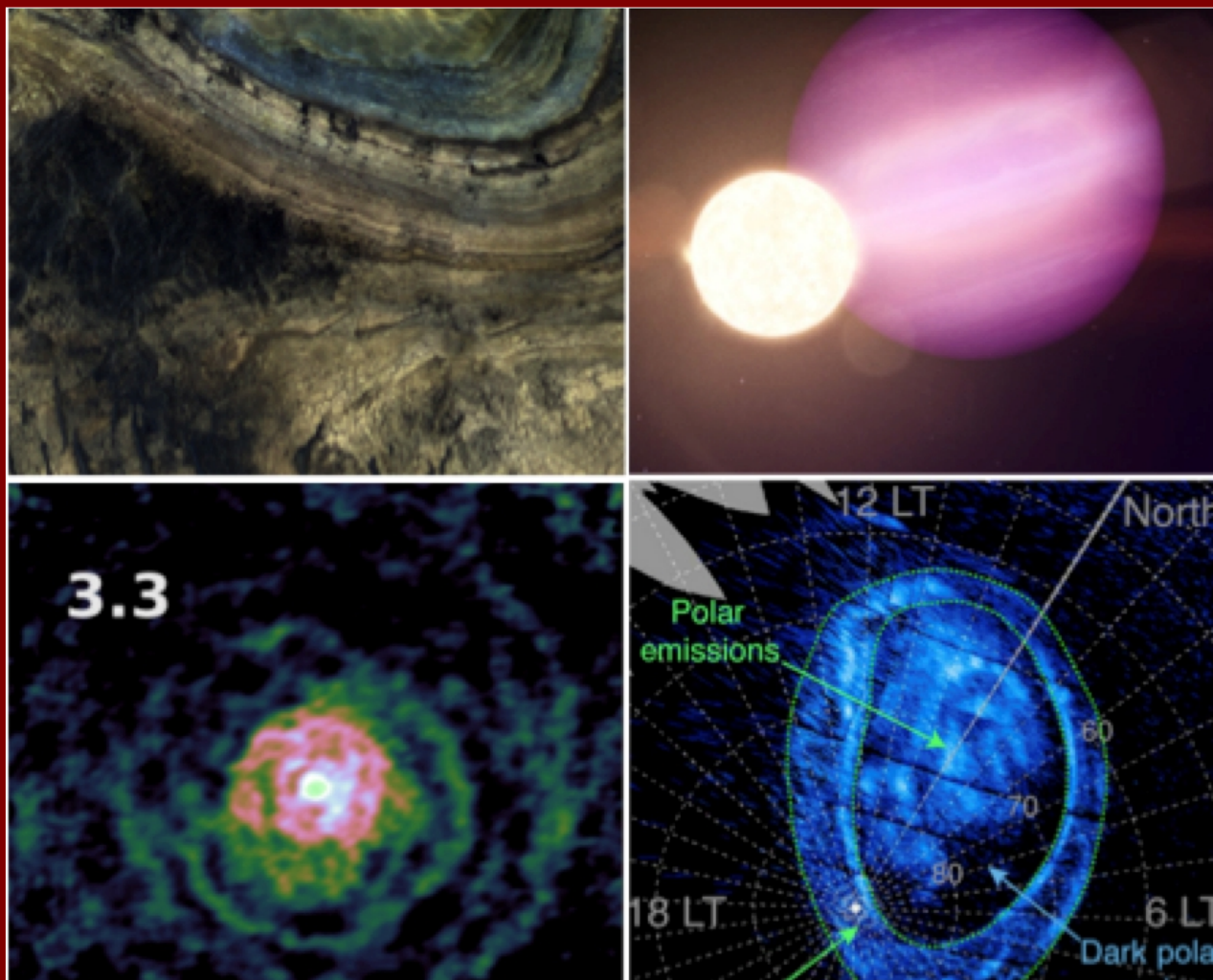


Laboratory for Space Research Annual Report 2021

Faculty of Science
The University of Hong Kong



From 1st September 2020 to 31st August 2021

Prof. Quentin Parker
Director LSR

Dr. Meng Su (til 23/3/21) & Dr. Joe Michalski
Deputy Directors LSR

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2021 LSR Annual Report

From 1st September 2020 to 31st August 2021

Foreword by the LSR director, Prof. Quentin Parker



It gives me great pleasure to present the second annual report for the Laboratory for Space Research. There is no denying that with the global Covid pandemic it has been a very difficult year for most of us. We have been unable to travel for field trips to gather science data, to go to conferences in person to present our research or to meet with collaborators. Zoom is all very well and has been vital for some semblance of continuity but it is far from ideal. Nevertheless, I can report that this has been another outstanding year for the LSR! This continues to be based on the enduring level of success we have shown over the last 12 months as recorded in this 2nd report. Above all else it is the dedication and quality of our members that drives all our activities, positive initiatives and achievements. I remain very proud to be able to serve the LSR and Faculty of Science at HKU and to be surrounded by a collegiate, supportive and caring group of colleagues.

I would like to express particular thanks to our Laboratory manager Ms. Birry Zhu for her outstanding technical and administrative support, including with helping with the annual reports and Ms. Mila Ho, her excellent temporary maternity leave replacement. I also want to express my heartfelt gratitude to my deputy directors Dr. Meng Su and Dr. Joe Michalski. Dr. Su left HKU at the end of March 2021 but remains an HKU honorary Associate Professor and LSR affiliate. He will continue to support us strongly from the Mainland. I hope you enjoy reading this report and can see clearly the evidence that shows the value to HKU of this vibrant, vigorous and impactful interdisciplinary centre.

With my best wishes

A handwritten signature in blue ink, which appears to be 'Q. Parker'.

Professor Quentin Parker

柏坤霆教授

September 1st 2021

1. Executive Summary of LSR activity 2020-2021 by the numbers

- 64 LSR members across 5 departments and 2 faculties (c.f. 15 in 2017 and 41 in 2020 so strong growth, 56% over the reporting period, continues)
- HK\$98 Million in Grants: 5 LSR RMGS (~HK\$79 M), 2 LSR affiliated RMGS award (HK\$12.5 M) and 8 GRF/seed LSR grants (~HK\$6.45 M).
- 3 MoUs signed with: Orion Astropreneur Space Academy (OASA); The HKU-Academy for the talented; The East Asian Observatory (EAO)
- 10 publications by LSR members in top journals: 4 in Nature, Nature Astronomy & Nature comms., 1 in Science, 2 in Science Advances, 1 in Science Bulletin, 1 in Physical Review Letters & 1 in Space Science Reviews
- 111 refereed publications in total (~6 ref. papers per faculty member)
- 6 major press releases and many associated news stories
- 43 TV interviews, newspaper interviews and radio show contributions – a big increase in activity resulting from the burgeoning Chinese Space scene
- 5 major initiatives commenced:
 - Joined Chinese Space Station Telescope GBA Consortium
 - Joined East Asian Observatory (EAO) as an Associate member
 - Established a foundational STEM initiative “BEST” for HK high schools with our OASA and HKU academy for the talented partners
 - Partnered with Kiron refugee university to record a special “LSR series” of 9 lectures for refugee students (see Sec 9.3)
 - Commenced 6U MeV Cubesat program under RMGS funding
- Key LSR achievements over the reporting period includes:
 - Successful operation of the “Lobster Eye X-ray Satellite” following July 25th 2020 launch; HKU co-leads the science mission with NJU
- 17 Interns hosted, including 3 from University of Chicago USA (via Zoom supervision) under the dynamic LSR Internship program, the most robust and successful internship program in the FoS (see special focus in Sec 9.2)

2. Our LSR Mission, Vision & Brand remains unchanged and undimmed

- 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

2.1 Updated LSR website with Chinese Language Version

As part of our mission to broaden our reach and grow our profile in the Chinese Mainland, in the first half of 2021 we undertook a major revamp to our LSR web pages. This included the development of a parallel translated version in Chinese. An example page of this LSR Chinese website is shown below.



2.2. New Formal LSR Governance Structure Established

With the expansion and emergence of the LSR as a powerful, interdisciplinary entity, with a burgeoning brand and profile and with a range of important projects and initiatives that promise significant impact, the FoS decided to place the LSR's operation on a more formal footing. Hence, to also alleviate some of the difficult problems and issues in operating under departmental processes, a new governance structure was implemented in October 2020. The LSR adopts the Good governance principles based on the Progressive Good Governance guidelines as below:



We adhere to good governance guidelines – creative commons graphic.

LSR operational parameters

The LSR is an interdisciplinary entity under the Faculty of Science and the following base-level operational parameters have been set.

- The LSR director reports directly to the Dean
- The LSR director is responsible for its management and for setting its strategic direction in consultation with LSR members
- The LSR director has the authority to negotiate agreements and MoUs on behalf of the LSR
- The Faculty is then responsible for approving research proposals such as the LSR RGMS and other LSR specific grant spending which concern the LSR as an entity
- The Faculty of Science is responsible for approving agreements, contracts, MoUs etc. following established procedures
 - This includes, where relevant, approval by the Faculty Board and/or involvement and checking by TTO and/or Research Services
 - Copies of the approved agreements, contracts, etc. will be provided to the relevant RDDs for their information and reference after the approval process has been completed

LSR Advisory Board

To assist with oversight and management a formal LSR advisory board was established in October 2020 as an official committee of the FoS. It has the following terms of reference. To:

1. Advise the Faculty of Science Board on all academic matters relating to the Laboratory for Space Research (LSR hereafter).
2. Report annually to the Board of the Faculty of Science on the activities of the LSR.
3. Advise on the program of activities and strategic development of the LSR.
4. Advise on suitable candidates for visiting research appointments in the LSR.
5. Recommend appointment of the Director of the LSR.

Membership of the LSR Advisory Board

1. The Membership of the LSR Advisory Board is as follows:
Dean or Associate Dean (Research and Graduate Studies) of Faculty of Science (Chairperson).
2. The Director of the LSR or his/her delegate (to be one of the Deputy LSR Directors).
3. The Research Division Directors of Physics & Astronomy and Earth & Planetary Science (or his/her nominee(s)).
4. Three teachers of the Faculty of Science who work wholly or partly at the LSR, at least one each from the Divisions of Physics and Astronomy, and Earth and Planetary Science as appointed by the Board of the Faculty of Science (appointments 2 years, renewable).
5. At least one, and not more than three, reputable and relevant international scientists who are not members of the University staff, as nominated by the Dean of Science, and appointed by the Board of the Faculty of Science (appointments 2 years, renewable).
6. Not more than three other members, co-opted by the Advisory Board (appointments 2 years, renewable). To include at least one industry or government representative to represent views of non-academic stakeholders.

3. Summary of Current LSR Membership

There are currently 64 LSR members from 5 departments and 2 faculties including various affiliates from outside HKU (www.lsr.hku.hk/members/). This compares with 41 members for the last report in 2020 and 15 when first established in 2017. Our strong pattern of growth (56% this year) continues.

We are an open, inclusive and free association of HKU faculty (18), RAPs (2), postdocs (7), RPG students (15), RAs (3), undergraduates (6) and external associates (12). 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 wish to maintain strong ties, but they are so indicated. We have selectively allowed some particularly important outside associates as members where this is seen as beneficial to the LSR, but we limit these. The current membership list does not include interns (17 this summer – see Section 9.2). We have 15 ex-members who have left HKU. The full membership list is given in Appendix V.

4. Budget and Funding

Currently there is no ongoing annual HKU budget allocated that supports the LSR but we hope this will change. 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 members (Meng Su, Joe Michalski and Binzheng Zhang) and then by a HK\$10 million BRC in October 2018 meant for HKU-ZIRI that included 5 million RMB for our first satellite (the Lobster Eye X-ray satellite launched July 25th 2020). The BRC grant remains active until December 2022 with ~HK\$1.5 million still available as of August 2021.

Despite the above success it is clear a secure, adequate, HKU based funding stream is required given the nature of our activities. We cannot rely in future on one-off schemes like the fortuitous appearance of the RMGS to survive.

4.1 UGC Research Matching Grant Scheme (RMGS)

Our ability to function has lately relied on the RMGS scheme. Success in Rounds 1, 2, 4, and 5 for five LSR RMGS proposals led by Parker & Su brought in HK\$79.0 million after UGC review. Further LSR affiliated applications from Michalski and Webb (round 5) provided a further HK\$1.9 and HK\$10.6 million respectively. Remarkably, these combined LSR grants accounted for >20% of all HKU funding awarded via this scheme.

4.2. RGC General Research Fund (GRF) and Collaborative Research Fund (CRF)

Individual LSR members remain very active in winning RGC GRF and ECR grants with 27 such grants over the last 4 years, including 8 LSR faculty who won grants in the 2021 GRF round relevant to this report (cf 7 LSR faculty last year). Indeed GRF success in Physics and DES was very disappointing this year overall but 2/5 Physics grants were to LSR members and 3/6 DES grant were also to LSR members. Two GRF grants also went to LSR members in the Faculty of Engineering and one to our sole SBS LSR member. These GRF grants brought in HK\$5.67 million at an average of HK\$700K/grant. 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 , usually worth several million HKD annually. Dr Joe Michalski also currently leads a shortlisted CRF grant application so we hope for positive news here soon.

5. Research Activities

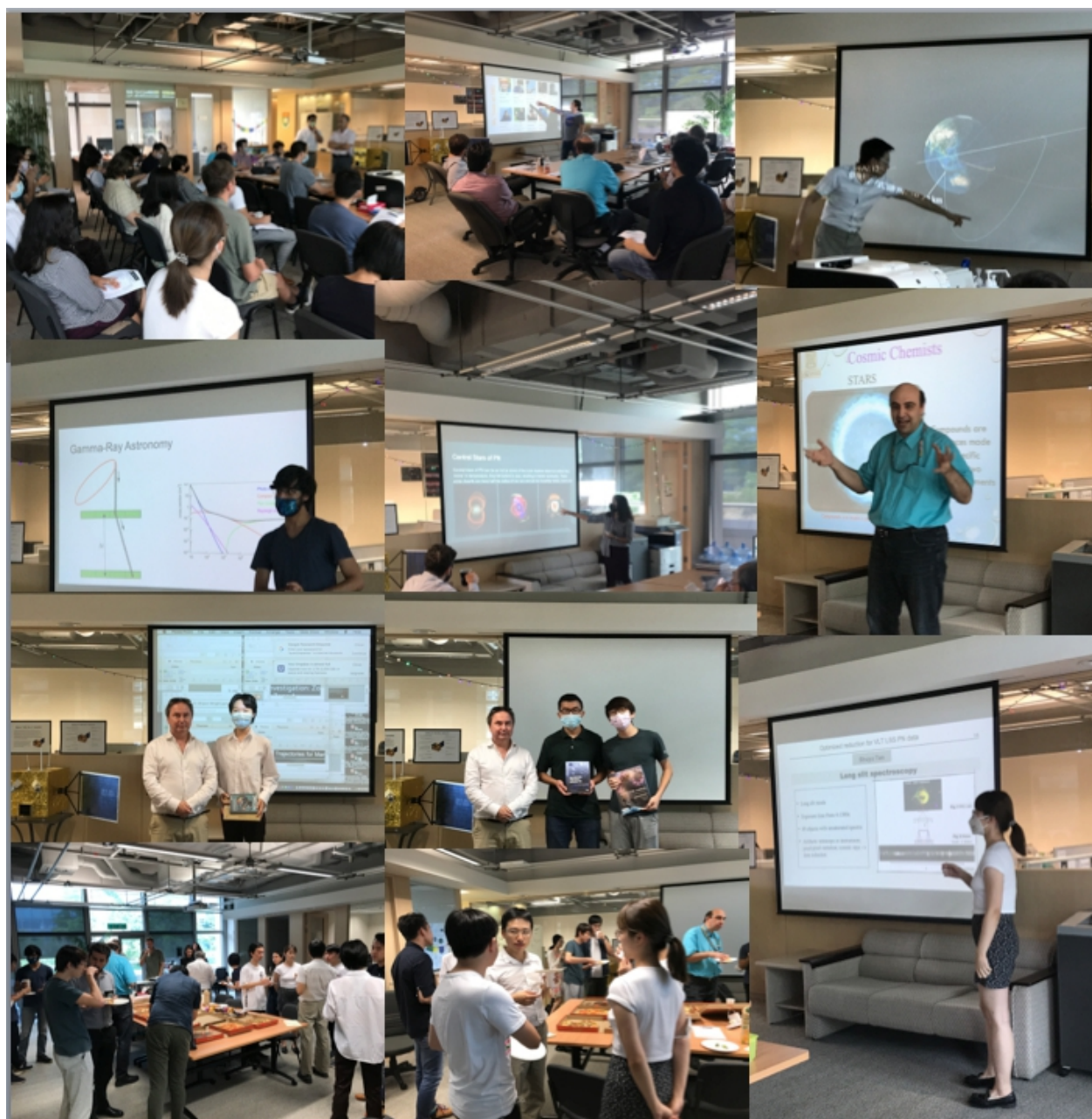
Members have a vibrant, active and diverse interdisciplinary research program (see: <https://www.lsr.hku.hk/research/>). Members engage in multi-disciplinary research including high-energy astrophysics from ground-based and satellite-based detectors; space-based Earth remote sensing; atmospheric science, near Earth environment, planetary and associated geological sciences with an emphasis on terrestrial planets, and late stage stellar evolution, including planetary nebulae and supernova remnants. We have added recent expertise in CubeSat engineering as we continue to emerge as a strong interdisciplinary entity at HKU.

LSR Distinguished Visitors Program: The LSR normally promotes a vigorous distinguished visitor program. Unfortunately, due to severe Covid restrictions in Hong Kong we have been unable to host any international visitors this year including our Hung Hing Ying distinguished professor Albert Zijlstra. As soon as the global pandemic eases we will seek to robustly address this.

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. A few specific highlights from the reporting year are given below but a more comprehensive listing from individual members is given in Appendix I.

5.1 The LSR Research Jamboree

Due to Covid, it was impossible for the LSR to attend or run significant international meetings this year. We did however run an LSR Research Jamboree on 30th July 2021 at the LSR Laboratory in Cyberport. This inaugural LSR research Jamboree was attended by about 30 members and interns who participated in a fun afternoon where 23 speakers picked from Faculty, RAPs, postdocs, RPG students and our cohort of undergraduate and high-school summer interns, each had 5 minutes to present a snapshot of their research. At the end, prizes for the best Undergraduate and High School presentations were awarded by a 3-person panel of judges of senior LSR members. The whole event was topped-off by a Pizza and Drinks party.



Montage of selected photos from the event held Friday July 30th 2021.

HKU Laboratory for Space Research

Inaugural Research Jamboree

Friday 30th July 2021

Final Program – Each Talk is 5mins (max 1 min for questions)

Session 1 – Faculty, RAPs, PDFs

| | <i>Speaker</i> |
|---|-------------------------|
| 3:00 The LSR: the Good, the Bad and the Sparkly | Quentin Parker |
| 3:05 OASA: The Orion Astropreneur Space Academy | Justin Yam/ Gregg Li |
| - a new force for change in HK SAR Space thinking | Joe Michalski |
| 3:10 The most important thing about Mars | Alex Webb |
| 3:15 Tectonics Research: Lithospheric Dynamics & Planetary System Interactions | David Yu |
| 3:20 Bayesian Astrostatistics | Mike Pittman |
| 3:25 Laser based Mars Hunter Drone | Pablo Saz Parkinson |
| 3:30 Search for Very High Energy emission from a millisecond pulsar | Q Li (Joss) |
| 3:35 Estimates of forest structure and structure metrics from airborne LiDAR data | S. Sadjadi (Abdi) |
| 3:40 Cosmic Alchemy | Katie Strattman |
| 3:45 Wildfires in HK? Characterizing Fuels using LiDAR & Multispectral Imagery | Yushan Li |
| 3:50 Searching for PNe in VPHAS+ with AI Methods | Shuyu Tan |
| 3:55 Optimized reduction procedure for ESO 8m VLT PN Long-slit spectral data | |

4:00 Short “Bio” Break (10mins)

Session 2 – Mostly Intern (high-school: HS, Undergraduates: UG)

| | <i>Speaker</i> |
|--|-----------------------|
| 4:10 Exhuming Central Stars from their Galactic Graves: The Search for CS within elliptical PNe | Drisa (HS) |
| 4:15 The future of MeV Gamma-ray astronomy | Aditya (HS) |
| 4:20 Measuring the excitation class of HASH Planetary Nebulae - its hot stuff! | Jenny (HS) |
| 4:25 Search for gamma-ray emission from a population of FRBs. | Ethan (HS) |
| 4:30 Radial velocity of planetary nebulae spectra using cross-correlation | Keith (UG) |
| 4:35 Drill in drill: a possible development on a Mars drill based on an exciting concept by TC Ng | Kehan (UG) |
| 4:40 Machine learning at the pixel level to improve the low energy sensitivity of the MAGIC Telescopes | Adilet/Leo (UG) |
| 4:45 X-ray study of young Gamma-ray pulsars | Naixin (UG) |
| 4:50 NICER study of PSR J2021+4026 | Stella (UG) |
| 4:55 Automatic Generation of High-Accuracy Circumlunar Free-Return Trajectories for Manned Missions | Boris Yim |
| 5:00 PSML analyses of Martian rocks and terrestrial analogs mirror instrument data from Mars | Shawn Wright |

5:05 Wrap-up QAP; Prize ceremony for best High-School & undergraduate summer intern talks

5:05-6:30: Pizza, Poulet Roti, Peanuts, Pineapple Juice and Pinot (over 18s only)

UG and Intern Talk Judges:

Dr. Pablo Saz Parkinson, Dr. Michael Pittman, Dr. Sayedabdolreza Sadjadi

5.2 The PSML and initiatives (special focus for this issue)

WELCOME TO THE **PLANETARY SPECTROSCOPY AND MINERALOGY LABORATORY**, DESIGNED TO SUPPORT
ROBOTIC EXPLORATION OF THE SOLAR SYSTEM AND INVESTIGATE MINERALOGY AND BIOSIGNATURES IN
PLANETARY MATERIALS



The Planetary Spectroscopy and Mineralogy Laboratory: PSML <https://www.clays.space/lab> is an LSR affiliated lab run by LSR deputy director Joe Michalski. It has two primary missions. The first is to produce cutting edge hyper-spectral imaging across a wide range of spatial scales, from sub-micron scales to millimeters scale, to hand samples and higher. We use the data to investigate key textural-mineralogical relationships in rocks and meteorites, and to

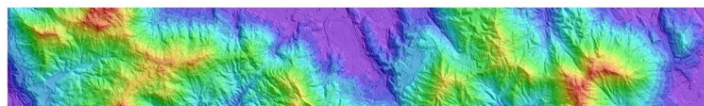
search for bio-signatures in rocks here on Earth. The second major goal is to provide support for planetary missions in Asia and around the globe. We explore the infrared and Raman spectral characteristics of materials analogous to those found on the Moon and Mars.

PSML has made further development of a smartphone app called RIMS (Reduce Identify Map Sort) for monitoring, characterizing and affecting plastics consumption and pollution. The initial software was completed in 2021 meaning that the app can now be installed. We are making progress with HKU TTO on issues related to certain legalities. On the technical side, we are making strides toward distributed computing of geo-located images related to documentation of pollution information.

In late 2020 the PSML also saw the roll out of their “LIDAR” data hosting systems facilitated by an HKU KE grant and run by Dr. Qiaosi Li and Dr. Joe Michalski.



LIDAR DATA FOR HONG KONG



DONATED TO HKU BY **DIMAP**
HOSTED BY THE **DEPARTMENT OF EARTH**
SCIENCES

DIMAP COLLECTED LIDAR DATA OF ~500 KM² OF HONG KONG IN NOVEMBER 2017 USING A RIEGL LMS-Q780 (WAVELENGTH 1064 NM) SCANNER. BOTH DISCRETE RETURN DATA AND FULL-WAVEFORM DATA ARE AVAILABLE. THE HIGH-QUALITY LIDAR POINT CLOUD IS DELIVERED WITH AN AVERAGE DENSITY OF 20 POINTS / M², UP TO SEVEN RETURN PER PULSE, AND BETTER THAN 10 CM ACCURACY IN ALL DIRECTIONS. THE DATA HAVE BEEN PROCESSED INTO SOME BASIC DATA PRODUCTS, INCLUDING DIGITAL TERRAIN MODELS AND DIGITAL SURFACE MODELS, AS WELL AS CORRESPONDING HILLSHADE MAPS. THE MAXIMUM SPATIAL RESOLUTION OF THESE RASTER DATA PRODUCTS IS 0.5 METERS PER PIXEL. THESE DATA, AS WELL AS RAW DATA (DISCRETE RETURN AND FULL-WAVEFORM DATA) OR OTHER DATA PRODUCTS ARE AVAILABLE FOR RESEARCH PURPOSES. IF YOU WOULD LIKE TO KNOW MORE ABOUT THE AVAILABLE DATA, PLEASE FILL IN AN INQUIRY FORM BELOW AND WE WILL GET BACK TO YOU AS SOON AS POSSIBLE.

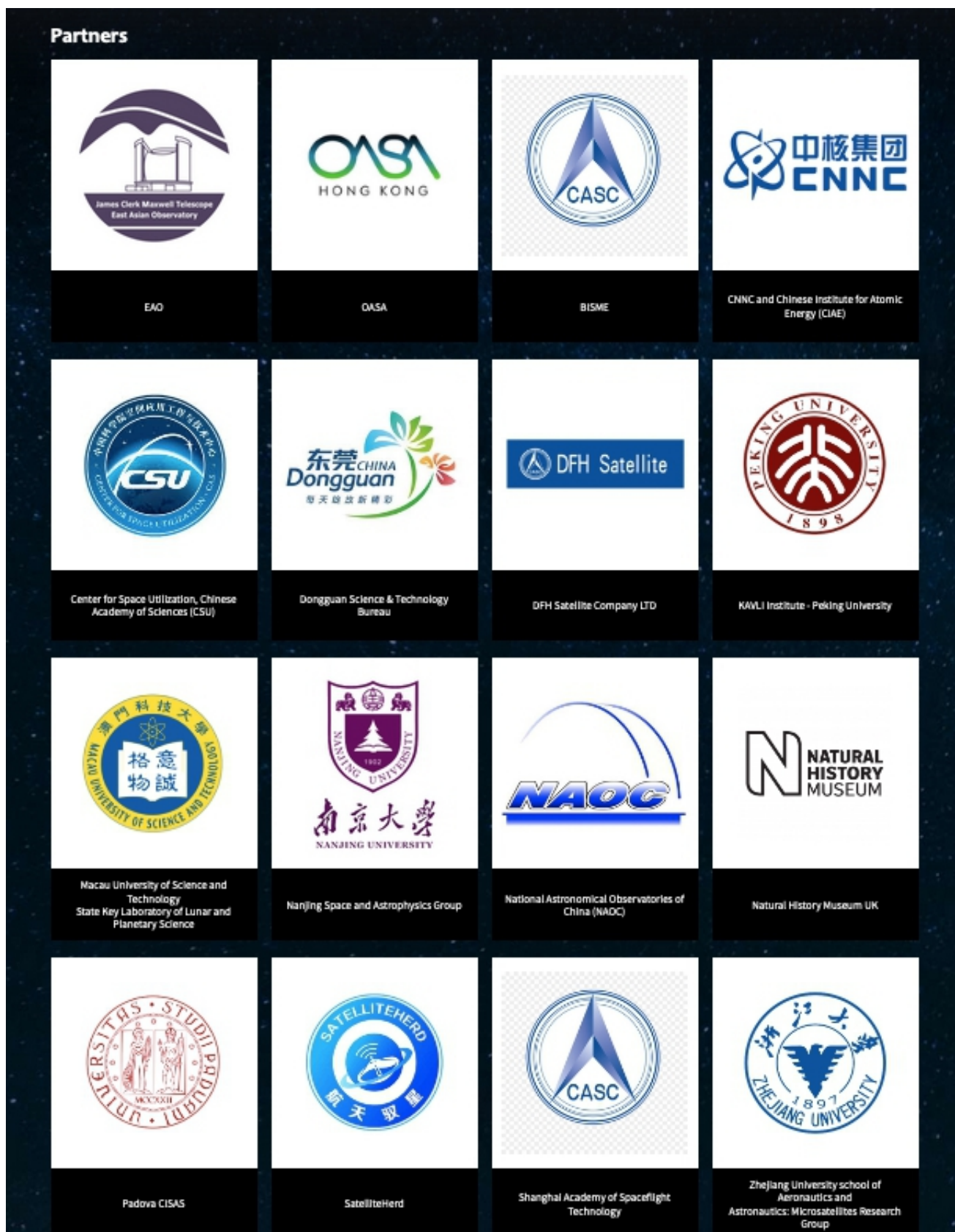


And finally in 2021 PSML saw the delivery and installation of their new micro/nano-Raman instrument in the PSML. This device is capable of identification and mapping of crystalline and amorphous phases down to ~100 nm spot sizes and is a powerful addition to their characterization and measurement capacity.



Renshaw micro/nano-Raman instrument.

6. Collaborations and Partnerships



Official logos of all current, formal LSR partners. All partnerships have been established via signed MoUs and agreements.

The LSR currently has 20 active MoUs and agreements starting with the first in October 2017 and the most recent in May 2021. We have been proactive and highly strategic in establishing many key international collaborations and partnerships that often lead to MoUs. 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 create joint, impactful endeavours. The LSR only teams-up with the highest quality partners possible – the most influential, leading, and significant. We are not interested in collecting scraps of meaningless paper. The MoUs signed over the 2020-2021 reporting period are summarized below.

6.1. MoUs and agreements signed over the reporting period

The LSR signed 3 MoUs and agreements over the period. This is lower than in previous years but simply reflects the fact that our primary Mainland and International partnerships for such things have now been largely realised over the last 3 years in particular. This year’s signings are very important and associated with i) access to international observing facilities and the associated organization ii) involvement with a key new HK SAR based NGO in the Space Economy and iii) LSR leadership in a new STEM based educational initiative around CubeSats.

I. MoU with The East Asian Observatory – November 2020

The University of Hong Kong (HKU) under the auspices of the Laboratory for Space Research (LSR), Faculty of Science signed an MoU with the East Asian Observatory (EAO) in November 2020. HKU thereby becomes an associate partner of this international organisation for 3 years in the first instance, and proudly becomes a member of another elite club that has aspirations to grow into the Asian equivalent of the European Southern Observatory. EAO currently consists of Japan, South Korea, Mainland China and Taiwan as full members, with Indonesia, Malaysia, Thailand and Vietnam as observers, and with India currently working on becoming a full member.

The EAO currently operates the James Clerk Maxwell Telescope (JCMT). This 15-meter telescope is located on the summit of Hawaii’s Maunakea and is the largest single-dish telescope in the world designed to operate at submillimeter wavelengths. Our associate partnership gives us 2.5 nights/year guaranteed time on this facility each year (but with the opportunity to get much more) together with technical and administrative support and much else besides. This includes unique pathways and opportunities for international collaborations. As an associate partner of the EAO, LSR members can access all the facilities that the EAO operates, as well as other facilities to which EAO will have access to in the future. The EAO also acknowledges HKU as one of the university partners of the National Astronomical Observatory of China (NAOC) under the Chinese Academy of Sciences.



Image of the JCMT sub-mm telescope atop Mauna Kea on the large island of Hawaii.

II. Collaborative Agreement with OASA: The Orion Astropreneur Space Academy – March 2021

From their website “The Orion Astropreneur Space Academy in Hong Kong (OASA) is an independent, non-political, and not-for-profit action-oriented leadership development academy for global young leaders with stellar and outer space aspirations. The Academy is a member of the global leadership development initiatives with other space onboarding and off-boarding institutions such as the Laboratory for Space Research at the University of Hong Kong, and other forward-looking and space-related institutions and world-class educators who believe together we can connect, contribute, and command.” The LSR had the honour of the being the first organization to have a formal signed agreement with the new NGO OASA ([see: https://www.oasahk.org/](https://www.oasahk.org/)). The LSR was a foundational supporter of OASA involved in and supporting its establishment from the beginning. The LSR director Prof. Quentin Parker serves on the OASA board in an unremunerated capacity (<https://www.oasahk.org/team-oasa>).



LSR director Quentin Parker (left seated) and OASA Chairman Gregg Li (right seated) sign the formal collaborative agreement between the LSR and OASA with witnesses Dr. Pablo Saz Parkinson from the LSR (left standing) and Mr. Perry Lam, OASA deputy Chairman (right standing).



LSR and OASA members celebrating after the formal collaborative agreement signing.

III. 3-way MoU with HKU Academy for the Talented , OASA and the LSR

On May 27th 2021, at 2:30pm, the HKU Academy for the talented (<https://talented.hku.hk/>), the Orion Astropreneur Space Academy (OASA: <https://www.oasahk.org/>) and the LSR signed a 3-way MoU on a foundational STEM interdisciplinary program that will launch in September 2021. We plan to jointly offer a first-of-its-kind Space Technology initiative in Hong Kong named the “Business Economy for Space Technology (BEST)” programme for secondary school students.



LSR director Prof. Quentin Parker (left), Prof. Bennett Yim, Director of Undergraduate Admissions and International Student Exchange of the University of Hong Kong (middle) and OASA Chairman Gregg Li (right) sign the 3-party MoU.



Attendees from the LSR, OASA and the HKU Academy at the LSR in Cyberport in mid May 2021 for MoU signing.

6.2. The East Asian Observatory LSR Initiative

The MoU with the EAO (<https://www.eaobservatory.org/>) was a strategic move on the part of the LSR. However this step was not taken lightly given our annual associate membership subscription is US\$50,000/year for 3 years. To gauge LSR membership support to take this path the LSR executive initiated a trawl of members to seek their opinion on joining and supporting the signing of the MoU given scepticism from the HKU Physics department HoD about whether this initiative enjoyed LSR membership support before he would allow the MoU to proceed. Such issues contributed to establishment of the new LSR operational parameters and governance by the Faculty of Science. Of the 40 LSR members available at the time of the trawl 34 replied for an 85% response rate. Of the replies 33 answered “YES” and one abstained. This is an 82.5% overall positive response. Of the 21 LSR members who are faculty 19 responded YES (90.5% positive response). One did not reply and one abstained.

The University of Hong Kong, via the LSR, strives to play an important role in strategically positioning astrophysics, space and planetary research of both HKU and Hong Kong SAR at a higher level. This EAO associate partnership puts HKU in a special position as all other full members are the top bodies from Mainland China, Japan, South Korea and Taiwan. Thailand and Indonesia are represented by their National Observatories and Malaysia and Vietnam by their top universities. We were invited to join the EAO partly because of a successful LSR initiative to propose the EAO through NAOC to set up its international headquarters in Dongguan*, at a shared site with the proposed HKU-LSR “INSPIRE” lab (INSPIRE: International Space and Planetary Institute for Research Excellence).

The LSR believes that by joining the EAO, we demonstrate our clear international vision for the bright future of international Asian focused astrophysics research and infrastructure. Although HKU has taken this new step, to go with our earlier MoU with the NAOC, we hope our sister universities and colleagues across HKSAR and indeed Macau SAR will join us in a united front, where our scientists can play key roles in moving Asian astrophysics research forward in a true spirit of trust and collaboration.

See: <https://www.hku.hk/press/press-releases/detail/21895.html> for details.

*due to HKU developments and plans for the new HKU campus in the GBA INSPIRE is now likely to be established in Shenzhen

6.3. Membership of the GBA Chinese Space Station Telescope (CSST) Centre

On the 19th September 2020 the LSR became a member of the new GBA CSST centre being established at SYSU in Zhuhai during an official launch ceremony where HKU-LSR was represented by LSR deputy director Dr. Meng Su. Membership will provide direct collaborative access opportunities for the 2m UV/Optical wide-field Space Telescope associated with the Chinese Space Station, due for launch in 2024. The first serious kick-off meeting was held via Zoom on 19th August 2020 with HKU-LSR represented by LSR director Prof. Q.A. Parker and now LSR affiliate and HKU Honorary Associate Professor Dr. Meng Su.



Official opening of the GBA CSST centre at SYSU Zhuhai –HKU logo can just be made out on the plaque



After the official launch:
At right CSU director General Gao Ming with Dr. Meng SU deputy director LSR 2nd from Right and 3 other senior CAS/SYSU representatives

中国空间站工程巡天望远镜粤港澳大湾区科学中心 CSST Science Center for the Greater Bay Area



- Kick-off telecon, 10:00-11:00am, Tuesday 17 August 2021
- Member institutions (ordered alphabetically):



CUHK
香港
中文



GXU
广西
大学



GZHU
广州
大学



HKU
香港
大学



HKUST
香港
科大



HUST
华中
科大



MUST
澳门
科大



PolyU
香港
理工



SCNU
华南
师大



SCUT
华南
理工



SYSU
中山
大学



XMU
厦门
大学

- Participants (confirmed but incomplete):

CUHK: 朱明中, 严人斌

GXU: 梁恩维

GZHU: 樊军辉

HKU: Quentin Parker, 苏萌

HKUST:

HUST: 吴庆文

MUST: 张可可, 蔡涛

PolyU: 余长源

SCNU: 李乡儒, 张金区

SCUT: 张向东

XMU: 方陶陶

SYSU: 李成, 黄志琦, 余聪
李程远, 马波, 汪洋

First kick-off meeting for the new GBA CSST Science Centre 17th August 2021

7. Selected Contributions and Achievements

1. The LSR participated in two important Webinars run by OASA in December 2020: i) Future of the Space Economy – How to build your own satellite and ii) Doorways to the Space Economy.



Landing About OASA ▾ Learn More ▾ ... ▾ Login f in @

Login

2020 Events



Play Back

Doorways to the Space Economy. (OASA and Cyberport Quarterly)

17 Dec 2020 | Webinar

Brought to you by the new Orion Astropreneur Space Academy (OASA) and Cyberport, this panel of venture capitalists, investors, and teachers shall aim to change your mindsets about space. Space is no longer a mystery and unreachable. Space and the businesses that will seed the next generation of businesses have already started. Moderated by Mr. Perry Lam, Vice Chairman of OASA, this series of short discussions make you realise the Space Economy is already here.

Prof. Quentin Parker of the Lab for Space Research at HKU; Mr. Furuzonfar Zehni, Partner at Fresco; Ms. Rosana Wong, founder of Ophylla Ventures and Executive Director of Yau Lee Holdings; Prof. Lin Hui, Chief Scientist of HKATC; and Prof. Gregg Li, Chairman of OASA, opened our eyes to a new reality.

Free for all to view.



Play Back

OASA x The Wave: Future of the Space Economy - How to Build Your Own Satellite

01 Dec 2020 | Webinar

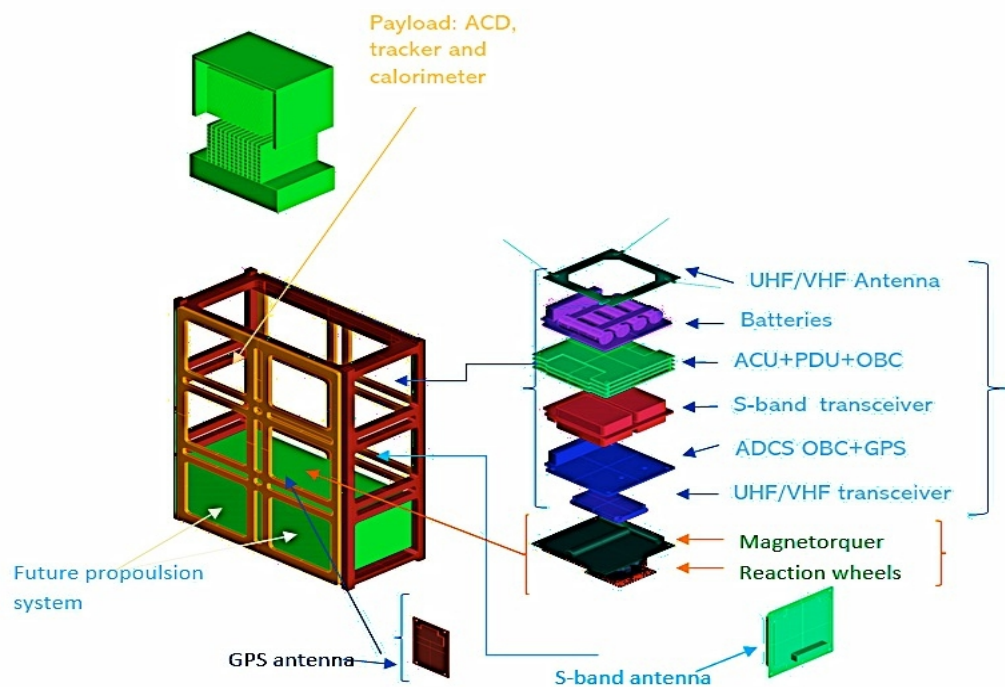
It was recently reported that Elon Musk's SpaceX colony on Mars will not follow Earth-based laws. Does this mean people will soon be moving to space? Has space science and technology now reached a higher stage?

Take a look at this video as OASA attempts to unravel the latest space mysteries. It's hard to know where to begin to comprehend space, from the vast space economy to mini man-made satellites. OASA will help you understand, by showing us how cube satellites (CubeSats) work and how to go about designing and building them. They will talk about the economic aspects of space and how Hong Kong can benefit from opportunities in the growing space economy. Moderated by Kimberly Lam, Prof. Quentin Parker an Astrophysicists and Mr. Hubie Lem, OASA Vice Chairman, discussed how indeed one can build one's own satellite today.

2. Ms. Rosaria Prochilo became the first Padova-CISAS/HKU-LSR MSc graduate that emerged from our LSR-Padova MoU when she successfully defended her thesis remotely from HKU-LSR in December 2020 “cum laude”. Her MSc thesis “Preliminary Design of a 6U CubeSat for an MeV Telescope” concerns a pathfinder mission for a hoped for much large 1billion RMB gamma-ray Space telescope mission called PANGU. This CubeSat mission is now funded from the LSR RMGS funds to the level of HK\$2.95 Million and Ms. Prochilo is the official project engineer. The project team is being assembled at time of writing.



Immediate aftermath of Ms. Prochilo’s thesis defence late one night on December 3rd 2020 in Cyberport due to time lag with Padova. Prof. Parker was Ms. Prochilo’s HKU supervisor – she graduated with distinction – he had a broken collar bone.



Preliminary layout for the LSR’s new 6U MeV Gamma-ray detector Cubesat from Ms. Prochilo’s thesis. We officially start the project in September 2021 with our Padova-CISAS and Zhejiang University partners.

3. LSR member Dr. Ryan McKenzie won HKU's 'Outstanding Young Researcher Award for 2019/2020' announced in December 2020 for his exceptional work on climate change, volcanism and tectonics. The link below gives a video of his remarkable work: <https://uvision.hku.hk/playvideo.php?mid=24527>



Still-shot from the HKU video on this specific award to LSR member Dr. Ryan McKenzie.

4. The LSR participated with OASA in an important live streamed event organised by KPMG in the Space Economy Section in "The Connected Cities Conference" at the "StartmeupHK" Festival on 27th May 2021 that had thousands of attendees. See: <https://home.kpmg/cn/en/home/events/2021/05/the-connected-cities-conference.html>

Space is becoming increasingly accessible. Investment in space technology has created infinite possibilities in scaling up space travel and the potential economic, research and leisure applications. Professor Quentin Parker, Director of HKU Laboratory for Space Research, and Dr. Gregg Li, HKU Physics adjunct Professor and Chairman of the "Orion Astropreneur Space Academy" (OASA), shared their insights about space economy.

18:15 Space Economy - The Missing Link Connecting our Smart City?



Dr. Gregg Li Moderator

Chairman and Acting CEO
OASA Hong Kong



Prof. Quentin Parker

Director, Laboratory for Space Research
The University of Hong Kong



Prof. Lisa C. Wan

Associate Professor of School of Hotel and Tourism
Management and Department of Marketing
The Chinese University of Hong Kong Business School



The Space Economy panel at the connected cities conference with Prof. Gregg Li (OASA-LSR), Prof Q.Parker (LSR-OASA) and Prof. C.Wan (CUHK) plus senior KPMG leaders.

5. DES PhD student and LSR member Mr. Binlong YE under the supervision of LSR Deputy Director Dr. Joe Michalski was awarded an Outstanding Paper Prize at a large planetary science conference organised by Chinese Geophysical Society in June 2021. 500 papers were submitted this year, from which only 27 (~5%) were selected to receive the award. Details of the award: <https://bit.ly/3yslom8>



The formal event opening.



Binlong YE on “location” at the Natural History Museum in London, U.K.

8. LSR Press Releases (September 1st 2020 to 31st August 2021)



We remain very proactive in seeking publicity for our most significant activities, research outputs and initiatives. Over the reporting period we have had several important HKU LSR press releases that have generated news stories and significant press coverage. Our coverage has been especially prominent in the Mainland, including TV, radio and in print. Links to all 5 of the HKU press releases are given below while the list of the key media coverage arising from these and all other media coverage involving the LSR (including relevant web links) are provided in Appendix VI.

1. September 16th 2020. Member of HKU's Laboratory for Space Research Thomas Kaye, co-discovers the first planet found around a white dwarf star.
https://www.hku.hk/press/news_detail_21604.html
2. September 18th 2020. A joint team of astronomers including a member of HKU's Laboratory for Space Research, Hung Hing Ying visiting Prof. Albert Zijlstra captures stellar winds in unprecedented detail.
https://www.hku.hk/press/news_detail_21617.html
3. November 10th 2020. HKU becomes an associate partner of East Asian Observatory strategically enhancing its research in astrophysics, space and planetary sciences to a higher level via the LSR.
https://www.hku.hk/press/news_detail_21895.html
4. April 30th 2021. China Business Network interviewed LSR Director Prof. Quentin Parker and wrote a news article about China Space Station (press interview write-up).
<https://m.yicai.com/news/101038483.html>
5. June 27th 2021. Launch of the "First-of-its-kind" Business Economy for Space Technology Programme for Secondary School Students in Hong Kong, led by the LSR, OASA and HKU Academy for the Talented.
https://www.hku.hk/press/news_detail_22954.html
6. August 7th 2021. HKU geologists Mr J.Liu and LSR Dep Director Dr. Joe Michalski discover that the NASA rover has been exploring surface sediments, not lake deposits for last eight years
<https://www.hku.hk/press/press-releases/detail/23093.html>

9. Knowledge Exchange, community service and outreach activities

The LSR prides itself on its KE, outreach and community service activities believing these are an important part of its mission to educate and influence students and the public more broadly. The LSR was instrumental in the establishment of the Taught Postgraduate MSc in Space Science that will formally launch this year under the Department of Physics.

9.1 The “BEST” Business Economy in Space Technology STEM initiative

The “Business Economy for Space Technology (**BEST**)” programme for secondary school students is an exciting and immersive new STEM initiative that aims to nurture the next generation of “Astropreneur”. We aim to provide them with an understanding of how Space Technology and Space Data can generate a myriad of business opportunities in the “NewSpace” era (“NewSpace” is a term coined to refer to the recent commercialisation of the space sector). See: <https://talented.hku.hk/other-opportunities/business-economy-for-space-technology>.

Under this bold initiative, secondary school students will apply Space Technology to seek to tackle critical issues and imminent challenges such as those under the United Nations’ 17 Sustainable Development Goals. School teams will build a CubeSat prototype with the use of computer-aided design tools.

To give participants authentic exposure to project management, there will be dedicated lectures and year-round workshops with professional mentorship guidance on topics of space science, engineering and astropreneurship, the concept and mission of a CubeSat, as well as the build and deployment of a prototype. Through solid training in leadership, teamwork, critical and analytical thinking and communication and presentation skills, students will accomplish a common goal together with their team members. The “**BEST**” CubeSat design chosen by our expert judges may even form the basis of a viable CubeSat mission for launch.

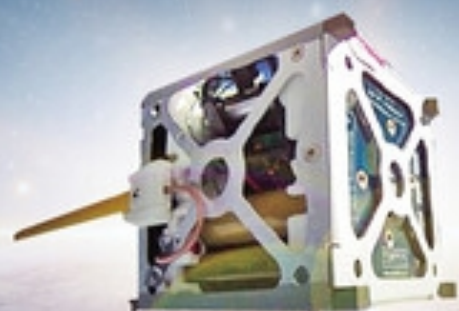
“HKU has always aspired to cultivate and inspire visionary and creative talents. It is hoped that secondary school students taking part in this initiative can exchange ideas with professionals of Space Technology to design and produce a “CubeSat,” and learn how to utilise Space Data to yield profitable business opportunities and plan the future blueprint for human beings,” said Professor Bennett Yim, Director of Undergraduate Admissions and International Student Exchange, HKU.

“The HKU Laboratory for Space Research, is proud to be a foundation member of this exciting new STEM and Knowledge Exchange, Secondary School initiative. We encourage you to **B**ecome a space technology enthusiast; **E**xplore the future Space Ecosystem; **S**tretch your Imagination and **T**rain your mind to be the **BEST** it can be as you get to conceive, design and build your very own CubeSat,” said Professor Quentin Parker, Director of the HKU Laboratory for Space Research.

“Exciting new opportunities in space businesses are launching across the globe. This fun and innovative programme prepares students with a forward-thinking mindset and enables them to be space-ready, entrepreneurial and be equipped with practical skills to make the most of these opportunities,” said Dr Gregg Li, Chairman of OASA. “The NewSpace economy has arrived in Hong Kong; without the use and application of data from Space, Hong Kong will never be a Smart City.” Dr Li added.

BUSINESS ECONOMY FOR SPACE TECHNOLOGY (BEST)

新 時 代 太 空 經 濟 計 劃



CUBESAT CHALLENGE

A "NEWSPACE" SOLUTION TO GLOBAL ISSUES

Year-round workshops will be launched with professional mentorship guidance on:

- Space Science, Engineering & Astropreneurship
- Concept of Cubesat & how to formulate a Cubesat mission
- Project Management of Prototype Build & Deployment
- Project Payloads

ELIGIBILITY:

All Secondary Schools in Hong Kong
(school-based application)

DEADLINE: 13 SEP 2021



Online Info Session
27 AUG (FRI) 5pm
Welcome Teachers &
Students to join

9.2 The LSR summer Internship program (special focus for this report)

We remain very proactive in this area and have the most active student internship program across the Faculty of Science. 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 52 interns since 2016 for periods of between 2-3 weeks and 3 months. Interns come not just from local international schools, HKU and local universities but also (Covid notwithstanding) from overseas (e.g. India, USA, Singapore, Spain). This year's interns are a mix of Summer Research Fellows, Laidlaw Scholars and other undergraduate students from HKU; high school students from various top HK schools and overseas students from the University of Chicago. We had to limit University of Chicago numbers to 3 this year (from 6 put forward) as all are being supervised remotely due to the pandemic.



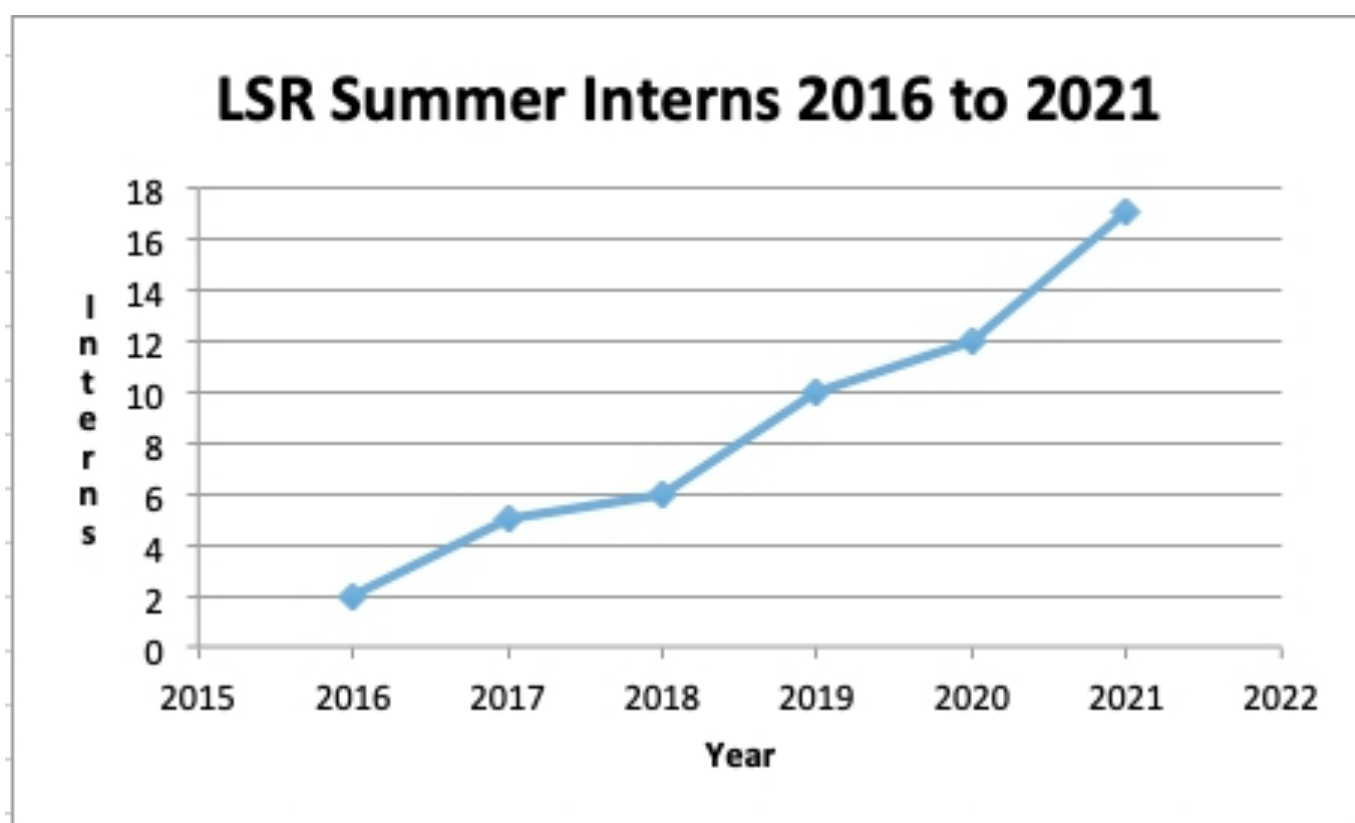
Photo showing the first 8 of our record number of 17 interns who arrived at the LSR in the first week of June 2021 to start their 2-3 month long research projects under the expert supervision of LSR members.

The LSR internship program has grown organically and rapidly since inception in 2016 with our first two interns to reach capacity today at 17. We currently do not advertise this program with applications all generated via word of mouth and reputation. We do not cater just to physics majors but have also accepted students from computing and engineering as befits the interdisciplinary nature of the LSR. Student projects cover work on computer simulations and aerospace design (for CubeSats and Mars rover drills), late stage stellar evolution and high-energy astrophysics.



Full house in the open plan LSR work area at Cyberport due to all the interns.

Although all current interns will be based at the LSR in Cyberport we encourage all LSR faculty and postdocs to offer to host LSR interns next year on main campus too as we have reached saturation point at the LSR itself.



Charting the growth of the LSR internship program between 2016 and 2021.

| Name | Status | Discipline | University/School | Year | LSR supervisor | Period | # |
|---------------------|---------------|------------------|--|------|----------------|----------------|----|
| David He | High School | Physics | Singapour International School (HK) | 2021 | AR/QAP | 2 weeks June | 36 |
| Alec Lam | High School | Physics | Singapour International School (HK) | 2021 | AR/QAP | 2 weeks June | 37 |
| Drisana NANDHA | High School | Physics | West Island School | 2021 | QAP | June-July | 38 |
| Aditya Mangla | High School | Physics/Maths | West Island School | 2021 | PSP | June-August | 39 |
| Ethan Huan Kao | High School | Physics/Maths | West Island School | 2021 | PSP | June-August | 40 |
| Jenny Jiang Yongzhe | High School | Physics/Maths | St. Pauls Convent School | 2021 | PSP | June-July | 41 |
| Levin Szeto | High School | Science/Physics | Po Leung Kuk Choi Kai Yau | 2021 | QAP | July-August | 42 |
| David Ian Ng | High School | Science | Po Leung Kuk Ngan Po Ling college | 2021 | QAP | July | 43 |
| Yang-Wo Seong | Undergraduate | Science | HKU - SRF awardee | 2021 | QAP/RP | June-August | 44 |
| Raghav Agarwal | Undergraduate | Computer Science | HKU - Laidlaw Scholar | 2021 | QAP | June-August | 45 |
| Long Kehan | Undergraduate | Engineering | HKU - Volunteer - will be paid a stipend | 2021 | RP/QAP | July-September | 46 |
| Keith Tsz Ki Tse | Undergraduate | Physics | HKU - Volunteer - will be paid a stipend | 2021 | QAP/AR | June-August | 47 |
| Naixin Liang | Undergraduate | 3rd yr Physics | University of Chicago - remote* | 2021 | PSP | July-September | 48 |
| Stella Kraus | Undergraduate | 1st yr Physics | University of Chicago - remote | 2021 | PSP | July-September | 49 |
| Jiatong Li | Undergraduate | 1st yr Physics | University of Chicago - remote | 2021 | PSP | July-September | 50 |
| Leo | Undergraduate | 3rd yr Physics | HKU - Volunteer - will be paid a stipend | 2021 | PSP | TBC | 51 |
| Adilet Uvaliyev | Undergraduate | 3rd yr Physics | HKU - Volunteer - will be paid a stipend | 2021 | PSP | June-August | 52 |

For the reporting period Sept 2020 til August 2021 we have hosted the above 17 LSR interns, a new record intake.

LSR interns in their own words:

“My internship experience at LSR so far has been absolutely amazing. I'm working under the supervision of Prof. Quentin Parker on excitation of planetary nebulae. These beautiful glowing clouds are an important phase in the stellar evolution of an intermediate-mass star such as our sun. I've learnt to use techniques such as spectroscopy and data analysis to obtain results. It introduced me to the field of astronomy.

I'm grateful that Prof. Parker and LSR accept high school students as interns - very rare for any research laboratory, so this is a valuable opportunity for high school students like myself to get a taste of the academic realm. LSR provides wonderful guidance and resources to all its members that aid our research. I'm very much enjoying the intellectual community here. My experience this summer has strengthened my aspiration to pursue a research career.

Academics aside, who wouldn't enjoy working at Cyberport? The view is spectacular.

In all seriousness professor, thank you so much for the past 2 months or so. I'm so looking forward to the upcoming month.

Best,
Jenny (July 2021)”

Simba Zou, a SRF undergraduate student shared his inspiring research experience as an LSR intern from the summer of 2020 in the FoS Newsletter of April 2021.

Mr Simba Xiang ZOU is a second-year BSc student, majoring in Physics (Intensive) in HKU. He enrolled in the Faculty's Summer Research Fellowship (SRF) Scheme, which supports science undergraduates to conduct research under the supervision of an academic. He was assigned to work at the Laboratory for Space Research (LSR) in Cyberport last summer in 2020. Because of his outstanding performance, Faculty invited him to share his inspiring research experience.



Here is the link of the article:

<https://www.scifac.hku.hk/news/SRF-scheme-Simba-Zou>

YouTube video:

https://www.youtube.com/watch?v=Y_zjYD8VOEU

Details in Faculty Newsletter:

[https://www.scifac.hku.hk/f/newsletter/7304/Newsletter April 2021.pdf](https://www.scifac.hku.hk/f/newsletter/7304/Newsletter%20April%202021.pdf)

9.3 The Kiron refugee campus “LSR Lecture Series”

The LSR is very proud to participate in the Kiron refugee campus (see: <https://kiron.ngo/en/>) under their Phoenix Space student program organised by Alex Dutton, Head of Education of Phoenix Space. The audience is made up of teenage refugees, generally from and living in the Middle East. Their knowledge of science and maths is highly variable. A key aim is to bring STEM education to such disadvantaged students who are refugees from war, famine, natural disasters and other calamities. We have put together a series of 9 lectures and the first 3 have already been filmed at the LSR in Cybeport in June 2020.

After each lecture (webinar), the full video of our LSR lectures together with the accompanying live Question & Answer session gets uploaded to YouTube. It is then added to what will be a specially branded LSR course on Kiron. Kiron is an online platform that offers free education for refugees. Each LSR lecture will be supported by a text summary, suggested reading/viewing and a short quiz - all to assist students with their learning. This will be in both Arabic and English. We hope that the special LSR lecture series will grow and will form part of dozens of videos that will eventually become a high-quality STEM educational resource for Arabic language science teaching worldwide, not just for refugees.



Dr. Sadjadi being filmed during his lecture for the “Kiron Refugee Campus” at the LSR in Cyberport.

| LSR KIRON lecture series | | |
|--------------------------|------------------------|------------------|
| Lecturer | Topic | Level |
| Q Parker | The Galactic Graveyard | Prof. |
| G.Li | Astropreneurship | Prof. (LSR-OASA) |
| J. Michalski | Is there life on Mars | Assoc.Prof |
| A.Webb | Tectonics Research | Assoc.Prof |
| P. Saz Parkinson | The high energy Sky | RAP |
| A.Ritter | Galactic Archaeology | PDF |
| A.Sadjadi | Cosmic Chemisty | PDF |
| S.Wright | Martian rocks | PDF |
| R.Prochilo | CubeSats | RAII |

List of LSR lectures and topics for the special Kiron Campus “LSR lecture series”.



It is important that the future plans for the LSR are aligned with and in the same direction as the plans for HKU as a whole. To a large degree our future depends on the level of support from HKU senior management and the Faculty of Science as we transition to a new Dean and also if the INSPIRE initiative for the planned new HKU campus in Shenzhen can be realised. Nevertheless, we have been adept at securing significant funding, undertaking impactful projects, growing our partners and raising our profile. A few key future LSR plans, evolved from last year's report, are listed below:

- Secure long-term funding
 - this is essential if our future is to be secured
- Achieve more autonomy
 - Given current severe operational constraints this is a vital need
- Set up the "INSPIRE" laboratory in Shenzhen
 - this will depend on HKU agreement with the Shenzhen government
- Establish CAS-HKU joint INSPIRE laboratory in HKU and Shenzhen
 - this would be only the 2nd HKU-CAS joint lab in 10 years if realised
 - If joint CAS lab is established re-brand the LSR to INSPIRE at HKU
 - perhaps via conversion to a proper HKU centre or institute
- Consolidate projects and develop our space & planetary science program:
 - Move forward with UV/IR satellite with NJU, BISME and DFH – RMGS funding available
 - Move forward with the funded 6U CubeSat MeV Gamma-ray mission as a pathfinder to the hoped for RMB 1 billion PANGU
 - Continue to pursue LSR participation in the "HERD" instrument package on the
- Chinese Space Station with help of Dr. Meng Su
 - Develop a World class spectroscopy lab under Dr. Joe Michalski
 - CubeSat and Commercial missions including via "BEST" program
- Grow our capacity in terms of academic staff, RAPs, PDFs, RPG students and distinguished international visitors

11. Glossary of Terms

- BEST – Business Economy for Space Technology LSR led STEM initiative
- 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 – DFH Satellite Company Ltd.
- EAO – East Asian Observatory
- ECR – Early Career Researcher
- ESO – European Southern Observatory
- FAST – Five Hundred Meter Aperture Telescope, Guizhou, SW China
- GBA – Greater Bay Area
- 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
- OASA – Orion Astropreneur Space Academy
- 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, Zhuhai
- TPG – Taught PostGraduate Masters
- UDF – University Development Fund, HKU
- VLT – Very Large Telescope (ESO 8m telescopes)

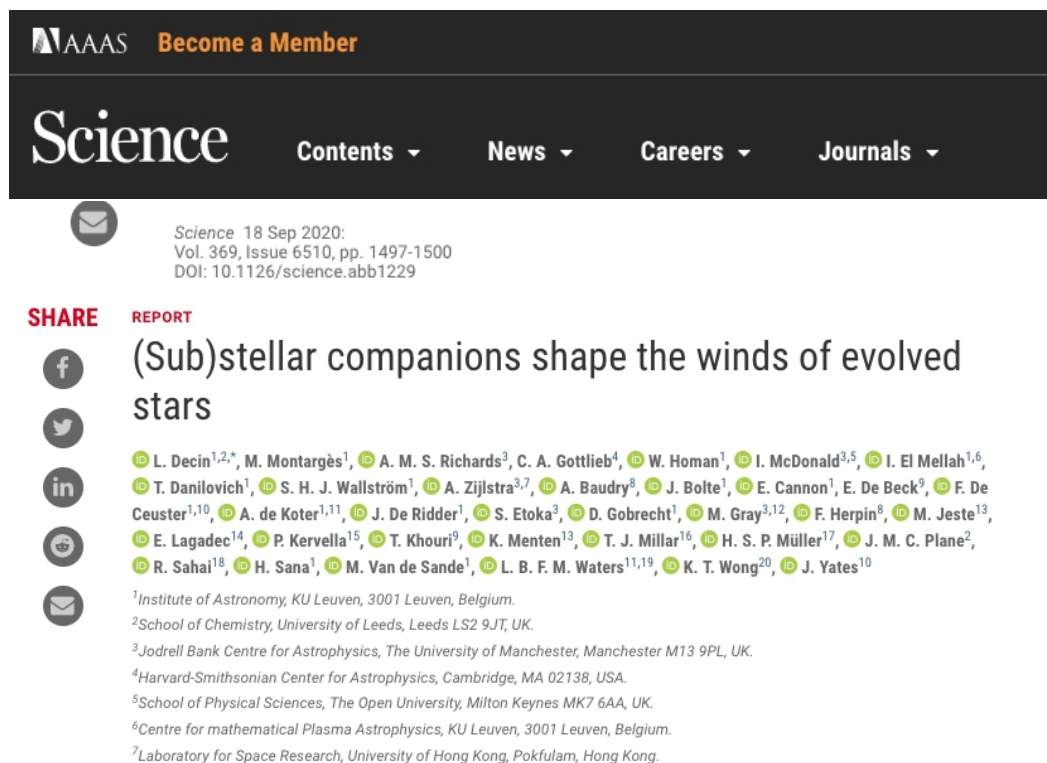
It is a pleasure to acknowledge and thank Dr. Pablo Saz Parkinson for valuable feedback on an earlier draft of this report and also Ms. Bingrong Zhu and Ms. Mila Ho our LSR laboratory managers, for help with content.

We acknowledge the wonderful support and funding from the Research Grants Council for our RMGS and GRF funds and HKU for UDF and BRC support that has enabled the LSR to flourish so far. We thank the completing Dean of Science, Prof. Matthew Evans for his support of the LSR throughout his tenure.

APPENDIX I

Selected research highlights in top journals from LSR members

I.1. LSR co-authored paper:



AAAS Become a Member

Science Contents News Careers Journals

Science 18 Sep 2020:
Vol. 369, Issue 6510, pp. 1497-1500
DOI: 10.1126/science.abb1229

SHARE REPORT

(Sub)stellar companions shape the winds of evolved stars

L. Decin^{1,2,*}, M. Montargès¹, A. M. S. Richards³, C. A. Gottlieb⁴, W. Homan¹, I. McDonald^{3,5}, I. El Mellah^{1,6}, T. Danilovich¹, S. H. J. Wallström¹, A. Zijlstra^{3,7}, A. Baudry⁸, J. Bolte¹, E. Cannon¹, E. De Beck⁹, F. De Ceuster^{1,10}, A. de Koter^{1,11}, J. De Ridder¹, S. Etoka³, D. Gobrecht¹, M. Gray^{3,12}, F. Herpin⁸, M. Jesty¹³, E. Lagadec¹⁴, P. Kervella¹⁵, T. Khouri⁹, K. Menten¹³, T. J. Millar¹⁶, H. S. P. Müller¹⁷, J. M. C. Plane², R. Sahai¹⁸, H. Sana¹, M. Van de Sande¹, L. B. F. M. Waters^{11,19}, K. T. Wong²⁰, J. Yates¹⁰

¹Institute of Astronomy, KU Leuven, 3001 Leuven, Belgium.
²School of Chemistry, University of Leeds, Leeds LS2 9JT, UK.
³Jodrell Bank Centre for Astrophysics, The University of Manchester, Manchester M13 9PL, UK.
⁴Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA.
⁵School of Physical Sciences, The Open University, Milton Keynes MK7 6AA, UK.
⁶Centre for mathematical Plasma Astrophysics, KU Leuven, 3001 Leuven, Belgium.
⁷Laboratory for Space Research, University of Hong Kong, Pokfulam, Hong Kong.

HKU HHY Professor and LSR member Albert Zijlstra co-author on “Sub-stellar companion shape the winds of evolved stars” published in Science in September 2020; DOI:

10.1126/science.abb1229

Abstract

Binary interactions dominate the evolution of massive stars, but their role is less clear for low- and intermediate-mass stars. The evolution of a spherical wind from an asymptotic giant branch (AGB) star into a nonspherical planetary nebula (PN) could be due to binary interactions. We observed a sample of AGB stars with the Atacama Large Millimeter/submillimeter Array (ALMA) and found that their winds exhibit distinct nonspherical geometries with morphological similarities to planetary nebulae (PNe). We infer that the same physics shapes both AGB winds and PNe; additionally, the morphology and AGB mass-loss rate are correlated. These characteristics can be explained by binary interaction. We propose an evolutionary scenario for AGB morphologies that is consistent with observed phenomena in AGB stars and PNe.

I.2. LSR co-authored paper: Mr. Thomas Kaye, “A giant planet candidate transiting a white dwarf, published in nature in September 2020, DOI <https://doi.org/10.1038/s41586-020-2713-y>

nature

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Article | Published: 16 September 2020

A giant planet candidate transiting a white dwarf

Andrew Vanderburg , Saul A. Rappaport, [...]Liang Yu

Nature **585**, 363–367 (2020) | [Cite this article](#)

7221 Accesses | **18** Citations | **1518** Altmetric | [Metrics](#)

Abstract

Astronomers have discovered thousands of planets outside the Solar System¹, most of which orbit stars that will eventually evolve into red giants and then into white dwarfs. During the red giant phase, any close-orbiting planets will be engulfed by the star², but more distant planets can survive this phase and remain in orbit around the white dwarf^{3,4}. Some white dwarfs show evidence for rocky material floating in their atmospheres⁵, in warm debris disks^{6,7,8,9} or orbiting very closely^{10,11,12}, which has been interpreted as the debris of rocky planets that were scattered inwards and tidally disrupted¹³. Recently, the discovery of a gaseous debris disk with a composition similar to that of ice giant planets¹⁴ demonstrated that massive planets might also find their way into tight orbits around white dwarfs, but it is unclear whether these planets can survive the journey. So far, no intact planets have been detected in close orbits around white dwarfs. Here we report the observation of a giant planet candidate transiting the white dwarf WD 1856+534 (TIC 267574918) every 1.4 days. We observed and modelled the periodic dimming of the white dwarf caused by the planet candidate passing in front of the star in its orbit. The planet candidate is roughly the same size as Jupiter and is no more than 14 times as massive (with 95 per cent confidence). Other cases of white dwarfs with close brown dwarf or stellar companions are explained as the consequence of common-envelope evolution, wherein the original orbit is enveloped during the red giant phase and shrinks owing to friction. In this case, however, the long orbital period (compared with other white dwarfs with close brown dwarf or stellar companions) and low mass of the planet candidate make common-envelope evolution less likely. Instead, our findings for the WD 1856+534 system indicate that giant planets can be scattered into tight orbits without being tidally disrupted, motivating the search for smaller transiting planets around white dwarfs.

I.3. LSR co-authored paper: Dr. Pablo Saz Parkinson as a co-author of the Fermi-LAT collaboration: “High-energy emission from a magnetar giant flare in the sculptor galaxy”, published in nature astronomy, January 2021. <https://doi.org/10.1038/s41550-020-01287-8>

nature astronomy

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nature > nature astronomy > letters > article

Letter | Published: 13 January 2021

High-energy emission from a magnetar giant flare in the Sculptor galaxy

The Fermi-LAT Collaboration

Nature Astronomy **5**, 385–391 (2021) | [Cite this article](#)

1156 Accesses | **1** Citations | **170** Altmetric | [Metrics](#)

Abstract

Magnetars are the most highly magnetized neutron stars in the cosmos (with magnetic field 10^{13} – 10^{15} G). Giant flares from magnetars are rare, short-duration (about 0.1 s) bursts of hard X-rays and soft γ rays^{1,2}. Owing to the limited sensitivity and energy coverage of previous telescopes, no magnetar giant flare has been detected at gigaelectronvolt (GeV) energies. Here, we report the discovery of GeV emission from a magnetar giant flare on 15 April 2020 (refs. ^{3,4} and A.J. Castro-Tirado et al., manuscript in preparation). The Large Area Telescope (LAT) on board the Fermi Gamma-ray Space Telescope detected GeV γ rays from 19 s until 284 s after the initial detection of a signal in the megaelectronvolt (MeV) band. Our analysis shows that these γ rays are spatially associated with the nearby (3.5 megaparsecs) Sculptor galaxy and are unlikely to originate from a cosmological γ -ray burst. Thus, we infer that the γ rays originated with the magnetar giant flare in Sculptor. We suggest that the GeV signal is generated by an ultra-relativistic outflow that first radiates the prompt MeV-band photons, and then deposits its energy far from the stellar magnetosphere. After a propagation delay, the outflow interacts with environmental gas and produces shock waves that accelerate electrons to very high energies; these electrons then emit GeV γ rays as optically thin synchrotron radiation. This observation implies that a relativistic outflow is associated with the magnetar giant flare, and suggests the possibility that magnetars can power some short γ -ray bursts.

I.4. LSR co-authored paper: Dr. Joe Michalski as a co-author; Jarosite formation in deep Antarctic ice provides a window into acidic, water-limited weathering on Mars, published in nature communications, January 2021, <https://doi.org/10.1038/s41467-020-20705-z>


nature communications

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Article | [Open Access](#) | Published: 19 January 2021

Jarosite formation in deep Antarctic ice provides a window into acidic, water-limited weathering on Mars

Giovanni Baccolo , Barbara Delmonte, P. B. Niles, Giannantonio Cibir, Elena Di Stefano, Dariush Hampai, Lindsay Keller, Valter Maggi, Augusto Marcelli, Joseph Michalski, Christopher Snead & Massimo Frezzotti

Nature Communications **12**, Article number: 436 (2021) | [Cite this article](#)

6204 Accesses | **1** Citations | **236** Altmetric | [Metrics](#)

Abstract

Many interpretations have been proposed to explain the presence of jarosite within Martian surficial sediments, including the possibility that it precipitated within paleo-ice deposits owing to englacial weathering of dust. However, until now a similar geochemical process was not observed on Earth nor in other planetary settings. We report a multi-analytical indication of jarosite formation within deep ice. Below 1000 m depth, jarosite crystals adhering on residual silica-rich particles have been identified in the Talos Dome ice core (East Antarctica) and interpreted as products of weathering involving aeolian dust and acidic atmospheric aerosols. The progressive increase of ice metamorphism and recrystallization with depth, favours the relocation and concentration of dust and the formation of acidic brines in isolated environments, allowing chemical reactions and mineral neo-formation to occur. This is the first described englacial diagenetic mechanism occurring in deep Antarctic ice and supports the ice-weathering model for jarosite formation on Mars, highlighting the geologic importance of paleo ice-related processes on this planet. Additional implications concern the preservation of dust-related signals in deep ice cores with respect to paleoclimatic reconstructions and the englacial history of meteorites from Antarctic blue ice fields.

I.5. LSR led paper: Dr. Jane Lixin Dai, The Physics of Accretion Discs, Winds and Jets in Tidal Disruption Events. In Space Science Reviews, 217, 12 (2021). <https://doi.org/10.1007>



Space Science Reviews



Published: 12 January 2021

The Physics of Accretion Discs, Winds and Jets in Tidal Disruption Events

Jane Lixin Dai , [Giuseppe Lodato](#) & [Roseanne Cheng](#)

[Space Science Reviews](#) **217**, Article number: 12 (2021) | [Cite this article](#)

340 Accesses | **2** Citations | **9** Altmetric | [Metrics](#)

Abstract

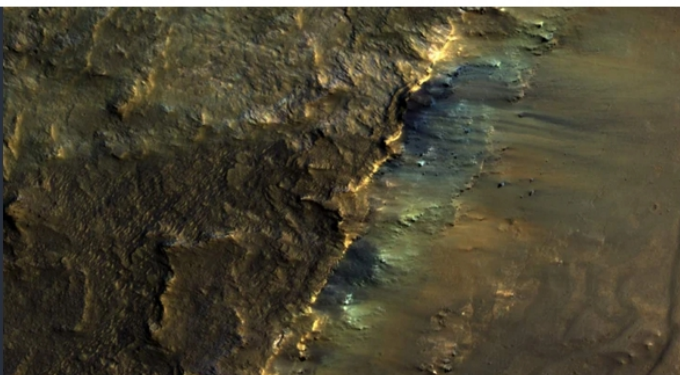
Accretion onto black holes is an efficient mechanism in converting the gas mass-energy into energetic outputs as radiation, wind and jet. Tidal disruption events, in which stars are tidally torn apart and then accreted onto supermassive black holes, offer unique opportunities of studying the accretion physics as well as the wind and jet launching physics across different accretion regimes. In this review, we systematically describe and discuss the models that have been developed to study the accretion flows and jets in tidal disruption events. A good knowledge of these physics is not only needed for understanding the emissions of the observed events, but also crucial for probing the general relativistic space-time around black holes and the demographics of supermassive black holes via tidal disruption events.

I.6. LSR led paper: Mr. J. Liu and Dr. Joe Michalski “Anoxic chemical weathering under a reducing greenhouse on early Mars”, published in *Nature Astronomy*, February 2021, DOI:10.1038/s41550-021-01303-5

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Read the May issue

This month we look at cosmic neutrinos (cover story) and peta-electronvolt cosmic rays, and then zero in on our closest neighbours, Venus and Mars (pictured to the right), plus much more...



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Article | Published: 11 February 2021

Anoxic chemical weathering under a reducing greenhouse on early Mars

J. Liu, J. R. Michalski , W. Tan, H. He, B. Ye & L. Xiao

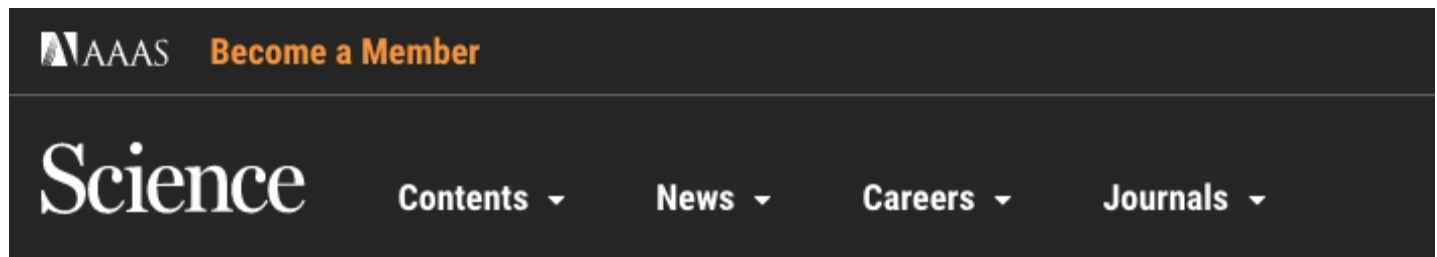
Nature Astronomy **5**, 503–509 (2021) | [Cite this article](#)

1211 Accesses | 84 Altmetric | [Metrics](#)

Abstract

Reduced greenhouse gases such as methane (CH₄) and hydrogen (H₂) might be the only tenable solution to explain warming of the ancient Martian climate, but direct geological evidence that a reduced atmosphere actually existed on Mars has been lacking. Here we report widespread, strong Fe loss in chemically weathered bedrock sections in the Mawrth Vallis region and other 3–4-billion-year-old terrains on Mars. The separation of Fe from Al in Martian palaeosols, which is comparable to trends observed in palaeosols before the Great Oxidation Event on Earth, suggests that the ancient Martian surface was chemically weathered under a reducing greenhouse atmosphere. Although for different reasons than on Earth, Mars underwent an oxidation event of its own in the late Noachian that forever changed the geological path of the planet.

I.7. LSR led paper: Dr. Binzheng Zhang “How Jupiter’s unusual magnetospheric topology structures its aurora” published in Science Advances, 7, 1204 in April 2021, DOI: 10.1126/sciadv.abd1204



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RESEARCH ARTICLE | PLANETARY SCIENCE



How Jupiter’s unusual magnetospheric topology structures its aurora

Binzheng Zhang^{1,2,3,*†}, Peter A. Delamere^{4,†}, Zhonghua Yao^{5,*}, Bertrand Bonfond⁶, D. Lin³, Kareem A. Sor...

+ See all authors and affiliations

Science Advances 09 Apr 2021:
Vol. 7, no. 15, eabd1204
DOI: 10.1126/sciadv.abd1204

Article

Figures & Data

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Abstract

Jupiter’s bright persistent polar aurora and Earth’s dark polar region indicate that the planets’ magnetospheric topologies are very different. High-resolution global simulations show that the reconnection rate at the interface between the interplanetary and jovian magnetic fields is too slow to generate a magnetically open, Earth-like polar cap on the time scale of planetary rotation, resulting in only a small crescent-shaped region of magnetic flux interconnected with the interplanetary magnetic field. Most of the jovian polar cap is threaded by helical magnetic flux that closes within the planetary interior, extends into the outer magnetosphere, and piles up near its dawnside flank where fast differential plasma rotation pulls the field lines sunward. This unusual magnetic topology provides new insights into Jupiter’s distinctive auroral morphology.

I.8. LSR co-authored paper: Dr. Meng Su “Measurement of the Cosmic Ray Helium Energy Spectrum from 70 GeV to 80 TeV with the DAMPE Space Mission” published in Physical Review Letters, 126, 201101 in May 2021,
DOI: <https://doi.org/10.1103/PhysRevLett.126.201102>

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Editors' Suggestion

Measurement of the Cosmic Ray Helium Energy Spectrum from 70 GeV to 80 TeV with the DAMPE Space Mission

F. Alemanno *et al.* (DAMPE Collaboration)

Phys. Rev. Lett. **126**, 201102 – Published 18 May 2021

PhysICS See synopsis: [Confirming a Cosmic-Ray Bump](#)

Article

PDF

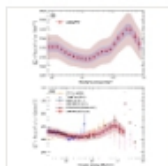
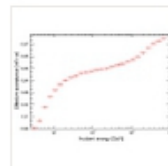
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ABSTRACT

The measurement of the energy spectrum of cosmic ray helium nuclei from 70 GeV to 80 TeV using 4.5 years of data recorded by the Dark Matter Particle Explorer (DAMPE) is reported in this work. A hardening of the spectrum is observed at an energy of about 1.3 TeV, similar to previous observations. In addition, a spectral softening at about 34 TeV is revealed for the first time with large statistics and well controlled systematic uncertainties, with an overall significance of 4.3σ . The DAMPE spectral measurements of both cosmic protons and helium nuclei suggest a particle charge dependent softening energy, although with current uncertainties a dependence on the number of nucleons cannot be ruled out.








Received 5 January 2021 Revised 25 March 2021 Accepted 6 April 2021

DOI: <https://doi.org/10.1103/PhysRevLett.126.201102>

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I.9. LSR led paper: J. Liu, J. Michalski, and M. F. Zhou , “Intense Sub-aerial Weathering of Eolian Sediments in Gale Crater, Mars”, published in Science Advances August 7th 2021.
DOI: [10.1126/sciadv.abh2687](https://doi.org/10.1126/sciadv.abh2687)

ScienceAdvances



RESEARCH ARTICLE | PLANETARY SCIENCE

Intense subaerial weathering of eolian sediments in Gale crater, Mars

 Jiacheng Liu^{1,2},  Joseph R. Michalski^{1,2,*} and  Mei-Fu Zhou^{1,3}

+ See all authors and affiliations


Science Advances 06 Aug 2021:
Vol. 7, no. 32, eabh2687
DOI: 10.1126/sciadv.abh2687

Article

Figures & Data

Info & Metrics

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 PDF

Abstract

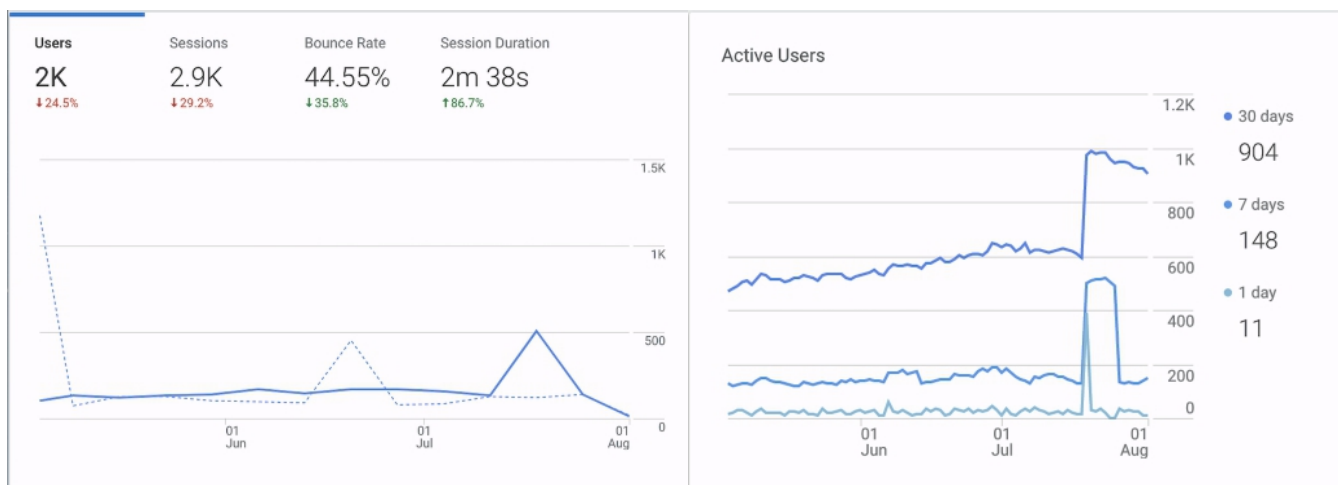
After over 8 years of successful surface operations on Mars, the Curiosity rover has revealed much about the environment in Gale crater. Despite early observations of a lacustrine environment, few of the subsequent deposits exhibit demonstrable lacustrine character. We suggest instead that most of the stratigraphic section explored to date can be best explained as eolian and/or volcanoclastic sediments subaerially chemically weathered by acidic precipitation in a reduced atmosphere. Most of the deposits in Gale crater seemingly did not form in an ancient lake, but the results nonetheless shed considerable light on ancient climate, environmental change, and the astrobiology of Mars. Discoveries by Curiosity provide a critical piece to Mars' global alteration puzzle.

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APPENDIX II

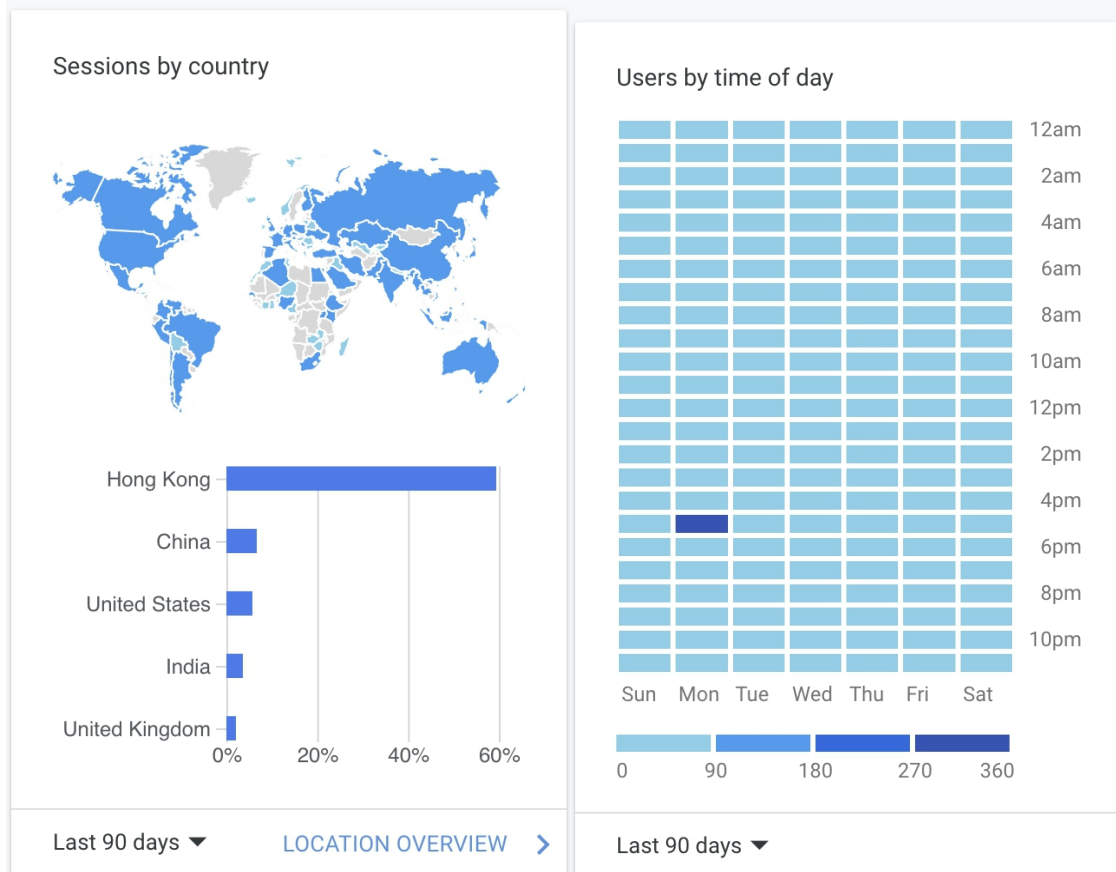
APPENDIX IIIA. LSR Website traffic June-August 2021

The LSR website (www.lsr.hku.hk) is our window to the world. Since the last report there has been a significant growth in traffic – no more so than in June-July 2021 as a result of significant press coverage of LSR activities and commentary around the burgeoning Chinese Space programme. The number of users has increased from 988 to ~2000 over the same period as last year with the number of access sessions also doubling and from 137 countries. Mainland China has also overtaken the USA in second place in terms of country of origin of access. Active users have also tripled from the same period last year.



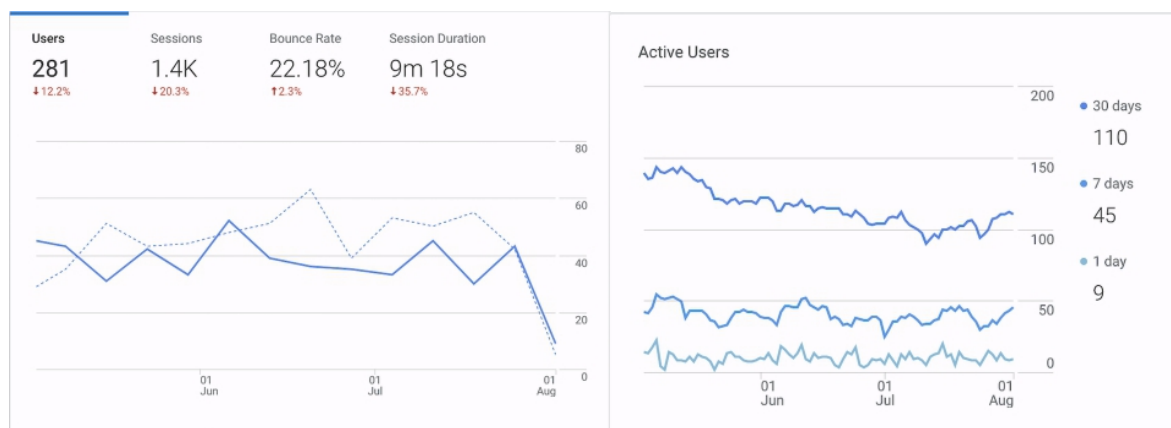
Where are your users?

When do your users visit?



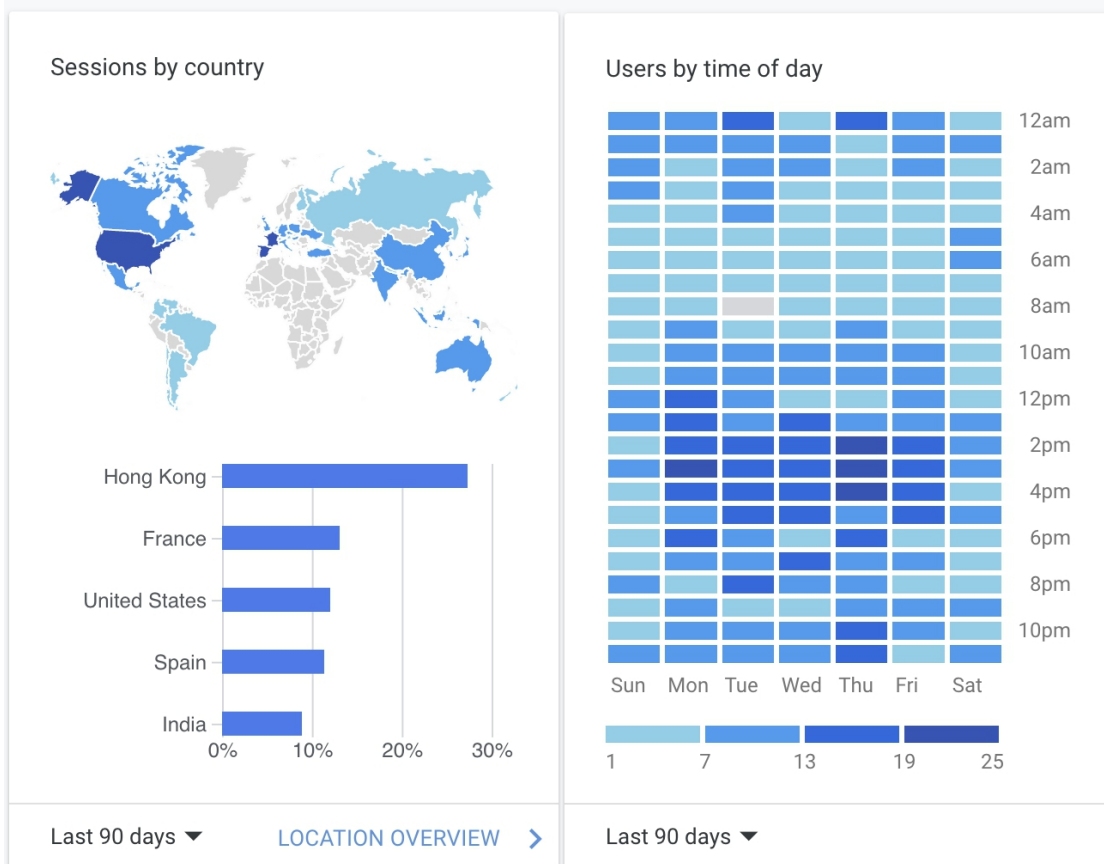
APPENDIX IIIB: HASH Website traffic May-August 2021

The HASH database is a key service for our global research community in late stage stellar evolution. The LSR hosts the “Hong Kong/AAO/Strasbourg H-alpha Planetary Nebulae database” (HASH: www.hashpn.space), a world-class repository for this community. An LSR PDF, Dr. Andreas Ritter curates and manages HASH. We currently have ~450 users from more than 50 countries with ~250 affiliations. Over the last 90 days, May to early August 2021, 281 users had 1,400 sessions at ~40/day visiting HASH, a 28% weekly activity increase since last year – see below for graphical details of usage statistics of this important LSR resource.



Where are your users?

When do your users visit?



APPENDIX III

Current complete list of all LSR Mainland and International MoUs and agreements

The LSR has engaged in a vigorous but strategically targeted program of Mainland and International partnerships consolidated by the signing of various MoUs and agreements from 2017 onwards. This was to establish a firm foundation and basis for growth with the strongest and most relevant groups possible.

LSR MoUs signed

1. Natural History Museum UK – October 2017
2. Nanjing University - November 2017
3. Padova-CISAS ITALY – March 2018
4. Zhejiang University – December 2018
5. National Astronomical Observatories of China (NAOC) – March 2019
6. Shanghai Academy of Space Flight Technology (SAST) – March 2019
7. CNNC and Chinese Institute for Atomic Energy (CIAE) – September 2019
8. Beijing Institute for Science and Mechanical Electricity (BISME) – December 2019
9. Dongguan Science & Technology Bureau - December 2019
10. DFH Company limited – December 2019
11. CSU – China Space Utilisation – May 2020
12. East Asian Observatory – October 2020
13. 3 way MoU with LSR, OASA & HKU Academy for the talented – May 2021

LSR Agreements signed

1. KAVLI institute, PKU, Beijing – May 2018
2. Beijing Institute for Science and Mechanical Electricity (BISME) – December 2018
3. Shenzhen 5 party agreement for Space Payloads - December 2018
4. Greater Bay Space Alliance - March 2019
5. Membership of the Joint Innovation Centre for Space Science (JICSS) – March 2019
6. China Space Utilization (CSU) – December 2019
7. Orion Astropreneur Space Academy (OASA) – March 2021

APPENDIX IV

Miscellany of additional materials

IV A: Recap of proposed CAS-HKU joint lab in Space and Planetary Sciences and the prospects for establishing the ‘INSPIRE’ laboratory in the GBA

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 via a joint laboratory in the Greater Bay Area and HK SAR
- 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 HKSAR.

Background:

- Proposal, suggested by CAS and emerged from the new LSR-CSU agreement signed at CSU* HQ in Beijing on December 10th 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 only the second CAS-HKU joint laboratory since 2011

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

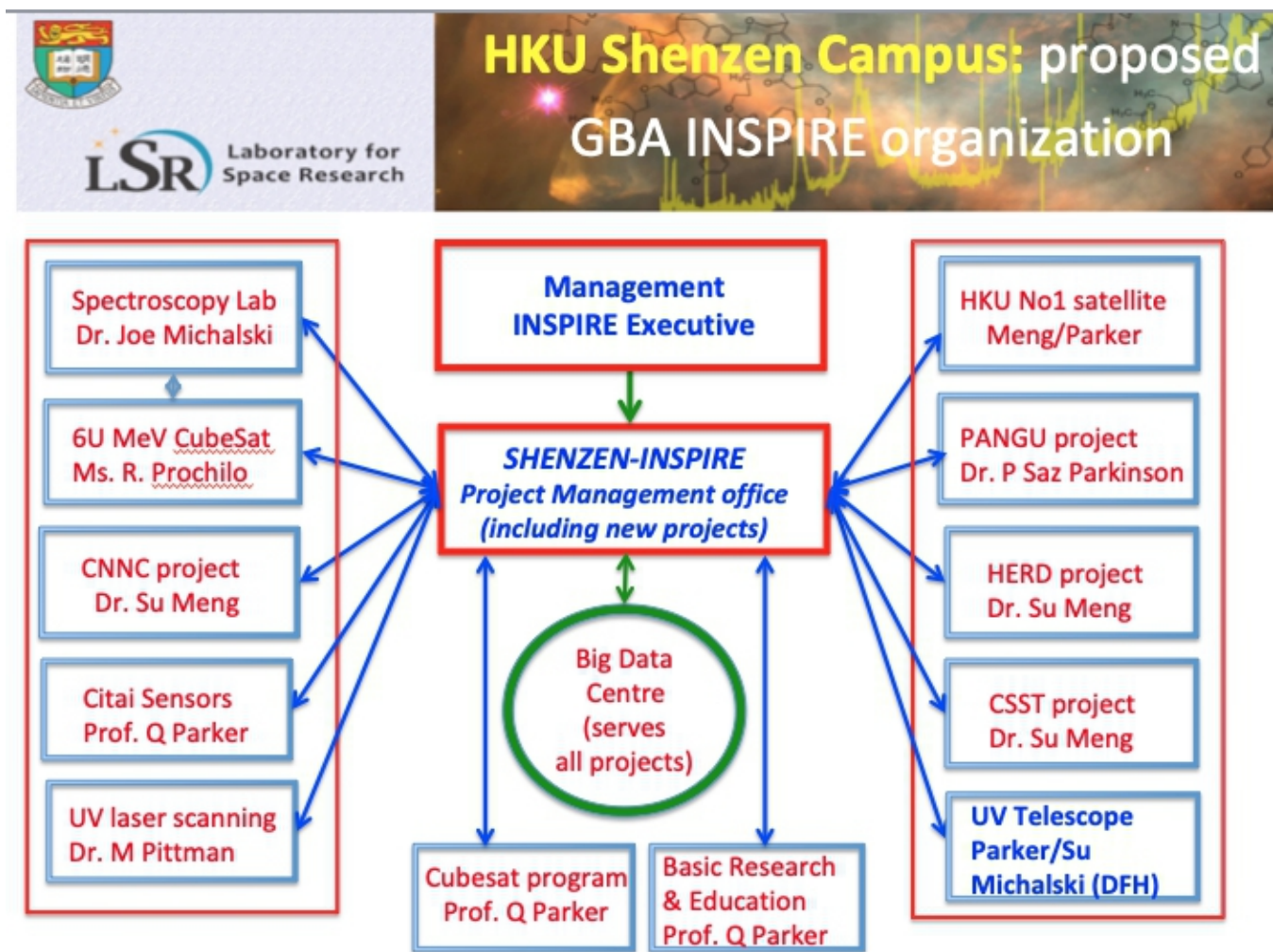
(see http://english.csu.cas.cn/About_CSU/General_Information/)

Developments and Context

In the three years since the CAS president's visit, the LSR has continued to consolidate 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) –refer to Section 8, 9 and Appendix VI.

We now have 13 MoUs and 7 agreements with elite Mainland and global partners. 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.

Unfortunately, two years of hard work developing a strong relationship with the Science and Technology Bureau in Dongguan that led initially to a very serious proposal to set up the International Space and Planetary Institute for Research Excellence (INSPIRE) in Dongguan with resources and investments that could have amounted to >500M RMB (with 100M RMB cash over 5 years) did not eventuate. This was due to a combination of factors including the impact of Covid preventing travel and face-to-face discussions. Nevertheless, we hope still to more formally link with the LSR-INSPIRE now planned for the HKU Shenzhen campus and also as part of a HKU-CAS joint lab.



Updated graphic showing the proposed project based organizational structure for the "INSPIRE" lab in the new HKU Shenzhen campus. INSPIRE is an acronym for "International Space and Planetary Institute for Research Excellence" as an evolution of the LSR.

IV B: Some recent LSR activities and initiatives



Visit to the LSR by the Italian Consul General Mr. Clemente Contestabile to HK and Macau in March 2021. The visit was prompted by interest in our MoU with Padova-CISA and our LSR project engineer from Padova Ms. Rosaria Prochilo.


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Contributor

What science is ahead for the Zhurong Rover in Utopia Planitia?

China made history becoming the second nation to land a rover on the surface of Mars. The robotic science laboratory will explore the plains of Utopia Planitia over a 90 day primary mission. What sorts of geological observations and testable hypotheses lay ahead for mission scientists?

 **Joe Michalski**
Associate Professor, University of Hong Kong

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Published May 17, 2021

Nature astronomy blog by LSR deputy director Dr. Joe Michalski.

On May 17th 2021 the LSR deputy director Professor Joe Michalski published a blog story on Nature Astronomy: “What science is ahead for the Zhurong Rover in Utopia Planitia?” China made history becoming the second nation to land a rover on the surface of Mars. The robotic science laboratory will explore the plains of Utopia Planitia over a 90 day primary mission. What sorts of geological observations and testable hypotheses lay ahead for mission scientists? You can use this link to view the full article:

<https://astronomycommunity.nature.com/posts/what-science-is-ahead-for-the-zhurong-rover-in-utopia-planitia>



Senior Cyberport management and OASA leadership visit to the LSR on July 23rd 2021 to discuss the establishment of a Space park at Cyberport.



IV.C Miscellaneous LSR Knowledge Exchange Events

1. The LSR was a supporter and participant of the “Digital November” French digital arts festival in the Hong Kong Space Museum. As part of the “UNIVERS/E” theme LSR Director Prof. Quentin Parker gave an Astrophysics Conference Speech on Planetary Nebulae – the Ghostly Relics of Dying Stars.



zoom

Quentin Parker's Personal Meeting Room - Shared screen with speaker view

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00:01:12 I thought to be

fatoumata Kebe

00:01:14 Nice to meet you.

Quentin Parker

00:01:15 Nice to meet you too.

00:01:18 So I'm here at the liberty to space research and cyber born in Hong Kong, are you in France.

fatoumata Kebe

00:01:24 Yes, I'm stalking premise.

Quentin Parker

00:01:27 Stuck in Paris. Well, I can think of worse places to be stuck in a lot

Digital November 2020 LSR video.

2. LSR participation in the National Italian Science Day on April 30th 2021 via a Webinar "Towards Mars and Beyond". This invitation from the HK-Macau Italian Consul was due to our collaboration with Padova-CISAS.



 **giornata della
RICERCA
ITALIANA**

TOWARD MARS AND BEYOND

30 April | 3.00PM

Mr Clemente Contestabile, Consul General of Italy in Hong Kong | Welcome Remarks

Prof. Quentin Parker, FRAS, Director of the Laboratory for Space Research, The University of Hong Kong | Introductory Remarks

Prof. Stefano Debel, Director of CISAS "G. Colombo", University of Padua |

Contribution of the University of Padua to the Human Space Exploration through the CISAS G.Colombo

Prof. Joseph Michalski, Deputy Director of the Laboratory for Space Research, The University of Hong Kong |

The Geology of Lakes and Seas on Ancient Mars with Implications for Climate and Habitability

Dr. Rosaria Prochillo, Research Assistant at the Laboratory for Space Research, The University of Hong Kong |

An Italian Researcher Abroad: Designing a CubeSat for Space Exploration

Prof. Denis Bastlerl, Special Advisor for Guangdong at the University of Padua | Closing Remarks




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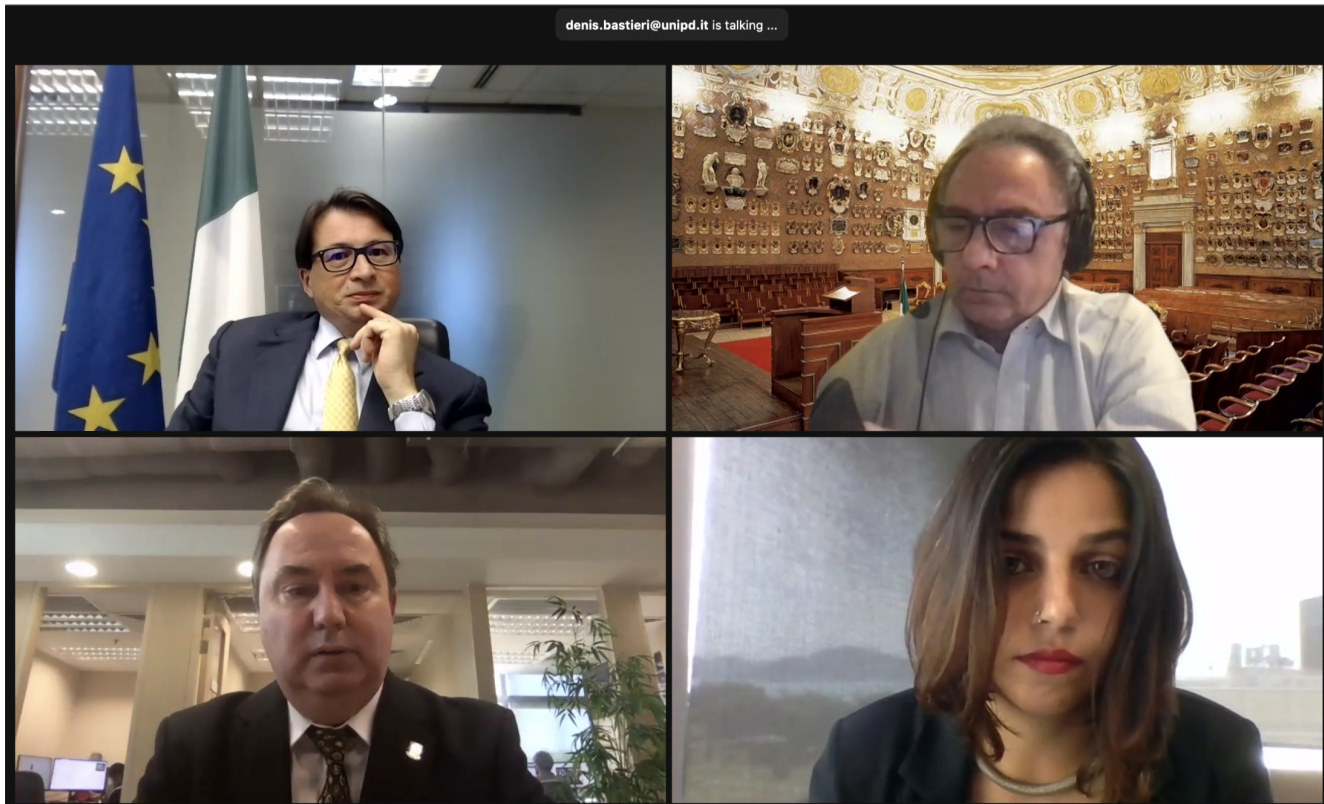
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Left to right and top to bottom i) The Italian Consul Clemente Contestabile, ii) Stefano Debei, Director, Padova-CISAS; iii) Quentin Parker, LSR director; iv) Rosaria Prochilo, Project Engineer for our LSR-Padova-Zhejiang 6U MeV CubeSat mission, see: <https://www.lsr.hku.hk/webinar-on-mars-and-space-science/>.

3. Dr. Joe Michalski, the Deputy Director of LSR gave a webinar on June 8th 2021 at Cafe Scientifique Hong Kong. He presented a short journey through Mars exploration, outlining some of the big scientific goals.



A New Space Race

China and USA have both landed rovers on Mars in recent months. What science is ahead for these robotic explorers?

Dr Joe Michalski

Associate Professor, University of Hong Kong
Deputy Director, Laboratory for Space Research
Division of Earth & Planetary Science

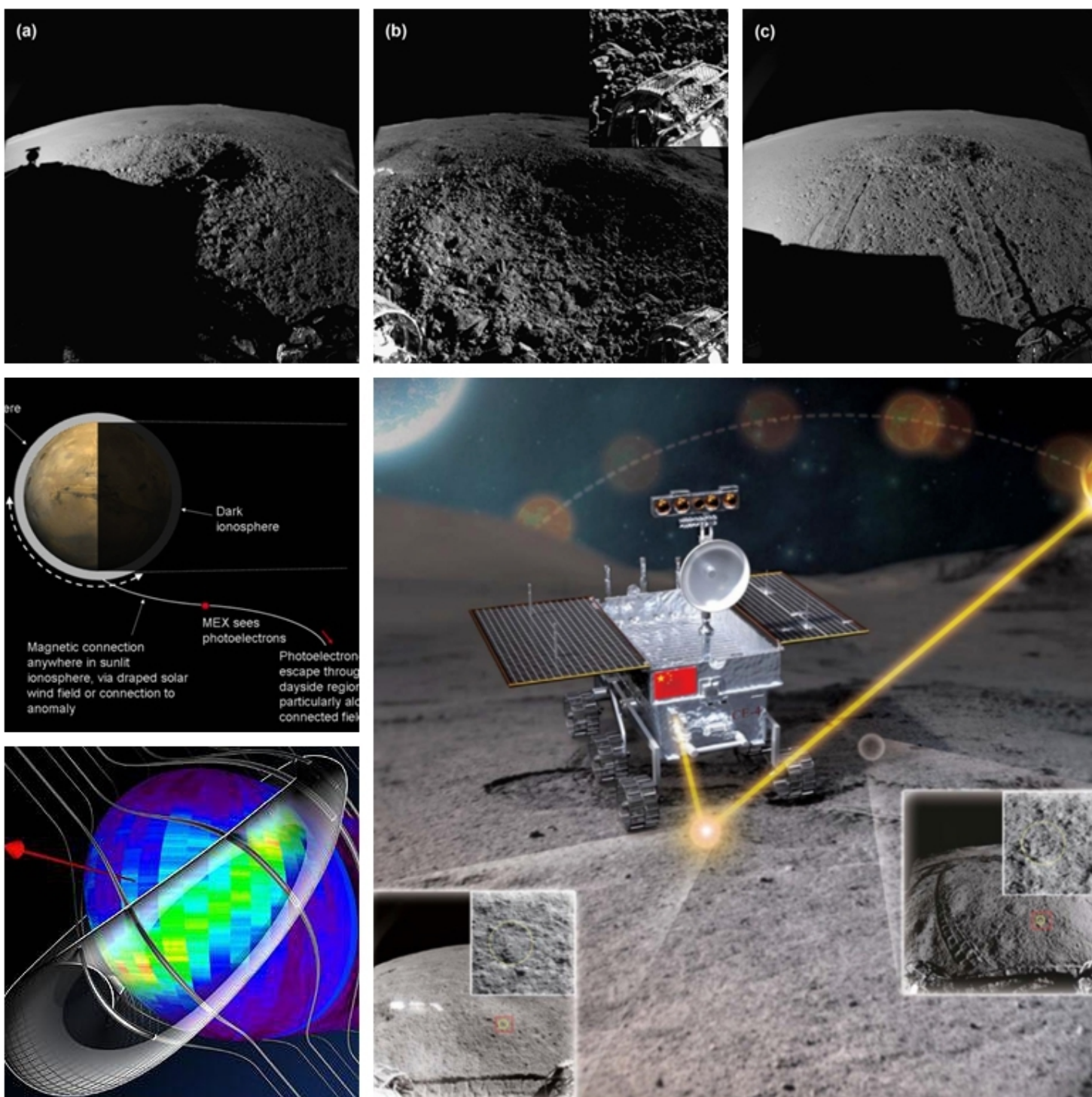
7:00 pm
June 7th, 2021

Café Scientifique
Cyber Edition

clays.space

He addressed the question of “Why are we spending resources exploring Mars when we have unsolved problems here on Earth?” The talk gave an idea of where this exploration is heading, and how it might lead to human settlements on the Martian surface in our lifetime.

4. Associate Professor Joseph Michalski, the Deputy Director of LSR, was invited again to give a lecture at the Summer School in Planetary Sciences this year.



Interesting graphic from the 2021 CAS summer school.

About the Summer School in Planetary Sciences:

Chinese Academy of Sciences (CAS) Center for Excellence in Comparative Planetology and University of Science and Technology of China (USTC) held the 2021 Summer School in Planetary Sciences as a continuing from last year's successful summer school. This summer school's aims were to provide a unique platform for access both basic knowledge and frontier researches at the broad aspects of planetary sciences including cosmochemistry, space physics, astrobiology, planetary geophysics, planetary geology, and more.

5. Visit of CBS news team to LSR on June 15th 2021 to interview LSR director concerning the emerging Chinese Space Program – segment later appeared on morning and evening CBS news across the USA – see Appendix VI.



CBS news team and selected LSR members.

6. Visit of AAMA Pearl River Delta Chapter to the LSR on July 7th 2021 to discuss investment, possible synergies and funding opportunities.



Senior AAMA delegates and selected LSR representatives.

7. LSR member Dr. David Yu participated in a panel discussion on July 9th 2021 on the RTHK TV31 Science Talk Show: “Science Night 2021” in an episode that featured his research work on gamma-ray bursts.



RTHK TV talk show – Dr. David Yu is seated first on the left.

8. The LSR and OASA participated in a KPMG “podcast” on August 4th 2021 under the subject of “To another world - The Space Economy - The Missing Link Connecting our Smart City?”



LSR director Prof. Quentin Parker(left) , OASA Chairman Dr. Gregg Li (middle), KPMG co-head of infrastructure (China) Julian Vella (right).

APPENDIX V

LSR Current Membership List (64 members as of 20th August 2021)

| Name | Title | University/ Institute | Faculty | Department |
|-------------------------|--|---|------------------|----------------------------|
| <i>Quentin Parker</i> | <i>Director, Professor</i> | <i>HKU</i> | <i>Science</i> | <i>Physics</i> |
| <i>Joseph Michalski</i> | <i>Deputy Director, Associate Professor</i> | <i>HKU</i> | <i>Science</i> | <i>Earth Science</i> |
| <i>Meng Su</i> | <i>Deputy Director, Associate Professor til March 2021</i> | <i>HKU</i> | <i>Science</i> | <i>Physics</i> |
| Denis Bastieri | Chair Professor | University of Padova (Italy); & Guangzhou | Science | Physics and Astronomy |
| Kamila Chan | PhD Research Postgraduate Student | HKU | Science | Physics |
| Kayi Chan | Research Assistant | HKU | Science | Earth Sciences |
| Ruilin Cheng | PhD student | HKU | Science | Earth Sciences |
| Vanessa Chan | Undergraduate Student | HKU | Science | Physics |
| Yoyo Chu | PhD student | HKU | Science | Earth Sciences |
| Charles Cosgrove | Senior Research Assistant | HKU | Forensic Science | Faculty of Science |
| Max Collins | MPhil Research Postgraduate Student | HKU | Science | Earth Sciences |
| Jane Lixin Dai | Assistant Professor | HKU | Science | Physics |
| Xuan Fang | Research Professor | HKU | Science | Physics |
| Enhao Feng | PhD Student | HKU | Science | Physics |
| Yuan Gao | PhD Student | HKU | Science | Physics |
| Chih-Hao Hsia | Assistant Professor | MUST, Macau (ex HKU) | Science | Lunar & Planetary Sciences |
| Ruolan Jin | Postdoctoral Fellow | NTHU, Taiwan | Science | Physics |
| Kenny Ka | Undergraduate Student | HKU | Science | Physics |
| 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, HKU Professor Emeritus | UBC, Canada / HKU | Science | Earth, Ocean Atmospheric |
| Charles Lee | MPhil Research Postgraduate Student | HKU | Science | Earth Sciences |
| Leo Man Yin Lee | Undergraduate Student | HKU | Science | Physics |
| Gregg Li | Adjunct Professor | HKU | Science | Physics |
| Qiaosi Li | Postdoctoral Fellow | CUHK | Science | Earth Sciences |
| Yushan Li | PhD Student | HKU | Science | Physics |
| Jiacheng Liu | PhD Student | HKU | Science | Earth Sciences |
| Kehan Long | Undergraduate Student | HKU | Engineering | Engineering |
| 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 | MSc Student | Montreal Institute of Learning Algorithms | Engineering | Computer Science |
| 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 |
| 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 |
| Snehalata Sahu | Postdoctoral Fellow | Pondicherry University | Science | Physics |
| Yang-woo Seong | Undergraduate Student | HKU | Science | Physics |
| Victor Schubert | Space Entrepreneur | CUHK | Business Administration | Global Econ & Finance |
| Katie Strattmann | PhD Student | HKU | Science | Earth Sciences |
| Shuyu Tan | MPhil Research Postgraduate Student | HKU | Science | Physics |
| Keith Ki Tse Tsz | Undergraduate Student | HKU | Science | Physics |

| | | | | |
|--------------------|---|-------------------------------|--------------------------------------|-------------------------------------|
| Safoura Tanbakouei | Postdoctoral Fellow | HKU | Science | Earth Sciences |
| Adilet Uvaliyev | Undergraduate Student | HKU | Science | Physics |
| Alex Webb | Associate Professor | HKU | Science | Earth Sciences |
| 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 |
| Binlong Ye | PhD Student | HKU | Science | Earth Sciences |
| Boris Yim | Instructional Assistant | HKUST | Science | Physics |
| David Hoi-Fung Yu | Assistant Lecturer | HKU | Science | Faculty of Science |
| Binzheng Zhang | Assistant Professor | HKU | Science | Earth Sciences |
| Yong Zhang | Professor | Sun Yat Sen University | Science | Physics and Astronomy |
| Siyang Zhong | Research Assistant Professor | HKUST | Engineering | Mechanical & Aerospace Engineering |
| Wenhan Zhou | PhD Research Postgraduate Student | HKU | Science | Physics |
| Birry Bingrong Zhu | LSR Laboratory Assistant | HKU | Science | Faculty of Science |
| Albert Zijlstra | Hung Hing Ying HKU Distinguished Visiting Professor | University of Manchester/ HKU | Jodrell Bank Centre for Astrophysics | Physics and Astronomy |

APPENDIX VI

List of all press, TV and radio stories and interviews with members during reporting period

This reporting period has seen a spectacular explosion of more than 40 press, television, radio and opinion pieces interviewing or quoting LSR members. This is largely thanks to the burgeoning Chinese Space program and emerging new space race. The LSR is turning into one of the “go-to” organisations in Hong Kong and even globally for opinion regarding these “space” related activities.

1. September 21st 2020

EurakAlert article on work by LSR member Dr. Michael Pittman on how laser imaging informs early beak development

<https://www.eurekalert.org/news-releases/683174>

2. October 23rd 2020

EurakAlert article on work by LSR member Dr. Michael Pittman on bat-winged dinosaurs

<https://www.eurekalert.org/news-releases/469519>

3. November 3rd 2020

LSR director Prof. Quentin Parker gave a speech on planetary nebulae in the online Astrophysics Conference as part of “Digital November” at the HKU Space Museum

<https://hongkong.consulfrance.org/Digital-November-2020-Novembre-Numerique-Univers-e-is-landing-in-Hong-Kong>

4. November 23rd 2020

Sing Tao Daily Interviewed LSR director, Prof. Quentin Parker (press interview write-up);

5. December 4th 2020

LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on “Backchat” concerning the Chinese spacecraft landing on the moon

<https://www.rthk.hk/radio/radio3/programme/backchat/episode/719917/autoplay/contentindex/2/>

6. December 4th 2020

Doorways to the Space Economy – Webinar Talk by LSR director Prof. Quentin Parker

<https://www.oasahk.org/blog/oasa-doorways-to-the-space-economy>

7. December 4th 2020

China Business Network Quoted LSR director Prof. Parker in a News Story (press interview write-up)

<https://m.yicai.com/news/100932650.html>

8. December 9th 2020
EurakAlert article on work by LSR member Dr. Michael Pittman on into the origins of flight
<https://www.eurekalert.org/news-releases/667013>
9. February 16th 2021
EurakAlert article on LSR deputy Director Dr. Joe Michalski's Nature article on the reduced atmosphere on ancient Mars
<https://www.eurekalert.org/news-releases/813045>
10. February 16th 2021
LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on "Backchat" about the Chinese Mars Mission
<https://www.rthk.hk/radio/radio3/programme/backchat/episode/734720/autoplay/contentindex/2>
11. March 29th 2021
The Italian Consul, the honourable Clemente Contestabile, together with Luca Querin, business attaché, visited the LSR at Cyberport. About Clemente Contestabile:
https://conshongkong.esteri.it/consolato_hongkong/en/il_consolato/il_console
12. April 23rd 2021
LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on "Backchat" concerning the Helicopter on Mars
<https://www.rthk.hk/radio/radio3/programme/backchat/episode/744980/autoplay/contentindex/2>
13. April 9th 2021
Mr. Simba Zou, a SRF undergraduate student shared his inspiring research experience in LSR
https://www.scifac.hku.hk/f/newsletter/7304/Newsletter_April_2021.pdf
14. April 30th 2021
LSR director Prof. Quentin Parker was interviewed by China Business Network and wrote a news article about the China Space Station
<https://m.yicai.com/news/101038483.html>
15. May 11th 2021
LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on "Backchat" concerning the Chinese rocket debris re-entering the Earth's atmosphere
<https://www.rthk.hk/radio/radio3/programme/backchat/episode/748260/autoplay/contentindex/1>
16. May 14th 2021
LSR director Prof. Quentin Parker and Dr. Gregg Li of OASA gave a talk on the emerging space economy at KPMG organized Connected Cities
<https://home.kpmg/cn/en/home/events/2021/05/the-connected-cities-conference.html>

17. May 15th 2021
LSR deputy director Dr. Joe Michalski interviewed for an article in nature news about the landing of China's first rover on Mars and what happens next
https://www-nature-com-s.caas.cn/articles/d41586-021-01301-7?error=cookies_not_supported&code=eb2b085a-28c8-48e8-95d1-8cbece6d1662
18. May 26th 2021
LSR deputy director Dr. Joe Michalski was quoted in a Bloomberg article entitled "Elon Musk's Mars Ambition Could Be the Riskiest Human Quest Ever"
<https://www.bloomberg.com/news/articles/2021-05-25/elon-musk-s-mars-ambition-could-be-the-riskiest-human-quest-ever>
19. May 20th 2021
LSR deputy director Dr. Joe Michalski interviewed for an article in Forbes Magazine concerning China's Zhurong rover and prospects for studying sand dunes, subsurface ice and mud volcanoes
<https://www.forbes.com/sites/davidbressan/2021/05/20/chinas-mars-rover-zhurong-will-study-sand-dunes-subsurface-ice-and-maybe-mud-volcano/?sh=9c154d65b633>
20. May 20th 2021
LSR deputy director, Dr. Joe Michalski quoted in a Nature news item on the first images returned by China's Mars rover
<https://www.nature.com/articles/d41586-021-01365-5>
21. June 11th 2021
LSR deputy director, Dr. Joe Michalski interviewed for an article in Nature concerning China's Zhurong rover
<https://www.nature.com/articles/d41586-021-01588-6>
22. June 18th 2021
LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on "Backchat" discussing the significance of China's manned space mission
<https://www.rthk.hk/radio/radio3/programme/backchat/episode/755258/autoplay/contentindex/2>
23. June 28th 2021
LSR director, Prof. Quentin Parker was interviewed by China Radio International regarding the Chinese space program
<http://chinaplus.cri.cn/podcast/detail/1/2694446>
24. July 8th 2021
PhD student, Mr. Binlong Ye from Earth Sciences won an outstanding paper prize
<https://www.earthsciences.hku.hk/news-and-events/news/phd-students-from-earth-sciences-won-an-outstanding-paper-prize>

June 16th to July 2nd 2021:

Hong Kong-based space expert Prof. Quentin Parker welcomed the new horizons for humanity in space under a series of related media interviews and press stories:

25. The Standard: HKU unveils a first-of-its-kind space technology programme for secondary school students (2nd July 2021)
<https://www.thestandard.com.hk/section-news/fc/4/231756/HKU-unveils-a-first-of-its-kind-space-technology-programme-for-secondary-school-students>
26. HKU unveils a first-of-its-kind space technology programme for secondary school students (28th June 2021)
<https://hd.stheadline.com/news/realtime/hk/2112133>
27. Bastille Australia: HKU unveils a first-of-its-kind space technology programme for secondary school students (28th June 2021)
<https://www.bastillepost.com/australia/article/2518272>
28. Sing Tao Daily: HKU unveils a first-of-its-kind space technology programme for secondary school students (28th June 2021)
<https://std.stheadline.com/daily/article/2370771>
29. OpenGov: HKU Co-launches First-ever Space Tech Programme for Young Students (26th June 2021)
<https://opengovasia.com/hku-co-launches-first-ever-space-tech-programme-for-young-students/>
30. China Plus: What's driving China's space exploration? Interview with LSR director Prof. Quentin Parker on China Radio International (25th June 2021)
<http://chinaplus.cri.cn/podcast/detail/1/2694446>
31. China Daily: Scientists hail HK's role in space missions (24th June 2021)
https://newsletter.chinadailyhk.com/newsletter/top_headlines/article/225241?user_id=179966&email_id=3100#Scientists-hail-HK's-role-in-space-missions
32. China Daily: Scientists hail HK's role in space missions - video interview with LSR director Prof. Quentin Parker (24th June 2021)
<https://m.facebook.com/chinadailyhkedition/videos/156608456410907/?refsrc=deprecated&rdr>
33. RTHK: China's manned space mission - radio interview with LSR director Prof. Quentin Parker (18th June 2021)
<https://www.rthk.hk/radio/radio3/programme/backchat/episode/755258/autoplay/contentindex/2>

34. South China Morning Post: Building China's new space station, Beijing's moon base plans and its growing space industry (24th June 2021)
<https://www.scmp.com/podcasts/inside-china/3138561/building-chinas-new-space-station-beijings-moon-base-plans-and-its>
35. Ahead of Chinese space station mission, a call for more collaboration by LSR director, Prof. Quentin Parker (17th June 2021)
<https://www.scmp.com/news/china/science/article/3137565/nobody-benefits-these-barriers-call-more-collaboration-ahead>
36. Meet the astronauts set to blast off on first Chinese space station mission with LSR director, Prof. Quentin Parker's comments (16th June 2021)
<https://www.scmp.com/news/china/science/article/3137539/meet-astronauts-set-blast-first-chinese-space-station-mission>
37. CBS News: Will China's fast pace in the space race fuel U.S. ambitions? TV interview with LSR director Prof. Quentin Parker coast to coast USA (June 17th 2021)
<https://www.cbsnews.com/news/china-space-launch-space-station-us-nasa-iss/?ftag=CNM-00-10aag7e>
38. July 9th 2021
LSR member Dr. David Yu was part of a panel on RTHK TV Science Talk Show: "Science Night 2021" and featured his research work on gamma-ray bursts
www.rthk.hk/tv/dtt31/programme/sciencenight2021/episode/758049?lang=en
39. July 12th 2021
China Radio international interview with LSR director Prof. Quentin Parker on the Chinese Space program
<http://chinaplus.cri.cn/podcast/detail/1/2694869> (view from 31:30)
40. July 21st 2021
LSR director, Prof. Quentin Parker was interviewed by RTHK Radio 3 on Backchat concerning space tourism
www.rthk.hk/radio/radio3/programme/backchat/episode/761575/contentindex/1/
41. August 4th 2021
KPMG podcast recorded with LSR director Prof. Quentin Parker, OASA Chairman Dr. Gregg Li and hosted by KPMG co-head of infrastructure (China) Julian Vella on "The Space Economy - The Missing Link Connecting our Smart City?" to air late August 2021
42. August 7th 2021
Nature astronomy contribution from LSR deputy director Joe Michalski on "Curious results from the Mars stratigraphy rover"
<https://astronomycommunity.nature.com/posts/curious-results-from-the-mars-stratigraphy-rover>
43. August 20th 2021
The Wall Street Journal aired a video interview with LSR Director, Prof. Quentin Parker on the emerging Chinese Space Program.
<https://www.wsj.com/video/chinas-tiangong-vs-international-space-station-tech-design-unpacked/63ECB569-CC4E-4470-9951-A5F4417A4975.html>

APPENDIX VII

Strength in Diversity – The LSR family

The LSR subscribes to an ethos of tolerance, equal recognition and equal treatment regardless of race, religion, gender or LGBTQ status. Currently 28% (18) of our members are female, which, though lower than we would like, still bears very favourable comparison with most departments in the Faculty of Science.



Our international representation is also high with 23 members from 11 different countries other than the Chinese Mainland and the HK SAR of the PRC, as represented in the flags above.


APPENDIX VIII

Member focus: Diganta Misra, Msc



Why did I join LSR?

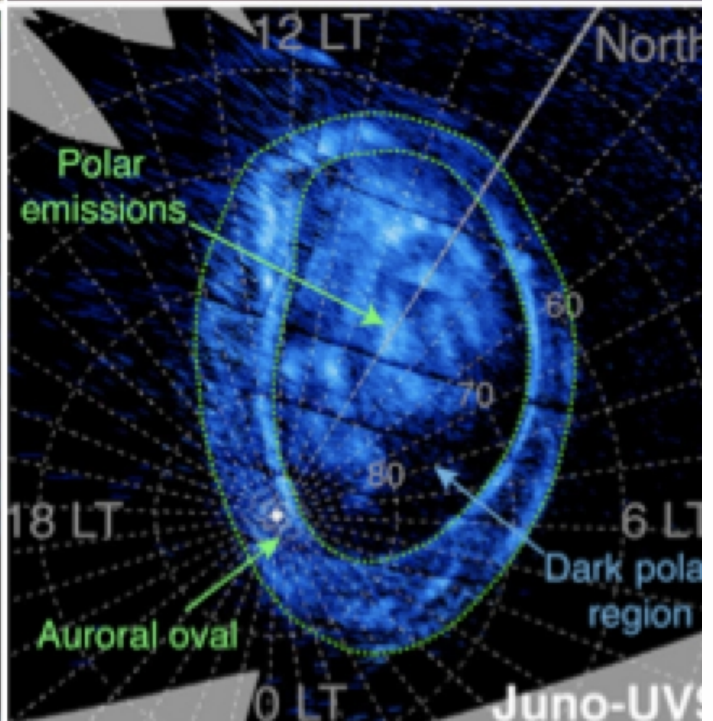
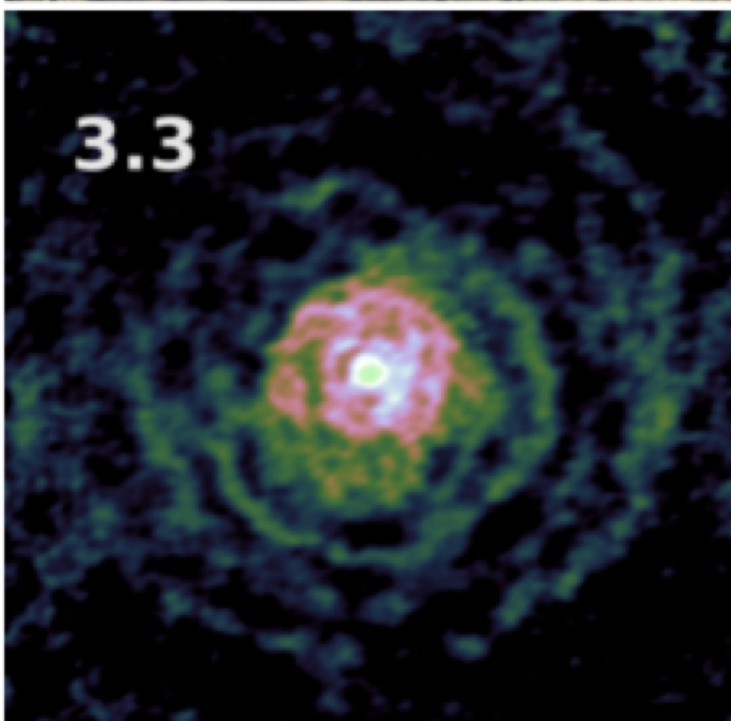
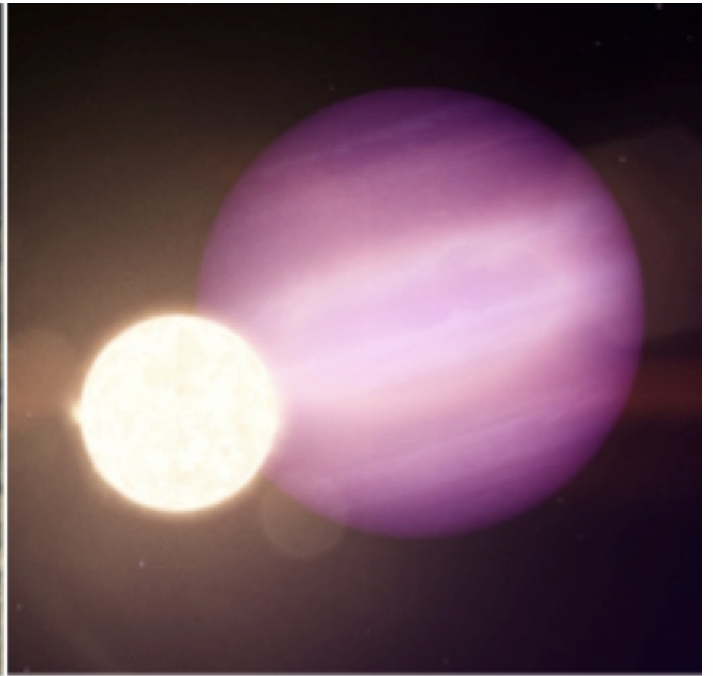
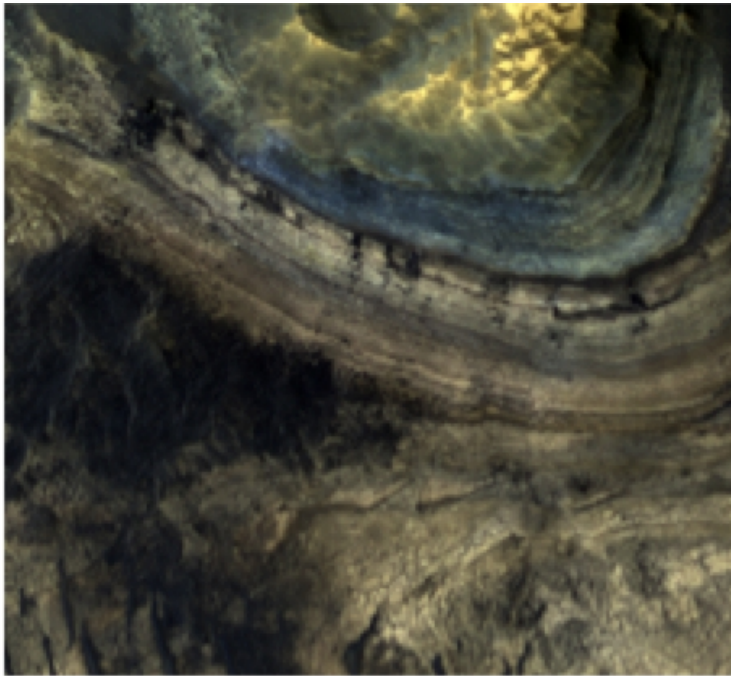
1. I have always been keen to contribute to real scientific and qualitative progress in understanding the universe and especially expanding our current scope in remote exploration. Primarily, I am heavily interested in understanding PNe and in using satellite data for better and enhanced mapping using computer vision techniques. I use machine learning based modelling in understanding the storm systems in exoplanets.
2. I view LSR as one of the leading pioneers in collaborative, interdisciplinary and cross-modal research into astrophysics and space research. The diverse backgrounds and expertise brought to the table by the different distinguished members of the lab offered me a fantastic environment to not just explore ideas from different perspectives but also get familiar with the culture that exists in different scientific communities. I found LSR's goal to be ambitious and the progress demonstrated over the year is extremely promising in terms of inviting more bright minds and enthusiastic novices like me.

- 
3. I also joined because I felt the importance of extending machine learning (computer vision) based technologies and models to solve challenging problems in space research ranging from advanced signal processing and data sparsity/ restoration. My background in math and machine learning along with the platform of LSR provides me with the right recipe of exploring different facets of space research from a more intelligent computational perspective.

My research: “Mish: A self Regularized Non-Monotonic Activation Function”

My paper doesn't solve a problem in current space research but is a more generalistic literature on non-linear smooth dynamics in neural networks (the default component in the paradigm of deep learning). The paper provides a strong insight into how we can improve our models and make them more reliable, robust and interpretable. The method proposed in the paper "Mish" is strongly proven by validation to be an universal performance incrementing function and has been used by the state of the art object detection methods. To the extent the paper has been used in networks designed by researchers from the Astrophysics department of John Hopkins University in modelling the HI Mass Fraction in low redshift galaxies. My paper has so far amassed over 270 citations as a single author paper published at BMVC 2020. The paper has also been covered by several blog posts, podcasts and academic talk shows. See: <https://arxiv.org/abs/1908.08681>. Applications that can benefit from this work include most, if not all, deep learning based modelling used in space research and astrophysics.

Details for the image montage on the front cover all taken from some of the top LSR papers over the reporting period



1. Top left – from paper led by Mr J.Liu and Dr. Joe Michalski of the LSR on “Anoxic chemical weathering under a reducing greenhouse on early Mars”, published in *nature astronomy*, February 2021, DOI: 10.1038/s41550-021-01303-5
2. Top Right – artist’s rendition of a giant planet orbiting a white dwarf star taken from the press materials associated with the LSR member Mr. Thomas Kaye who co-authored the paper: “A giant planet candidate transiting a white dwarf”, published in *Nature* in September 2020, DOI: 10.1038/s41586-020-2713-y
3. Bottom left – Alma data of the star “W Aql” taken from the press materials associated with the LSR member Prof. Albert Zijlstra’s participation as co-author on “Sub-stellar companion shape the winds of evolved stars” published in *Science* in September 2020; DOI: 10.1126/science.abb1229
4. Bottom right – image of Jovian auroral distribution from the LSR led paper by Dr. Binzheng Zhang on “How Jupiter’s unusual magnetospheric topology structures its aurora” published in *Science Advances*, 7, 1204 in April 2021, DOI: 10.1126/sciadv.abd1204

