Expanding astronomy research in Malaysia

Astronomy research in Malaysia has progressed rapidly in the last few decades, with an increasing number of enthusiastic Malaysian astronomers working together to build new research groups and observing facilities, while establishing research networks both locally and globally.

Zamri Zainal Abidin, Mhd Fairos Asillam and Jun Yi Koay

Malaysia's astronomy history is closely linked to the spread of Islam in the Malay Archipelago in the early fourteenth century. Syeikh Abdullah Fahim was one of the Malaysian Muslim scholars renowned for linking Islamic worship with astronomy. He was consulted by the leaders of then Malaya for selection of the date for the nation's Independence Day based on his astronomical observations[1]. Further such efforts have led to the recent historic announcement on the change in prayer time for Islamic followers in Malaysia. This project was led by the country's Department of Islamic Development (JAKIM), with strong support from local astronomers due to the need to calculate the sun's depression angles of 19° and 20° below the horizon to determine the start of prayer time[2].

Early national-level astronomy programs were introduced in the 1990s, with support from the Malaysian government, to create awareness about astronomy research and promote educational activities nationwide. These programs were achieved via the establishment of the National Planetarium in 1994. This effort was then followed by university-level research efforts initiated at Universiti Malaya (UM) in topics such as binary stars and crescent moon visibility criteria (pioneered by Mohd Zambri Zainuddin, and subsequently by Nazhathulshima Ahmad), stellar evolution and nuclear astrophysics (pioneered by Hasan Abu Kassim, and subsequently by Norhasliza Yusoff), as well as ethnoastronomy (Ahmad Hakimi Khairuddin and Nurul Fatini Jaafar).

The Malaysia Space Agency and the Langkawi National Observatory

The Malaysia Space Agency (MYSA), previously known as the Space Science Study Division (BAKSA) and the National Space Agency of Malaysia, played a leading role in empowering astronomy researchers in Malaysia by spearheading and coordinating national-level programs in all branches of astronomy, as well as space weather and microgravity sciences. In 1988, through the efforts of its founder, Mazlan Othman, the then BAKSA officially became a member and the national contact point for the International Astronomical Union (IAU) under category 1. Mazlan Othman was Malaysia's first astrophysicist (she obtained her PhD in 1981) and served as the director of the United Nations Office for Outer Space Affairs between 1999 and 2002 and between 2007 and 2014. As of 2019, there are 20 astronomers registered under the IAU in Malaysia.

Fig. 1 | The Langkawi National Observatory. Translated to *Observatori Negara Langkawi* in the Malaysian language, it is the national pride of astronomy development.

MYSA's efforts to develop and expand optical astronomy research in Malaysia led to the construction of the Langkawi National Observatory (LNO) (Fig. 1). The LNO was built in 2006 on Bukit Malut Dam on the island of Langkawi. It was established to be the main training platform for Malaysia's astronomy human capital, and for Malaysian astronomers to embark on international collaborations in optical astronomy research[3]. Its primary telescope is a Ritchey–Chrétien reflector optical telescope that has an aperture of 0.51 metres in diameter[4]. Its main charge-coupled device (CCD) camera has an array of 1024 × 1024 pixels, which produces a field of view of 20.1' × 20. 1' with a pixel scale of 1.2" per pixel[5]. Due to the median seeing for the LNO (at best 0.8 arcseconds in May 2014) and the local sky brightness ($V = 18.6 \pm 1.0$ magnitude), the LNO is a suitable location for astronomical spectroscopic work[6].

National programs with the LNO have seen the involvement of Malaysian astronomers in the cataloguing of equatorial astronomical phenomena and monitoring of potentially hazardous near-Earth objects via astrometric CCD observations. One of the LNO's main achievements is its success in officially acquiring the observatory code O43 (named Observatori Negara from the Minor Planet Centre) on 21 May 2014, marking successful efforts by the LNO in meeting IAU standards for instrumentation and methodology for observatories.

Another branch of astronomy research involves the national space weather program, which has further expanded since the installation of a solar telescope system at the LNO. The system is equipped with different filters capable of monitoring the Sun at three wavelengths (white light, Calcium K and Hα). Since 2008, the LNO has commenced digital collection of daily solar images[7]. Daily sunspot numbers and images have been regularly provided to the Solar Influences Data analysis Center[8]. The national space weather research and development has also benefited from the installation of a ground-based magnetometer network, the Magnetic Data Acquisition System, through the collaboration between MYSA, Universiti Kebangsaan Malaysia and the International Center for Space Weather Sciences and Education at the University of Kyushu, Japan. Its scientific goal is to understand the dynamics of plasmaspheric changes during space storms[9].

In 2011, another important milestone was achieved when MYSA and the Malaysian Meteorological Department successfully set up a national committee on space weather to monitor solar activity at the administrative level. In 2015, MYSA and Universiti Teknologi Malaysia established the National Space Weather Lab for nowcasting and forecasting solar activities. There is a need for the future development and operation of an automated national-level early warning system for space weather to minimize the

Fig. 2 | The UPSI-UM Radio Astronomical Observatory. This L-band radio telescope is the first and currently only research-grade radio astronomical telecope in Malaysia.

risks posed by severe weather conditions in space.

The rise of radio astronomy in Malaysia

Radio astronomy is among the most recent and fastest growing astronomical research areas in Malaysia. It was pioneered by a couple of returning radio astronomy graduates from the University of Manchester's Jodrell Bank Centre of Astrophysics, Abdul Halim Abdul Aziz and Zamri Zainal Abidin. The latter, with the assistance of a senior professor in electronics, Zainol Abidin Ibrahim, established the Radio Cosmology Research Lab (RCRL) in 2005, based at the Physics Department at the University of Malaya[10]. The lab's first masters student graduated in 2010. Since then, the research group has produced seven PhD and ten MSc students, with five PhD and seven MSc students registered at present. The group's research topics include dark matter, galactic rotation curves, galaxy cluster dynamics, active galactic nuclei, black holes, the cosmic web, solar radio bursts, fast radio bursts and radio astronomy instrumentation[11–15]. Graduates from the RCRL have also been instrumental in establishing their own radio astronomy groups at other universities, for example, at Universiti Teknologi MARA (headed by Zety Sharizat Hamidi) and Universiti Sultan Zainal Abidin (headed by Roslan Umar).

One of the RCRL's main achievements is the construction of the first radio telescope observatory in Malaysia, named the UPSI-UM Radio Astronomical Observatory (Fig. 2). It was constructed at the grounds of the Universiti Pendidikan Sultan Idris (UPSI). The 7 m diameter L-band radio dish is currently undergoing interferometric fringe testing with the Tianma radio telescope in China and the Usuda radio telescope in Japan. This joint research will kickstart Malaysian radio astronomers' effort to use the very long baseline interferometry (VLBI) technique, together with their East Asian collaborators[16], for research.

The RCRL has been conducting extensive radio frequency interference surveys to determine suitable sites for radio observatory construction, including the abovementioned UPSI-UM observatory[17]. These efforts have also led the RCRL to decide on the best site for the construction of a larger radio astronomy observatory in Malaysia, at Jelebu in Negeri Sembilan[18,19], which is planned in collaboration with the Shanghai Astronomical Observatory (SHAO). Early works for this joint effort began in 2015 and a memorandum of understanding (MOU) between UM and SHAO was signed in 2019. The signing ceremony took place during the first Malaysia VLBI Workshop on 11 November 2019. The workshop also provided an important platform for radio astronomers in Malaysia to network with each other and with international VLBI experts (Fig. 3) from other institutes in Asia.

Another critical milestone for radio astronomy in UM and Malaysia was the signing of an MOU between UM and the East Asian Observatory (EAO), also in 2019, that led to the formation of the UM-led Malaysia/EAO Observer Consortium (MEASOOC). The MEASOOC's main task is to nominate Malaysian astronomers and researchers to participate in EAO collaborations. Through this MOU, Malaysian astronomers are granted access to all facilities operated by the EAO, including the James Clerk Maxwell Telescope.

Expanding globally and reversing the brain drain

In addition to Malaysian astronomers working in Malaysia, there is now a growing number of Malaysian astronomers who have obtained or are pursuing PhDs in well-established astronomy and astrophysics institutes abroad. This is seen as another pathway to expand and diversify astronomy expertise in the country. Indeed, some of these overseas PhD graduates have returned to Malaysia recently to take up academic positions in local universities while carrying on their astronomical research with their international colleagues. These include Adlyka Annuar at the Universiti Kebangsaan Malaysia (with expertise in X-ray astronomy and black holes), Hafizah Noor Isa at the International Islamic University Malaysia (a member of the Laser Interferometer Gravitational-Wave Observatory collaboration) and John Soo at the University of Science Malaysia (with expertise in cosmology).

Nevertheless, there remains a significant number of these overseas graduates who continue to work abroad. In total, there are about 35 Malaysian astronomy researchers currently based overseas; of these, about 20 are postgraduate students, while the rest are currently holding postdoctoral, support scientist and faculty positions. Their expertise ranges from theoretical to observational astronomy and instrumentation work. Some are members of large international collaborations including the Event Horizon Telescope[20] and the Zwicky Transient Facility[21], as well as various scientific working groups for next generation telescopes such as the Square Kilometre Array[22]. These Malaysian astronomers are therefore conducting

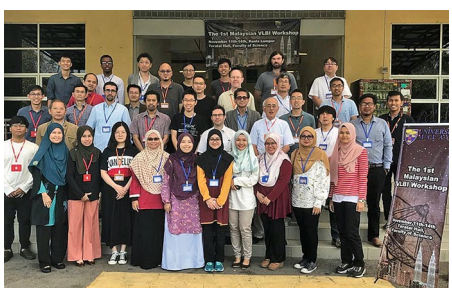

Fig. 3 | Malaysian radio astronomers and their collaborators gathered at the 1st Malaysian VLBI Workshop. This workshop witnessed the historic signing of an agreement that paved the way towards establishing the first ever radio astronomical interferometer network involving radio telescopes in Malaysia and a foreign country.

cutting-edge research using world-class astronomical facilities and have been successful on the international stage. For example, to date, three Malaysians (Lee Khee Gan, Ting Yuan-Sen and Marc Teng Yen Hon) have been awarded the prestigious NASA Hubble Fellowships. Harnessing the expertise, resources and global networks of these overseas Malaysian astronomers will provide a significant boost to astronomy development in Malaysia.

In early 2019, a group of Malaysian astronomers teamed up to organize the first Global Malaysian Astronomers Convention. The goal was to bring together Malaysian astronomers based locally and internationally for a week to learn about each other's research, form long-term collaborations, discuss and formulate concrete plans to develop astronomy in Malaysia, and strengthen the network of Malaysian astronomers. Such a strong network would make more efficient use of our limited national resources and have a stronger influence on policymakers and funding agencies. The meeting agenda included discussions on the formation of a Malaysian society for professional astronomers, planning for the joint supervision of postgraduate students, and training workshops. This program was listed as a 2020 recommended project by the IAU Office of Astronomy for Development. Unfortunately, the event had to be postponed due to the coronavirus pandemic. Nevertheless, it is hoped that the meeting, when eventually held, will be a platform for launching a more unified approach to the development of astronomy in Malaysia.

Looking ahead, the future looks promising for astronomy and astrophysics in Malaysia and it is definitely the best time to intensify efforts to promote and further expand and diversify astronomy in the country. This goal can be achieved by further supporting astronomy research and education. ❐

Zamri Zainal Abidin[1]✉, Mhd Fairos Asillam[2] and Jun Yi Koay[3]

[1]Department of Physics, Universiti Malaya, Kuala Lumpur, Malaysia. [2]Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia. [3]Academia Sinica Institute of Astronomy and Astrophysics, Taipei, Taiwan.
✉*e-mail: zzaa@um.edu.my*

Published online: 14 October 2020
https://doi.org/10.1038/s41550-020-01230-x

References

1. Man, S. et al. *Middle East J. Sci. Res.* **12**, 108–113 (2012).
2. Bahali, K., Samian, A. L., Muslim, N. & Hamid, N. S. A. *IJMWC* **7**, 37–48 (2019).
3. Zainuddin, M. Z. et al. *ASM Sci. J.* **12**, 107–124 (2019).
4. Loon, C. W., Zainuddin, M. Z., Ahmad, N., Shukor, M. S. & Tahar, M. R. *AIP Conf. Proc.* **1657**, 050006 (2015).
5. Ngeow, C.-C. & Luo, S.-C. *J. Phys. Conf. Ser.* **852**, 012002 (2017).
6. Zainuddin, M. Z., Loon, C. W. & Harun, S. *AIP Conf. Proc.* **1250**, 51–54 (2010).
7. Kamarudin, F. et al. In *Proc. 2015 International Conference on Space Science and Communication (IconSpace)* 314–318 (Curran Associates, 2015).
8. Radzi, Z. et al. *Adv. Sci. Lett.* **23**, 1248–1253 (2017).
9. Yumoto, K. MAGDAS Group. *AIP Conf. Proc.* **1144**, 173–178 (2009).
10. Abidin, Z. Z. & Ibrahim, Z. A. In *Proc. 2009 International Conference on Space Science and Communication (IconSpace)* 179–181 (IEEE, 2009).
11. Pauzi, F. A. M. et al. *Sol. Phys.* **295**, 42 (2020).
12. Kiew, C.-Y., Hwang, C.-Y. & Abidin, Z. Z. *Mon. Not. R. Astron. Soc.* **470**, 2834 (2017).
13. Azeez, J. H., Abidin, Z. Z., Hwang, C.-Y. & Ibrahim, Z. A. *Adv. Astron.* **2017**, 8416945 (2017).
14. Hassan, M. S. R., Abidin, Z. Z., Ibrahim, U. F. S. U., Hashim, N. & Lee, D. A. A. *Mon. Not. R. Astron. Soc.* **458**, 264–269 (2016).
15. The Event Horizon Telescope Collaboration et al. *Astrophys. J. Lett.* **875**, L1 (2019).
16. Abidin, Z. Z., Hashim, S. J., Wei, L. Y., Zhong, C. & Rosli, Z. *Indian J. Phys.* **92**, 1–6 (2018).
17. Umar, R., Abidin, Z. Z., Ibrahim, Z. A., Rosli, Z. & Noorazlan, N. *Res. Astron. Astrophys.* **14**, 241–248 (2014).
18. Abidin, Z. Z. et al. In *Proc. 31th URSI General Assembly* 6929985 (URSI, 2014).
19. Abidin, Z. Z. et al. *New Astron.* **17**, 61–64 (2012).
20. The Event Horizon Telescope Collaboration et al. *Astrophys. J. Lett.* **875**, L2 (2019).
21. Bellm, E. C. et al. *Publ. Astron. Soc. Pac.* **131**, 018002 (2019).
22. Carilli, C. L. & Rawlings, S. *New Astron. Rev.* **48**, 979–984 (2004).

Acknowledgements

Z.Z.A. thanks the University of Malaya for their Frontier Research Grant (FG033-17AFR) and Malaysia's Ministry of Higher Education for their High Impact Research Grant (UM.S/625/3/HIR/28).

Competing interests

The authors declare no competing interests.