A 厅) |
|---|---|---|---|

# GUIDELINE FOR ATTENDANCE

## For Everyone

- The whole conference program is scheduled in Beijing Time (UTC+8).
- Please double check your Test Time and Presentation Time, and adjust times to device's time zone.
- English will be the only language used for presentation.
- **September 15:** Online Test, Onsite Sign in; **September 16:** Opening Ceremony, Conference Speeches, Oral Sessions; **September 17:** Oral Sessions.
- Each Keynote Speech is within 40 Mins; Each Invited Speech is within 30 Mins.
- Each oral presentation is allocated with 15 Mins (13 Mins presentation, 2 Mins for Q&A), please prepare your English PPT in advance.

## For Onsite Presenters

### ❖ Oral Presentation

- Your punctual arrival and active involvement in each session will be highly appreciated.
- Get your Presentation PPT slides, or PDF files prepared in advance and backed up.
- Laptop, projector & screen, laser sticks will be provided in the meeting room for presentation use.

### ❖ More Tips:

- Please take all your belongings when leaving meeting room.
- Conference Organizers do not provide accommodation, please reserve your hotel room in advance.

## For Online Presenters

### ❖ Tool

- **ZOOM** (**zoom.com.cn or zoom.us**) will be used for the whole online event. On the buttom of the web page, you can choose download the app for free and then choose 'JOIN A MEETING ', then input room's ID. As usual you could not create an account now, so you can join in our conference as a visitor, ZOOM may ask you to input your phone number and the passwords they sent to your number to verify.

### ❖ How to Use Zoom

- Download the ZOOM on https://www.zoom.us/download.
- Turn on your Audio and start your Video. Use headsets/Earphones to enhance the audio effect and avoid the speaker echo or howling. Stay in a quiet place without noise.
- Join TEST DAY on September 15, we will help the delegates know better how to use ZOOM functions as following:
  1. RENAME: authors please rename like Session Number+ Paper ID+ Name as you join the room. E.g.: S1+ME001+Lily. For KN/IS/SC, please rename like KN/IS/SC+ Name
  2. SHARE SCREEN: Choose the files you need to share
  3. RAISE HAND FUNCTIONS: If you have any questions, you can use this function
  4. CHAT: type the word on the chat broad, you can chat to everyone in the room or someone privately

### ❖ Presentation Tips

- Please prepare a digital device with Microphone (mandatory) and Webcam (optional), a computer or laptop is recommended; And make sure you are connected to a stable and high-quality Wi-Fi network, or 4G/5G or Internet if available.

- Read the detailed program, check the time and Zoom information of the session that you will do your presentation.
- One best Presentation will be chosen from each presentation session and announced at the end of the session. The conference secretary will email you the certificates after the conference.
- Please enter in your session's room 10 Mins earlier of the start of session.
- When giving your presentation, please turn on the video.
- After your presentation, please leave the session room. At the end of the session, a group photo will be taken.

## ❖ Zoom Information

| | | | |
|---|---|---|---|
| Zoom ID | 870 2366 2330 | Zoom Link | https://us02web.zoom.us/j/87023662330 |

# CONFERENCE AGENDA

## Day 1 | Friday September 15, 2023

| Time | Activity | Venue |
|---|---|---|
| 10:00-12:00 | Online Test 线上测试 | ZOOM ID: 870 2366 2330 |
| 13:00-17:00 | Sign in & Conference Kit Collection 线下签到 | Hotel Lobby<br>酒店大厅 |

## Day 2 | Saturday September 16, 2023

| Time | ➤ Venue: Hall A Wuchang (三楼武昌 A 厅) ZOOM ID: 870 2366 2330 |
|---|---|
| | **Opening Ceremony** |
| 9:00-9:10 | **Opening Remarks**<br><br>**Renfu Li**<br>Huazhong University of Science and Technology, China |
| | **Program Address**<br><br>**Danhe Chen**<br>Nanjing University of Science and Technology, China |
| | **Conference Speeches** |
| | Host: Renfu Li, Huazhong University of Science and Technology, China |
| 9:10-9:50 | **Keynote Speaker I:**<br><br>**Chih-Yung Wen**<br>The Hong Kong Polytechnic University, Hong Kong, China<br><br>**Speech Title:** *"Progress in Hypersonic Shock Wave/Boundary Layer Interactions Over A Compression Ramp and A Double Cone"* |
| 9:50-10:30 | **Keynote Speaker II:**<br><br>**Zheng Hong Zhu**<br>York University, Canada<br><br>**Speech Title:** *"Deep Reinforcement Learning for Autonomous Space Debris Capture by Free-Floating Space Robotic Manipulator"* |
| 10:30-11:00 | **Group Photo & Morning Break** |
| | Host: Danhe Chen, Nanjing University of Science and Technology, China |

| | |
|---|---|
| 11:00-11:30 | **Invite Speaker I:**<br><br>**Yan Wang**<br>Nanjing University of Aeronautics and Astronautics, China<br><br>**Speech Title:** *"A Rotated Lattice Boltzmann Flux Solver (RLBFS) With Improved Stability for Two- and Three-Dimensional Compressible Flows"* |
| 11:30-12:00 | **Invite Speaker II:**<br><br>**Lei Shi**<br>Northwestern Polytechnical University, China<br><br>**Speech Title:** *"Key Technical Issues Study on Rocket-Based Combined-Cycle Inlet"* |
| 12:00-13:30 | **Lunch（四楼银塔餐厅）** |

| Time | ➤ Venue: Hall A Wuchang (三楼武昌 A 厅) |
|---|---|
| | **Oral Sessions (Onsite Only)** |
| 13:30-15:30 | **Onsite Session 1: New Propulsion Technology Based on Combustion Mode**<br>A1003, A1007-A, A1004, A1019, A1029-A, A1055, A1006, A1005-A |
| 15:30-15:45 | **Coffee Break** |
| 15:45-17:30 | **Onsite Session 2: System Design and Safety Analysis in Aerospace Engineering**<br>A1008, A1051-A, A1060, A1028, A1010, A1045, A1046 |
| 17: 30-20:00 | **Dinner（四楼银塔餐厅）** |

# Day 3 | Sunday September 17, 2023

| Time | ➤ ZOOM ID: 870 2366 2330 |
|---|---|
| | **Oral Sessions (Online Only)** |
| 10:00-12:00 | **Online Session 3: Aviation System and Engine Performance Simulation and Evaluation**<br>A1001, A1033, A1053, A1012, A1054, A1039, A1024, A1057 |
| 12:00-14:00 | **Lunch Break** |
| 14:00-15:45 | **Online Session 4: Aircraft Structural Design and Wing Aerodynamic Analysis**<br>A1030, A1002, A1031, A1041, A1036, A1047, A1042 |

# KEYNOTE SPEAKERS

## Keynote Speaker I

**Beijing Time: 9:10-9:50, Sep. 16** **Onsite Room: Hall A Wuchang (武昌 A 厅)**

**Zoom ID: 870 2366 2330**

**Chih-Yung Wen**

**The Hong Kong Polytechnic University, Hong Kong, China**

**Speech Title:** ***"Progress in Hypersonic Shock Wave/Boundary Layer Interactions Over A Compression Ramp and A Double Cone"***

**Abstract:** In this talk, the recent numerical and theoretical research activities on shock wave/boundary layer interactions (SBLI) in High-speed Thermo-fluid and MAV/UAV Laboratory (HTML), HKPolyU, will be introduced, with emphases on the hypersonic laminar separation flows over a compression ramp and a double cone. Three areas will be reviewed: (i) understanding the intrinsic instability and transition, (ii) thermochemical/vibrational nonequilibrium effects, and (iii) leading-edge bluntness effects.

As demonstrated by recent numerical works and the earlier experiments, streamwise heat flux streaks form on the ramp/cone surface downstream of reattachment, and they are non-uniformly distributed in the spanwise/azimuthal direction. Due to the presence of intrinsic instability, the surface heat flux exhibits a low-frequency unsteadiness, which propagates in the streamwise direction. Additionally, the unsteadiness of the heat flux streaks downstream of reattachment is coupled with a pulsation of the reattachment position. Substantial success has been achieved in understanding the intrinsic instability and laminar-turbulent transition through complementary Direct numerical simulations (DNS) and theoretical studies by the Global Stability Analysis (GSA) and the triple-deck theory. Both DNS and GSA confirm that the supercritical ramp/double-cone flow is intrinsically three-dimensional, unsteady and exhibits strong spanwise/azimuthal variations in the peak heating. The global instability is shown to be closely linked with the occurrence of secondary separation beneath the primary separation bubble. Meanwhile, it is found that the shock-induced separated flow system becomes unstable when the deflection angle is beyond a certain value. A criterion is established based on a scaled deflection angle defined in the triple-deck theory to predict the global stability boundary, which depends on the free-stream conditions and geometries only. The critical deflection angle increases slightly with the wall temperature and, as the Reynolds number is further increased, the flow is strongly destabilized with the coexistence of multiple stationary and low-frequency oscillating unstable modes, leading to a transition process in a hypersonic compression-ramp/double-cone flow due to intrinsic instability of the flow system.

For thermochemical/vibrational nonequilibrium effects on SBLI, systematic studies were performed using different coupling models of vibrational excitation and dissociation, including a conventional two-temperature model as the baseline and an improved model established on elementary kinetics and validated against existing shock tube experimental data. For the double-cone flow with the highest total enthalpy, the improved model predicts a larger separation region and greater peak heat flux with relative differences of 20.3% and 29.2%, respectively, compared with the baseline two-temperature model. The differences are attributed to inaccurate modeling of the vibration–dissociation coupling effects by the conventional two-temperature model, which overestimates the post-shock degree of dissociation and underestimates the post-shock temperature. The size of the separation bubble is therefore altered due to the change in its density. For the condition with the low total enthalpy, the most representative flow model still underestimates the sizes of the separation regions for double cone flow and overestimates those for hollow-cylinder flare flow. It is concluded that inaccurate modeling of vibrational nonequilibrium may not be responsible for the discrepancies observed at the low total enthalpies. Suggestions for further study are also presented.

For leading-edge bluntness effects on SBLI, DNS of a compressible ramp flow shows that the separation bubble enlarges when the leading-edge radius is increased from zero up to a critical value. Beyond the critical radius, the separation bubble conversely shrinks as the radius is further increased. GSA demonstrates that the inherent instability in the flow field also exhibits a reversal trend, that is, the flow system firstly becomes more unstable and then tends to be more stable with increasing leading-edge radius. The growth rate and spanwise wavelength of the unstable modes identified by GSA are verified by DNS. The present study demonstrates that a proper blunting of the leading edge can suppress flow separation, reduce aerodynamic heating and stabilise the flow system for a hypersonic compression-ramp flow. Contrarily, the double-cone flow is insensitive to small bluntness in terms of shock structures, separation region sizes and surface pressure and heat flux distributions. A critical nose radius is observed, beyond which the separation bubble grows dramatically. The numerical data are analysed and interpreted based on a triple-deck formulation. It is shown that the sudden change in flow features is mainly caused by pressure overexpansion on the first cone due to leading-edge bluntness, such that the skin friction upstream of the separation is significantly reduced and the upstream pressure can no longer resist the large adverse pressure gradient induced by shock impingement. An estimation of the critical radius is established. Simulations at a higher enthalpy with the presence of both vibrational relaxation and air chemistry show a similar trend with increasing nose radius. The proposed criterion agrees well with the experimental observations.
Recent efforts on shock wave/turbulent boundary layer interactions will also be introduced.

**BIO:** Professor Wen received his Bachelor of Science degree from the Department of Mechanical Engineering at the National Taiwan University in 1986 and Master of Science and PhD from the Department of Aeronautics at the California Institute of Technology (Caltech), U.S.A. in 1989 and 1994 respectively. He worked at Caltech as a Research Fellow from February 1994 to July 1994 and then continued his teaching and research works at the Department of Mechanical Engineering at the Da-Yeh University, Taiwan. He was promoted to full professorship in February 2002. He had been the Chairman of the Department of Mechanical and Vehicle Engineering from August 1997 to July 2000, and the Provost from August 2004 to July 2006 in the Da-Yeh University, Taiwan. In August 2006, Professor Wen joined the Department of Aeronautics and Astronautics of the National Cheng Kung University (NCKU), Taiwan, before joining the Department of Mechanical Engineering, The Hong Kong Polytechnic University in 2012 as professor. While serving in HKPolyU, he has been the associate head (research) of ME department and the interim head of AAE from 2015 to 2019 and from 2019 to 2021, respectively. He is currently serving as the head of AAE. Professor Wen has authored and co-authored more than 300 scientific papers, conference papers and book chapters. He was also awarded 15 patents. His current research interests are in the areas of (1) Technology development of UAVs and MAVs; (2)Hypersonic/Supersonic aerothermodynamics; (3) Shock/Droplet and Shock/Bubble Interactions; (4) Detonation; (5) Flow Control by plasma actuators; and (6) Urban Environment Simulation. Professor Wen, served as associate editor of the prestigious international journal—AIAA Journal and the vice chair of the technical committee of fluid mechanics, ASME. He is currently an HKIE Fellow and AIAA Associate Fellow and editor of Shock Waves Journal, and Advanced in Aerodynamics. He is also a member of, various key professional boards and bodies related to the Aerospace Engineering.

## Keynote Speaker II

**Beijing Time: 9:50-10:30, Sep. 16** **Onsite Room: Hall A Wuchang (武昌 A 厅)**

**Zoom ID: 870 2366 2330**

**Zheng Hong Zhu**
**York University, Canada**

**Speech Title: *"Deep Reinforcement Learning for Autonomous Space Debris Capture by Free-Floating Space Robotic Manipulator"***

**Abstract:** This talk presents the integration of deep reinforcement learning (DRL) for path planning and visual servoing in the autonomous capture of space debris using a free-floating 6 DOF space robotic manipulator. The inherent dynamics of the manipulator create a distinct dynamic coupling with its base spacecraft, where the end effector's pose is directly influenced by the combined movements of both entities. Such interactions challenge the spacecraft's positional and attitudinal consistency, further complicating manipulator control and path planning. In response, we have developed model-free path planning and grasp control strategies employing DRL, leveraging the deep deterministic policy gradient optimization and enhanced by the actor-critic architecture. This system adeptly combines policy gradient approaches with temporal-difference learning, undergoing continuous adjustments within a simulated domain. The presentation delves into the intricacies of reward function shaping for the manipulator's path planning, accounting for convergence speed, kinematic reliability, sensor disturbances, and the manipulator-to-spacecraft mass distribution. Moreover, we introduce a DRL-oriented algorithm designed for debris acquisition via a 3-finger robotic hand with an emphasis on fine-tuning the reward function to optimize grasp outcomes. To interact with the debris, we have incorporated an eye-in-hand camera integral to the manipulator's visual servoing. This tool accurately discerns the 3D pose of the target debris by merging photogrammetry, adaptive extended Kalman filtering, and neural network methodologies. Validation of these algorithms is executed through computational simulations, highlighting the end effector's capacity to accurately and reliably maintain the desired pose for debris interactions. Finally, we present the development of an advanced hardware-in-the-loop testbed, fortified with active gravity offsetting, to validate DRL algorithms in space conditions.

**BIO:** Dr. Zheng H. (George) Zhu received B.Eng. (1983), M.Eng. (1986), and Ph.D. (1989) degrees in Engineering Mechanics from Shanghai Jiao Tong University in China. He also received his M.A.Sc. degree (1998) in Robot Control from the University of Waterloo and Ph.D. degree (2004) in Mechanical Engineering from the University of Toronto in Canada. He is currently a Professor and Tier I York Research Chair in Space Technology with the Department of Mechanical Engineering at York University in Toronto, Canada. Before joining York University in 2006, he worked as a senior stress/structural engineer in Curtiss-Wright Indal Technologies in Mississauga, Canada. From 2019-2022, he served as the inaugural Academic Director of Research Commons at the Vice-President Research and Innovation Office. His research interests include dynamics and control of tethered space systems, spacecraft attitude dynamics, computational control, space robotics control, machine learning, and space debris removal. He has authored and co-authored more than 340 articles. Dr. Zhu is the Principal Investigator of two CubeSat missions for deorbiting space debris for sustainable use of space and measuring the environmental impact of permafrost thawing in Northern Canada. Dr. Zhu is an elected Member of the International Academy of Astronautics, College Member of the Royal Society of Canada, Fellow of the Canadian Academy of Engineering, Fellow of the Engineering Institute of Canada, Fellow of the Canadian Society for Mechanical Engineering, Fellow of the American Society of Mechanical Engineers, Academician of International Academy of Astronautics, Associate Fellow of American Institute of Aeronautics and Astronautics. He is the recipient of the 2021 York President's Research Excellence award, the 2021 Robert W. Angus Medal by the Canadian Society for Mechanical Engineering, the 2019 PEO Engineering Medal in R&D by Professional Engineer Ontario, the 2013 & 2018 NSERC Discovery Accelerator Supplement awards, and ranked in the Top 2% Most cited Scientists of All Knowledge Fields Combined since 2020 by a Stanford University list.

# INVITED SPEAKERS

## Invited Speaker I

**Beijing Time: 11:00-11:30, Sep. 16** **Onsite Room: Hall A Wuchang (武昌 A 厅)**

**Zoom ID: 870 2366 2330**

**Yan Wang**
**Nanjing University of Aeronautics and Astronautics, China**

**Speech Title: "*A Rotated Lattice Boltzmann Flux Solver (RLBFS) With Improved Stability for Two- and Three-Dimensional Compressible Flows*"**

**Abstract:** A Rotated Lattice Boltzmann Flux Solver (RLBFS) with improved stability is proposed in this paper for effective simulation of compressible flows with intense shock waves at high Mach numbers. Unlike the conventional LBFS or conventional Riemann solvers, which evaluate its mass, momentum and energy fluxes in the normal direction of each cell interface, the present RLBFS decomposes the outer normal direction of the cell interface into two perpendicular directions of the velocity difference and their counterparts. The fluxes in these two directions are respectively evaluated by the LBFS and the final fluxes at each interface are obtained by weighted summations of the two obtained fluxes. The matrix-based stability theory is applied to analyze the proposed solver by simulating the strong normal shock problem from Mach number 1.5 to 10. It reveals that the RLBFS has a smaller negative eigenvalue than the original LBFS, indicating that the RLBFS is more stable. The performance of the RLBFS is further demonstrated by simulating several compressible flow problems. The obtained results agree well the published data, showing that the RLBFS can effectively avoid the phenomenon of shock instability and thus has a potential for simulating practical compressible flows with intense shock waves at high Mach numbers.

**BIO:** Dr. Wang Yan is a professor at the department of aerodynamics, Nanjing University of Aeronautics and Astronautics. He obtained his PhD degree at National University of Singapore in 2014 and received BEng degrees from Nanjing University of Aeronautics and Astronautics (NUAA), China in 2009. His research interests include CFD methods and their applications, such as Flow-Structures-Interaction problems, Multiphase flows and AI for CFD. He has published more than 60 academic papers in international journals. He is also an editorial board member of Applied Sciences and a guest editor of Physics of Fluids His research work has been supported by Thousand Young Talents Plan, NSFC, National Wind tunnel project and et al.

## Invited Speaker II

**Beijing Time: 11:30-12:00, Sep. 16** **Onsite Room: Hall A Wuchang (武昌 A 厅)**

**Zoom ID: 870 2366 2330**

**Lei Shi**

**Northwestern Polytechnical University, China**

**Speech Title: "*Key Technical Issues Study on Rocket-Based Combined-Cycle Inlet*"**

**Abstract:** The rocket-based combined-cycle (RBCC) engine can work in an extremely wide fight range within better performance through flexible transitions between different operational modes, including the ejector, ramjet and scramjet modes. It combines the advantages of the rocket engine and the airbreathing engine in specific impulse and thrust-to-weight ratio. And the dynamic operation technology of the inlet and the mode transition technology are identified as key technologies in RBCC research, which are closely related to the RBCC inlet. Compared to conventional inlets, RBCC inlet operates in a much wider Mach range, covering static, subsonic, transonic, supersonic and hypersonic speed regimes. And the components of the RBCC engine have strong coupling relationships in physical structures and thermodynamic cycles. The RBCC inlet start is of a strong-disturbance, highly dynamic and widely compatible process under the combined influences of the embedded rocket jet, combustion pressure, and other factors in ejector mode. This report presents the research on start characteristics, active control and mode transition characteristics of RBCC inlets. The aerodynamic impact of the embedded rocket on the start and flow characteristics is investigated, and the control strategies for the embedded rocket and secondary combustion during the mode transition are also discussed.

**BIO:** Dr. Shi Lei is a professor at the Institute of Aerospace Propulsion, Northwestern Polytechnical University. He obtained his PhD degree at Northwestern Polytechnical University in 2014. He is majored in airbreathing propulsion and combined cycle propulsion. His research work has been supported by Young Elite Scientists Sponsorship Program, NSFC, et al.

# TECHNICAL SESSIONS

## Onsite Session 1
## New Propulsion Technology Based on Combustion Mode

**Chair: Fengquan Zhong, Chinese Academy of Sciences, China**

| Beijing Time | 13:30-15:30, Sep.16, 2023 | Venue | Hall A Wuchang (三楼武昌 A 厅) |
|---|---|---|---|

| Time | ID | Presenter | Affiliation |
|---|---|---|---|
| 13:30-13:45 | A1003 | Zhao Jiajun | Beihang University |
| 13:45-14:00 | A1007-A | Fabio Mota | Xi'an Jiaotong University |
| 14:00-14:15 | A1004 | Chen Zhang | Beihang University |
| 14:15-14:30 | A1019 | Jiacheng Tang | Nanjing University of Science and Technology |
| 14:30-14:45 | A1029-A | Peibo Li | National University of Defense Technology |
| 14:45-15:00 | A1055 | Haoran Li | Beihang University |
| 15:00-15:15 | A1006 | Wenjian Jiang | Academy of Space Information Systems |
| 15:15-15:30 | A1005-A | Erkang Gao | Chinese Academy of Sciences |

Details:

| ID | Title, Authors and Abstract |
|---|---|
| A1003 | **Numerical Analysis of Flow and Heat Transfer Characteristics of Supercritical Endothermic Hydrocarbon Fuel in Taper Tube**<br><br>*Zhao Jiajun, Gao Hui, Zhang Chen, Wen Dongsheng*<br><br>Abstract: To enhance the cooling performance of the scramjet regenerative cooling system, a novel taper tube is proposed. The flow and heat transfer characteristics of supercritical endothermic hydrocarbon fuel (EHF) in taper tube, narrow cylindrical tube, and wide cylindrical tube are numerical investigated and compared. The results indicate that the taper tube effectively facilitates the pyrolysis of n-decane and the total conversion of n-decane is increased by 3.94%, compared with narrow cylindrical tube. Compared with wide cylindrical tube, the taper tube enhances cooling effect and the wall temperature near the outlet is reduced by 50.16 K. The taper tube contributes to |

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| | the optimization of cooling structure and promotion of regenerative cooling system performance. |
| **A1007-A** | **Development of Hypergolic Green Fuel Systems Based on N,N,N'N' Tetramethylethylenediamine/Alkanolamine with Hydrogen Peroxide for Aerospace Propulsion: From Ignition to Airframe**<br><br>*Fabio AS Mota, Jiawei Jiang, Mingyang Liu, Lihan Fei, Chenglong Tang*<br><br>Abstract: For nearly six decades, hydrazine and its derivatives have been the standard fuels for rockets and spacecrafts. However, their attractive features are offset by their toxicity and associated high handling and storage costs. This work presents a novel green fuel system based on N,N,N'N'-Tetramethylethylenediamine (TMEDA) and N-Methyldiethanolamine (MDEA) with high test peroxide (HTP) which was identified by our new approach of combining chemicals from ethylediamine (EDA) family and alkanolamine class. First, blends with different proportions of TMEDA and MDEA were prepared. Lower amounts of MDEA relative to TMEDA give best ignition delay time (IDT) performances but at the cost of lower solubility in solution with copper catalyst. Blends with higher amounts of MDEA present significantly higher solubility and lower vapor pressure while also act as a stability agent. However, the viscosity may become an issue if the concentration of MDEA is higher than 70% because the viscosity exceeds 30 cP. Based on these results, we selected an intermediate range to further investigate the influence of the copper salt content on the IDT. Results have shown that by adding around 2 wt% catalyst ultrafast IDT values as low as 10 ms can be measured. The fuels were further characterized by thermal methods (TGA/DSC). To investigate the role of the density of the propellants on the vehicle weight and size, the Chinese Long March 2D that burns UDMH/NTO was used as a reference vehicle. It was demonstrated that although a green version of the Chinese rocket would require more propellant mass (due to slightly low specific impulse) its size would be considerably smaller because of the higher density of the green fuels. This novel hypergolic fuel system with HTP is a promising candidate to replace hydrazine based fuels in rockets and spacecrafts applications. |
| **A1004** | **Numerical Simulation About Transient Performance of Regenerative Cooling System for Combustion Chamber**<br><br>*Chen Zhang, Jiajun Zhao, Dongsheng Wen, Hui Gao*<br><br>Abstract: Regenerative cooling is one of the most promising methods for the active thermal protection of hypersonic vehicles. The transient performance of regenerative cooling system using hydrocarbon fuels for combustion chamber before/after ignition is simulated. The cooling performance of the cooling system under different thermal boundaries is compared and discussed by referring to the distribution of temperature, velocity, and conversion of hydrocarbon fuels. Results show that the temperature of the fuel first decreases with the heat flux and then rises due to the endothermic reaction during pyrolysis process. The relaxation time of the cooling system is longer than the ignition delay time. The heat transfer characteristics under uniform and distributed thermal boundary are different, which significantly affects the wall temperature distribution. |
| **A1019** | **Design and Simulation of Anti-Sloshing Baffles Applied to Detumbling Payload Propellant Tanks**<br><br>*Jiacheng Tang, Zhenhua Liang, Kan Zheng, Pan Zheng* |

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| | Abstract: The method to suppress the liquid sloshing in the tank applied to the jet detumbling payload is investigated in this study. Among all kinds of anti-sloshing structures, the symmetrical annular baffle was chosen due to the features of impact on the payload's tank. The damped mass-spring liquid sloshing model established is used to compare the damping ratio of the baffle with different baffle layers and different baffle heights. Using FLUENT software, based on VOF (volume of fluid) numerical simulation technology, the damping effects of baffles with different layers and heights is simulated. The results show that 3-layer 15mm or 4-layer 10mm baffles can effectively reduce the influence of liquid sloshing. The damping ratio of the storage tank with a 3-layer 15mm anti-sloshing baffle is at least 18.3 times that of a smooth tank, and the damping ratio of the tank with a 4-layer 10mm anti-sloshing baffle is at least 18.7 times that of a smooth tank. |
| **A1029-A** | **Optimization Analysis of Rocket Parameters of RBCC Engine Under SMC Combustion Organization**<br><br>*Peibo Li, Yizhi Yao*<br><br>Abstract: RBCC engine needs to consume a lot of propellant in the acceleration stage, so it is very important to carry out the parameter optimization analysis of the ejector mode. This study focuses on RBCC engines based on the SMC (Simultaneous Mixing and Combustion) combustion organization method. Under the premise of fixed engine inlet size and nozzle outlet size, we conducted a parametric study on the mass flow rate, total pressure, and nozzle exit static pressure (nozzle Mach number) of the center rocket in the RBCC engine using the RANS method. Based on the thrust and specific impulse performance of a single point, and the fuel consumption during the acceleration stage, the above rocket parameters were compared and analyzed. The results show that with the increase of the central rocket mass flow rate, the specific impulse performance of the RBCC engine gradually decreases, but the thrust of the engine increases significantly. Based on the effective specific impulse evaluation considering the influence of drag, the increase of the central rocket mass flow rate can significantly improve the effective specific impulse of the RBCC engine. The increase of the rocket total pressure can significantly improve the ejection performance of the RBCC engine, and then obtain better thrust and specific impulse performance. Within the current testing range, the lower the static pressure at the exit of the rocket, the more conducive it is to increase the injection coefficient, which in turn improves the thrust specific impulse performance of the RBCC. Based on the evaluation of the weight of combustion chamber structure and the weight of the motor pump system, the study found that there exists an optimal rocket mass flow rate, rocket total pressure, and rocket exit static pressure under specific battery/motor power density and energy density conditions, which can achieve the best comprehensive performance of the RBCC engine. |
| **A1055** | **Multiple Fault Isolation Method for Micro Thrusters of Drag-free Systems**<br><br>*Haoran Li, Xiaodong Shao, Qinglei Hu, Dong Zhao, Yonghe Zhang, Pengcheng Wang, Zhaohui Dang, Dongyu Li*<br><br>Abstract: This paper proposes a multiple fault isolation framework for micro thrusters of drag-free systems, based on the minimum number of isolation filters. Based on the consideration of fault isolatability, the original system is reasonably divided into two completely isolated subsystems, and then two sets of fault isolation filters are designed based on the principles of duality design for state feedback decoupling, which achieves residual decoupling, and therefore, can detect and isolate multiple faults occurred on the micro thrusters. In particular, this method has low computational burden (a feature of practical importance in reducing the usage of onboard resources) and short isolation time, making it suitable for on-board fast and precise fault isolation. The simulation results demonstrate the efficacy of the proposed method |

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| | when utilized for a drag-free system with 12 field emission electric propulsion (FEEP) thrusters. |
| **A1006** | **Numerical Simulation of Ply Angle Deviation and Thermal Deformation Behavior of CFRP Reflector**<br><br>*Wenjian Jiang, Hengkun Jiang, Tonglong Huo, Yun Liang*<br><br>Abstract: As we know, the ply angle deviation of resin-based carbon fiber composite reflector is difficult to obtain accurately in engineering applications, it will make thermal deformation of reflector unpredictable due to the discreteness of ply angle. In this paper, based on constitutive relationships between generalized internal force and strain of laminated composite, a novel ply angle deviation model based on normal distribution is proposed. Additionally, an orthogonal test was designed and significance analysis were carried out by means of a 2.6m aperture reflector with polygonal back structure. Assumed that the ply angle deviation obeys normal distribution, a number of samples were further randomly generated, and the sample mean and standard deviation of the thermal deformation of reflector were calculated. According to $\chi 2$-test of goodness of fit, the thermal deformation of reflector still follows normal distribution. Finally, an example was employed to verify the validity and effectiveness of the proposed method. The results reach a good agreement with the experimental data, thus it is capable of providing a promising prospect for engineering practice. |
| **A1005-A** | **Study on the Coupling Effect of Direct Thermoelectric Conversion and Active Cooling**<br><br>*Erkang Gao, Fengquan Zhong*<br><br>Abstract: Thermal management is one of the key technology for high-speed flight vehicle and engine applications. With higher flight speed, the traditional thermal protection method such as regenerative cooling is not adequate to meet the cooling requirements. As a new technology, the direct thermoelectric conversion can convert aerodynamic and combustion heat into electrical energy for storage and utility. For an effective thermal management system, the direct thermoelectric conversion coupled with active cooling is a promising way, which has advantages of increasing cooling efficiency and providing electrical power for high-speed vehicle. Therefore, it is necessary to study energy conversion and heat transfer mechanisms between direct thermoelectric conversion and active cooling for flight vehicle and engine applications. In this paper, a one-dimensional heat transfer model is proposed to reveal the mechanism of energy conversion and transport of the direct thermoelectric conversion system coupled with active cooling. Based on the analytical model, the effects of the structural parameters of thermoelectric devices and the convective heat transfer coefficient of active cooling on the output power and the energy conversion efficiency are investigated for the leading edge of a hypersonic vehicle at Mach 7 condition. The present analytical results show that with the same thermoelectric material and preparation process, the larger size of the thermoelectric device can effectively improve the output power per unit area as well as the energy conversion efficiency. Specifically, both two indicators of a 40mm-side-length Half-Heusler thermoelectric device can reach approximately 9 times those of a 20mm-side-length device under the same thermal environment. Moreover, enhancing the convective heat transfer coefficient can not only lower the structural temperature and improve temperature uniformity on the thermoelectric device surface, but also increase the output power and energy conversion efficiency. When the convective heat transfer coefficient is below 1000W/m2K, the thermal protection needs for a 40mm-side-length Half-Heusler thermoelectric device cannot be met, and when the convective heat transfer coefficient increases from 1000W/m2K to 10000W/m2K, the output power per unit area can be increased by 10%. Additionally, numerical simulations-based Reynolds average method with SST k-ω turbulence model validates the results of the one-dimensional model. |

# TECHNICAL SESSIONS

## Onsite Session 2
## System Design and Safety Analysis in Aerospace Engineering

**Chair: Danhe Chen, Nanjing University of Science and Technology, China**

| Beijing Time | 15:45-17:30, Sep.16, 2023 | Venue | Hall A Wuchang (三楼武昌 A 厅) |
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| Time | ID | Presenter | Affiliation |
|---|---|---|---|
| 15:45-16:00 | A1008 | Tingrui Zhang | Huazhong University of Science and Technology |
| 16:00-16:15 | A1051-A | Yusong Wang | Nanjing University of Aeronautics and Astronautics |
| 16:15-16:30 | A1060 | Tang Chu | Northwestern Polytechnical University |
| 16:30-16:45 | A1028 | Jie Wang | National University of Defense Technology |
| 16:45-17:00 | A1010 | Tianlang Chen | Huazhong University of Science and Technology |
| 17:00-17:15 | A1045 | Shuai Dong | Shanghai Aerospace Control Technology Institute |
| 17:15-17:30 | A1046 | Kai Wang | Nanjing University of Science and Technology |

Details:

| ID | Title, Authors and Abstract |
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| **A1008** | **Exploring the Potential of a Vertical Takeoff and Landing Flying Car**<br><br>*Tingrui Zhang, Aimen Jiger, Yanlan Zhang, Jiazhi Zou, Xiao Ning, Fengnian Tian*<br><br>Abstract: The characteristic of vertical takeoff and landing (VTOL) aircraft is that it combines the functions of a helicopter and a fixed-wing aircraft. As an important branch of the VTOL aircraft, flying cars have attracted more attention from capital and media. However, most products claiming to be "flying cars" are more like aircraft than cars because they do not have the ability to travel on the ground. Therefore, this paper proposes a new concept of flying car. It ingeniously retracts the wings and multi-rotors through a rotating folding method to achieve a mode conversion from aircraft to vehicle. This paper introduces the concept source, basic dimensions, key components, and preliminary calculation of the flying car. The paper also derives the relationship curve between the propeller size and power device and finally calculates the flying envelope of the flying car. The concept proposed in this paper has the |

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| | capability of vertical takeoff and landing, long endurance, and ground driving. The conceptual design method proposed in this article can provide design references for similar types of aircraft. |
| **A1051-A** | **Research on Shear Adhesion Strength of Impact Ice in Icing Wing Tunnel**<br><br>*Yusong Wang, Chunling Zhu, Ke Xiong, Chengxiang Zhu, Lei Chen*<br><br>Abstract: Aircraft icing has a detrimental effect on flight safety. The design of aircraft anti-icing/de-icing systems requires a thorough comprehension of the adhesion between the ice and the substrate. In this research, the multi-hole rotating cylinder method (MHRC) is developed in an icing wind tunnel. Simulations of interfacial stress show that ice thickness does not change the evenness of stress, whereas reducing the contact area can impair uniformity. Moreover, the ice layer would not experience any cohesive damage during the experiments. The shear ice adhesion strength is evaluated using the methodology outlined in this research. At lower temperatures, glaze ice demonstrates a rise in its shear adhesion strength, while the change trend is the opposite for rime ice. The lowest adhesion strength is observed at the medium volume diameter (MVD) of 45 μm. Furthermore, the growing liquid water content (LWC), rough surfaces, and surface painting will enhance the interface adhesion of ice to the substrate to varying degrees. Stainless steel substrate exhibits higher adhesion strength with ice as compared to aluminum and titanium. In addition, superhydrophobic surfaces have proven to possess a significant reduction in adhesion strength at higher temperature. The proposed experimental method and platform afford accurate measurements of the shear adhesion strength of impact ice in the icing wind tunnel. |
| **A1060** | **Research on Safety Issues and Safety Analysis of New Energy Aircraft**<br><br>*Tang Chu, Li Zhongyang, Wang Libo*<br><br>Abstract: As the global aviation industry faces increasing pressure on the environment, the International Civil Aviation Organization (ICAO) has implemented increasingly strict requirements for air-craft carbon emissions. The adoption of innovative energy technologies, such as electric power, hydrogen fuel, and sustainable biofuels in the aviation sector, will enable us to achieve zero carbon emission targets and mitigate environmental pollution associated with air transporta-tion. Drawing on statistical data of aviation accidents, this paper analyses the primary causes of flight mishaps and summarizes several safety issues faced by new energy aircraft. Based on these, the new energy aircraft is divided into several subsystems, including power system, ener-gy system, flight control system and so on. Then, safety analysis tools and methods are then used to conduct an analysis of the aircraft's safety, with the aim of improving overall safety. |
| **A1028** | **Research on Solar Sail Attitude Maneuvering Method Based on Adaptive Sliding Mode Control**<br><br>*Jie Wang, Tianyi Ma, Haibo Song, Ye Yu* |

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| | Abstract: A solar sail is a spacecraft propulsion system that uses the pressure of light to push a spacecraft. It consists of a lightweight support structure that deploys a large area of flexible film. During attitude maneuvering in space, the solar sail will excite vibrations in the flexible support structure and film, which can affect the accuracy of the attitude control system. To address this issue, this article first establishes a rigid-flexible coupled dynamic model of the solar sail that includes attitude motion and flexible structure elastic vibrations. Then, based on an adaptive sliding mode control method, a solar sail attitude maneuvering method is proposed. Finally, a numerical simulation is conducted using a hexagonal-shaped solar sail as the object. The numerical simulation results show that the attitude maneuvering method has the performance of attitude tracking and attitude stabilization, can meet the requirements of large-angle attitude maneuvering for solar sail spacecraft, and has strong robustness to model parameter uncertainty. |
| **A1010** | **Development of an Innovative Amphibious Carrier Platform for Multi Mode Drones**<br><br>*Tianlang Chen, Jiaxue Han, Jinglan Wang, Sitan Yan, Chieh Wan, Fengnian Tian*<br><br>Abstract: Nowadays, amphibious UAVs are getting more and more popular. There are two or three loading methods for them to overcome the limitations of the traditional carrier method. Compared to existing amphibious or triphibious drones, this study presents a novel design for an amphibious carrier platform with a physical model. On the one hand, this study proposes a mechanical structure which uses a single lead screw and connecting rod mechanism to expand or retract four arms at the same time. On the other hand, this study also proposes a comprehensive solution for the drone landing gear and vehicle chassis. This paper discusses the composition, working principle, sub-system structure, key functional design calculations, and field flight tests of the amphibious carrier platform. The research shows that the platform proposed in the study has a reliable deformation structure which can easily transform between aircraft and vehicle. The modular drone and vehicle chassis greatly reduces the maintenance costs. Obviously, this paper has important practical significance for the research and development of multi-mode drones. |
| **A1045** | **Optimization and Verification of Mechanical Design for Small Total Reflection Optics**<br><br>*Shuai Dong, Yangbo Xu, Youwei Ma, Libin Li, Shengsheng Han*<br><br>Abstract: Mechanical performance assurance is one of the key concerns in the design of small total reflection optics. This article addresses the issue of insufficient strength margin in the design of a total reflection optics for a space photoelectric sensor. Firstly, structural design optimization research was conducted on the optics, and the effectiveness of structural improvement was verified through finite element analysis; Secondly, a concave analysis was conducted under mechanical test conditions to further reduce the risk; Afterwards, the accuracy of the simulation results was verified by comparing the simulation with the experiment through small-scale random vibration tests; Finally, sine vibration tests, random vibration tests, shock tests, acceleration tests were conducted on the entire machine, and optical tests were conducted before and after the tests. The experimental and testing results indicate that |

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| | the entire machine has passed the mechanical test assessment at the appraisal level and maintained good optical performance. The total reflection optics optimized by mechanical design meets the requirements of engineering applications. |
| **A1046** | **Orbit Design and Optimization of Small Thrust Spacecraft for Jupiter Exploration**<br><br>*kai Wang, Danhe Chen, Zhihong Yang*<br><br>Abstract: Jupiter has been the main object for exploration except other planets, considering not only the great significance for revealing the formation of solar system, but also can obtain more valuable space resources and information. In this paper, the orbit of Jupiter probe is designed and optimized by small thrust propulsion with gravity assistance. The combined coordinate system combining polar coordinates and orbital parameters is used to construct a spatial dynamics model of the motion of small thrust spacecraft. Three gravitational assist schemes are selected, based on the shape method and optimization algorithms the gravitational assist scheme parameters are determined. Also, the optimization problem of continuous small thrust trajectory is analyzed, and the particle swarm optimization(PSO) algorithm coordinated with the improved Newtonian iterative method is used to search for the initial value of the exact covariate variable with the optimal energy, and the optimal transfer orbit of the heliocentric fuel is obtained by the homotopy method. The final results show that the "Earth-Mars-Jupiter" scheme requires a minimum increase in delta-v, further orbital optimization, and calculation of fuel consumption throughout the process. This method provides a solution for Jupiter exploration, rapid determination of orbit design, and optimization of solutions. |

# TECHNICAL SESSIONS

## Online Session 3
## Aviation System and Engine Performance Simulation and Evaluation

**Chair: Rui Zhao, Beijing Institute of Technology, China**

| Beijing Time | 10:00-12:00, Sep.17, 2023 | Zoom ID | 870 2366 2330 |
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| Time | ID | Presenter | Affiliation |
|---|---|---|---|
| 10:00-10:15 | A1001 | Wenguo Zhang | AVIC Chengdu Aircraft Industrial (Group) Co., Ltd. |
| 10:15-10:30 | A1033 | Xian Xu | Shanghai Aircraft Design and Research Institute |
| 10:30-10:45 | A1053 | Yuqiang Guo | China Helicopter Research and Development Institute |
| 10:45-11:00 | A1012 | Yang Mingfeng | Xi'an Modern Control Technology research Institute |
| 11:00-11:15 | A1054 | Yuqiang Guo | China Helicopter Research and Development Institute |
| 11: 15-11:30 | A1039 | Yan Li | Shanghai Aircraft Design and Research Institute |
| 11:30-11:45 | A1024 | Vsevolod V. Koryanov | Bauman Moscow State Technical University |
| 11:45-12:00 | A1057 | Sreya Etherajan | Thomas Jefferson High School for Science and Technology |

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| ID | Title, Authors and Abstract |
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| **A1001** | **Research on Radial Velocity and Airspace Position Calculations of Target in Airborne Active Radar Simulation**<br><br>*Wenguo Zhang, Hanghua Gan, Xin Pan, Feng Tian, Li Pan, Peng Shao, Xiangle Jiang, Xiaobin Zou*<br><br>Abstract: The detection of the target in the airborne active radar simulation is simplified to the calculations of the radial velocity, the maximum detecting range of the airborne active radar corresponding to the RCS, and the airspace position of the target. However, the coordinate transformations related to the calculations of the radial velocity and the airspace position are usually bewildering due to the different |

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| | referenced coordinate systems. This paper introduces the radial velocity and airspace position calculations of the target in the airborne active radar simulation to illuminate the transformation process containing the specific rotation matrices, suggesting the unifying transformation to the north-up-east (NUE) rectangular coordinate system of the aircraft for both the radial velocity calculation and airspace position calculation of the target. |
| **A1033** | **Numerical Study on Visual Cue Technology of SLD Based on CRM Aircraft**<br><br>*Xian Xu, Yingchun Chen, Xiong Huang, Zhirong Han, Hang Chen*<br><br>Abstract: Ice detection of supercooled large droplets(SLD) is a key technology for ensuring aircraft flight safety. With reference to the advisory circular and combination of the flight scenarios, this paper studies the visual cue technology of SLD using numerical simulation method based on the CRM aircraft. Unstructured grids are generated for the entire aircraft, and FENSAP-ICE software is used to calculate the droplet impingement characteristics. Sensitivity analysis of the icing and flight parameters is carried out. The droplet impingement characteristics after encountering normal droplets and SLD conditions are analyzed. The reference component and it's specific visual location for visual cue are determined. |
| **A1053** | **An Aeronautical System Context Analysis and Modeling Method Crossing Muti-Architecture Levels in the MBSE Approach**<br><br>*Yuqiang Guo, Shuping Chen, Qiang Sun, Junxian Guo*<br><br>Abstract: Model based system engineering(MBSE), which uses the architecture model to drive system development, has been widely used in aeronautical and aerospace systems development. System context modeling is an essential part of architecture modeling, but there is no clear guidance on how to perform the system context modeling in the system engineering life cycle. This paper proposes a system context analysis and modeling method crossing muti-architecture levels, which gives a straightforward system context modeling approach. The method includes three-level analysis processes: platform-level context modeling, subsystem-level context modeling, and equipment-level context modeling.This modeling approach takes full advantage of the SoS architecture model. It builds a unified SoS engineering and System engineering structure modeling way which will guarantee the different architecture level model consistency and save cost and time in the modeling practice. |
| **A1012** | **Effect of Oxygen Rich Environment on Detonation Characteristics of Pulse Detonation Engine**<br><br>*Yang Mingfeng, Song Jun, Hu Bowen, Xu Ze*<br><br>Abstract: The detonation tests of propane/air pulse detonation engine at normal temperature were carried out in this paper. The effects of chemical ratios on the detonation performance of propane/air pulse detonation engine in oxygen-rich environment were studied. The propagation modes and characteristics of detonation waves and the detonation characteristics of the engine under different conditions were |

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| | analyzed. Detonation tests were conducted on propane/air mixtures with oxygen mass fraction of 20%, 25%, 30% and 35% respectively. The results showed that: In the detonation experiment of the propane/air mixture with oxygen content of 20%, 25% and 30%, the flame wave propagation velocity in the detonation tube is low, which fails to form a stable detonation wave. The detonation effect of the fuel mixture with oxygen content of 20% is the worst, and the propagation velocity of flame wave is 384.00 m/s. In the experiment of propane/air mixture with oxygen content of 35%, the detonation velocity and pressure obtained by pressure signal analysis are both greater than the theoretical CJ detonation velocity, and the detonation state is successfully reached. |
| **A1054** | **An Aeronautical System Use Case Atomistic Analysis Method Based on Mission Phase in the MBSE Approach**<br><br>*Yuqiang Guo, Xinxin Sun, Hui Zhao, Junxian Guo*<br><br>Abstract: Model based system engineering(MBSE), which uses the architecture model to drive system development, has been widely used in aeronautical and aerospace systems development. System use case modeling is an essential part of architecture modeling. Still, the use case concept needs to be clarified, and there is no idea how to model it in the system engineering life cycle.This paper proposes a system use case atomic analysis and modeling method based on the mission phase, which gives a clear use case modeling approach. The method includes two-level analysis processes, including top-level use case analysis and atomic use case analysis.This modeling approach takes full advantage of the SoS architecture model and builds a unified SoS engineering and System engineering behavior modeling way which will guarantee the different architecture level model consistency and save cost and time in the modeling practice. |
| **A1039** | **Body Effect on Inflow Distortion in Civil Engine Intake Under Crosswind Condition**<br><br>*Yan Li, Yingchun Chen, Pan Cheng, Dongyun Zhang*<br><br>Abstract: The effect of body on the inlet aerodynamic performance of distortion under crosswind condition for a high pass ratio turbofan engine was investigated. The work is carried out by using computational fluid dynamics on civil nacelle and body. The investigation suggests that: due to the shelter of the body, the inlet distortion on the windward side and leeward side is very different under crosswind conditions. The nacelle on the windward side mainly takes in air from the side while the engine on the leeward side takes in air from above and below. The existence of body makes it easier to produce fuselage vortex and tail vortex near the nacelle. The body has an adverse impact on the intake of the engine on the leeward side and improves the requirement of the crosswind resistance of the upper section of the nacelle. |
| **A1024** | **Descent Vehicle Movement Control by the Angular Position Change Method Payload**<br><br>*Vsevolod V. Koryanov, Andrey S. Kukharenko*<br><br>Abstract: An analysis of the rotational motion resulting from the control of the descent vehicle is presented in the paper. The descent vehicle is controlled by the method of shifting the center of mass, which occurs due to a change in the angular position of the payload. The analysis of rotational motion consists in revealing the peculiarities in the motion of the descent vehicle |

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| | controlled by the above method. To carry out this analysis, a mathematical model of the rotational motion of the descent vehicle has been compiled in this work. Modeling of the angular motion was performed using the developed software that implements the 4th order Runge-Kutta method. The simulation results are presented in the form of graphic dependencies, which include the trajectory of a point on the surface of the descent vehicle, as well as the hodograph of the angular velocity vector in a moving coordinate system. Based on the results of the research, conclusions were drawn about the features of the rotational movement during control, as well as the possibility of using this control method. |
| **A1057** | **Learned Prediction for Space Debris Collision Risk and Avoidance**<br><br>Sreya Etherajan<br><br>Abstract: There are over 23000 pieces of debris, ranging in size from miniscule particles to larger meteor-sized particles, present in Earth's orbit. Although these particles may appear to be small in size, at high speeds of 15700 mph, they pose catastrophic threats to current operating satellites and future orbital missions. This research study proposes a random forest machine learning classification model that is tasked with accurately predicting the level of risk of various satellite collisions. Through training and testing a model, an accuracy rate of 98.24% is achieved. Additionally, using decision trees, the variables and qualities of satellites are assessed and ranked in terms of determining the final risk of a satellite collision. This research is a suitable asset to modern Space Situational Awareness (SSA), as improved accuracy of predicting risk of space debris collisions is crucial to the future of space debris collision warning systems. |

# TECHNICAL SESSIONS

## Online Session 4
## Aircraft Structural Design and Wing Aerodynamic Analysis

**Chair: Hui Gao, Beihang University, China**

| Beijing Time | 14:00-15:45, Sep.17, 2023 | Zoom ID | 870 2366 2330 |
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| Time | ID | Presenter | Affiliation |
|---|---|---|---|
| 14:00-14:15 | A1030 | Hao Gong | Shanghai Aircraft Design and Research Institute |
| 14:15-14:30 | A1002 | Wu Yansen | Beihang University |
| 14:30-14:45 | A1031 | Hao Gong | Shanghai Aircraft Design and Research Institute |
| 14:45-15:00 | A1041 | Peiyuan Li | Beijing Institute of Astronautical Systems Engineering |
| 15:00-15:15 | A1036 | Jinyang Cai | Shanghai Aircraft Design and Research Institute |
| 15: 15-15:30 | A1047 | Partha Pratim Das | Northwestern Polytechnical University |
| 15: 30-15:45 | A1042 | Wang Junhong | Shanghai Aircraft Design and Research Institute |

Details:

| ID | Title, Authors and Abstract |
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| **A1030** | **Performance Optimization Design of Wide-body Aircraft Pressure Refueling System**<br><br>*Hao Gong*<br><br>Abstract: In order to reduce the wide body aircraft refueling process time-cost and improve the airport operation efficiency, pressure refueling system design strategy was innovated. The shutoff valves' operation sequence in refueling process was optimized. The diameter of the orifices on the pressure refueling system fuel line was designed. Pressure refueling performance was simulated and analyzed at different scenarios. The results show that it can improve the pressure refueling system performance at different scenarios by optimizing the pressure refueling process strategy design including optimizing the fuel line orifice design and optimizing the wing tank inner side shut-off valve operation sequence. |

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| **A1002** | **Research of a Novel Aerodynamic Evaluation Method for Fixed-wing UAV**<br><br>*Yansen Wu, Deshan Liu, Tiancheng Wang, Anmin Zhao*<br><br>Abstract: The aerodynamic parameters of unmanned aerial vehicles (UAVs) play an important role in the newly designed drone. For the purpose of the real-time measurement of the aerodynamic performance parameters of the UAV in flight status, based on the self-development connected-wing configuration airplane, a novel airborne aerodynamics test scheme is researched and verified in this work. The findings of this study indicate that the effectiveness of numerical calculations can be verified by comparison with both results of the numerical simulation and airborne flight test in the same conditions. The newly designed UAV equipped with this test system in the future, not only achieves quick and reliable results of aerodynamic performance and powered system efficiency but also can save the expense of wind tunnel experiments, which is of high potential to the UAV application. |
| **A1031** | **Wide-body Aircraft Fuel Jettison System Design and Analysis**<br><br>*Hao Gong*<br><br>Abstract: In order to design the highly integrated fuel jettison system, the hydrodynamic performance design flow chart for the highly integrated fuel system has been proposed, and the 1-D fuel line network performance model has been developed. An innovative fuel jettison system for wide-body aircraft has been designed. The system performance has been simulated and analyzed. The results show that the proposed flow chart can be used for the highly integrated fuel system design, and the fuel jettison performance requirements can be met. The system parameters including the wing tank main pump characteristic, the flow area of the orifice set in the fuel line connecting the feeding line and the refueling line, and the flight height have significant effects on the fuel jettison performance. Besides, the aircraft total fuel jettison performance is also affected by the central tank override pump characteristic, the engine fuel consumption, and the flow resistance of fuel line network. |
| **A1041** | **Simulation and Analysis of Delamination Damage Propagation in CFRP Structures**<br><br>*Peiyuan Li, Qiaoyan Cai, Fei Wang, Tao Zhang, Riming Tan*<br><br>Abstract: For aerospace vehicles, composite materials are used in large-scale integral panels due to their excellent material properties. In the structure of vehicles, this kind of composite material panel is connected to the internal structure through fasteners. During the composite material molding process and the process of drilling connection holes, some local delamination sometimes occurs, this delamination is hardly detected in time, it can cause great damage to the compressive strength of the structure. In this paper, the ABAQUS/Explicit solver is introduced to analyze the progressive damage of interlaminar separation with cohesive elements, the accuracy difference between different damage modes with typical solvers is verified. Then based on the self-compiled three-dimensional Hashin failure criterion subroutine, the numerical simulation is carried out on the compressive strength of the composite laminate under different pre-delamination damage ranges, and the compressive strength of the single-fastener connection structure with pre-delamination, indicates the fiber |

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| | damage, matrix damage and delamination damage, in order to explore its failure mode and residual strength law. |
| **A1036** | **Aerodynamic Design of the Civil Aircraft with Sealed Leading Edge Slat**<br><br>*Jinyang Cai*<br><br>Abstract: Studying the aerodynamic design of leading edge slat in civil aircraft was carried out. Two type of slats were studied. Two slats have different takeoff configurations and aerodynamic shape. One is the slat with no gap between fixed wing and slat, another is the slat with gap between fixed wing and slat. Aerodynamic design was carried out to achieve that there is no gap between slat and fix wing. Numerical simulation and wind tunnel test were applied to obtain aerodynamic characteristics, results show that: the takeoff configuration with no gap between slat and fixed wing has better lift-to-drag ratio than that configuration with gap between slat and fixed wing.The configuration with gap between slat and fixed wing has higher lift coefficient than the configuration with no gap between slat and fixed wing, the two type configurations have the same stalling angle. |
| **A1047** | **Reentry Trajectory Design of Hypersonic Vehicle Based on Reinforcement Learning**<br><br>*Partha Pratim Das, Wang Pei, Chenxi Niu*<br><br>Abstract: In this research, we investigate control of a hypersonic vehicle (HV) following its reentry into the Earth's atmosphere, using deep reinforcement learning (DRL) in a continuous space. Here, we incorporate the basic kinematic and force equations of motion for a vehicle in an atmospheric flight to formulate the reentry trajectory satisfying the boundary constraints and multiple mission related process constraints. The aerodynamic model of the vehicle emulates the properties of a common aero vehicle (CAV-H), while the atmospheric model of the Earth represents a standard model based on US Standard Atmosphere 1976, with significant simplification to the planetary model. In an unpowered flight, we control the vehicle's trajectory by perturbing its angle of attack and bank angle to achieve the desired objective. We design our control problem based on different actor-critic frameworks that utilize neural networks (NNs) as function approximators to select and evaluate the control actions in continuous state and action spaces. First, we train the model following each of the methods, that include on-policy proximal policy approximation (PPO) and off-policy twin delayed deterministic policy gradient (TD3). From the trajectory generated, we select a nominal trajectory for each algorithm that satisfies our mission requirements based on the reward model. |
| **A1042** | **Streamline Nose Aerodynamic Design for Civil Aircraft**<br><br>*Wang Junhong, Zhou Feng, Zhang Miao*<br><br>Abstract: Aerodynamic characteristics of traditional noses have been analyzed, and the deficiencies of the aerodynamic shape of the noses are summarized. Streamline nose aerodynamic design for civil aircraft is studied in this paper. Special control elements are defined based on the demands of cockpit space and airworthiness to generate the nose surface with CATIA. Parametric modeling technique is used to shape the nose profile, and CFD analysis is conducted to optimize the aerodynamic |

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| | characteristics by adjusting the special control element. Aerodynamic characteristics of the noses designed have been evaluated by CFD and wind tunnel test, and the results show that the pressure and flow on the nose is well-distributed, and there is no supersonic zone existing on the nose at cruise condition. The method in this paper is feasible, can be widely used in the future aircraft design. |

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