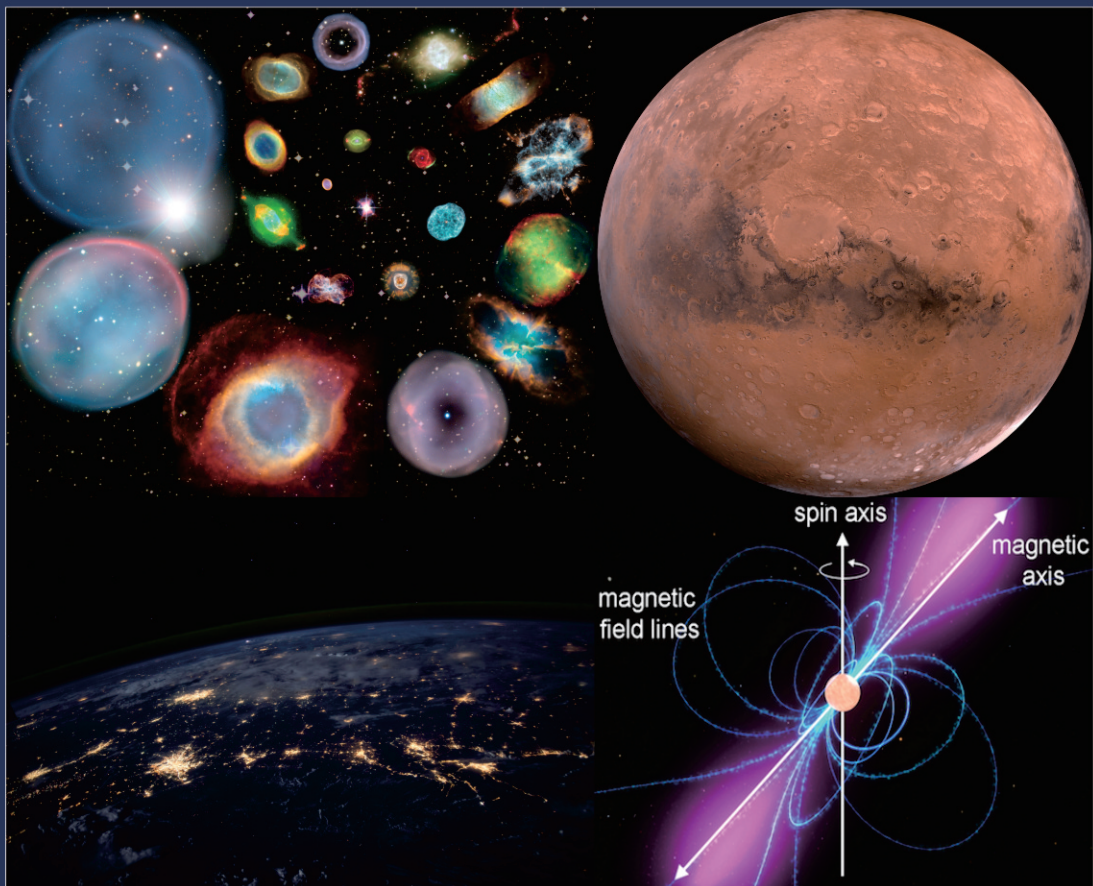




# Laboratory for Space Research Annual Report 2020

Faculty of Science  
The University of Hong Kong



From 1<sup>st</sup> September 2019 to 31<sup>st</sup> August 2020

Prof. Quentin Parker  
Director LSR

Dr. Meng Su & Dr. Joe Michalski  
Deputy Directors LSR



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## 2020 LSR Annual Report

From 1<sup>st</sup> September 2019 to 31<sup>st</sup> August 2020

Foreword by the LSR director, Prof. Quentin Parker



It gives me great pleasure to present the inaugural annual report for the Laboratory for Space Research. After a period of growth and consolidation the LSR is now at the stage where we can look forward, with great confidence, to a bright and productive future. This is based on the remarkable level of on-going success we have demonstrated over the last 12 months in particular and as recorded in this report.

It is the human capital in our leadership team and membership that has led to all our activities, initiatives and achievements. I am proud to be able to serve the LSR and Faculty of Science at HKU and to have such an excellent group of colleagues.

I would like to express particular thanks to my two outstanding deputy directors Dr. Meng Su and Dr. Joe Michalski without whom much of this story would not be possible. I hope you enjoy perusing this report and that at the end you are able to see what we see – an important interdisciplinary centre full of outstanding people, ideas and vision and an excellent asset for HKU!

With my best wishes



Professor Quentin Parker

柏坤霆教授

September 15<sup>th</sup> 2020



## 1. Executive Summary of LSR Activity By The Numbers

- 41 LSR members across 5 departments and 2 faculties (c.f. 15 in 2017) includes a 1% HKU scholar (Dr. Saz Parkinson), one of only 119 at HKU
- \$36.8M HKD Grants awarded: 3 RMGS (~\$33.3M HKD); 7 GRF (~\$3.5M)
- 4 key science meetings, 3 led by LSR: Zhuhai (China), Dongguan (China), HK SAR and one with 4 LSR member participation, Leiden (Netherlands)
- 5 MoUs signed: BISME, CNNC, DFH, STB Dongguan, CSU
- 108 referred publications by LSR faculty, including 2 in Nature Astronomy and Nature communications (averages ~5.7 ref. papers per faculty member)
- 10 major press releases and associated news stories (only one example link to each news story included), 1 TV interview, 2 newspaper interviews
- 2 major initiatives endorsed:
  - East Asian Observatory (EAO) Associate Partnership agreed
  - LSR initiative for International EAO HQ for Dongguan accepted
- 3 Major LSR achievements
  - Launch of the “Lobster Eye X-ray Satellite” on July 25<sup>th</sup> 2020 where HKU co-leads the science mission with NJU
  - Development of new TPG MSc in Space Science
  - INSPIRE lab in Dongguan agreed in principle and moving forward
- 12 Interns hosted and supervised, including 7 from overseas (USA, India)
- 9 International/Mainland distinguished visitors hosted



## 2. LSR Mission, Vision & Brand

- i) To emerge as a leading interdisciplinary research centre in Space and Planetary sciences across the Asian region with a strong identity
- ii) To maintain and grow the LSR to be an *internationally recognised brand* for research excellence in mainstream space science and related programs
- iii) To strengthen and develop our ties to the Mainland Space program and globally

## 3. Summary of Current LSR Membership

There are currently 41 LSR members from 5 departments and 2 faculties including 7 various affiliates from outside HKU ([www.lsr.hku.hk/members/](http://www.lsr.hku.hk/members/) and see Appendix VII). *We are an open, inclusive and free association of HKU academics (19), RAPs, postdocs, RPG students and some external associates.* There is no pressure to join. The LSR has a flat structure under the executive where collegiality and respect are paramount. Most of our members are naturally based at HKU though we retain a few ex-HKU staff as members when they move to another institution if they express a strong wish to remain associated, but they are so indicated. We have selectively allowed some particularly important outside associates as members where they want, but we strictly limit these. The current membership list does not include interns.

In June 2020 a full-time laboratory manager from our RMGS funding was appointed, Ms. Bingrong Zhu (Birry). She is the only staff member employed by the LSR, not including RA's PDFs etc funded from member's own grants.

In March 2020 we conducted a survey of LSR members to gauge their level of interest and commitment to who we are and what we stand for. The individual responses are provided as Appendix I. The most interesting aspect is the reasons given for why they value the LSR. They see the worth, activities and potential of our interdisciplinary family and its relevance to the future. We recommend in particular reading the responses from Alex Webb, Pablo Saz Parkinson, Xuan Fang, Jed Kaplan and people like Gregg Li and Stephen Cheung (new Physics adjuncts brought in by the LSR for our TPG MSc in Space Science for a course in entrepreneurship but actually from the Faculty of Business). These members speak to the power and importance of the LSR, its interdisciplinary aspects and its perceived value to HKU and more broadly.



## 4. Budget and Funding

There is no ongoing annual HKU budget allocated that supports the LSR. The FoS does pay for the rent of our offices in Cyberport. The LSR was funded first by a \$10 million UDF (2016-2018) that was used to hire 3 faculty (Drs. Meng Su, Joe Michalski and Binzheng Zhang) and then by a \$10 million BRC in October 2018 meant for HKU-ZIRI that included 5M RMB for our first satellite (the Lobster Eye X-ray satellite launched July 25<sup>th</sup> 2020). Some BRC grant residue remains at HKU and \$0.5M of this was recently approved for LSR travel.

Our ability to function has lately relied on the RGC RMGS. This brought in \$33.3M to HKU (\$24.97M to the LSR after 25% top-slice). This round 1 & 2 success for 3 proposals led by Parker, Su and Michalski remarkably accounted for 19.7% of all HKU funding awarded via this scheme from 566 supported HKU proposals. Further RMGS LSR success in round 4 at the level of another \$35.6M HKD has just been announced.

Individual LSR members are very active in winning RGC GRF and ECR grants with 19 such grants over the last 3 years, including 7 LSR faculty who won grants in the 2020 GRF round relevant to this report. Winning peer reviewed competitive facility access on ground and space based observing facilities (such as FAST, Arecibo, NICER, SALT, ESO VLT) is also a regular feature of LSR members worth several million HKD annually. However, a secure, HKU based funding stream is required given the nature of our activities. We cannot rely exclusively on one-off schemes like the fortuitous appearance of the RMGS.

## 5. Research Activities

Members have a vibrant, active and diverse interdisciplinary research program (see <https://www.lsr.hku.hk/research/>) and we engage in multi-disciplinary research in space-based earth remote sensing; atmospheric science, near Earth environment, planetary and associated geological sciences, high-energy astrophysics from ground-based and satellite-based detectors and late stage stellar evolution. We are currently adding important, additional research capacity to these LSR activities as we emerge as a strong interdisciplinary force at HKU.

We have key international and mainland collaborations established off the back of strong research outputs, with co-leveraged funding including jointly funded postdoctoral fellows with Nanjing and Zhejiang universities. Specific highlights from the reporting year are given below but a more comprehensive listing from individual members is given in Appendix II.



## 5.1. Science Meetings led by or involving the LSR



I. October 20<sup>th</sup> 2019 SYSU, Zhuhai, PANGU Science meeting led by the LSR. There were about 24 participants from 4 countries.



II. November 2019, Beijing, 2<sup>nd</sup> annual LSR-BISME partnership meeting funded by LSR. Were 20 participants (8 from LSR, 12 from BISME + Dongguan representative- event co-incided with the Dongguan "city day")



III. December 2019 4 LSR members gave talks (1 invited 3 contributed) at WORKPLANS II workshop in Leiden with a special refereed publication:  
[https://www.mdpi.com/journal/galaxies/special\\_issues/workplans\\_PNO](https://www.mdpi.com/journal/galaxies/special_issues/workplans_PNO)





IV. January 2020 Dongguan. Key science and mission scope meeting between BISME, DFH and the LSR on our next space satellite mission. LSR members in attendance: Parker, Su, Michalski, Saz Parkison, Bastieri, plus 2 from BISME, 3 from DFH and 1 from STB Dongguan.

V. PSHK 2020 July 2020. The LSR via Dr Meng Su and Prof. Quentin Parker was tasked to manage the PSHK astronomy session. The entire event was on line due to Covid. There were 33 PSHK members who attended via zoom from HK SAR and the Mainland. Seven LSR members gave talks with two invited (QAP & PSP) accounting for 54% of all HKU contributions to the PSHK meeting in 2020. *HKU remains poorly represented in this HK SAR Physics forum dominated by HKUST, CUHK, PolyU and CityU who all had more talks than HKU but the LSR at least played a dominant role this year.*

## 6. Collaborations and Partnerships



We have been proactive and highly strategic in establishing international collaborations and partnerships. We have committed to only signing “meaningful” and highly targeted MoUs and agreements, i.e. those where our partners can commit real intent and resources to joint endeavours. We currently have 12 such active MoUs and agreements. We are not interested in scraps of paper. It is clear from the summary below for all 5 MoUs signed over the 2019-2020 reporting period that this is a highly successful approach, perhaps unlike other areas across HKU.

We partner with the highest quality partners possible – the most influential, leading and significant.



## 6.1. MoUs signed over the Reporting Period

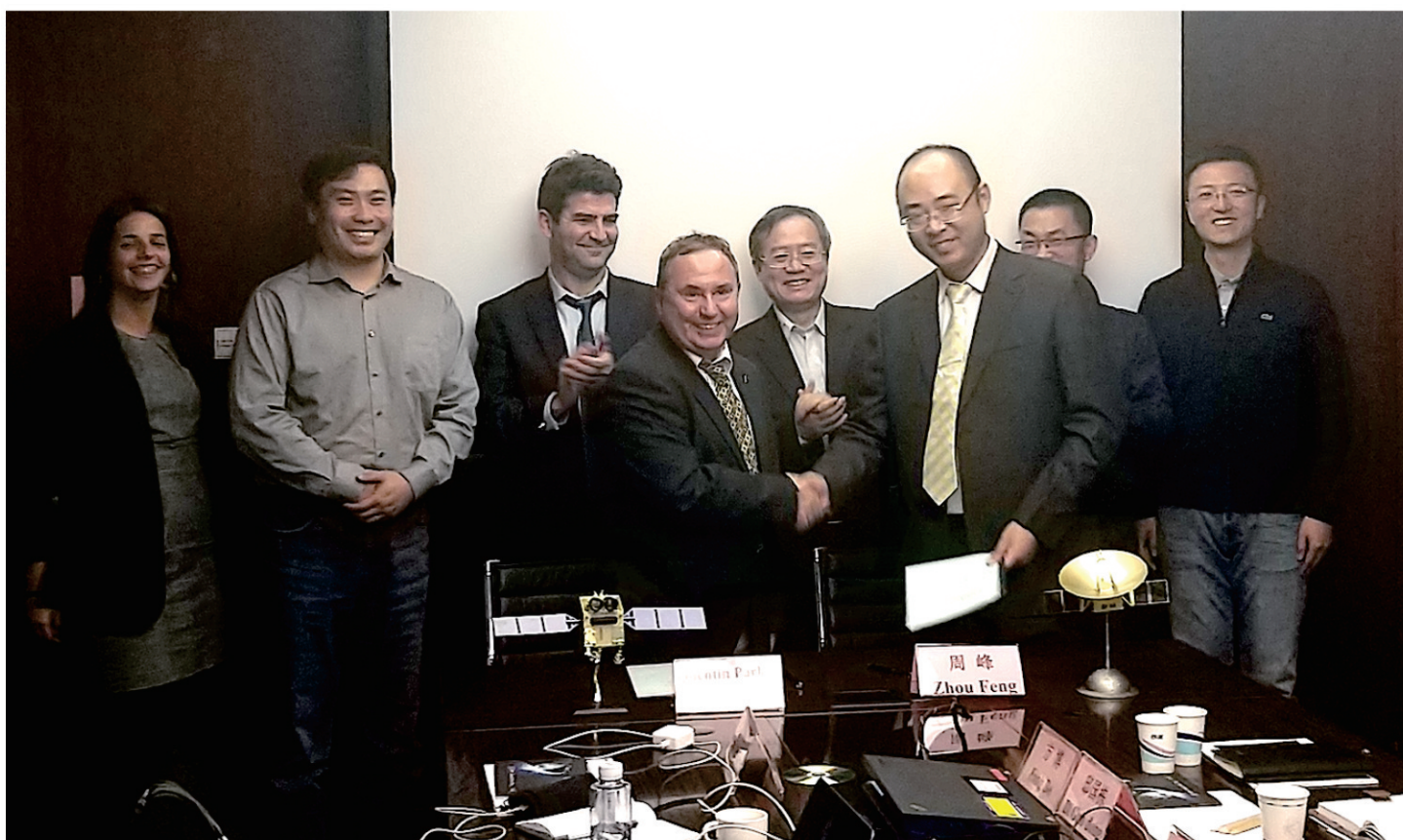


I. *BISME (space 5) December 2019* - top Chinese entity that builds space infrastructure. We have a deep relationship with BISME and have held two joint meetings in 2018 & 2019. BISME are providing 10 internships/yr for our MSc Space Science students (inc. accommodation, meals and small stipend). Prof. Parker negotiated 300,000RMB/yr scholarships for this: [https://www.hku.hk/press/news\\_detail\\_21079.html](https://www.hku.hk/press/news_detail_21079.html). They are our payload build partner in our next satellite (small IR/UV telescope). HKU leveraged ~165M RMB for the Lobster Eye. satellite, HKU's contribution was ~10M RMB.



II. *CNNC - Chinese National Nuclear Corporation - September 2019* CNNC employs 80,000. We signed a MoU with their sub-body, the Chinese Institute for Atomic Energy, on Sept 23<sup>rd</sup> 2019. The top director of the entire CNNC and all his major division directors (about 10 in total) all came to HK just to visit HKU because of the LSR. This followed on from our initial visit to CNNC in Beijing in April by Parker and Su. This MoU could lead to HKU taking a main science role in a major Chinese deep space mission.





III. *DFH Company limited* – December 2019 - this is the company building the platform for the HKU led IR/UV telescope. Here we are leveraging about 30M RMB in the platform build. They have also agreed to take interns from our MSc program and we are negotiating scholarships. Key point: this IR/UV telescope is our first solo HKU flag and could lead to a 2Billion RMB major satellite project – a PRC “gift” to HK SAR and potentially HKU.



IV. *Dongguan Science and Technology Bureau* –December 2019 - MoU between FoS and STB signed after 18 months of negotiation. This is, we feel, absolutely key to our future. It is the precursor to a major, multi-phase >1 billion RMB project involving the establishment of the HKU International Space and Planetary Science Institute for Research Excellence (INSPIRE).



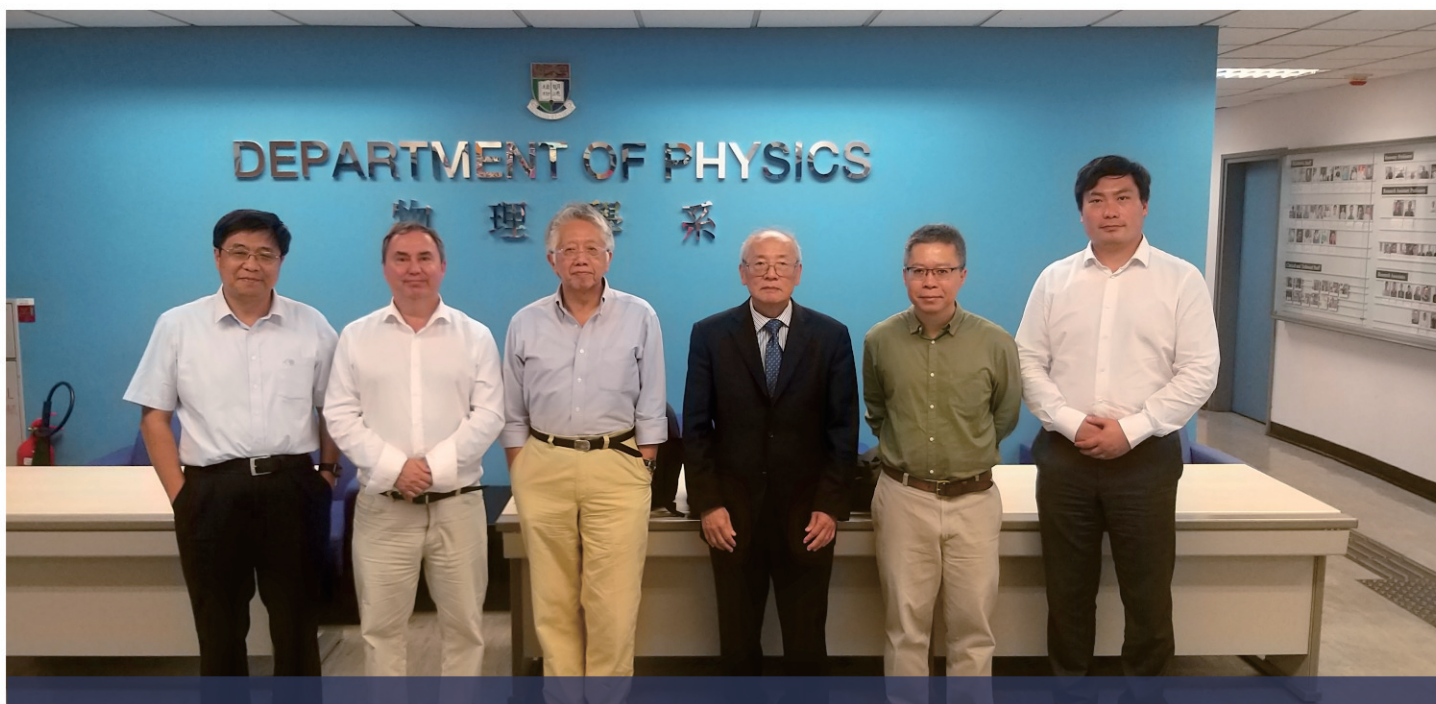
V. CSU – China Space Utilization – May 2020 - this top body is responsible for China's program for space utilization and includes the Chinese Space Station. It is potentially one of the most important relationships we are building. We signed an agreement on Dec 9<sup>th</sup> 2019. An MoU was to follow but this has now been upgraded to establishing a joint CAS-HKU lab in Space and Planetary Sciences in Dongguan and HKU at HKU-LSR and INSPIRE. This will be the first new joint CAS-HKU lab for 10 years if we get it up. The implications of this will be profound (CSU is establishing a major presence in Dongguan).



## 6.2. The East Asian Observatory LSR Initiative

The LSR, under a Prof. Parker Initiative, proposed that the new, East Asian Observatory (<https://www.eaobservatory.org/>) International HQ should be based in Dongguan in a shared location with the LSR proposed INSPIRE lab (refer Appendix V). The idea was born during a meeting at HKU Physics department on Sept 27<sup>th</sup> 2019 and was strongly supported by the senior meeting attendees, so much so that Prof. Parker and Dr. Su were invited to the EAO Board Meeting on November 25<sup>th</sup> 2019 at the FAST radio telescope site in Guizhou to present the case to the full EAO board (refer Appendix VI). This was very well received and the case was developed further and presented to the EAO Board at its next meeting in May 2020 where the proposal was formally endorsed. This then led to a formal invitation for HKU-LSR to become an Associate partner in the EAO itself, representing, at least to begin with, the whole HK SAR astronomy community, similar to the NAOC access agreement the LSR also negotiated. The associated MoU for HKU EAO has been developed and at time of writing is awaiting endorsement by the EAO Board.





Meeting HKU Sept 27<sup>th</sup> 2019 to Discuss the EAO. From left: Prof. Suijian Xue, Deputy Director NOAC; Prof. Quentin Parker, Director LSR; Prof. Paul Ho, Director EAO; Prof. Frank Shu, Shaw Prize Laureate; Prof. Luis Ho, Director KAVLI Institute Peking and Dr. Meng Su, Deputy Director, LSR

## 7. Major Contributions and Achievements

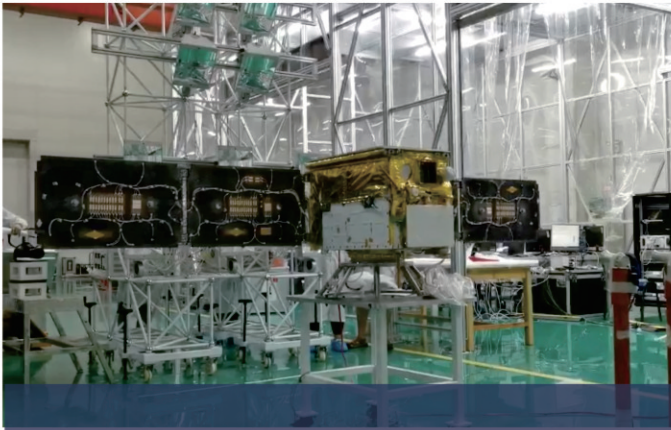
Three of our most significant areas of effort over the last year in particular are highlighted below.

### **I. Launch of the “Lobster Eye X-ray Satellite” on July 25<sup>th</sup> 2020 where HKU co-leads the science mission with Nanjing University.**

This is a very major deal and the first time any HK SAR university has played a lead role in a space science research mission. It is also the first time lobster eye X-ray imaging technology has been deployed in space – a world first. This is the culmination of several years of intensive team effort led by Dr. Meng SU of the LSR. Excellent PR has ensued with front page SCMP coverage on May 2018 and onwards with global coverage. This includes a TV show segment broadcast on July 11<sup>th</sup> 2020, on HK Open TV, Chanel 77, click this link (and start the video from 18:14):

<http://www.hkopentv.com/#/videopage/BW02128?t=13m02s>





left: Lobster-eye satellite final testing; right: launch of the satellite

## II. Our Taught Postgraduate (TPG) MSc in the area of Space Science:

<https://aal.hku.hk/tpg/programme/master-science-field-space-science>.

The LSR had the initiative to create and lead a TPG in Space Science to leverage off our interdisciplinary capacity and strongly growing brand. Over a difficult 2 year period and despite many obstacles we were approved by the HKU academic board and put together a robust, well thought out and exciting program across 4 HKU departments and 2 faculties with support from NJU and ZJU, our 2 key LSR mainland university partners. Despite the undoubted effects of covid-19 we received about 40 applicants by the deadline, had a viable program, secured major scholarship funding and were ready to implement.

Unfortunately, the Physics department who host the program, though it is at least as much a DES as Physics offer given it was put together by the LSR, decided to postpone the launch by one year, ostensibly due to Covid. Please see Appendix IV for further details.

## III. Proposed establishment of the “International Space and Planetary Sciences Institute for Research Excellence: INSPIRE” in Dongguan

This has occupied much our our leadership activity for over 2 years and we have developed an “oven ready deal” with the Dongguan Bureau of Science and Technology that culminated in a signing of an MoU with Dongguan in December 2019 (see above). Covid and difficulties at the HKU SMT level have led to significant delays moving forward with this initiative. In August 2020 senior HKU management have adopted a more positive posture and it may be possible to now move forward. This is a major deal over 5 years including 100M RMB cash donation from the Dongguan city government.



## 8. Press Releases, KE, community service and outreach activities

We have been very proactive in seeking publicity for our activities and we have had several important news stories and significant press coverage over the reporting period. Our coverage has been especially prominent in the mainland including TV, radio and in print. Links to some of the most significant examples are given below:

- <https://www.hku.hk/research/stories/20037/> Nature Astro. Sept. 2019
- <https://www.earthsciences.hku.hk/news-and-events/news/the-excellent-young-scientists-award-to-dr-zhang-binzheng> October 2019
- <https://www.newsweek.com/taal-volcano-photos-philippines-eruption-ash-1481846> January 14<sup>th</sup> 2020 (press interview write-up)
- <https://eos.org/articles/taal-eruption-and-ashfall-continue-thousands-still-at-risk> January 14<sup>th</sup> 2020 (press interview write-up)
- [https://www.hku.hk/press/news\\_detail\\_21079.html](https://www.hku.hk/press/news_detail_21079.html) May 25th 2020
- [https://hku.hk/press/news\\_detail\\_21067.html](https://hku.hk/press/news_detail_21067.html) June 23rd 2020
- <https://phys.org/news/2020-06-automated-laser-scanning-hunter-drone-fossils.html> June 23rd 2020
- [https://www.hku.hk/press/news\\_detail\\_21307.html](https://www.hku.hk/press/news_detail_21307.html) July 19th 2020
- [https://www.hku.hk/press/news\\_detail\\_21360.html](https://www.hku.hk/press/news_detail_21360.html) July 26th 2020
- <https://bit.ly/2ABRjs4> August 17th 2020 (press interview write-up)

Also a “HASSE” motivational webinar “In search of Dark Matter” was given by Prof. Parker LSR director as a lead-up to our Satellite Launch. See Appendix VII and:

<https://www.youtube.com/watch?v=BbRqKpWYj8o>

### 8.1. The HASH database – an important service for our global community

The LSR hosts the “Hong Kong/AAO/Strasbourg H-alpha Planetary Nebulae database (HASH:[www.hashpn.space](http://www.hashpn.space)) via our servers in Cyberport. HASH is a world-class repository for the Global Science community working in later stage stellar evolution. A GRF funded PDF Dr. Andreas Ritter is tasked with curating and managing HASH to service our global community.

We currently have ~450 users from more than 30 countries. On average, over the last 90 days June-August 2020, 10 different users are accessing HASH per day, 35 per week, 107 per month. Over the last 90 days 275 users had 1,600 sessions visiting HASH – see Appendix III-B for graphical details of usage statistics of this important LSR managed resource.





## FBP2

PNG	PNG 012.3-00.1
Status	True PN
Morph.	E
Diam.	na
Cat.	<a href="#">CornishCandidates</a>
dbID	23902

## Centroid Coords

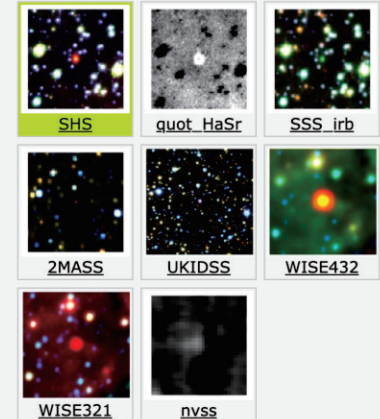
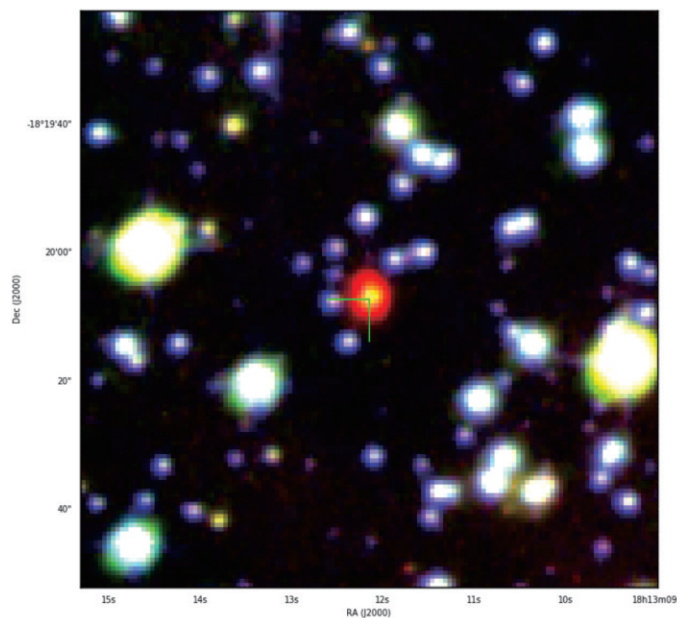
RA/DEC	18:13:12.15 -18:20:07.31
$\alpha/\delta$	273.3006 -18.3354
l/b	12.3314 -0.1807

## Central Star Coords

RA/DEC	NA
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Gallery Fits Files Spectra Notes Basic Data General Data Full Data



1 2 Next >

## Overlays

- ☒ Centroid / centroid.reg
- ☐ CS position / cspos.reg
- ☐ Diameter / diam.reg

## SHS

R	ha.fits	3	97	%
G	sr.fits	3	97	%
B	b.fits	3	97	%

HASH database entry for PN F2BP1 – the 1<sup>st</sup> PN discovered and confirmed by the CORNISH radio survey – reported in Fragkou, Parker & Bojicic, 2018, MNRAS, 480, 2916

## 8.2. LSR Interns

We are very proactive in this area and believe we have the most active internship program across the Faculty of Science. *We cannot be sure as the FoS currently keeps no records of its internships.* Our robust internship program not only serves a valuable KE and community service but it also helps to build our brand while offering our research staff useful, short-term research support. We have hosted 35 interns since 2016 for periods between 1-2 weeks and 3 months. Interns come from overseas (e.g. India, USA, Singapore, Spain) and locally via International Schools, HKU and local universities. For the reporting period we have hosted the following 12 LSR interns:

Name	Status	Discipline	University/School	Year	LSR supervisor	Period	#
SimranRajpal	Undergraduate	Science	HKU intern	2020	QAP	July-September	24
Zou Xiang	Undergraduate	Science	HKU - SRF awardee	2020	QAP	June-August	25
Hazel Yung	Undergraduate	Science	University of Michigan	2020	QAP	June-August	26
Charles Willard	Undergraduate	Science	University of Chicago - remote	2020	PSP	June-August	27
Niall Coffey	Undergraduate	Econ & Physics	University of Chicago - remote	2020	PSP	June-August	28
Naixin Liang	Undergraduate	Physics	University of Chicago - remote	2020	PSP	July-September	29
Ryan Friberg	Undergraduate	Computer Science	University of Chicago - remote	2020	PSP	July-September	30
Elisabeth Medina	Undergraduate	Astrophysics	University of Chicago - remote	2020	PSP	July-September	31
Rishank Diwan	Undergraduate	Physics	IIT Kharagpur, India	2020	PSP	May-August	32
Lee, Man Yin Leo	Undergraduate	Physics	HKU - SRF awardee	2020	PSP	July-September	33
Geoffrey Lee	High School	Science	Singapour International School (HK)	2020	QAP/SAS	2 weeks July	34
Vince Yuan	High School	Science	St. Paul's College (HK)	2020	QAP/AR	1 week August	35



## 9. LSR Distinguished Visitors Program

We also promote a vigorous distinguished visitor program. Of course visits have been difficult in 2020 due to covid. Nevertheless since September 2019 we had the following important visitors to the LSR:

- Prof. Pak-Hin Thomas Tam, Sun Yat-Sen Univ., Zhuhai (China), 2019-09-30
- Prof. Denis Bastieri, Padova (Italy), 1000 talents Guanzhou, China, 2019-09-30
- Prof. Suijian Xue, Deputy Director NOAC, Beijing (China), 2019-09-27
- Prof. Paul Ho, Director East Asian Observatory, Hawaii, (USA) 2019-09-27
- Prof. Frank Shu, Shaw Prize Laureate 2009, California (USA) 2019-09-27
- Prof. Luis Ho, Director KAVLI Institute, Beijing (China) 2019-09-27
- Mr. Jianfeng Yu, Chairman China National Nuclear Corporation, Beijing (China) together with 8 senior CNNC directors 23-09-19
- Prof. Achamveedu Gopakumar, Professor, Tata Institute of Fundamental Research (TIFR), Mumbai (India), 2019-09-05
- Dr. Alberto Dominguez, Ramón y Cajal Fellow, Universidad Complutense, Madrid (Spain), 2019-08-30 to 2019-09-03



## 10. Future Plans

To a large degree our future depends on the level of support from HKU and the Faculty of Science and if the INSPIRE initiative can be realised. Nevertheless, we have been adept at securing significant funding, undertaking impactful projects, growing our partners and raising our profile.

### Key Future Plans Are Listed Below

- Secure long-term funding
  - This is essential if our future is to be secured
- Set up the “INSPIRE” laboratory in Dongguan
  - This will depend on HKU top level agreement
  - Ensure JV with Guangda goes forward as brings major resources
- Establish CAS-HKU joint INSPIRE laboratory in HKU and Dongguan
  - This would be the first HKU-CAS joint lab in 10 years if realised
  - If joint CAS lab is established re-brand the LSR to INSPIRE at HKU
- Seek more autonomy
  - Perhaps via conversion to a proper HKU Centre or Institute
- Consolidate our projects and develop our Space and Planetary science program:
  - UV/IR satellite with BISME and DFH (HKU No.1 satellite)
  - PANGU
  - CCST
  - HERD on Chinese Space Station
  - World class spectroscopy laboratory
  - Cubesat and Commercial missions
- Grow our capacity in terms of Staff, RAP, PDF and RPG and distinguished international visitors



## 11. Glossary of Terms

- BISME – Beijing Institute of Space Mechanics and Electricity
- CAS – Chinese Academy of Sciences
- CCST – Chinese Space Telescope
- CNNC – Chinese National Nuclear Corporation
- CSU – Center for Space Utilisation, Chinese Academy of Sciences
- DES – Department of Earth Sciences
- DFH – Dong Fang Hong Satellite Company Ltd.
- EAO – East Asian Observatory
- ECR – Early Career Researcher
- ESO – European Southern Observatory
- FAST – Five Hundred Meter Aperture Telescope, Guizhou, SW China
- FoS - Faculty of Science
- GRF – General Research Fund of RGC
- HERD – High Energy Radiation Detector
- HKU – The University of Hong Kong
- INSPIRE - International Space & Planetary Institute for Research Excellence
- JV – Joint Venture Company
- KE – Knowledge Exchange
- LSR – Laboratory for Space Research
- MoU – Memorandum of Understanding
- NAOC - National Astronomical Observatory of China
- PANGU – Pair production N Gamma-ray Unit (a gamma-ray space telescope)
- PDF – Postdoctoral Research Fellow
- PSHK – Physical Society of Hong Kong
- RAP – Research Assistant Professor
- RGC – Research Grants Council
- RMGS – Research Matching Grant Scheme
- RPG – Research Postgraduate
- SALT – South African Large Telescope
- SCMP – South China Morning Post
- SMT – Senior Management Team, HKU
- STB – Science & Technology Bureau, Dongguan
- SYSU – Sun Yat – Sen University, Zuhai
- TPG – Taught PostGraduate Masters
- UDF – University Development fund, HKU
- VLT – Very Large Telescope (ESO 8m telescopes)
- ZIRI – Zhejiang Institute for Research Innovation (HKU-ZIRI)





## 12. Acknowledgments

It is a pleasure to acknowledge and thank Dr. Pablo Saz Parkinson for valuable feedback on this report and also Ms. Bingrong Zhu, our LSR laboratory manager, for help with content and editing.

We acknowledge the support and funding from the Research Grants Council for our RMGS and GRF funds and HKU for UDF and Budget and Resources Committee support that has enabled the LSR to flourish.

We thank the Dean of Science, Prof. Matthew Evans for his support of the LSR and Prof. Yiwu He, Senior advisor to the VC and director of the HKU Technology Transfer Office, for his support and engagement with our Dongguan initiative. We are also grateful to the support staff of the Faculty of Science and the China Affairs Office for their assistance with the Dongguan initiative.

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## APPENDIX I

### LSR member responses to e-mail sent April 28th 2020 asking: “Do you want to remain a member of the LSR and if yes why?”

LSR member	Level		Dept/Fac	e-mail
Zhou Wenhan	RPG	HKU	Physics	zhou.wenhan@qq.com
Andreas Ritter	PDF	HKU	Physics	azuri.ritter@gmail.com
Quentin Parker	Faculty	HKU	Physics	quentinp@hku.hk
Michael Pittman	RAP	HKU	DES	mpittman@hku.hk
Tom Kaye	Associate	USA	LSR	tom@tomkaye.com
Kris A. Stern	RPG	HKU	Physics	krisastern@gmail.com
Takashi Nakagawa	Faculty	HKU	DES	ntakashi@hku.hk
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Y/N	Comments
Y	I am Zhou Wenhan, a RPG student supervised by Dr. Su. I'd like to continue my membership in LSR because I believe it's my honor to work with so many intelligent and knowledgeable researchers.
Y	The LSR offers many opportunities for international collaborations and access to small and big telescopes all over the World.
Y	The LSR is an interdisciplinary entity that has shown great proactive engagement in Mainland Space activities and successfully built key, strategic partnership with leading Mainland and global entities to acquire important resources and create capacity and opportunity
Y	I want to remain an LSR member to continue to build upon collaborative opportunities involving my research into space-based long-distance geochemical remote sensing.
Y	I would like to confirm my membership in the LSR for the foreseeable future. I am currently working with Dr. Pittman on long range, geochemical remote sensing. We have successfully implemented ground and UAV systems that would be very appropriate for space research and collaborations with the team at LSR.
Y	I would like to continue my membership so that I could contribute to LSR via my (near) future research output.
Y	Because the planetary science discipline plays an important role in composing the LSR, which is one of my main research fields. Because of my research stuff, I want to contribute to the LSR mission but I'm not sure...Anyway, I want to work for further enhancement for LSR in terms of planetary science ways.
Y	Deputy director LSR
Y	I hope to continue to contribute to the research in evolved stars and to provide support as possible. The current plan is to spend time at the LSR in 2021
Y	Ex LSR director and HKU emeritus professor: I wish to see LSR continue to succeed and accomplish its original goals
Y	ex HKU PDF; I have a paper published Feb 2020 in FNCN with LSR and SYSU affiliations,
Y	(1) LSR is the only multi-disciplinary international research center in Hong Kong SAR, engaging in research in a number of pioneering fields, and well representing the astronomy, astrophysics, and space science in Hong Kong. (2) Your research group at LSR is the only research group in Hong Kong (and also in China) that works specifically on PNe and late-stage evolution of low- to intermediate-mass stars. These are also my expertise; and I certainly will continue our collaboration. (3) I spent unforgettable 3 years and 10 months at LSR, where I see so many joys, struggles, happiness (and also sadness). I am deeply connected with the LSR, both scientifically and emotionally. (4) I will be happy to play my connection role for the collaboration between LSR and the astronomical community in mainland China.
Y	I think LSR's involvement with a new infrared satellite has great potential, and as we have already discussed, it could be used as a pathfinder for evolved stars research too. I can wrap up my suggestions for a project
Y	I am obsessed with space exploration, I am glad Professor Quentin has accepted me as a contributor . Hope LSR can give me more chances to participate in the missions for my mother country
Y	The truth is, the Laboratory for Space Research is probably the main reason I am still at HKU. Space Science is one of the most exciting areas to work in at present, and one in which China is investing heavily in, with a clear goal of becoming world leaders, rivaling (and maybe surpassing) the US and Europe. Hong Kong still enjoys a privileged position compared to any other city in China; it is seen by many as the "gateway to China", and a global metropolis that can attract international talent like no other. As Hong Kong's leading university, HKU benefits from this, almost for free ... although it is unclear for how much longer. The LSR is fortunate, at present, to be able to capitalize on this, and achieve major returns with relatively small investments. With its single-focus on space, the LSR plays a unique role in accreting members of the HKU "space science" community (astrophysicists, planetary scientists, Earth scientists, engineers, statisticians, etc.). The potential for the LSR is enormous. I have witnessed first hand how doors are opened for us in Mainland China (and elsewhere), and how much we have achieved in just a few years, with limited resources. I am always honoured to travel on behalf of HKU, and the LSR, and the treatment we get, tells me that we have a unique opportunity that we should not waste. We should turn the respect and admiration for us and our ideas into real, tangible leadership in this field. I am an optimist by nature, so I continue to believe that, with proper backing and sufficient autonomy, the LSR will become a world-leading center for Space Science. I am therefore eager to remain associated with it, and will continue to work towards its success. I look forward to the day (hopefully in the not-too-distant future), when the LSR's future being secure, I can focus most of my time and energy on specific LSR-led projects, which themselves promise to make a huge impact in specific areas of research, such as the PANGU telescope in MeV gamma-ray astronomy. On a final note, the LSR's philosophy of openness, transparency, and collaboration (ones which I strongly identify with) are a big part of its appeal, and another major reason for me remaining associated with it.
Y	Because I was working in LSR or pre-LSR about eight years and happy to work with pre-colleagues here.
Y	I would be happy be a member of LSR because I wish to promote the collaboration between HKU and SYSU, and the building up of CSST science center.
Y	



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Y	I want to remain a member of the LSR because it offers more opportunities for me to participate in research projects with interdisciplinary topics.
Y	Two main reasons include i) my lab research is tightly related with space research and ii) I would hope to remain the collaboration with other members in LSR, and see whether there is any probability for proposal writing together in near future.
Y	There are many academic excellent in LSR who I hope to learn from. LSR, I believe its a great door to opportunities in different space research and interesting projects all over the world which I would like to expose myself to! T
Y	Deputy director LSR; 1) while any individual might be able to carry out space-related research on his or her own, the LSR allows us to engage science ideas with actual missions and instrument/spacecraft design and flight. This aspect represents a very pure form of science in which we can truly set up the experiment to ask and answer some of the biggest questions. 2) LSR has a recognizable brand at this point and I find it very interesting and attractive to participate in the process of creating a space and technology identity at HKU that will be seen as an authority in Asia and around the world.
Y	Unlike what some may say has been insidious and partisan resistance from known parties within Physics management and administration and others from time to time: resistance to the high level of scholarship and achievement delivered by the LSR members and management appears to have been a constant threat to the existence and good conduct of the LSR HKU and the interesting, important, international and successful collaboration in Space Research during the administration of Professor Kwok and now under Professor Parker that is not only World Class but has been highly successful under great adversity. At all times the good name and progress of the University of Hong Kong and people of Hong Kong in World Class science and research has been at the forefront of the day to day operation and ethos of the LSR HKU. The LSR may not be on the future agenda for what some may say are politically motivated individuals and possible 'ginger' groups within HKU - real education and science, based on collaboration and excellence is why I remain dedicated to the LSR and HKU.
Y	Made outside application to become a member - working on software with LSR member; I just joined LSR and would like to build something constructive with our collaboration. I look forward to contributing to LSR activities. Specifically, I am more inclined towards constructing and maintaining a python package for analyzing planetary nebulae along with LSR member Kris Stern. After getting acquainted with LSR proceedings, I can definitely contribute to a multitude of projects considering they align with my collective interests.
Y	I see tremendous value in the LSR, I put it on all of my papers as an affiliation. The reasons are: A) LSR provides interdisciplinary discussion and collaboration space between solid planetary sciences, housed in DEPS, and other space sciences housed in Physics. B) LSR has provided funding opportunities, notably a BRC and a type-C position open for LSR applicants to apply to. (Q, please remind me of the deadline for the C-type RPG position application?) C) LSR provides a platform for us to collaborate with other institutions on space sciences, be they in mainland, Macau S.A.R., or elsewhere around the world. This is an issue of group strength, leadership, and projecting prominence, capability, and visibility, as spear-headed by Director Parker and the two Deputy Directors Michalski and Su, who do the hard work of regularly showing up, shaking the hands, establishing the networks, and advancing the science projects. D) LSR is spearheading HKU's first satellite. E) LSR is the vehicle by which I had the opportunity to participate in knowledge exchange, as through the LSR I was invited to a joint industry-academia space science conference in Shenzhen and given the opportunity to explain the value of early Earth research for planetary science to this mixed audience. DES has certainly never provided me with such an opportunity, whereas in fact I have had to turn down more such opportunities than I've been able to accept, all through LSR, due to lack of time. As such, and echoing point C) above, LSR is my window into a larger academic and industrial world of space science. F) LSR has been the functional home for the folks who together have created our latest MSc offering, in Space Sciences. G) LSR has promoted an expanded view of joint Earth and planetary science exploration. This has been central to our Division's recent Area of Excellence proposal, with Prof. Guochun Zhao as the frontman, for which I wrote the core science elements using this integrated perspective as a primary theme. H) LSR provided me with a physical location to work safely (Cyberport) during the many disruptions of the 2019-2020 academic year. I) Because LSR has few institutional resources at its command, and must largely seek support external to the Faculty, it has a half-decent collaborative spirit, in stark contrast to the other institutional blocks within the Faculty. People try to work together to make things work. Resources don't sit idle for years on end. There aren't major turf wars over resources. Incompetent technical support is not urged to act dishonestly by poor internal leadership. The Dean does not need to constantly moderate our internal politics. The senior staff do not openly question in Dean's and Head's meeting why we even hired any of the junior staff. LSR is a safe space from certain pernicious elements of senior leadership of because they want no part of it. If they ever do want a part of it, then we'll have a problem. In short, you have a team of many of our most successful planetary and space scientists, furthering a large range of collaborative and high-impact activities, and acquiring an unusually large pool of external resources to do so. What's not to like here?
Y	Key player in our Padova-CISAS/LSR partnership; because of the exchange of ideas. Many people with different expertise, like the ones you find at LSR, are the ideal arena where to brainstorm and discuss new proposals.
Y	On contract but also MSc with Padova-CISAS and HKU; Cubesat design; 1) I have started my thesis in LSR and I would like to complete it there. 2) I am really interested in collaborating with you on some projects planned for this year.
Y	Will also be teaching entrepreneurship in new TPG in Space Science; Most happy and honoured to join the LSR. Space is the next frontier and the only way to learn and expand our insight into understanding Space is to combine the great minds of leaders from all disciplines. Surely the void of space is vast enough to entertain all perspectives, however strange at first. Only through dialogues and understanding can we truly begin to fathom the implications and impact our limited insights would have on all of humanity.



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**Previous LSR members who have either not responded by the deadline (2) or have explicitly said No (2) or who have left Hong Kong University (4)**

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Xiaojia Zhang	PDF	ex HKU	DES	expired
Vassiliki Fragkou	RPG	ex HKU	Physics	expired
Sin Yi	RPG	ex HKU	Engineering	expired
Wayne Chau	RPG	ex HKU	Physics	expired



Y	De facto member as LSR UDF is paying for this position for first 3 year; I'd love to remain as a member of LSR. Space and Planetary science is going to be a major focus in the near future Chinese strategic plan for basic science, and I do see a bright future of the LSR.
Y	would like to remain as a member. As space is a wide research, my research area on earth science also apply to the space research environment. I'm hoping to have collaboration in the near future.
Y	<p>I look forward to contribute to the programme the best I can. my focus is not about research but instead about creating a wider audience for Space, either in direct connection to the MS programme or setting the foundation in Hong Kong to promote interest in Space. 1. The HK public's general impression of Space is it is an esoteric subject and primarily an academic exercise. As evidenced by the NewSpace era the last two decades, commercial interests and entrepreneurship play critical roles in turning Space into a multi-trillion dollar industry. Therefore, the commercial applications side deserves some coverage.</p> <p>2. Space is not a stand-alone industry. Advanced technologies have been seamlessly deployed throughout the Space industry chain. This implies expanded employment opportunities. Students of science and engineering disciplines will be wise to include Space in their career portfolio. We want our students to be recruitment targets sought after by businesses looking to be in this field.</p> <p>3. I believe there are hobby groups and trade associations in Hong Kong that are fascinated by Space. Many of us grew up under the spell of reaching for the stars. HKU could take up the leadership position by becoming a platform/hub for such interest groups.</p>
Y	I want to be an affiliated member of LSR as I have still involved in a number of projects with Pablo.
Y	I wish to stay a member of the LSR. Despite protests and viruses, I have hope that the LSR can still start the Taught Masters Program in Space Science. I may work at LSR 1 day a week. The LSR is a unique institution that is sorely needed in this day and age due to the strengths and limitations of science academia, engineering, and government. By signing MOU's that bridge these limitations, each of these three areas is able to understand what the other two can do to help with our joint goals of exploration and research. Personally, I also look forward to: With the establishment of a Taught Master's in Space Science to go along with LSR's current research team, LSR can educate the next generation of scientists and engineers to explore new landing sights in our solar system.
Y	One of our newest members from DES; With the new global climate modeling facility that will be hosted at the LSR, Dr. Kaplan and his team will study the evolution and dynamics of not only Earth's atmosphere, but also that of other planets. Our high performance computer (HPC) cluster will be among the most powerful computers of its size in Hong Kong, and serve a range of research projects from human-environment interactions to patterns of atmospheric electricity at the edge of space. The LSR provides an opportunity for HKU researchers engaged in HPC to break out of disciplinary silos, share best practices, and initiate new collaborations.
Y	Of course, I want to continue to be a consultant of the Space Research Laboratory of Hong Kong University. Shanghai is at the forefront of scientific and technological development. There is fertile soil for the application and transformation of scientific and technological achievements. There is a great demand for space and promotion in aerospace. In 2020, the space research field of the University of Hong Kong should have relatively great progress in Shanghai.
Y	Comments to follow
Y	Yes! I would like to remain my membership. Thanks very much!
Y	Thanks for asking, I'm happy to stay.
N	By response
N	By response--possibly temporary departure
N	By default--no response
N	By default--no response
N	Left HKU for Beijing--no longer associated
N	Left HKU for postdoc in Mexico--did not invite to remain an associate
N	Left HKU after degree
N	Left HKU after degree





The above information was received from LSR members by March 6<sup>th</sup> 2020 for receipt of responses to the e-mail below sent to members of April 28<sup>th</sup>.

Dear LSR members,

I hope you are all well during these difficult times. Anyway, I believe the time has come to trawl the membership again to see how many want to remain associated with the LSR. As I hope you will have read from my Christmas message, the LSR had a great year in 2019 with the wonderful news of our Research Matching Grant Scheme success being a fitting end to the year.

Q1. Do you want to remain a member of the LSR? Y/N

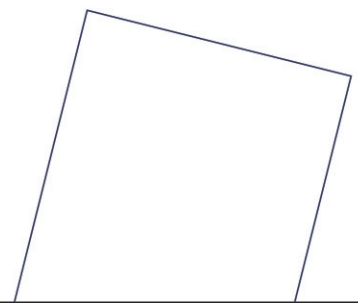
If the answer to Q1 is YES then

Q2. Why are you happy to remain a member?

The deadline for response is FRIDAY 6th March 2020.

Please remember we are a free association of academics, RAPs, PDFs, RPG students and associates. There will never be any pressure to join or become a member. Unlike the last time I asked this question 6 months or so ago a lack of response will be taken to indicate you DO NOT want to remain a member. I am looking forward to your replies to this e-mail whatever they may be.

Best regards, Quentin





II.A. LSR led and affiliated paper: published Nature Astronomy September 2019:  
[https://www.hku.hk/press/news\\_detail\\_19632.html](https://www.hku.hk/press/news_detail_19632.html)

# A high-mass planetary nebula in a Galactic open cluster

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**Planetary nebulae are the ionized ejected envelopes surrounding the remnant cores of dying stars. Theory predicts that main-sequence stars of one to about eight solar masses may eventually form planetary nebulae. Until now, this has not been confirmed at the higher end of the mass range. Here we report that the planetary nebula BMP J1613-5406 is associated with the Galactic star cluster NGC 6067. Stars evolving off the main sequence of this cluster have a mass of around five solar masses. Our confidence in the association between the planetary nebula and the cluster comes from their tightly consistent radial velocities in a sightline with a steep velocity-distance gradient, common distances, and reddening and location of the planetary nebula within the cluster boundary. This is an unprecedented example of a planetary nebula whose progenitor star mass approaches the theoretical lower limit of core-collapse supernova formation. This finding provides observational evidence supporting theoretical predictions that stars of five solar masses and more can form planetary nebulae.**

The fate of stars usually depends on their birth mass. Massive stars burn their nuclear fuel quickly and can explode as supernovae after a few million years, whereas the vast majority of stars have lower mass and live for many billions of years. Planetary nebulae are thought to form eventually from stars of about  $1\text{--}8\,M_{\odot}$ , where  $M_{\odot}$  is the solar mass. The progenitors of planetary nebulae represent 90% of all stars more massive than the Sun. Towards the end of their lives most such stars pass through the asymptotic-giant-branch phase, where the bulk of stellar mass-loss occurs. A final, ejected envelope is ionized by the ultraviolet radiation field from the hot, remnant central star, forming a planetary nebula. Planetary nebulae can be detected out to great distances, where their strong emission lines permit the determination of their expansion velocity and age, thus probing the physics and timescales of stellar mass loss<sup>1</sup>. The emission lines can be used to estimate central-star luminosity and temperature and the elemental abundances of the expelled gas. Planetary nebula formation rates give the death rate of low- to intermediate-mass stars and they directly probe Galactic stellar and chemical evolution<sup>2</sup>. The different shapes (morphologies) of planetary nebulae provide clues to their formation, evolution, mass-loss processes and the shaping action of any binary central stars<sup>3</sup>. As the central star fades to a white dwarf and the nebula expands, the integrated flux, surface brightness and radius change in ways predictable via hydrodynamic theory<sup>4</sup>. Planetary nebulae are consequently powerful astrophysical tools, providing key insights into late-stage stellar and chemical evolution.

Obtaining accurate distances to Galactic planetary nebulae has proved to be very difficult, except for the few with central-star trigonometric parallaxes. Gaia DR3<sup>5</sup> promises to rectify this for many Galactic central stars, excepting those that are too faint. Another problem is the unknown mass and abundances of the main-sequence progenitor stars that could be linked to planetary nebula evolution and chemistry<sup>6</sup>.

These issues are overcome for planetary nebulae within Galactic star clusters, whose stars were formed coevally from the same interstellar cloud and so share the same chemical environment. Indeed,

a key motivation for uncovering cluster planetary nebulae was to benchmark distances to planetary nebulae. Cluster distances, ages and planetary nebula progenitor masses are well determined from cluster colour-magnitude diagrams. Initial progenitor and final central-star masses can be used as independent points for the metallicity-dependent<sup>7</sup> fundamental white-dwarf initial-to-final mass relation (IFMR)<sup>8</sup> that correlates white-dwarf properties with their progenitor stars, enabling tracing of nitrogen and carbon in entire galaxies.

Associations between planetary nebulae and clusters are rare. Only five planetary nebulae have been proved to be members of Galactic clusters. Four are associated with globular clusters<sup>9</sup> and one with an open cluster with a turn-off mass of  $2.2\,M_{\odot}$  (ref. <sup>10</sup>). We report confirmation of another physical association between a planetary nebula and a cluster: the planetary nebula BMP J1613-5406 within the young open cluster NGC 6067. This example pushes the observationally confirmed planetary-nebula formation limit to much higher mass and provides an exceptional opportunity for detailed study of stellar evolutionary models. We set out evidence that this association is real. It is based on concordance between the planetary nebula and the cluster of distance, reddening, the nebula-cluster angular location and physical location within the cluster boundary and, crucially, radial velocity. The physical size, chemistry and morphology of the planetary nebula are also as expected for a high-mass progenitor in such a cluster.

BMP J1613-5406 (PNG 329.8-02.1) is a low-surface-brightness, bipolar planetary nebula discovered from the SuperCOSMOS H $\alpha$  Survey (SHS)<sup>11</sup> and listed in the Hong Kong/AAO/Strasbourg H $\alpha$  (HASH) Planetary Nebula Catalogue<sup>12</sup>. It is located in the northern region of the Galactic open cluster NGC 6067. Its centre is at RA 16 h 13 min 02 s, dec.  $-54^{\circ}06'32''$  (J2000) and its major and minor axes are 335 arcsec and 215 arcsec. The planetary nebula's proximity to the cluster's centre (around 7 arcmin) drew our attention to possible membership. Figure 1a,b gives an image montage of the cluster and planetary nebula from the SHS online data. The adopted planetary nebula integrated H $\alpha$  flux is  $\log F_{\text{H}\alpha} = -11.55\,\text{mW m}^{-2}$ ,

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## II.B. LSR led (corresponding author) and affiliated paper:

Nature Communications Physics: "Searching for dark photon dark matter in LIGO O1 data" (DOI: 10.1038/s42005-019-0255-0), Huai-Ke Guo, Keith Riles, Feng-Wei Yang & Yue Zhao, published on December 10th, 2019.

The screenshot shows the top of a web page for a paper in Nature Communications Physics. The header includes a 'MENU' button, the 'ASTRONOMY' logo, a search bar with the text 'Search Nature Research Astronomy Community', and links for 'Register' and 'Sign In'. The main content area features a large, stylized image of Earth with callouts for 'USA', 'LIGO' (with a location pin in the USA), and 'virgo' (with a location pin in Italy). The title 'LIGO or LIDMO, that is the question' is prominently displayed. Below the title, a subtitle reads: 'A gravitational wave experiment as LIGO can be used for dark matter direct detection. We use LIGO O1 data to perform such a search for the first time. We get the best sensitivity for U(1) dark photon dark matter in a certain mass region.' The author's name 'Fengwei Yang' is listed, along with their affiliation 'Postgraduate student, University of Hong Kong'. The publication date 'Published Dec 12, 2019' is also visible. At the bottom of the article preview, there are buttons for 'Like', 'Comment', 'Share', and 'Read the paper'.

The 2017 Nobel Prize in Physics was awarded for the direct detection of gravitational waves (GW) from binary black hole mergers, underscoring the excitement and vibrancy at the frontiers of physics research. As is well known, gravitational wave detectors probe gravity and astrophysical phenomena. Much less appreciated is their potential to probe - directly - new particle physics beyond the Standard Model.

A wealth of convincing observational evidence confirms the existence of dark matter (DM), which is estimated to compose about 27% of the energy density in our Universe. However, the Standard Model does not have a candidate particle to account for DM. Additionally, all evidence pointing to the existence of DM is related to gravitational effects and associated properties, such as DM mass; their other potential interactions are currently unknown.

In our study, we leveraged the recent advances in GW instrumentation to carry out a novel DM direct detection using the Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO is a highly advanced Michelson-Morley interferometer (with many extra mirrors and a sophisticated controls system), relying upon precise measurements of a relative change in interferometer arm length. Meanwhile, DM can be formed by an ultra-light 'dark' photon, such as the gauge Boson of a  $U(1)_B$  group. In the ultra-light regime, the dark photon DM (DPDM) can be treated as a classical wave, whose oscillation, like GW, can induce a relative change of the interferometer arm length; thus LIGO can carry out complementary searches for DPDM.



# Methods in Ecology and Evolution

Volume 11 • Number 8 • August 2020

ISSN 2041-210X



## **II.C. LSR led and affiliated paper:**

Fluorescence-based detection of field targets using an autonomous unmanned aerial vehicle system, Thomas. G. Kaye & Michael Pittmann. This paper was featured on the front cover of this journal First published: 21 June 2020:

[https://doi.org/10.1111/2041-210X.13402.](https://doi.org/10.1111/2041-210X.13402)

**Editors: Rob Freckleton, Aaron M. Ellison,  
Lee Hsiang Liow, Bob O'Hara**

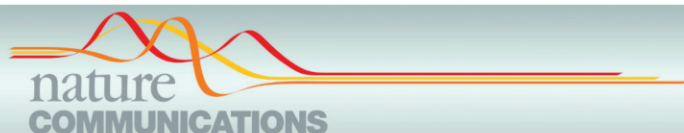
**BRITISH  
ECOLOGICAL  
SOCIETY**



## II.D. LSR led (corresponding author) and affiliated paper:

Tang, C.A., Webb, A.A.G., Moore, W.B., Ma, T.H., Wang, Y.Y., Breaking Earth's shell into a global plate network. *Nature Coms*, v.11, 3621, doi:10.1038/s41467-020-17480-2:

<https://www.scifac.hku.hk/press/release/press-release-earth-shell-breaking>



### ARTICLE



<https://doi.org/10.1038/s41467-020-17480-2>

OPEN

# Breaking Earth's shell into a global plate network

C. A. Tang <sup>1,2</sup>, A. A. G. Webb <sup>3✉</sup>, W. B. Moore <sup>4,5</sup>, Y. Y. Wang <sup>6</sup>, T. H. Ma <sup>1,6</sup> & T. T. Chen <sup>7</sup>

The initiation mechanism of Earth's plate tectonic cooling system remains uncertain. A growing consensus suggests that multi-plate tectonics was preceded by cooling through a single-plate lithosphere, but models for how this lithosphere was first broken into plates have not converged on a mechanism or a typical early plate scale. A commonality among prior efforts is the use of continuum mechanics approximations to evaluate this solid mechanics problem. Here we use 3D spherical shell models to demonstrate a self-organized fracture mechanism analogous to thermal expansion-driven lithospheric uplift, in which globe-spanning rifting occurs as a consequence of horizontal extension. Resultant fracture spacing is a function of lithospheric thickness and rheology, wherein geometrically-regular, polygonal-shaped tessellation is an energetically favored solution because it minimizes total crack length. Therefore, warming of the early lithosphere itself—as anticipated by previous studies—should lead to failure, propagating fractures, and the conditions necessary for the onset of multi-plate tectonics.

<sup>1</sup>State Key Laboratory of Coastal and Offshore Engineering, Dalian University of Technology, 116024 Dalian, China. <sup>2</sup>State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, 430074 Wuhan, China. <sup>3</sup>Division of Earth and Planetary Science and Laboratory for Space Research, University of Hong Kong, Pokfulam Road, 999077 Hong Kong, China. <sup>4</sup>Department of Atmospheric and Planetary Sciences, Hampton University, Hampton, VA 23668, USA. <sup>5</sup>National Institute of Aerospace, Hampton, VA 23666, USA. <sup>6</sup>Deep Underground Engineering Research Center, Dalian University of Technology, 116024 Dalian, China. <sup>7</sup>School of Resources and Civil Engineering, Northeastern University, 110819 Shenyang, China. ✉email: [aagwebb@hku.hk](mailto:aagwebb@hku.hk)



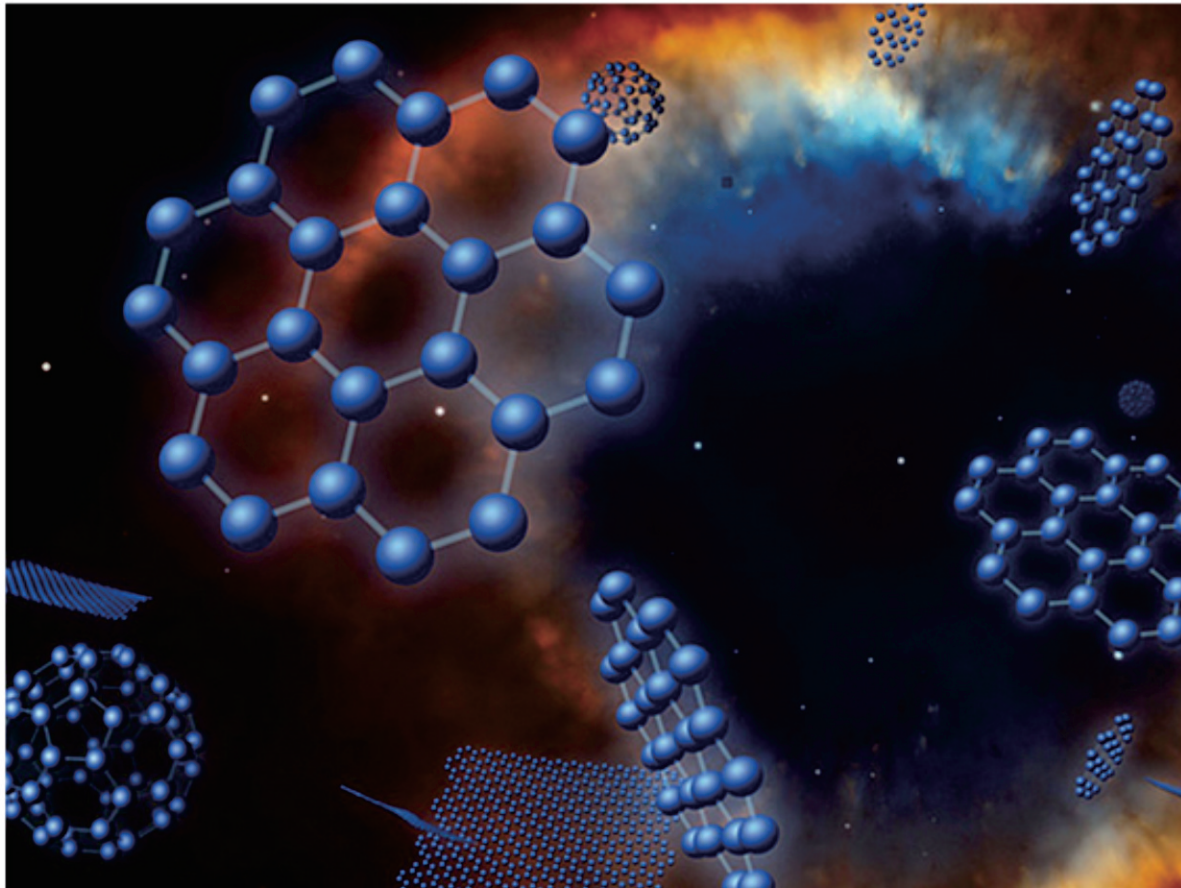
## II.E. LSR led and affiliated paper and press release of:

A Theoretical Investigation of the Possible Detection of C<sub>24</sub> in Space:

[www.astrobiology.com/2020/02/a-theoretical-investigation-of-the-possible-detection-of-c24-in-space.html](http://www.astrobiology.com/2020/02/a-theoretical-investigation-of-the-possible-detection-of-c24-in-space.html)

# A Theoretical Investigation of the Possible Detection of C<sub>24</sub> in Space

Press Release - Source: astro-ph.GA Posted February 24, 2020 1:57 PM 0 Comments



Graphene

©NOAO

Astronomical infrared spectral features at ~6.6, 9.8 and 20 micronm have recently been suggested as being due to the planar graphene form of C<sub>24</sub> carbon cluster.

Here we report density functional theory and coupled cluster calculations on wavefunctions stability, relative energies, and infrared spectra of four different types of C<sub>24</sub> isomers, including the graphene and fullerene forms. The types of vibrational motions under these bands are also discussed. Among the four isomers, we find that the astronomical data are best approximated by the graphene form of C<sub>24</sub>.

SeyedAbdolreza Sadjadi, Sun Kwok, Franco Cataldo, D.A. García-Hernández, Arturo Manchado

(Submitted on 20 Feb 2020)

Comments: 15 pages, 4 figures

Subjects: Astrophysics of Galaxies (astro-ph.GA); Solar and Stellar Astrophysics (astro-ph.SR); Chemical Physics (physics.chem-ph)

Cite as: arXiv:2002.08960 [astro-ph.GA] (or arXiv:2002.08960v1 [astro-ph.GA] for this version)



## II.F. LSR Faculty Hire wins prestigious Mainland Excellent Young Scientist Award



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### News



## The Excellent Young Scientists award to Dr Zhang Binzheng

Life and Planetary Evolution | October 30, 2019

---

Congratulations to [Dr Zhang Binzheng](#) from the Department of Earth Sciences for his being awarded The Excellent Young Scientists Fund, a prominent fund under the National Natural Science Foundation of China.

This highly competitive fund is granted annually to support young scientists with outstanding achievements in basic research to conduct research in areas of their own choice. Each project will receive a funding of HKD1.5 million for a maximum period of three years.

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Department of Earth Sciences, James Lee Building, The University of Hong Kong, Pokfulam Road, Hong Kong

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## II.G. LSR Deputy Director Dr. Joe Michalski's PSML Laboratory



香港大學  
THE UNIVERSITY OF HONG KONG

Department of Earth Sciences &  
Laboratory for Space Research

Contact:

Dr Joe Michalski

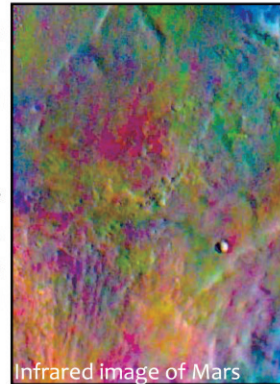
[jmichal@hku.hk](mailto:jmichal@hku.hk)

[www.clays.space](http://www.clays.space)

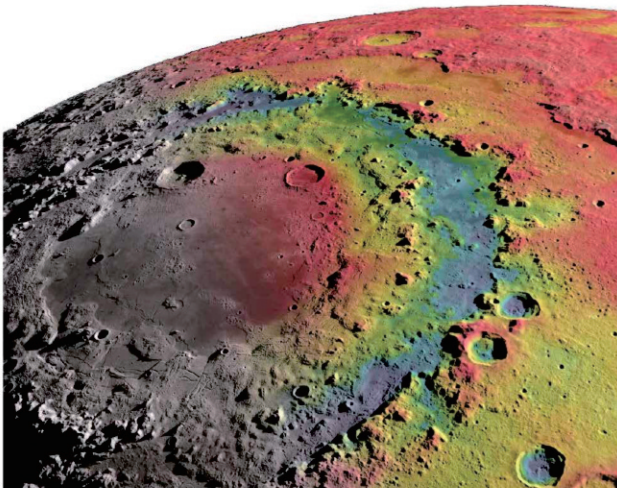
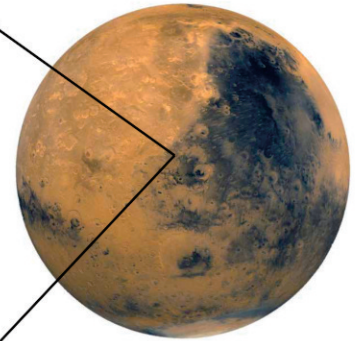


The Planetary Spectroscopy and Mineralogy Laboratory is facility focused on the application of laboratory infrared spectroscopy and remote sensing to solve big problems in Planetary, Earth and Environmental Sciences.

One of our main objectives to provide laboratory support for spaceborne robotic missions to Mars, the Moon, Asteroids and other Solar System objects. We apply the same technologies used in space science research to create real world solutions in Geological and Biological Sciences



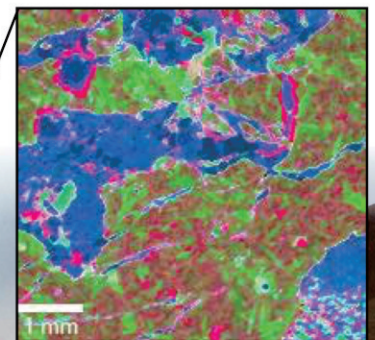
Infrared image of Mars



### WHAT DO WE OFFER?

- ✓ Support for space missions (Mars, Moon, asteroids)
- ✓ Analysis of planetary materials (meteorites, analogs)
- ✓ Infrared spectroscopy of minerals and powders
- ✓ Micro-IR phase identification and mapping
- ✓ Quantitative mineralogy of rocks and thin sections
- ✓ Detailed analysis of clay mineralogy and textures
- ✓ Nondestructive analysis of precious materials
- ✓ Environmental spectroscopy (vacuum, low/high T)
- ✓ Hyperspectral imaging of hand samples and rock cores
- ✓ Thermogravimetry and evolved gas analysis
- ✓ X-ray diffraction and seamless connection to IR
- ✓ General Planetary Remote Sensing Expertise

Planetary materials and analog materials





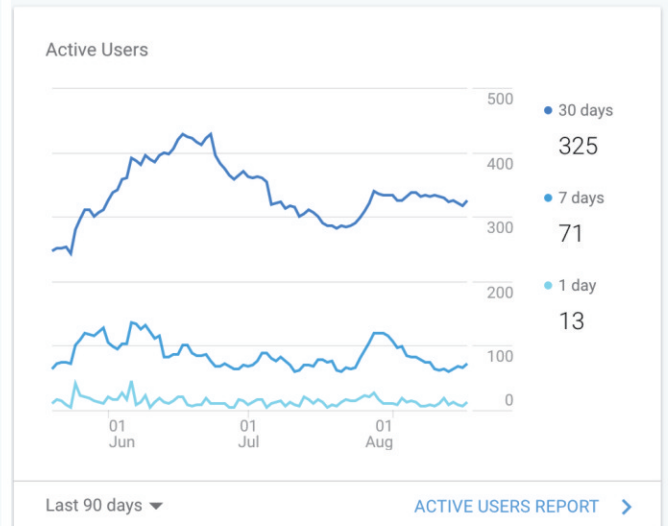
## APPENDIX III

### Web statistics for LSR and HASH websites that illustrate the level of interest in the LSR and level of use of HASH

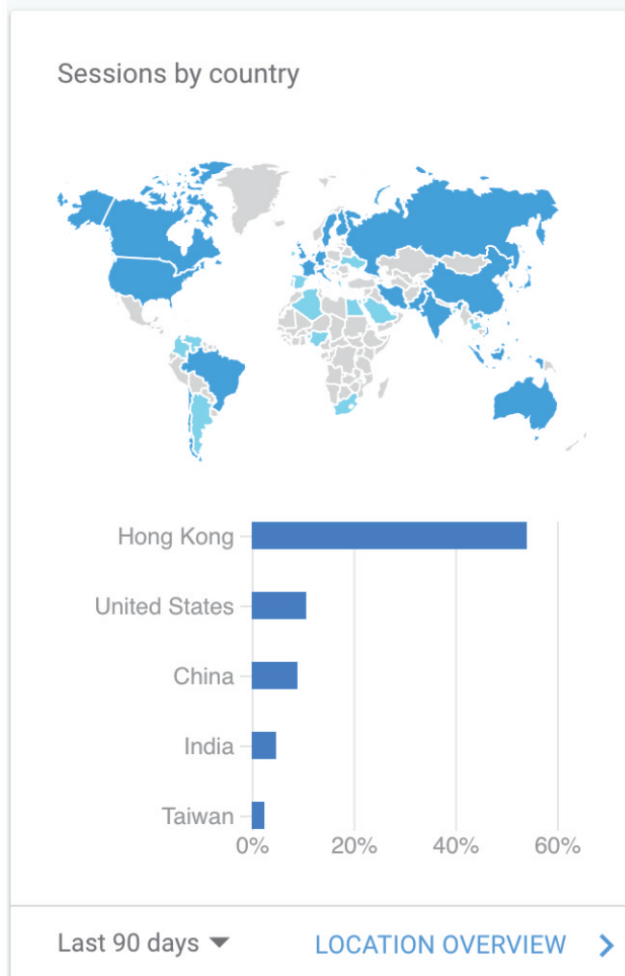
#### APPENDIX IIIA: LSR website traffic June-August 2020



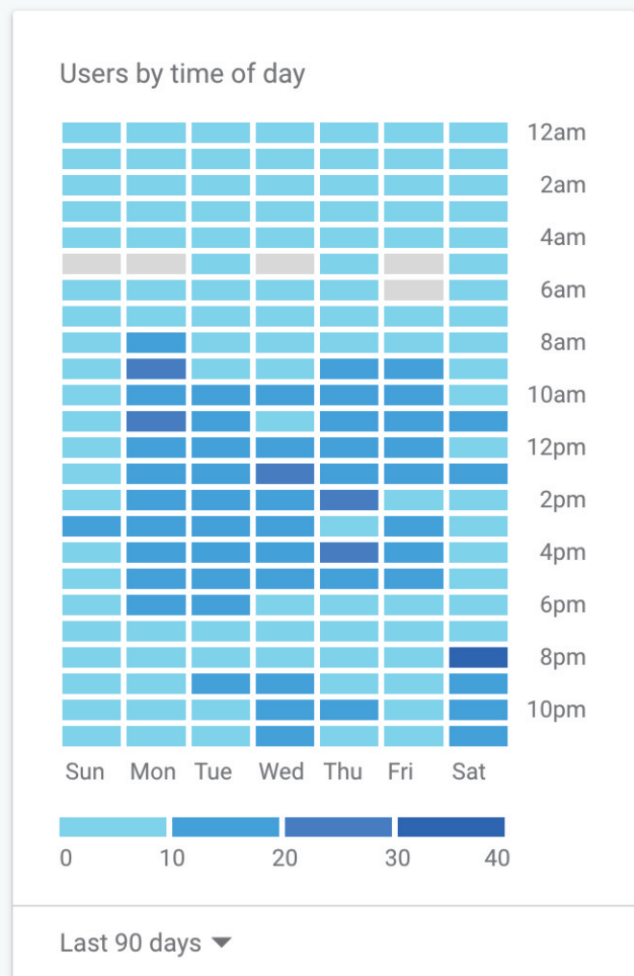
How are your active users trending over time?



Where are your users?



When do your users visit?

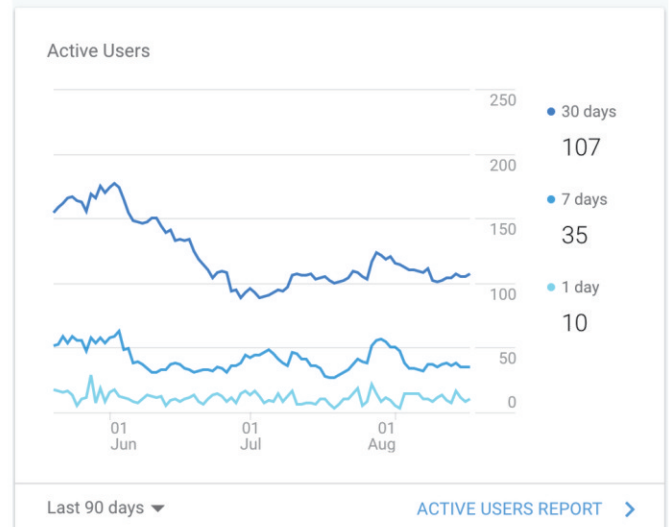




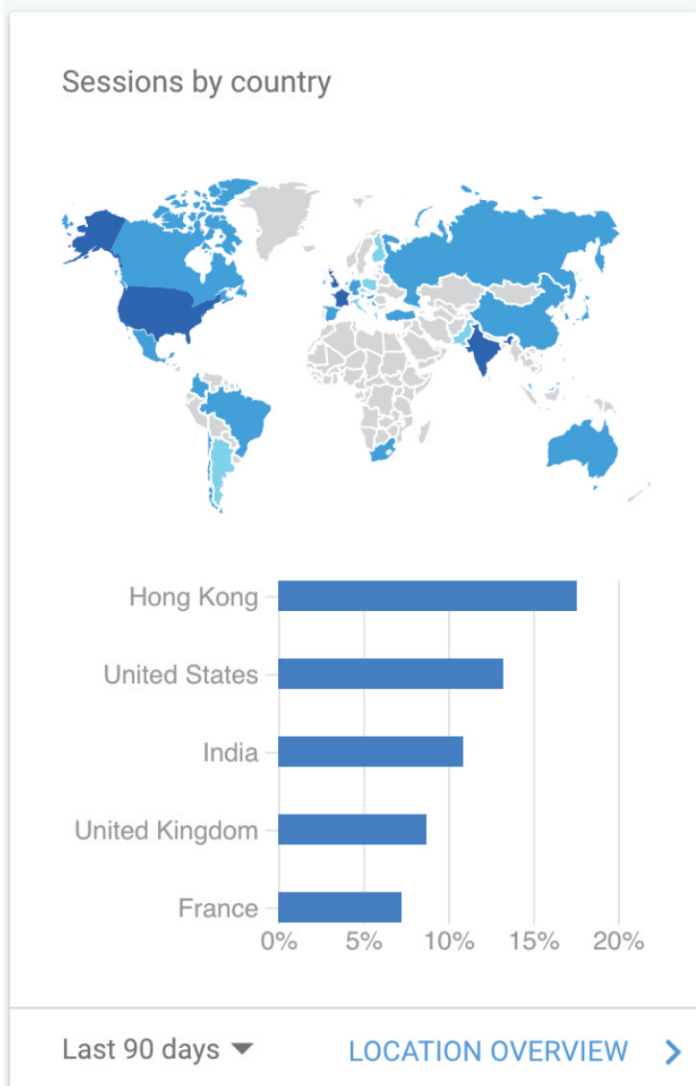
## APPENDIX IIIB: HASH website traffic June-August 2020



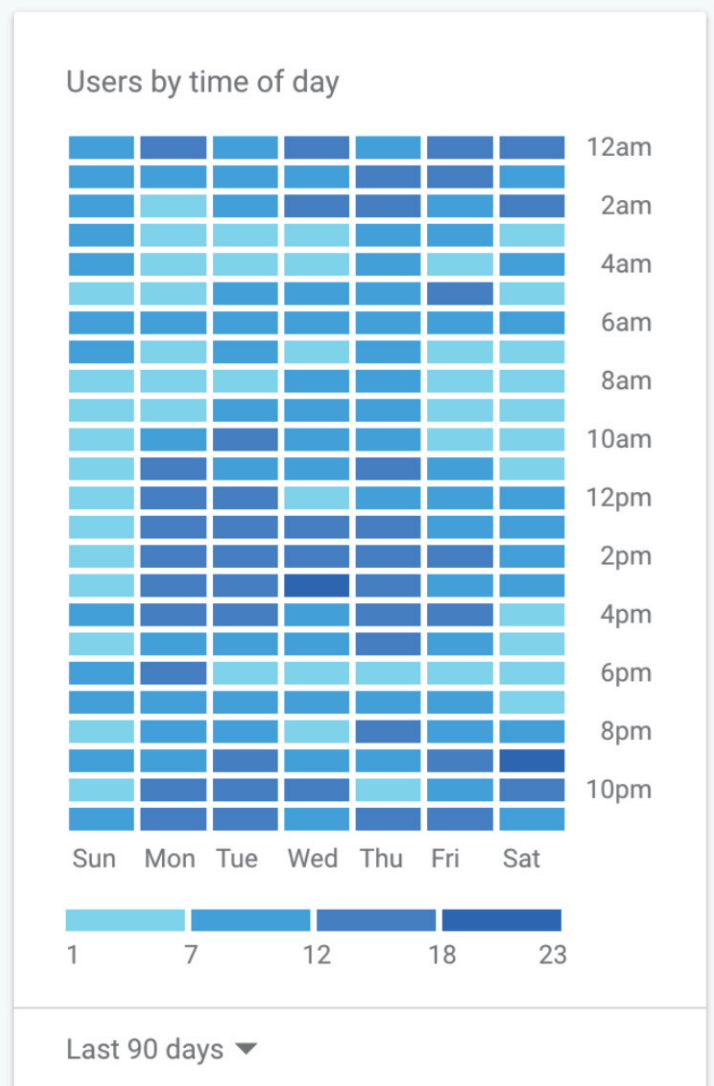
How are your active users trending over time?



Where are your users?



When do your users visit?







HKU-NJU No. 1 satellite,  
scheduled to launch July 2020



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FACULTY OF SCIENCE



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(extended) Deadline for local (HK) students: June 30, 2020

## Enquiries:

### Department of Physics

Programme Director  
Professor Quentin Parker  
Tel: +852 2859 2360  
Email: [mpace@hku.hk](mailto:mpace@hku.hk)

Co-Programme Director  
Dr Pablo Saz Parkinson



LSR Laboratory for  
Space Research

Faculty of Science, The University of Hong Kong  
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Tel: +852 3917 5287 Fax: +852 2858 4620 Email: [science@hku.hk](mailto:science@hku.hk)  
<https://www.scifac.hku.hk/prospective/tpg/about>





## BEIJING INSTITUTE OF SPACE MECHANICS AND ELECTRICITY

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Haidian District, Beijing  
P.R. China 100094

FAX: +8610-68113608  
TEL: +8610-68114764

21<sup>st</sup> May 2020

Professor Quentin Parker  
Director, Laboratory for Space Research  
Department of Physics  
University of Hong Kong

Dear Professor Parker:

The Beijing Institute of Space Mechanics and Electricity (BISME) is willing to provide an annual minimum sum of RMB300,000 to establish scholarships for outstanding postgraduate students pursuing an MSc in the field of Space Science at the University of Hong Kong.

The scholarships comprise  $2 \times 50,000$ RMB for Academic Excellence and  $4 \times 50,000$ RMB for Financial hardship and academic potential. On top of this there is a further scholarship program of 100,000 for Outstanding Contribution to the approval of any number of joint projects taken by the MSc students within the BISME-HKU/LSR Joint Laboratory.

The two scholarships for Academic Excellence and the four scholarships for Financial hardship and academic potential shall be administered each year by HKU. Whether to establish the Outstanding Contribution Scholarship(s) or not shall be determined each year by BISME as per whether there is any joint projects get approval in that year.

I believe that this Taught Postgraduate MSc program in Space Science will provide a steady stream of talent resources for space science research and wish you every success.

Sincerely yours,

Fan Bin  
Deputy Director  
BISME



Beijing Institute of Space Mechanics and Electricity

**Scholarships from BISME for TPG MSc in Space Science (300,000RMB)**





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25 MAY 2020 | PRESS RELEASE

### Brilliant “BISME” Bonaza Benefits Bright HKU students via many new prestigious MSc Scholarships in the field of Space Science



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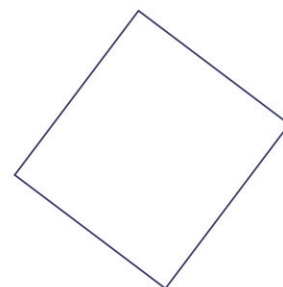


satellite

Brilliant “BISME” Bonaza Benefits Bright HKU students via many new prestigious MSc Scholarships in the field of Space Science [🔗](#)

北京空間機電研究所成立多個獎學金予港大新課程「太空科學碩士」學生 [🔗](#)

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## **APPENDIX V**

### **The INSPIRE concept and proposal in Dongguan**

International Space and Planetary Institute for Research Excellence (INSPIRE)

Prof. Quentin Parker & Dr Meng Su, Laboratory for Space Research

- Laboratory for Space Research (LSR:[www.lsr.hku.hk](http://www.lsr.hku.hk)) in active discussions with Dongguan Science and Technology Bureau for last 18 months to establish INSPIRE in Dongguan
- Motivation: take advantage of major funding, prime GBA location and science ecosystem
- Set against context of strategic MoUs signed with elite partners (most in 2019, see list)

#### **Funding Available (>500M RMB over 5yrs)**

- Base minimum offer of 250RMB over 5 years
  - 20M RMB/year cash donation (to hire staff)
  - 30M RMB/year for building rent, infrastructure, equipment, consumables etc
- Anticipated extra 100M RMB in year 2 under special talents scheme
- Anticipated >100M RMB over 5 years in matching grants and investments
- Total value to HKU FoS for LSR-type institute in Dongguan: >500M RMB after 5yrs

#### **Why Space Science?**

- A strategic Mainland focus of massive emerging significance globally
- LSR well placed to take advantage of considerable opportunities available

#### **Why Dongguan?**

- Dongguan pushing itself hard as science and high tech innovation hub
  - Firm support for basic science with strong investment environment
  - Convenient location - proposed CBD institute is <1.5 hours door-to-door from HKU
  - Prime office space in iconic building in heart of CBD (see fig.1 below)
  - Gives LSR the funding and capacity to pursue a rich portfolio of planned activities
  - Dongguan very keen to attract a top 100 global, elite university like HKU FoS
  - City is rich and has generous support schemes to attract major science programs
  - IHEP (Institute of High Energy Physics) & Neutron Spallation source already in place
  - Massive new HQ for Huawei also recently established
- China Space Utilization (CSU) group setting up in Dongguan (because of LSR) – they now Want a full joint lab with HKU (see separate document)



## Why HKU Faculty of Science?

- FoS LSR epitomizes high-tech cutting-edge science and vision - plays into current mainland narrative/focus on space science and the rapidly growing space economy
- Dongguan environment is excellent for support of university based science activities
- LSR, if established in Dongguan, could be vanguard of a significant FoS presence in the GBA, including a big data institute, AI and perhaps others

## Time Frame

- Funding available in mid 2020
- For this to occur agreement must be reached with HKU SMT to allow this set-up
  - HKU TTO/CAO, FoS and Dongguan must have an agreed establishment model
  - FEO needs to set up company structure in HK with subsidiary in Dongguan
  - SMT to agree that HKU brand can be spent in Dongguan via the FoS

## Supporting Materials

A very detailed set of supporting documents is available for scrutiny. These materials include the LSR-Dongguan co-developed “Executive Plan” (short version attached below), comprehensive budget estimates for each proposed project-based cost-centre, envisaged and the staffing profile (~150 staff envisaged by year 5) and individual project descriptions (see organogram below).

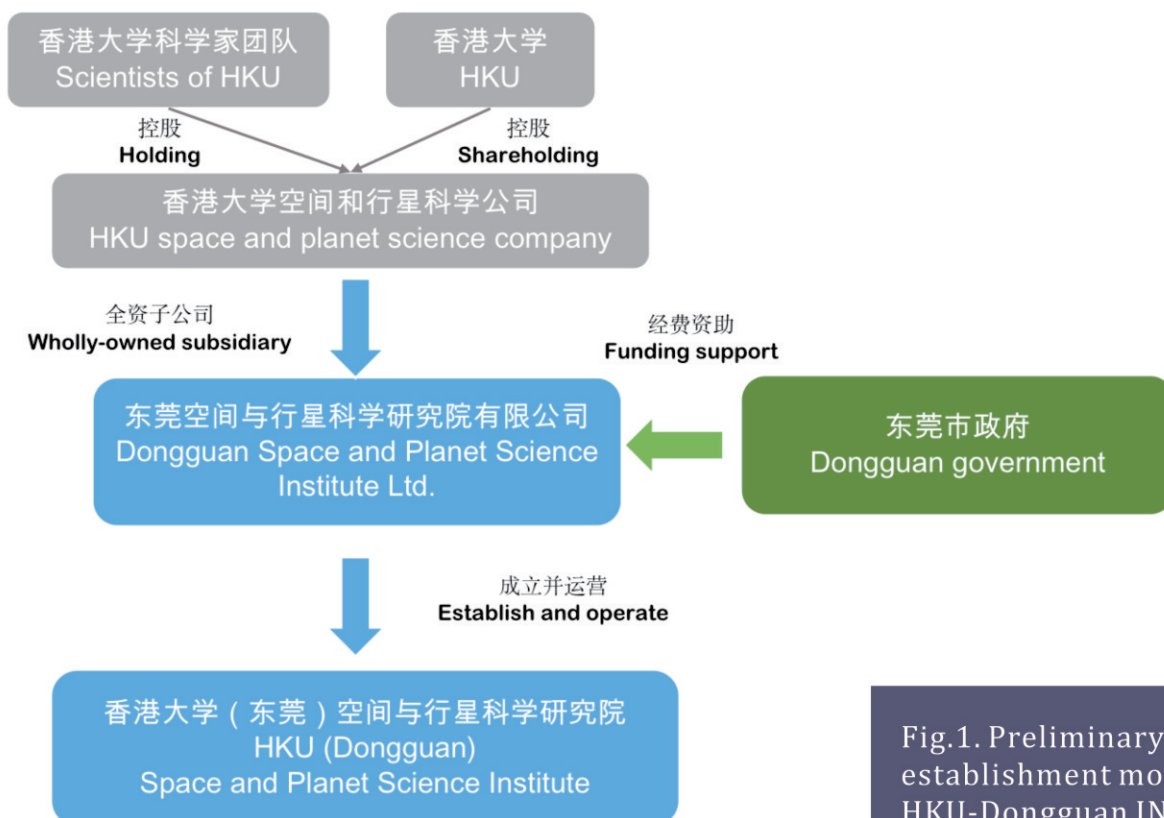


Fig.1. Preliminary establishment model for HKU-Dongguan INSPIRE



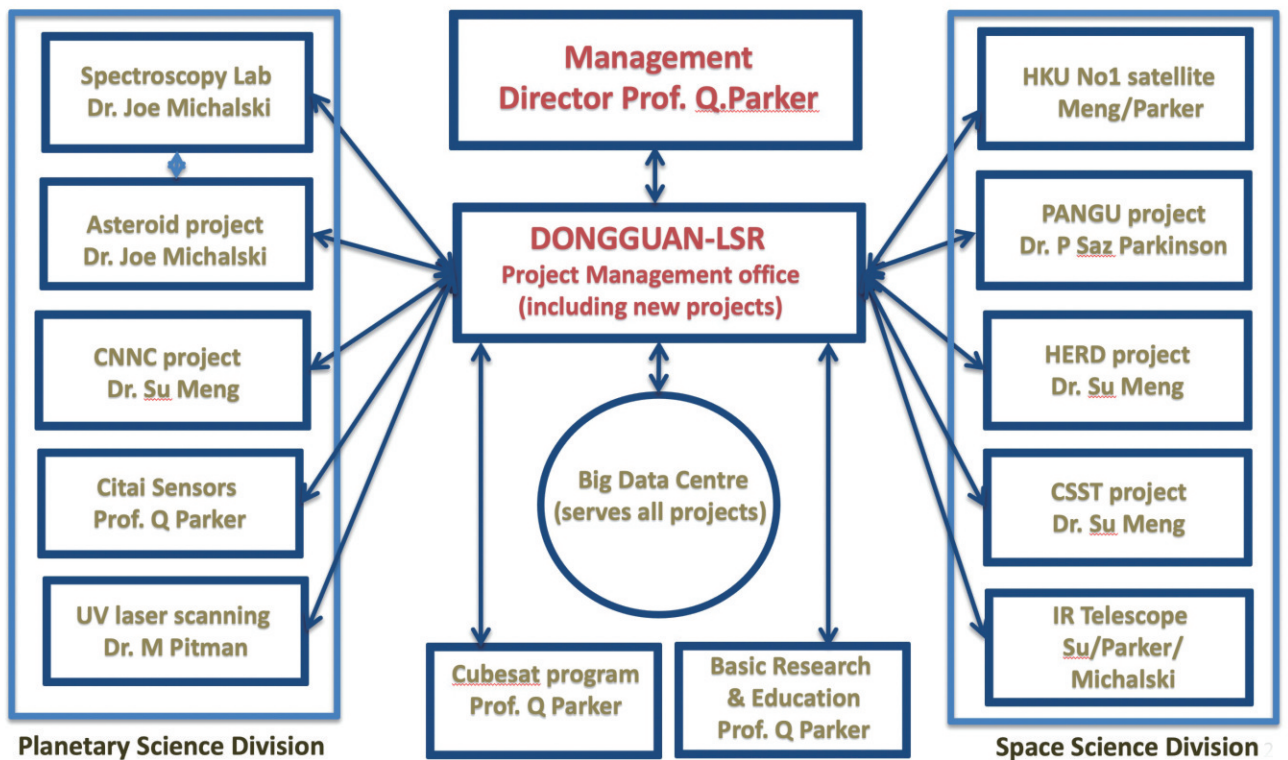


Fig.2 Organogram for International Space & Planetary Institute for Research Excellence (INSPIRE)



Fig.3. Organogram for how INSPIRE links to our major partners





## **APPENDIX VI:**

### **LSR proposal for the East Asian Observatory (EAO) HQ**

#### **LSR Led, accepted and EAO Board endorsed proposal for Dongguan City as the location for the International Headquarters of the East Asian Observatory**

Prof. Q.A. Parker, Director, Laboratory for Space Research, HKU

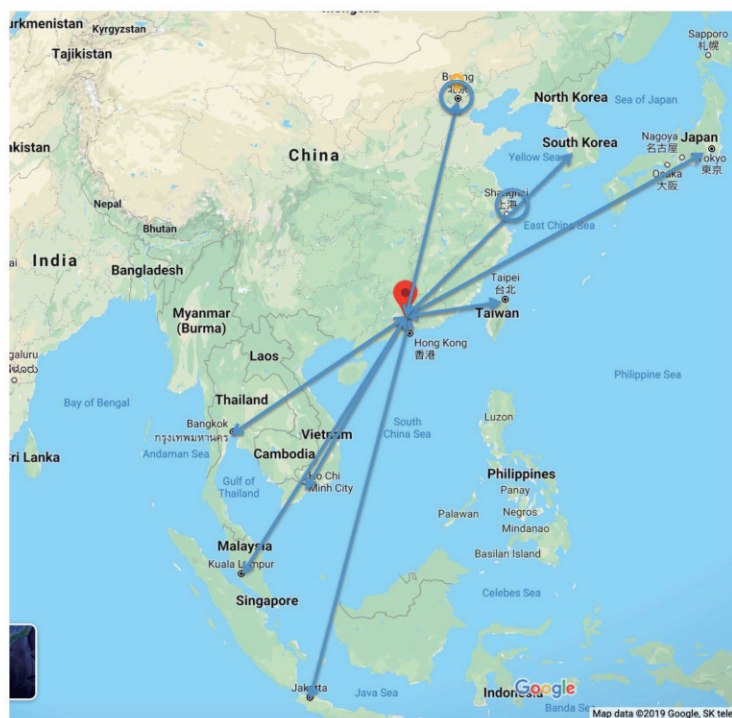
#### **Introduction**

The new HQ of the EAO has still to be decided after several years. Several proposals have already been considered as far back as 2015 but with no decision. The proposed, new EAO HQ must ideally satisfy several competing criteria and be broadly acceptable to the current and likely future membership of the EAO. It is worth recalling that the European Southern Observatory (ESO), which the EAO is hoping to emulate as it evolves and grows, is based in Germany, in the heart of Europe. However, it is not in a capital city but in a satellite town of the Bavarian state capital Munich. Here we propose something similar for the EAO HQ to be based in the city of Dongguan in the strategically important Greater Bay Area of China. I believe it is clear, based on the resources and facilities invested and the growing size and importance of the communities, that only China, Japan or Korea are viable host countries for the EAO HQ with China emerging as the most likely. When other considerations are examined I do believe China should host the EAO HQ but not in the rival cities of Beijing, Shanghai or even Nanjing but in the rich city of Dongguan.

**Why Dongguan and the GBA?** The GBA is a major economic and emerging high-tech zone with a population of ~68 million across 11 major cities including Hong Kong and Macau with a GDP that is currently US\$1.34 trillion, equivalent to ~50% that of the U.K. There are many reasons to locate the EAO HQ in Dongguan that are presented in detail below but there are 3 main points. Firstly, Dongguan is extremely well placed geographically between all current and likely future members of the EAO with superb transport links so that visits to the HQ are more convenient and fair for most member states. Secondly, Dongguan is happy to host the EAO as it focuses on emerging as a key science and technology hub and incubator in the GBA. The city is already hosting IHEP, a major Neutron Spallation Source and the new HQ for Huawei and is likely to offer great on-going support to the EAO thanks to generous incentives from the Dongguan government. Finally, it is likely this choice would circumvent the rivalry that might otherwise complicate a choice between Beijing, Shanghai or Nanjing.



Fig.1 Excellent central location of Dongguan relative to EAO partner countries



## 1. Location of HQ relative to the hosting institute.

We propose that the new HKU-Dongguan International Space and Planetary Sciences Institute for Research Excellence (INSPIRE) will host the EAO HQ until the EAO evolves into a stronger and larger international entity. The exact location for the proposed HQ is in the very heart of the Dongguan CBD. It will be in a highly visible and modern, just completed building that sits directly on top of a major metro station that connects to high-speed rail. The floor space available is at least 1,000sq.m on the 4<sup>th</sup> floor. Sponsored rent for 5 years is likely.



Fig.2 Left: Proposed EAO HQ in Dongguan CBD. The Dongguan-HKU INSPIRE will have presence on the 4<sup>th</sup> floor. Right: View outside main entrance of this iconic CBD building.



## 2. Location of HQ relative to local universities.



Dongguan is surrounded by more than a dozen universities that are either local (e.g. SYSU, Guangzhou, Shenzhen, SUSTech) or are campuses established by leading universities from the HK SAR such as HKUST, CUHK and HKBU. Furthermore, Dongguan is only ~2 hours door to door by fast train from the elite university of HKU (placed 25 globally in the QS rankings and 35<sup>th</sup> in the Times Higher Education rankings for 2020).

HKU is itself setting up a major Faculty of Science footprint in Dongguan with the establishment of a joint HKU-Dongguan INSPIRE that includes astrophysics. In the first instance we propose that INSPIRE will also host the EAO HQ offices and support infrastructure. The director of the Chinese Academy of Science has now firmly indicated that CAS would like to establish a joint Space Science and Astrophysics lab with HKU via the CSU-LSR signed agreement. This could also be set-up in Dongguan at INSPIRE.

There are also other highly ranked universities in HK SAR such as CUHK and HKUST that are growing their Astronomy and Space Science communities while the Macau University of Science and Technology has a key state laboratory in Space and Planetary Sciences. In the GBA itself there are several key universities such as SYSU, Guangzhou, Shenzhen and SUSTech that are also strongly growing their Astrophysics and Space Science activities while Dongguan itself is also striving to build the so called “GBA” university.



Fig.3. There are more than 12 universities within 100km of Dongguan, including HKU (top 25 in the QS scheme). The radius of the blue circle is 100km.



### **3. Location of HQ relative to local communities.**

The local GBA universities of SYSU and Guanzhou in particular are developing their astronomy, astrophysics and space science programs while HKU, HKUST and CUHK in HK SAR already have strong and growing research capacity in these areas. It is likely that the combined scale of all astrophysics and space science activities in the GBA will lead to one of the largest such localized astrophysics communities in China after the KAVLI in Beijing. This provides a relevant, strong, local, university based research base to engage with the EAO.

### **4. Location of HQ relative to related industries.**

As stated Dongguan is positioning itself to be a major hub for high tech industries including in AI, Big Data, robotics and space science while also attracting and supporting major fundamental research facilities such as IHEP and the Neutron Spallation source. Important high-tech companies like Huawei have also recently established their HQs in Dongguan. As such the establishment of the Dongguan-HKU International Space and Planetary Sciences Institute for Research Excellence (INSPIRE) is a natural fit to their ideas while the proposed international EAO HQ in Dongguan also perfectly reflects their vision.

### **5. Location of HQ relative to international airports.**

There are exceptional transport links to/from Dongguan with motorways and high-speed rail. The proposed HQ, in the centre of the Dongguan CBD, provides direct and rapid links via the metro directly below the building and thence to the major airports in Guanzhou (84 km, 1hr 20m by taxi), Shenzhen (42km away, 38min by taxi) and HK SAR (114km, 1hr 15min by taxi). A rapid train connection corridor is under development that promises to link Dongguan with these three major airports in only 20-40minutes. In the case of Hong Kong airport this will allow direct access to international departures without the need for a HK SAR visa. These are significant international transport hubs with direct flights to all partner countries.



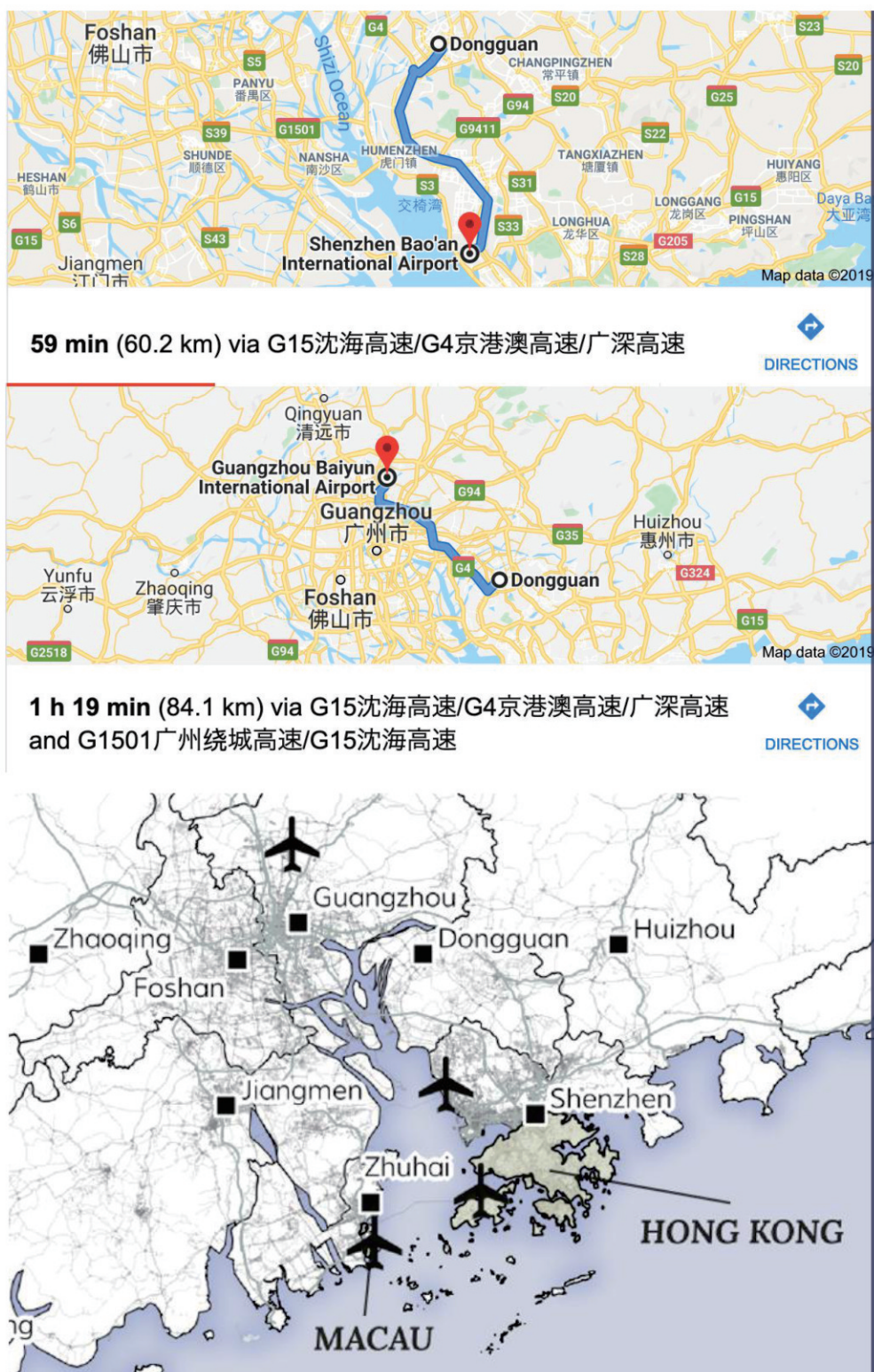


Fig.4. As can be seen Dongguan City is surrounded by several international airports with direct flights to all EAO partner countries.

## 6. Space and environment available for hosting HQ.

Dongguan has both the high quality, extremely well located office spaces in the heart of the CBD and a welcoming, engaged, local government environment to host and support the international EAO HQ via a variety of excellent incentives and financial assistance schemes.



## **7. Building with available office and laboratories.**

The building is shown in Figure 2 (left). It is in the process of being fitted out to host the INSPIRE. Hence, now would be the ideal time to make a decision on the EAO HQ location as this gives the opportunity to arrange the available space to suit the EAO organization before floor plans are more fixed.

## **8. Potential for future expansion.**

Based on discussions there is ample space to host the EAO HQ for the first 5 years at least and a second space area of ~4000sq/m, also on the building's 4<sup>th</sup> floor, could be allocated later if necessary. Should the EAO grow rapidly then a purpose built office block could also be established in Dongguan later on and in principle provided by the City Government.

## **9. Financial incentives for hosting HQ.**

In their earnest quest to become the GBA leader for both basic and high-tech science and associated enterprises and industries, Dongguan have the desire and capacity to provide significant financial support and an incentives package to establish the International EAO HQ. A “special deal” can be organized for a preliminary period of 5 years that is likely to offer rent-free offices and direct financial support for administrative staff etc. Precise details would be negotiated once an in principal agreement was established to set up the EAO HQ in Dongguan. Furthermore, having a de-centralised location for an International body like the EAO may deliver additional support from a city like Dongguan not otherwise available.

## **10. Infrastructure support from hosting institute.**

The INSPIRE will, in principle, provide all the necessary support and administrative infrastructure initially to the EAO HQ, assuming Dongguan City adopt this proposal and provide the additional financial support needed. Co-location and economies of scale will permit substantial savings in the first instance.

## **11. Cost for operations and maintenance.**

In the first instance, assuming a similar arrangement as prepared for the INSPIRE can be agreed, then the cost of Operations and Maintenance could be provided by the Dongguan City Government up to a certain ceiling (10-15M RMB/year for perhaps 3-5 years)

## **12. Tax Benefits and Liabilities.**

TBC



### 13. Housing options for staff and visitors.

Dongguan has plentiful high-quality modestly priced housing (2,000-5,000 RMB/month for 2 bedroom apartments). For locally hired and overseas staff of the SPSRI, Dongguan have promised to provide decent, family friendly housing and related infrastructure, such as help with child care and schooling (see below). INSPIRE would negotiate with Dongguan to provide equivalent support for EAO HQ staff too. Housing in Dongguan is very reasonably priced, depending on where you are and how many amenities you would like to have. Since this area is not known as a touristic site, the prices for many things are lower, including housing. Many apartments are not built to cater to expat tastes so some of the Western style amenities may cost a bit more in Dongguan.

***Renting in the City Centre:*** Here is where the most expensive apartments are found. A two-bedroom apartment that has the basic amenities (air conditioning, nice kitchen, western toilet, etc.) will cost up to 5,000 RMB per month (not including utilities, which may be between 200 to 500 RMB per month). This site provides a useful summary of living costs for Dongguan:

<https://www.expatisitan.com/cost-of-living/dongguan.>

### 14. Schooling options for EAO staff.

There are currently 45 English Language and International Schools in Dongguan catering for pupils of all ages including the QSI international school:

<https://www.qsi.org/dongguan/>

And the International School of Dongguan:<https://www.i-s-d.org/> as well as of course excellent Chinese schools. The map below shows the location of the top such schools in Dongguan.

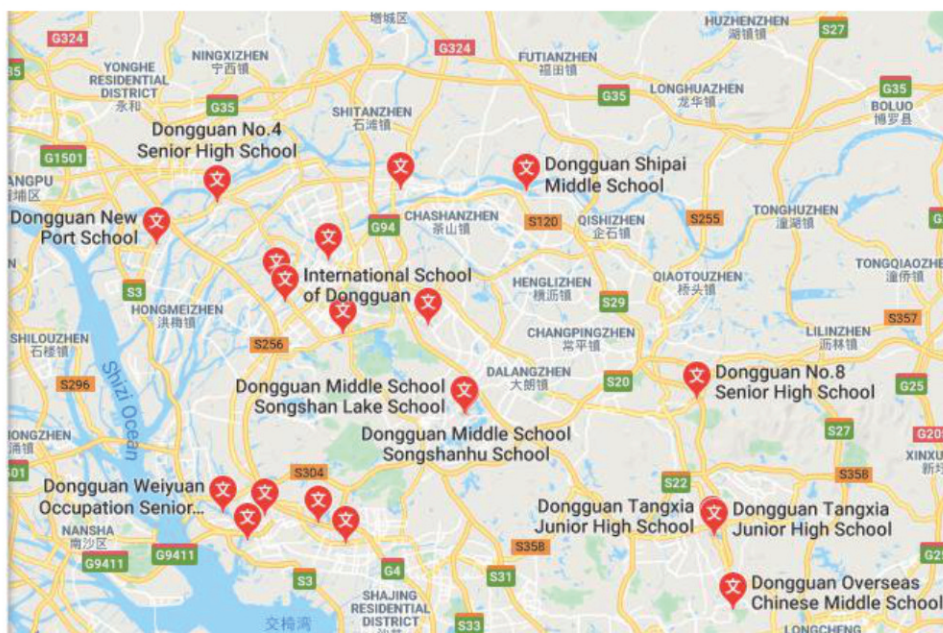


Fig.5. Location of the best schools in Dongguan



## **APPENDIX VII**

### **Miscellany of additional materials**

#### **VII A: Proposed CAS-HKU joint lab in Space and Planetary Sciences**

##### **Rationale for the CAS-HKU joint lab**

- Form deep scientific/technical collaboration between FoS/LSR and CSU as a highly desirable aim for mutual research/development benefit viaa joint laboratory in Dongguan/HKU
- Build close and long-term cooperation to advance frontier research in space science, planetary science and technical development in space manufacturing, space resources exploration and utilization
- Further develop in-depth cooperation across a series of scientific research and technology development projects including, but not restricted to, the LSR
- Jointly work on scientific research projects, and promote the transformation and application of Science and Technology in the Greater Bay Area including HK SAR

##### **Background:**

- Proposal, suggested by CAS and emerged from the new LSR-CSU agreement signed at CSU\* HQ in Beijing on December 10<sup>th</sup> 2019
- Follows the original suggestion from the CAS president in November 2017 (during his visit to HKU) that Space Science is one of only two areas CAS could foresee as the basis for a new CAS-HKU laboratory in the immediate future
- Also follows from all our accomplishments in the interim
- If we can establish this lab it would be the first CAS-HKU joint laboratory since 2011 jointly work on scientific research projects, and promote the transformation and application of Science and Technology in the Greater Bay Area including HK SAR

##### **Developments and Context:**

In the two years since the CAS president's visit, the LSR has set about consolidating our presence via a range of initiatives, projects and strategic partnerships that establish our brand, vision, capacity and international links, accompanied, when appropriate, by press-releases and excellent publicity (especially in the Mainland).



We now have 10 MoUs and 6 agreements with elite Mainland and global partners, signing 6 MoUs and 3 agreements in 2019 alone, a possible record for HKU for a calendar year. As a result our portfolio of internationally important projects and potential projects has grown significantly. We merely lack the resources and investments to make the most of the opportunities on offer and bring them to fruition.

With this in mind we have established over the last 18 months a strong relationship with the Science and Technology Bureau in Dongguan. This has culminated in a very serious proposal to set up the International Space and Planetary Institute for Research Excellence (INSPIRE) in Dongguan. It is a direct derivative of the LSR in HKU. The resources and investments could be >500M RMB with 100M RMB in cash.

The preliminary MoU with the Science and Technology Bureau Dongguan was signed in December 2019 and the full MoU between HKU and Dongguan government (that will release the major funding) will be in late 2020. This will be once the Dongguan Vice Mayor has had a chance to meet the HKU SMT and be sure of our commitment. These investments will enable us to resource and undertake the projects envisaged (refer to organogram). Off the back of all this activity the CSU has decided to set up a major presence in Dongguan and more formally link with the LSR-INSPIRE with a HKU-CAS joint lab.

\*CSU is the “Centre for Space Utilization” that runs China's interests in Space development including the Chinese Space Station.

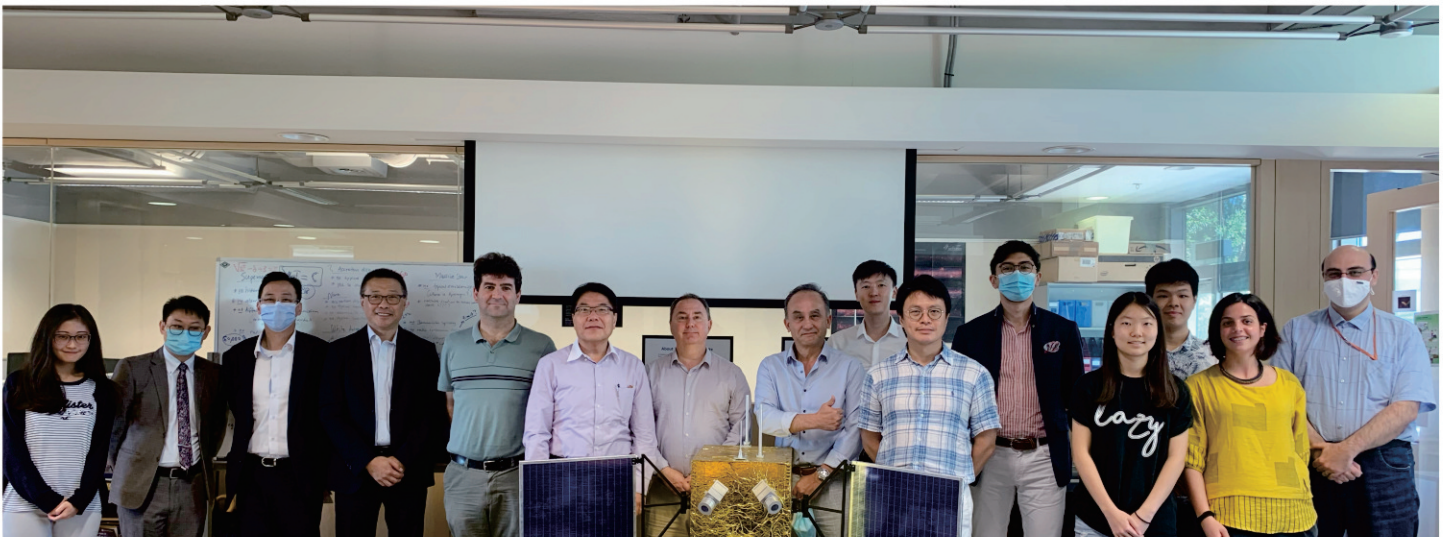
(see: [http://english.csu.cas.cn/About\\_CSU/General\\_Information/](http://english.csu.cas.cn/About_CSU/General_Information/))



## VII B: Some current LSR initiatives



Cyberport-LSR-SinoAlpha Ventures group meeting 22<sup>nd</sup> May 2020 hosted by Dr. George Lam, Chairman of Cyberport. Helped set the science and scope for how the LSR, Cyberport's and SinoAlpha Ventures can work together effectively in the future and especially with the emerging local space economy.



Inaugural Orion Astropreneur Space Academy (OASA) meeting 4<sup>th</sup> June held at the LSR offices in Cyberport. Kick-off meeting to discuss how to leverage the launch of the Lobster Eye X-ray satellite and to develop the concept of the "Space Academy" where the LSR will play a key supporting role.





May 28<sup>th</sup> 2020, OpenTV film crew, LSR Cyberport filming and interview for TV program on spaceflight and “Lobster Eye” X-ray Satellite led by NJU-HKU.



August 8<sup>th</sup> 2020, meeting between LSR Director Prof. Quentin Parker, HKATG Chairman Mr. Wen, Cyberport Chairman Dr. George Lam, and SinoAlpha Ventures Chairman Mr. Gregg Li and associates and investors. Subsequent to this meeting HKATG and the LSR are working on a new MoU.



## VII. C: Miscellaneous LSR Knowledge Exchange events

June 6<sup>th</sup> 2020, see:

<https://www.youtube.com/watch?v=BbRqKpWYj8o>



Professor Quentin Parker, director of LSR, was interviewed by HK Open TV on the NJU-HKU Lobster Eye X-ray Satellite on 28 May 2020. He shared the significance of this HK SAR first science mission satellite and devotion to nurturing the young generation in space science. The satellite carries a small “lobster eye” X-ray telescope, designed to hunt for clues of elusive “dark matter” in our universe. It was broadcast on July 11, 10:00pm, on HK Open TV, Chanel 77. For the full video, you can click this link (start from 18:14): <http://www.hkopentv.com/#/videopage/BW02128?t=13m02s>





Rocket ready for launch on July 25<sup>th</sup> 2020 with the Lobster-Eye X-ray Telescope whose science mission is co-led by HKU-LSR (Dr. Meng Su, co-science lead).



Nanjing University team members, HKU-LSR Deputy Director Dr. Meng Su and science lead and Dongguan Science & Technology Bureau representative just prior to launch of the "Lobster Eye" X-ray satellite, July, July 25<sup>th</sup> 2020 with the rocket in background.





## Faculty of Science, The University of Hong Kong

4 December 2019 ·

HKU Laboratory for Space Research (LSR) offers postgraduate study opportunities in the areas of planetary science, high energy astrophysics, evolved stars and space science.

Come explore more about LSR at [www.lsr.hku.hk](http://www.lsr.hku.hk) !

#hkuslr #spaceresearch #astrophysics #planetaryscience



UNIVERSITY OF HONG KONG  
**LABORATORY FOR SPACE RESEARCH**



**Focus Feature:**  
**PLANETARY SCIENCES & PLANETARY NEBULAE**

### OUR MISSION & VISION

**01** To emerge as a leading interdisciplinary research centre in Space and Planetary Sciences across the Asian region with a strong identity.

**02** To maintain and Grow the LSR to be an internationally recognised brand for research excellence in mainstream Space Science & related programs

**03** To strengthen and develop our ties to the Mainland Space Science program and globally

### OUR KEY RESEARCH AREAS

THE LSR has 45 current members across the HKU faculties of science and engineering. We have world class scientists engaged in cutting edge research across two broad areas of **PLANETARY SCIENCES** and **HIGH ENERGY ASTROPHYSICS**. We cover everything from cosmic-rays, pulsars, supernovae and planetary nebulae to space weather, remote sensing and deep space missions focussed on terrestrial planets and asteroids

### POSTGRADUATE OPPORTUNITIES

- HIGH ENERGY ASTROPHYSICS
- LATE STAGE STELLAR EVOLUTION
- THEORETICAL ASTROPHYSICS
- COMPUTATIONAL ASTROPHYSICS
- SPACE WEATHER
- DEEP SPACE SATELLITE MISSIONS
- PLANETARY SCIENCES

**NEW MSc IN SPACE SCIENCE**

- Due to start in Sept. 2020
- Elite taught postgraduate program

### OUR KEY PARTNERS

We have formed strong strategic alliances via a series of key MoUs with important partners in the Chinese Mainland and Globally such as Padovana-CISAS, the National Astronomical Observatories of China, BISM, SAST, Zhejiang and Nanjing Universities and Dongguan. These form the basis of our activities, projects and expansion plans

### PSML

Planetary Spectroscopy & Mineralogy Laboratory

- We are highly engaged in planetary science, applying theoretical, observational and experimental approaches to exoplanets in deep space, planets in this Solar System and exotic environments on this planet that are analog geological settings for other planets.
- We explore other planets via remote sensing and spectroscopy. Spacecrafts sent to the Moon, Mars, Jupiter or other objects return rich geological, geochemical and mineralogical information about planetary surfaces.

See: <https://www.clayspace/research>

- Infrared spectroscopy of the ancient crust of Mars is used to characterize the planet's mineralogy, habitability and astrobiology.
- Radar remote sensing of Venus is applied to understand if plate tectonics started and how it might have started on the Earth.
- To support these activities we have developed laboratory facilities focused on UV, visible and infrared spectroscopy. This equipment characterizes samples from important planetary analog sites on Earth, such as the Qaidam Basin in western China - one of the most Mars-like places on Earth. By applying laboratory studies to rocks, minerals and soils from Qaidam and other important sites we can understand fundamental planetary geological processes, and better interpret data returned from spacecraft.



**POTENTIAL** @HKU

- Planetary Nebulae (PNe) are the ejected ionised envelopes of low to intermediate mass stars at the end of their lives and are a key window into late stage stellar evolution.
- Our HK group is one of the strongest in the world and has published 4 Nature and Nature Astronomy papers on PNe in the last 2 years.
- We are actively seeking PhD students to join the group that wins time on the world's premier telescopes such as ESO VLT on a regular basis.



Montage of PNe arranged in a spiral pattern according to physical scale. See paper by Frew, Parker & Bojdo (2015) and HKU press release.

Latest research: [https://www.hku.hk/press/news\\_detail\\_19632.html](https://www.hku.hk/press/news_detail_19632.html)

**website: [www.lsr.hku.hk](http://www.lsr.hku.hk)**



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## APPENDIX VIII

### **LSR Current Membership List (41 members as at 26<sup>th</sup> August 2020)**

<b>Name</b>	<b>Title</b>	<b>University/ Institute</b>	<b>Faculty</b>	<b>Department</b>
Quentin Parker	Director, Professor	HKU	Science	Physics
Meng Su	Deputy Director, Associate Professor	HKU	Science	Physics
Joseph Michalski	Deputy Director, Associate Professor	HKU	Science	Earth Science
Denis Bastieri	Chair Professor	University of Padova (Italy); & Guangzhou	Science	Physics and Astronomy
Kamila Chan	PhD Research Postgraduate Student	HKU	Science	Physics
Stephen Cheung	Adjunct Professor	HKU	Business	Physics
Yoyo Chu	PHD student	HKU	Science	Earth Sciences
Charles Cosgrove	Senior Research Assistant	HKU	Forensic Science	Faculty of Science
Lixin Dai	Assistant Professor	HKU	Science	Physics
Xuan Fang	Research Professor	HKU	Science	Physics
Chih-Hao Hsia	Assistant Professor	MUST, Macau (exHKU)	Science	Lunar & Planetary Sciences
Jed Kaplan	Associate Professor	HKU	Science	Earth Sciences
Thomas G. Kaye	Director, Foundation for Scientific Advancement	Arizona, USA	Science	Astrophysics
Fiona Kwok	Assistant Professor	HKU	Engineering	Civil Engineering
Sun Kwok	LSR Founding Director, Professor Emeritus	UBC, Canada / HKU	Science	Earth, Ocean Atmospheric
Gregg Li	Adjunct Professor	HKU	Business	Physics
Foteini Lykou	Postdoctoral Fellow	Konkoly Obs., Hungary (ex HKU)	Research Centre for Astronomy and Earth Sciences	
Ryan McKenzie	Assistant Professor	HKU	Science	Earth Sciences
Diganta Misra	Senior undergraduate student	HKU	Engineering	Electrical & Electronic Engineering
Takashi Nakagawa	Associate Professor	HKU	Science	Earth Sciences
Stephen Ng	Associate Professor	HKU	Science	Physics



Tze Chuen Ng	Consultant Professor Beijing Spacecrafts	Chinese Space Agency/ HKU	Design	N/A
Aiuhua Qi	LSR Consultant (Shanghai), Director of Youguan Incubator	Shanghai, China	N/A	N/A
Michael Pittman	Research Assistant Professor	HKU	Science	Earth Sciences
Rosaria Prochilo	MSc Student	University of Padova/HKU	Engineering	Physics
Andreas Ritter	Postdoctoral Fellow	HKU	Science	Physics
SeyedAbdolreza Sadjadi	Postdoctoral Fellow	HKU	Science	Physics
Pablo Saz Parkinson	Research Assistant Professor	HKU	Science	Physics
Kris Stern	PhD Research Postgraduate Student	HKU	Science	Physics
Alex Webb	Associate Professor	HKU	Science	Earth Sciences
Zhou Wenhan	PhD Research Postgraduate Student	HKU	Science	Physics
Kenneth K. Y. Wong	Professor	HKU	Engineering	Electrical & Electronic Engineering
Shawn Wright	Postdoctoral Fellow	HKU	Science	Earth Sciences
Jin Wu	Assistant Professor	HKU	Science	Biological Sciences
Zexi Xing	PhD Research Postgraduate Student	HKU	Science	Physics
Fengwei Yang	PhD Research Postgraduate Student	HKU	Science	Physics
Philip Leung Ho Yu	Associate Professor	HKU	Science	Statistics and Actuarial Science
Binzheng Zhang	Assistant Professor	HKU	Science	Earth Sciences
Yong Zhang	Professor	Sun Yat-Sen University	Science	Physics and Astronomy
Birry Bingrong Zhu	LSR Laboratory Assistant	HKU	Science	Faculty of Science
Albert Zijlstra	Hung Hing Ying Distinguished Visiting Professor	University of Manchester/ HKU	Jodrell Bank Centre for Astrophysics	Physics and Astronomy



