2010 Beijing Orbital Debris Mitigation Workshop

2010北京轨道碎片减缓会议

October 18-19, 2010

The 8th Meeting Room,

Conference Center of New Main Building

Sponsored by:

Beihang University

Secure World Foundation

International Space University

时间：2010. 10. 18-19

地点：北航新主楼会议中心第八会议室

主办单位：北航宇航学院

安全世界基金会

国际空间大学

2010 Beijing Orbital Debris Mitigation Workshop

Beihang University (BUAA)

Beijing, China

Oct. 18-19, 2010

Funded by：

Secure World Foundation

Sponsored by：

School of Astronautics, Beihang University

Secure World Foundation

International Space University

Table of Contents

Participants

No.	Name	Organization
1	BOMBARDELLI Claudio	Technical University of Madrid
2	BUCKLEY Angie	International Space University (ISU)
3	CAO Yan	China Academy of Space Technology (CAST)
4	CARNETT Carol Lee	Secure World Foundation (SWF)
5	CHEN Shenyan	Beihang University (BUAA)
6	CLAEYS Yves	Tsinghua University
7	CUI Maodong	China Academy of Engineering Physics (CAEP)
8	GABRYNOWICZ Joanne	School of Law, University of Mississippi
9	GONG Zizheng	China Academy of Space Technology (CAST)
10	HAN Zengyao	China Academy of Space Technology (CAST)
11	HE Weiliang	Beihang University (BUAA)
12	HIRAYAMA Hiroshi	Kyushu University

13	HOBBS Stephen	Cranfield University
14	HOU Mingqiang	China Academy of Space Technology (CAST)
15	HUANG Hai	Beihang University (BUAA)
16	JIA Guanghui	Beihang University (BUAA)
17	JOHNSON-FREESE Joan	Secure World Foundation (SWF) U.S. Naval War College
18	KULACKI Gregory	Union of Concerned Scientists (UCS)
19	LANG Junyi	Tsinghua High School
20	LI Baojiang	Shanghai Institute of Satellite Engineering
21	LI Bin	Tsinghua University
22	NIU Jinchao	China Academy of Space Technology (CAST)
23	QIU Yong	China Academy of Engineering Physics (CAEP)
24	QU Changhong	China Academy of Engineering Physics (CAEP)
25	SCHAUB Hanspeter	University of Colorado
26	STUPL Jan	Stanford University

27	SONG Bin	Aerospace System Engineering Shanghai
28	SUN Chen	China Academy of Space Technology (CAST)
29	TELICHEV Igor	University of Manitoba
30	TRUSHLYAKOV Valeriy	Omsk University
31	WANG Xinsheng	Beihang University (BUAA)
32	WEEDEN Brian	Secure World Foundation (SWF)
33	WILLIAMSON Ray	Secure World Foundation (SWF)
34	WRIGHT David	Union of Concerned Scientists (UCS)
35	XU Kunbo	China Academy of Space Technology (CAST)
36	ZHAO Guowei	Beihang University (BUAA)
37	ZHANG Xiaotian	Beihang University (BUAA)
38	ZHENG Jiandong	China Academy of Space Technology (CAST)
39	ZHOU huan	China Academy of Engineering Physics (CAEP)

Schedule

Monday, 18 October

09:00-09:15	**Welcome and Overview** Prof. HUANG Hai, Beihang University Prof. Ray WILLIAMSON, SWF Prof. Angie BUKLEY, International Space University
09:15-09:55	**Overview of the Beihang Research Group** Prof. HUANG Hai, Beihang University
09:55-10:35	**The Current Space Debris Situation** Dr. David WRIGHT, Union of Concerned Scientists
10:35-11:00	**Break & Family Photo**
11:00-12:00	**Hypervelocity Impacts** Smaller Size and Bigger Damage - Dr. JIA Guanghui, Beihang University M/OD Hypervelocity Impacts Research in CAST - Prof. GONG Zizheng, CAST
12:00-14:00	**Lunch**
14:00-15:00	**Hypervelocity Impacts** Effect of Orbital Debris on Spacecraft Pressurized Structures - Dr. Igor TELICHEV, University of Manitoba Fragmentation Simulation and Debris Analysis of On-orbit Satellites Collision - ZHANG Xiaotian, Beihang University
15:00-15:30	**Overview of Orbital Debris Removal** Brian WEEDEN, Secure World Foundation
15:30-16:00	**Break**
16:00-17:30	**Debris Removal Concepts** Japanese Research - Prof. Hiroshi HIRAYAMA, Kyushu University Russian Research - Prof. Valeriy TRUSHLYAKOV, Omsk University

	Debris Reduction Investigation of GEO Satellite Through Its Whole Lifetime - Dr. LI Baojiang, Shanghai Institute of Satellite Engineering
	Electrodynamic Tethers - Dr. Claudio BOMBARDELLI, Technical University of Madrid
	Orbital Debris Characteristic Analyze and a Small Debris Collection Concept - Dr. CHEN Shenyan, Beihang University
17:30	**Day 1 Wrap-up**

Tuesday, 19 October

09:00-10:45	**Debris Removal Concepts Continued**
	Space Debris Removal: Laser as a Case Study – Dr. QU Changhong, China CAEP
	DR LEO:Debris Removal Mission for LEO - Prof. Stephen HOBBS, Cranfield University
	Debris-debris Collision Avoidance Using Medium Power Ground-based Lasers – Dr. Jan STUPL, Stanford University
	Orbital Debris Removal by the Active Maneuvering Spacecraft with Tether Net/Gripper – Dr. SONG Bin, Aerospace System Engineering Shanghai
	Reorbiting Large Geosynchronous Debris - Prof. Hanspeter SCHAUB, University of Colorado
10:45-11:00	**Break**
11:00-11:30	**Beihang Small Satellite Research**
	Beihang University Micro-satellite System Research - Dr. WANG Xinsheng, Beihang University
11:30-12:00	**Small Satellite Traffic Management**
	Brian WEEDEN, Secure World Foundation
12:00-14:00	**Lunch**

14:00-15:30	**Panel Discussion: Promoting Stability and Clarity of Intent in Debris Removal Operations** **Moderator:** Prof. Ray WILLIAMSON, SWF Dr. Gregory KULACKI, Union of Concerned Scientists Prof. Joan JOHNSON-FREESE, SWF Prof. LI Bin, Tsinghua University
15:30-16:00	**Break**
16:00-17:30	**Panel Discussion: Legal Issues and Measures for Debris Removal Issues** **Moderator:** Prof. Ray WILLIAMSON, SWF Prof. Joanne GABRYNOWICZ, University of Mississippi Prof. HAN Zengyao, CAST
17:30-17:45	**Day 2 Wrap-up and Conclusions**
19:00	**Workshop Dinner**

Abstracts of Presentations

The Current Space Debris Situation

David WRIGHT
Union of Concerned Scientists

This talk will give an overview of the current state of space debris, with an eye toward issues relevant to debris mitigation. It will include discussions of the recent rapid growth in the debris population, key contributors to debris growth in the past and present, and the altitude distribution of debris and its effect on lifetimes. It will also discuss the implications of debris collisions for current satellites operating in space and for the future evolution of the debris population.

Smaller Size and Bigger Damage

JIA Guanghui
Beihang University

Space debris problem is getting more and more attention around the world and there are two ways to deal with it. One is making the space debris dangerous event easier to understand by ordinary persons not only by experts. The other is seeking a better measurement to mitigate the debris environment. This presentation focuses on the first, simulation work show the damage results of spacecraft suffered by the space debris impact, especially connecting between size ratio of debris-spacecraft and damage. In the presentation, some impacting simulation scenes are given also, impacting on aluminum plate, honeycomb plate, these two kinds of plats are more usually used as the spacecraft outside walls. The damage hole size in wall and sequential debris clouds potential damage force behind the walls can be seen which are more concerned Spacecrafts users and designers.

M/OD Hypervelocity Impacts Research in CAST

Gong Zizheng, Yang Juyun, Cao Yan, Hou Mingqiang, Niu Jinchao, Zheng Jiandong, and Xu Kunbo
Beijing Institute of Spacecraft Environment Engineering, China Academy of Space Technology, Beijing 100094, China.

The M/OD hypervelocity impact experimental facilities and some recent progresses in M/OD protection researches in China Academy of Space Technology (CAST) were introduced and reviewed briefly, including: (1) two-stage light gas gun system, (2) development of the hypervelocity launching technique over 10km/s by pillow flyer method, (3) obtainment of the ballistic limit curve (BLC) of the typical protection shields, (4) development of the new concept protection shield, (5) investigation of the projectiles shape effects on hypervelocity impact were qualitatively and quantitatively, (6) The laser-driven flyer (LDF) system, (7) the hypervelocity impact cumulative effects of micro M/OD on the outer surfaces functional of material, such as the thermal control material, window glass, and OSR etc..

Also, the near future needs of protection spacecraft against the space debris in China and its corresponding requirements of hypervelocity impact test are addressed.

Keyword: *Micro meteoroids and orbital debris (M/OD), Hypervelocity impact, protection shield, Ballistic limit curve, Two-stage light gas gun, The laser-driven flyer (LDF) system*

Effect of Orbital Debris on Spacecraft Pressurized Structures

Igor TELICHEV
University of Manitoba

The presentation is devoted to the impact response of spacecraft thin-walled pressurized structure subjected to orbital debris impact. Experimental studies have shown that under certain conditions the pressurized structures perforation can lead to the unstable, rapid crack growth and the impact damage has a form of a hole surrounded by a zone of the crack-like defects. Two types of structures are considered: inhabited or laboratory pressurized modules and onboard system vessels with a gas under high pressure. Effect of shielding on the residual strength of structure in case of both shield and pressure wall penetration is analysed. Damage patterns and mechanisms leading to the unstable crack growth are discussed. A model of fracture of impact damaged pressure vessel is presented. The method of singular integral equations is used to calculate the critical stress for the impact damaged structure. A numerical solution is found by the method of mechanical quadratures. The validity of the developed models is tested by simulating the experimental results.

Fragmentation Simulation and Debris Analysis of On-orbit Satellites Collision

ZHANG Xiaotian
Beihang University

Fragment identification and statistics method is proposed base on the SPH simulation. This technique is applied to analysis the on-orbit collision of Iridium33 and Cosmos2251 in Feb, 2009. The impact and fragmentation process can be seen clearly in the simulation and the information of generated debris is obtained. The amount of large debris is closed to the space surveillant data. After that the cases of different impact locations are compared. The simulation shows that most material in the normal impact region is converted into small fragment after the impact while large fragments are from the material far from the impact location. The mass of fragment is computed and the total mass of either large fragments or small fragments is only related to equivalent normal impact mass and is irrelative to impact location.

Overview of Orbital Debris Removal

Brian WEEDEN
Secure World Foundation

This presentation will provide an overview of the topic of orbital debris removal, including a summary of the research and modeling that shows it is necessary and the potential benefits from removal operations. It discusses removal in the context of other measures necessary to ensure the long-term sustainability of space and the main technical, legal, and policy challenges involved in debris removal.

Small Satellite Space Traffic Management

Brian WEEDEN
Secure World Foundation

This presentation will provide an overview of the challenges posed by small satellites for tracking, traffic management, orbital crowding, and collisions.

Japanese Research about Debris Removal Concepts

Hiroshi HIRAYAMA
Kyushu University

I will introduce some activities about space debris in Kyushu University. Especially, I will present a concept to de-orbit small debris with low density materials, such as aerogel or polyimide foam. Preliminary study shows that the material with only 20 cm in thickness can decelerate incoming debris enough to de-orbit. Now we are preparing impact tests with the materials.

Russian Research about Debris Removal Concepts

Valeriy TRUSHLYAKOV
Omsk University

Use of energy, contained in a remaining fuel in separated tanks of upper stages of a space launch vehicle, for removal to orbits of disposal or utilization.

Debris Reduction Investigation of GEO Satellite Through Its Whole Lifetime

LI Baojiang
Shanghai Institute of Satellite Engineering

Space debris comprises all non-functional, man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the Earth's atmosphere. The growing population of these objects poses an increasing hazard to space systems.

In the article, debris reduction of GEO satellite through its whole lifetime is investigated, such as FY-4 satellite. The research can serves as reference for debris reduction of other GEO satellites through their whole lifetime. The experience of FY-4 debris reduction also provides a valuable experience for the standards on disposal of satellites which will be issued in the future.

The general aim of space debris reduction is to reduce the growth of space debris by ensuring that space systems are designed, operated, and disposed of in a manner that prevents them from generating debris throughout their orbital lifetime.

Electrodynamic Tethers

Claudio BOMBARDELLI
Technical University of Madrid

Electrodynamic Tethers offer high performance as propellantless deorbiting systems and are among the main candidates for the implementation of active debris removal. After a preliminary review of the current space debris population in Low Earth Orbit I will introduce the fundamental aspects of Electrodynamic Tethers (EDTs) design and modeling and discuss their performance when attached to different kinds of large space objects. Issues about tether impact risk with other debris and tether maneuverability are also discussed.

Orbital Debris Characteristic Analyze and a Small Debris Collection Concept

CHEN Shenyan
Beihang University

Space Debris is a gowning concern, as even small particles can be very destructive in a collision due to their high orbital speed. In this presentation, background information of current space debris situation is presented, including number, size, spatial distribution, source of the space debris, and its threat to satellite. It can be seen that the distribution of debris is not uniform in space, the threat to a satellite depends on its orbit. The regions (sun synchronous orbit, SSO) most heavily used by satellites are also the most heavily populated with debris. Conjunctions of SSN catalog against itself are calculated, which showed 99.9% conjunctions are in LEOs. Many concepts have appeared for active debris removal. There are two separate areas of concentration: small debris removal and large debris capture. A small debris collection concept is simulated, in which a specific material could be shaped into a sphere by inflating a folded bag in LEOs. Small debris (<10cm) are assumed as randomly collide with the collection satellites. The debris reduction and the collision between collection satellites and small debris are estimated. Several questions which need to answer are also presented for this concept.

Space Debris Removal: Laser as a Case Study

QU Changhong
China Academy of Engineering Physics

In my presentation, I will introduce the physics of debris removal using laser and review some existing proposals on this issue. Then I will analysis the feasibility, technical challenges and limitation of debris removal using laser. At last I will give some concerns about the implications on space security caused by this method.

DR LEO: Debris Removal Mission for LEO

Stephen HOBBS
Cranfield University

Active debris removal has become one of the main topics in space debris. Predictions suggest that unless action is taken, a natural debris cascade will have become established at some altitudes in low Earth orbit (LEO) by 2050. After that it could be many centuries before natural removal mechanisms stabilize the debris population.

DR LEO is a study to design a conventional-technology mission to remove large debris from LEO. A medium-cost mission capable of removing debris has been designed at Cranfield University: we are now working to improve the design using higher performance technologies. Important issues are raised by these studies and solutions are needed within the next few decades.

Debris-debris Collision Avoidance Using Medium Power Ground-based Lasers

Jan STUPL, James Mason, William Marshall, Creon Levit
Stanford University

We propose a new scheme to avoid collisions between debris objects using medium sized telescopes with adaptive optics coupled to off-the-shelf industrial lasers. Using high-power lasers to ablate and de-orbit space debris has previously been proposed. However, for ground-based systems the required high intensity lasers are not commercially available. There is also the risk that the proposed debris mitigation systems could be used as anti-satellite weapons.

We propose an alternative system which aims to avoid collisions as opposed to de-orbiting debris. In order to avoid collisions, small accelerations (\delta-v ~= 1cm/s) combined with high-accuracy tracking and laser de-confliction are shown to be sufficient. Instead of using the recoil of laser ablation, our calculations show that radiation pressure alone from commercially available ground-based lasers coupled to ~1m class telescopes and adaptive optics can achieve the necessary accelerations.

After a survey of previous laser debris mitigation schemes we focus on our proposal. We present a case study using a laser propagation code including atmospheric effects coupled with a high-precision orbital propagator to model the results of directed radiation pressure as a debris-debris collision avoidance scheme.

Orbital Debris Removal by the Active Maneuvering Spacecraft with Tether Net/Gripper

SONG Bin
Aerospace System Engineering Shanghai

Since the number of non-functional satellites and launch vehicle upper stages is steadily increasing, orbital debris will become a serious problem for low Earth orbit and for the geosynchronous orbit, so effective measures to mitigate them are urgent. Our teams are studying an active maneuvering spacecraft system for large space debris removal, and are examining the application of tether net/gripper as efficiency payloads. This paper describes the status of research on an orbital debris removal system for the mitigation of orbital debris, which includes study contents, key technologies and next steps.

Reorbiting Large Geosynchronous Debris

Hanspeter SCHAUB
University of Colorado

A novel, elegant, and patent-pending method is proposed to reorbit large debris objects from geosynchronous to super-synchronous orbits. A blend of electrostatic charge control and electric propulsion avoids any physical contact, thus circumventing the danger of docking maneuvers with an uncontrolled, and possibly spinning, debris object. Absolute electrostatic charge is used to create an attractive force between a “space-tug” and debris. Active charge control is employed to “lock-in” a separation distance of a few dozen meters. Electric micro-thrusters gently pull the debris into a super-synchronous disposal orbit while safely avoiding other geosynchronous residents. To achieve an appropriate level of opposing charge, the space-tug assumes an electrostatic potential opposite to that of the debris, and controls its potential through continuous charge emission. Geosynchronous debris charges naturally through plasma interaction and the photoelectric current. Depending on the space weather, GEO objects can naturally charge to 10-20kV levels. This natural charging may be augmented through wireless charge transfer from the tug. The presentation covers the basic concept of electrostatic actuation in space, how to use hybrid Coulomb/inertial thrusting to reorbit debris, and provides some preliminary performance estimates.

Beihang University Micro-satellite system research

WANG Xinsheng,
Beihang University

During the past decades, the micro-satellites have been applied widely to perform space experiments, demonstrate new technology and operational missions. Micro-satellite has become one of the key fields in the future space exploration. In order to improve student's innovation and engineering skills in spacecraft design, BUAA student micro-satellite (BUAA-SAT) is sponsored by Beihang University Students Education Program and Chinese Graduate Student Education Foundation.

The BUAA-SAT project mission is to study the micro-satellite system platform technology, demonstrate on-orbit coiled mast deployment technology, realize advanced integrated electrical system, demonstrate on-orbit imaging and on-board data compression. Most of the analysis, designs and system tests are completed by undergraduates and graduates students under the guide of professors and senior engineers. The BUAA-SAT is a gravity-gradient stable micro-satellite, consists of main-satellite and sub-satellite which are connected by coiled mast on orbit. Advanced integrated design concept is used to achieve the goal of light weight, compact volume, low cost, convenient assembly and enough ability to rapid-response.

This paper provides an overview of the BUAA-SAT project which has completed its preliminary design phase. The key technologies are discussed and the results of the system integration and test are given. The work of the BUAA-SAT ground engineering model puts a well way to design the BUAA-SAT flight model which will be launched as a piggyback micro-satellite.

Biographical Statements & Contact information of Participants

Prof. HUANG Hai

School of Astronautics, Beihang University

Professor HUANG received his bachelor, master and Ph. D degrees of Aerospace Engineering in 1983, 1986 and 1990 respectively, all from Beijing University of Aeronautics and Astronautics (BUAA). His interested research areas include concept design of spacecraft, structural strength & optimization, arms control & space sustainability. He worked as visiting scholar at Wichita State University, USA form July 1999 to September 2000. Now he works as a faculty member and vice dean in charge of graduate education at School of Astronautics Technology, BUAA. In the past decade, he joined or led his group to complete several research projects on advanced design technology for spacecraft structures. He has twenty years teaching experience in Aerospace Engineering, and has published more than 30 technique papers on journals.
hhuang@buaa.edu.cn

Prof. Ray WILLIAMSON

Secure World Foundation

Dr. Ray Williamson is Executive Director of Secure World Foundation, a private operating foundation with headquarters in Superior, Colorado. Colorado. He was formerly Research Professor of Space Policy and International Affairs in the Space Policy Institute, The George Washington University. At the institute, he had led several studies of security issues in space and on the socioeconomic benefits of Earth science and space weather research. Ray is also an external faculty member of the International Space University (ISU), Illkirch, France, teaching general space policy and remote sensing for the ISU Masters and Space Studies programs. He is editor of *Imaging Notes* and serves on the editorial board of the journal Space Policy. As a member of the International Academy of Astronautics, Dr. Williamson serves on Commission Five: Space Policies, Law & Economics. He is the author of more than 100 articles on space policy, remote sensing and space security and author or editor of nine books on outer space, the technologies of historic preservation, and American Indian astronomy, myth and ritual. From 1979 to 1995, he was a Senior Analyst and then Senior Associate in the Office of Technology Assessment (OTA) of the U.S. Congress. While at OTA, Dr. Williamson led more than a dozen space policy studies requested by Congressional committees.

Ray received his B.A. in physics from the Johns Hopkins University and his Ph.D. in astronomy from the University of Maryland. After two years on the astronomy faculty of the University of Hawaii, he taught philosophy, literature, mathematics, physics and astronomy at St. John's College, Annapolis. For the last five years he also served as Assistant Dean of the College.
rwilliamson@swfound.org

Prof. Angie BUKLEY

International Space University

Dr. Angie Bukley has nearly 30 years of professional experience in space and defense systems and holds a Ph.D. in Electrical Engineering, with a specialty in Control Theory, from the University of Alabama in Huntsville. Dr. Bukley is Associate Dean, Professor and Space Studies Program Director at the International Space University in Strasbourg, France. Prior to joining ISU, she was the Associate Vice President and Chief Administrator for the University of Tennessee Space Institute in Tullahoma, Tennessee, USA. From November 2003 – June 2007, she was a Professor in the School of Electrical Engineering and Computer Science and the Associate Dean for Research and Graduate Studies in the Russ College of Engineering and Technology at Ohio University, Athens, Ohio, USA. Before transitioning into academe, she was employed by The Aerospace Corporation in Albuquerque, NM, USA and was assigned to the Airborne Laser System Program Office at Kirtland Air Force Base from 1998-2003 where she was the chief systems engineer for the ABL beam control/fire control system. Dr. Bukley was also the Director of Laser Applications for The Aerospace Corporation. Prior to joining Aerospace, Dr. Bukley worked with a number of defense contractors on a wide variety of programs. She spent seven years at the NASA Marshall Space Flight Center in Huntsville, Alabama where she directed the Large Space Structures Laboratory and worked on remote sensing applications.

She is a 1993 alumna of the International Space University Space Studies Program and has been an ISU faculty member since 1998. Dr. Bukley has held department and team project chair positions in the SSP since 1994. Dr. Bukley has nearly 70 technical publications and received over 20 awards for technical achievement, including the 2003 University of Alabama in Huntsville Distinguished Engineering Alumni Award. The book Artificial Gravity that she co-wrote and co-edited was awarded the 2008 Life Sciences Book of the Year Award by the International Academy of Astronautics. She is active in the American Institute for Aeronautics and Astronautics (Associate Fellow), American Astronautical Society, International Federation for Automatic Control, National Space Society, and American Society for Engineering Education.
bukley@isu.isunet.edu

Dr. David WRIGHT

Union of Concerned Scientists

Dr. Wright is Co-Director and Senior Scientist in the Global Security Program at the Union of Concerned Scientists. He received his Ph.D. in theoretical condensed matter physics from Cornell University in 1983, and worked as a research physicist until 1988. Prior to joining UCS in 1992, he was a Fellow in the Center for Science and International Affairs in the Kennedy School of Government at Harvard (1988-90), and a Senior Analyst at the Federation of American Scientists (1990-20). He is also currently a Research Affiliate in the Program on Science, Technology, and Society at MIT. Wright's areas of expertise include the technical aspects of security and arms control, particularly those related space security, space debris, U.S. nuclear weapons policy, ballistic missile defense, and ballistic missile proliferation.
dwright@ucsusa.org

Dr. JIA Guanghui

Beihang University

Jia Guanghui obtained a Solid Mechanics Bachelor diploma form Lan Zhou University，in 1988, and a Mechanics Engineering PH.D. at Beijing Institute of Technology in 2003. He worked in Beihang University(BUAA) as a postdoctoral fellow from 2003 to 2005 and an Associate professor until Now. He has more than ten years teaching experience about Mechanics Engineering, The courses he has taught including: Finite element simulation method, Elastic mechanics, space debris and spacecraft.

His interested research areas include Structural Mechanics, Hypervelocity impact simulation technology, which is important to Spacecrafts protection, and new area: space security. He has participated in Summer Symposiums organized by UCS(Union of concerned scientists) three times since 2003，16th Summer Symposium in Tsinghua University, China, 17th Summer Symposiums in Princeton University, in the US. 18th in the Abdus Salam International Center for Theoretical Physics，Italy.

School of Astronautics, 37 Xueyuan Road, Haidian District, Beijing, China 100083
Phone: 86-10-8233-9067, Fax: 10-8231-6530 E-mail: jiaguanghui@buaa.edu.cn

Prof. GONG Zizheng

China Academy of Space Technology

Beijing Institute of Spacecraft Environment Engineering
China Academy of Space Technology
Add: No.104, Youyi Road, Haidian, Beijing, China
P.O.Box: 5142-100, Beijing, China
Postcode: 100094
Tel: 86-10-68746609 (O)
Fax: 86-10-68746751
Mobile Phone: 13366296508
E-mail: gongzz@263.net, zzhgong@home.swjtu.edu.cn

Zizheng Gong, PhD, Professor and Leading Scientist of hypervelocity impact research at Beijing Institute of Spacecraft Environment Engineering, China Academy of Space Technology (CAST). Research Interests including hypervelocity impact experiments and numerical simulations. Protection shield design for spacecraft against the space debris impact. theory, experiment and multi-scale simulations of materials properties (equation of state, phase transition, strength, melting behavior, damage dynamic, etc.) under high pressure and high temperature conditions and their applications by using shock waves, e.g. two-stage light gas gun, laser-driven flyer equipment, continuum mechanics, molecular dynamics and quantum mechanics simulations.

Research associate with Prof. Thomas James Ahrens from June, 2001-August, 2001, Seismological Laboratory, California Institute of Technology (Caltech). Visiting Professor from August, 2003-July, 2004, Geophysical Laboratory, Carnegie Institution of Washington. Professor Zizheng Gong and his collaborators have published more than 150 papers on Physical Review Letter, Physical Rev., Applied Physics Letters, J. Geophysical Research, Geophysical Research Letter, Phys. Earth Planet Inter., The Journal of Chemical Physics, Chinese Phys. Lett., etc.

Now professor Zizheng Gong is Member of American Physics Society. Member of American Geophysical Union. Member of Shock dynamic committee, Chinese Society of Mechanics. Administrative vice president of Chinese Society of Interdisciplinary Sciences. Also guest professor of Southwest Jiaotong University, Liaoning University. Associate editor-in-chief of Journal of Interdisciplinary Sciences. Member of the editorial board of Journal of Spacecraft Environment Engineering.

Prof. Igor TELICHEV

University of Manitoba

Prof. Igor Telichev received his PhD degree in Aerospace Engineering from Samara State Aerospace University (Russia) and PhD degree in Mechanics/Nanomechanics from the University of Calgary (Canada). During his career Dr. Telichev collaborated with numerous research/academic institutions and industry, namely: Samara State Aerospace University, State Research and Production Space Rocket Center "TsSKB-Progress" (Russia), Russian Federal Nuclear Center, Fraunhofer Ernst-Mach-Institute (Germany), European Space Agency (ESA/ESTEC), RWTH Aachen University (Germany), University of Calgary (Canada), University of Waterloo (Canada), AMEC Oil&Gas (UK/Canada), the University of Florida (USA), US Air Force Research Laboratory (AFRL/MN) and the University of Manitoba (Winnipeg, Canada). Dr. Telichev is a recipient of Soros Foundation Award in Physics and the ASME (American Society of Mechanical Engineers) and ASC (The American Society for Composites) Best Paper Awards, recipient of fellowships from DFG (German Research Foundation), DAAD (German Academic Exchange Service), and NSERC (Natural Sciences and Engineering Research Council of Canada). His area of research interests includes hypervelocity impact phenomena, spacecraft vulnerability/survivability, orbital debris protection, low- and high-velocity impact on composites, failure analysis and simulation of fracture in pressure vessels and pipelines.
telichev@cc.umanitoba.ca

ZHANG Xiaotian

Beihang University

He is a student in School of Astronautics, Beihang University (Beijing University of Aeronautics and Astronautics). He achieved his two BDs in Aerospace Engineering and Applied Mathematics in 2006, and now is in the fifth year of his PhD study. His main research field is the impact fragmentation simulation algorithms and the applications in space debris issue. The technique is used in the analysis of satellite protective structure against debris impact. With integrated method of hypervelocity tests and simulations the shield is designed and optimized. Another application is the analysis of on-orbit objects breakup. Different from the NASA standard breakup model, which is based on the statistics of space surveillant data, this analysis is based on impact and explosion simulations, so that some information beyond the surveillance limit can be obtained.
ultlever@gmail.com

Brian WEEDEN

Secure World Foundation

As the Technical Advisor for Secure World Foundation, Brian has over a decade of professional technical and operations experience in the national and international space security arena. His wealth of technical knowledge has established him as a thought leader for providing critical analysis that supports development of space policy on a global scale.

Prior to joining the Foundation, Mr. Weeden served nine years on active duty as an officer in the United States Air Force working in space and ICBM operations. As part of U.S. Strategic Command's Joint Space Operations Center (JSpOC), Captain Weeden directed the orbital analyst training program and developed tactics, techniques and procedures for improving space situational awareness.

In his current role as Technical Advisor, Mr. Weeden conducts research on global space situational awareness, space traffic management, protection of space assets, and prevention of conflict in space. He also organizes national and international workshops to increase awareness of and facilitate dialogue on space security and sustainability issues. Respected and recognized as an expert, Mr. Weeden's research and analysis have been featured in numerous news articles including the New York Times and the Economist, academic journals, presentations to the United Nations, and testimony before the U.S. Congress.

Mr. Weeden holds a Bachelor’s in Science (B.S.) in Electrical Engineering from Clarkson University and a Masters in Science (M.S) in Space Studies from the University of North Dakota. He is also a graduate of the International Space University Space Studies Program (2007, Beijing).
bweeden@swfound.org

Prof. Hiroshi HIRAYAMA

Kyushu University

Professor Hirayama majored in aeronautics and astronautics in the graduate school of the University of Tokyo. He has been conducting research at Kyushu University as an assistant professor since 1997. He received his PhD in engineering from Kyushu University in 2005, and his current research topic is space debris and micro satellites.
hira@aero.kyushu-u.ac.jp

Prof. Valeriy TRUSHLYAKOV

Omsk University

Dr. Trushlyakov graduated from Tomsk State University in 1970 and was sent to the Design Bureau of an Aviation plant in Omsk. He defended his candidate's dissertation in 1978, and in a 1991 doctoral dissertation. From 1991 to 2004, he was Vice-Director of science research of Omsk State Technical University (OmSTU), leader of department of Avio & rocket building (A&RB) of OmSTU. Since 2004 he has been a Professor in the Department of A&RB of OmSTU and Director of the Center for "Space ecology".
trushlyakov@omgtu.ru

Dr. LI Baojiang

Shanghai Institute of Satellite Engineering

Li Baojiang, born in 1978, doctor, senior engineer of Shanghai Institute of Satellite Engineering. His main interests include satellite structure design, space debris investigation.

Dr. Claudio BOMBARDELLI

Technical University of Madrid

Dr. Claudio Bombardelli received a master in mechanical engineering in 2001, and a PhD in Space Science and Technology in 2005 at the University of Padova, Italy. He has spent five years (2000-2004,2006) as Visiting Research Fellow at the Harvard-Smithsonian Center for Astrophysics, Cambridge USA. He was then awarded a two-year postdoctoral research fellowship at the Advanced Concepts Team of the European Space Agency (2006-2008). He is now Assistant Professor at the School of Aeronautics of the Technical University of Madrid in the department of Applied Physics. Main research interests are inert and electrodynamic tethers, orbital dynamics and mission analysis.
claudio.bombardelli@upm.es

Dr. CHEN Shenyan

Beihang University

School of Astronautics, Beihang University
37 Xueyuan Road, Haidian District, Beijing 100191
Phone: 10-8233-8404, Fax: 10-8231-6611, E-mail: chenshenyan@buaa.edu.cn

Chen Shenyan received her bachelor degree of Mechanical Engineering in 1995 from Nanchang University. She entered Beijing University of Aeronautics and Astronautics (BUAA) in 2000 and received Ph. D degree of Aerospace Engineering in 2005. Her interested research areas include structural strength & design optimization of spacecraft, hypervelocity impact, and arms control & space security. Now she works as a faculty member at School of Astronautics, BUAA. In the last years, she joined several research projects on structural optimization and advanced design technology for spacecraft structures. She gives courses to both Chinese and foreign students on the major of Aerospace Engineering. She participated the 16th and 21th Summer Symposiums organized by UCS in 2004 and 2009. She went to visit UCS within Oct 12~Nov 25, 2008. She is a main member in the project “Study on the Space Debris Mitigation and Small Satellite Traffic Management” which is sponsored by Secure World Foundation.

Dr. QU Changhong

China Academy of Engineering Physics

Qu Changhong is currently a technical staff of Institute of Structural Mechanics, China Academy of Engineering Physics (CAEP), and also is a postgraduate student at graduate school of CAEP. He got BS degree in Mechatronic Control Engineering from the Beijing Institute of Technology (BIT) in 2002, and then he became an employee of CAEP till now. His research focuses on missile defense technical analysis and space security issues. He is interested in arms control related technical issues, and takes part actively in international communication. He was the participant of 17th & 18th International Summer Symposium on Science and World Affairs organized by UCS in 2005 and 2006. He was also the participant of 10th and 12th PIIC Beijing Seminar on International Security in 2006 and 2010.
quchanghong@163.com

Prof. Stephen HOBBS

Cranfield University

Since 2005 Stephen has been Director of the Space Research Centre at Cranfield University. Prior to that he contributed to space engineering teaching and research at Cranfield – the Centre has around 500 alumni across the UK and European space industry. His professional experience includes secondment to EADS Astrium for system engineering work on science and Earth observation missions, and acting as the UK's representative to the engineering working group of ISO's Space Systems and Operations committee. His technical expertise covers space system engineering, with specific interests in radar and sensor systems, and risk management at end of mission (including space debris). His academic background is in mathematics, physics, and experimental physics, followed by postgraduate training in instrumentation, sensor system design, and radar remote sensing. He has participated in field experiments in the UK, Europe, and North America. Stephen has around 100 research publications and is a member or fellow of professional organizations in physics, Earth observation, and meteorology.
s.e.hobbs@cranfield.ac.uk

Dr. Jan STUPL

Stanford University

Jan Stupl is a Postdoctoral Fellow at the Center for International Security and Cooperation (CISAC) at Stanford University in California. His research concerns the current developments in laser technology regarding a possible application of lasers as an anti-satellite weapon (ASAT), as well as the proliferation of ballistic missiles. Recently, he is applying his knowledge of atmospheric laser propagation to assess the feasibility of a space debris collision avoidance scheme which uses medium power lasers.

Before coming to CISAC, Jan was a Research Fellow at the Institute of Peace Research and Security Policy (IFSH) at the University of Hamburg, Germany. His PhD dissertation was a physics-based analysis of future of High Energy Lasers and their application for missile defense and focused on the Airborne Laser missile defense system. This work was jointly supervised by the IFSH, the Institute of Laser and System Technologies at Hamburg University of Technology and the physics department of Hamburg University, where he earned his physics PhD in 2008.
stupl@stanford.edu

Dr. SONG Bin

Aerospace System Engineering Shanghai

Bin Song received the M.E.degree in navigation, guidance and control and the Ph.D. degree in control science and engineering form Harbin Institute of Technology, Harbin, China, in 2004 and 2007, respectively.

Since 2007, he has worked as a Research Engineering in spacecraft control at Aerospace System Engineering Shanghai, Shanghai Academy of Spaceflight Technology. He is currently the term leader of spacecraft attitude control group. His main research interests include attitude and orbit control of spacecraft, robust and nonlinear control, and applications to spacecraft.
songbinhit@gmail.com

Prof. Hanspeter SCHAUB

University of Colorado

Dr. Schaub joined the Aerospace Engineering Science department at the University of Colorado at Boulder in the fall of 2007 as an Associate Professor and an H. Joseph Smead Fellow. In 2010 he received the Provost Faculty Achievement Award for his work on charged relative motion. Prior to working at the University of Colorado, he worked 4 years as an assistant professor at the aerospace and ocean engineering department at Virginia Tech, worked 4 years as a research engineer at Sandia National Labs, and did a 1 year post-doc working on the Techsat-21 formation flying program. His 15 years of professional interests are in nonlinear dynamics and control applications, with a special emphasis on astrodynamics. This has led to 60+ journal and 90+ conference publications. He is also a co-author of the successful textbook “Analytical Mechanics of Space Systems” which was recently released in its 2nd edition.

Dr. Schaub has performed extensive research in near-Earth spacecraft formation flying problems, as well as lead studies on the spacecraft attitude and control challenges. Current research projects investigate spacecraft charge control and the associated relative motion dynamics of charged spacecraft. Beyond performing analytical studies, this work also led to the creation of the first terrestrial charged relative motion test bed. Dr. Schaub is the director of the Autonomous Vehicle Systems (AVS) lab at the University of Colorado that is developing robotic methods to simulated relative motion of aerospace vehicles, as well as perform direct visual control research of spacecraft. Finally, Dr. Schaub is collaborating with the Wacari Group to develop a touch-less method to reorbit large geostationary debris objects. He

is the lead scientist for this work investigating the requirements to move large debris objects to disposal orbits.
Hanspeter.Schaub@colorado.edu

Dr. WANG Xinsheng

Beihang University

Wang Xinsheng received the MS degree in control theory and control engineering from Chinese Academy of Space Technology(CAST) in 2001 and the Ph.D degree in signal and information processing from Beijing University of Post and Telecommunication(BUPT), Beijing, China, in 2005. He was pursuing postdoctoral work between 2006 and 2008. In 2003, he worked in EADS Space Transportation as an Associate Researcher. He pursued micro-satellite project work in Shenzhen Space Technology Center(SSTC), Shenzhen, China between 2004 and 2007. He is currently with Dept. of Spacecraft Technology, School of Astronautics, Beihang University. And he is leading an excellent student team on student micro-satellite project. His research interests include micro-satellite technology, spacecraft fault detection and diagnosis, satellite attitude control.

Dept. of Spacecraft Technology, School of Astronautics, Beihang University.
Addr: 37 Xueyuan Rd, Haidian District, Beijing, China, 100191.
Phone: +86-10-82316611;
Fax: +86-10-82339067;
E-mail: xswang@buaa.edu.cn.

Dr. Gregory KULACKI

Union of Concerned Scientists

Gregory Kulacki is Senior Analyst and China Project Manager in the Global Security Program at the Union of Concerned Scientists. He is fluent in Mandarin Chinese and an expert on cross-cultural communication between the United States and China. He has lived and worked in China for the better part of the last twenty years facilitating exchanges between academic, governmental, and professional organizations in both countries. Since joining the Union of Concerned Scientists in 2002, he has focused on promoting and conducting dialogue between Chinese and American experts on nuclear arms control and space security, as well as promoting the use of a broader set of Chinese-language documents in U.S. analysis.
gkulacki@ucsusa.org

Prof. Joan JOHNSON-FREESE

Secure World Foundation

Dr. Joan Johnson-Freese has been a Professor of National Security Studies at the Naval War College since August 2002. Previously, she was at the Asia Pacific Center for Security Studies in Honolulu, HI, the Air War College in Montgomery, AL, and Director of the Center for Space Policy & Law at the University of Central Florida. Within the realm of international and national security studies, Dr. Johnson-Freese has focused her research and writing on space security issues, including technology transfer and export, missile defense, transparency, space and development, transformation, and globalization. Her book publications include: Heavenly Ambitions: Will America Dominate Space? 2009; Space As A Strategic Asset, 2007; The Chinese Space Program: A Mystery Within a Maze, 1998; Space: The Dormant Frontier, Changing the Space Paradigm for the 21st Century, 1997; The Prestige Trap: A Comparative Study of the US, European and Japanese Space Programs, with Roger Handberg, 1994; Over the Pacific: Japanese Space Policy Into the 21st Century, 1993; and Changing Patterns of International Cooperation in Space, 1990. Articles written by Dr. Johnson-Freese have been published in such journals as Joint Forces Quarterly, Nature, Space Policy, Issues in Science & Technology and The Nonproliferation Review. She is a on the Advisory Committee of the Secure World Foundation, a Fellow of the International Academy of Astronautics; a Visiting Fellow at the Watson Institute of International Affairs at Brown University; a member of the International Institute for Strategic Studies; on the Space Studies Board of the National Research Council; the Editorial Board of China Security; and has testified before Congress on multiple occasions regarding space security and China.
joanjohnsonfreese@gmail.com

Prof. LI Bin

Tsinghua University

Li Bin received his Bachelor and Master Degrees in Physics from Peking University in 1985 and 1988, respectively. He received his Doctorate in Physics from China Academy of Engineering Physics in 1993 specializing in technical aspects of arms control. In 1994-1996, Dr. Li studied at the Program on Defense and Arms Control Studies at Massachusetts Institute of Technology and the Center for Energy and Environmental Studies at Princeton University under a Post-doctoral Fellowship on Peace and Security in a Changing Word. He then joined the CTBT negotiations as a technical advisor to the Chinese negotiation team. Dr Li was the director of Arms Control Division at Institute of Applied Physics and Computational Mathematics (IAPCM) and the executive director of the Program for Science and National Security

Studies (PSNSS). In 1999, Dr. Li left IAPCM to establish Institute of Science and Public Affairs based at China Youth College for Political Science. Dr. Li moved to the Institute of International Studies, Tsinghua University at the end of 2000. He is now a professor and the director of the Arms Control Program at the Institute.
libin@mail.tsinghua.edu.cn

Prof. Joanne GABRYNOWICZ

University of Mississippi

Professor Gabrynowicz is the Director of the National Remote Sensing and Space Law Center at the University of Mississippi and a Research Professor of Law. Prof. Gabrynowicz teaches United States and international space law and remote sensing law. She is the Editor-in-Chief of the Journal of Space Law and has served on a number of U.S. federal and international advisory panels and committees regarding remote sensing law and policy.

Prof. Gabrynowicz is a member of the Permanent Court of Arbitration Advisory Group of Legal Experts on Optional Rules for Arbitration for Disputes Relating to Outer Space, the Hague and serves as an official observer for the International Astronautical Federation to the UN Committee on the Peaceful Uses of Outer Space Legal Subcommittee. She was the organizer and chair of the Federal Advisory Committee for the National Satellite Land Remote Sensing Data Archive. She publishes extensively and is a frequent presenter at national and international conferences. In 2003, she briefed Secretary of the Interior Gale Norton on satellite data law and policy. In 1999, the International Institute of Space Law invited Prof. Gabrynowicz to present the remote sensing law position paper at the Third U.N. Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). In 2001, she was awarded the Outstanding International Award by Women in Aerospace. In 2008, Prof. Gabrynowicz was the 10th Alan R. Sommerfeld Lecturer in Information Operations and Space Operations sponsored by the International and Operational Law Department of the Judge Advocate General’s School, U.S. Army.
jgabryno@olemiss.edu

Dr. HOU Mingqiang

China Academy of Space Technology

Ph.D, mainly engaged in spacecraft protection against space debris.
Address: P.O. Box 5142-100,Youyi road, Haidian district, Beijing 100094, PR China
E-mail: hou0108007@163.com

Yves CLAEYS

Tsinghua University

He is a student in the Department of International Relations (School of Humanities and Social Sciences at Tsinghua University). He achieved his Bachelor's Degree in Mechanical Engineering in 2008 and subsequently his Master's Degree in Electro-Mechanical Engineering in 2010, both at the Free University of Brussels (VUB) in Belgium. Now he's in his first year of the English Master Program in International Relations at Tsinghua University.