

VLBI in Malaysia: Current Status and Future Plans

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The community of astronomers is growing in Malaysia and organizing their first steps towards a solid Malaysian Astronomical Society. The area of radioastronomy is growing on par, and so it is in particular the VLBI field. Here we present the Malaysian current VLBI status and future plans. Our local community is raising VLBI experts both from the scientific as well as from the technical and engineering points of view. Malaysian VLBI researchers are active in fields involving, but not limited to, AGN physics, masers, solar astronomy, clusters of galaxies, or dark matter, among others. Scientific collaboration and partnership with other (south) east asian regions and the East Asian Observatory (EAO) has also started. Malaysia has moved forward in the signing of a Memorandum of Agreement with the Shanghai Astronomical Observatory (SHAO) and Xiamen University Malaysia (XMUM) for the acquisition and operation of a VGOS radio telescope which will be expected to start its construction in the location of Jelebu in the near future. Malaysia is moving towards its readiness by finalizing VLBI tests with the UPSI pathfinder antenna.

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1. Background

Although Malaysian astronomy can be traced back to the 14th century, astronomy programs were only introduced in 1990s. Mazlan Othman was Malaysia's first astrophysicist, obtaining her PhD in 1981 from University of Otago, New Zealand, becoming also the first woman to do so since the university was founded. She returned to Malaysia where she created a curriculum in astrophysics and space physics in Malaysian universities. As of 2019, there are 20 astronomers registered under the IAU in Malaysia. The Global Malaysian Astronomical Convention (GMAC) in 2020 gathered more than 100 astronomers [1].

Radio astronomy pioneered by Zamri Zainal Abidin (PhD, University of Manchester) and Zainol Abidin Ibrahim. The Radio Cosmology Research Laboratory was established in Universiti Malaya (UM) in 2005 and is currently the only radioastronomy laboratory in Malaysia. The group has currently 1 Postdoc, 4 PhDs and 9 MSc students registered involved in the following topics: Dark matter, Galactic rotation curves, Galaxy cluster dynamics, Active galactic nuclei and black holes, Star Formation, The cosmic web, Solar radio bursts, Fast radio bursts, and Radio astronomy instrumentation.

The Radio Cosmology Research Laboratory is actively involved and collaborating with various associations and consortiums in the east asian region to build new research groups and establish research networks both locally and globally. There exist also an increasingly involvement with research facilities and the group is working on a series of radio astronomical instrumentation and engineering aiming to motivate and construct a path road toward the successful development of fully functional VLBI facilities in Malaysia that are expected to be part of the east asian and/or south-east asian network. In the following we briefly describe these.

2. Committees and Collaborations

A milestone for UM and Malaysian radio astronomy is the signing of agreements between various local and international institutions and the Radio Cosmology Laboratory in order to preserve and study and survey the local radio frequency situation of the country, managing and protecting the radio spectrum for radio astronomy in Malaysia, as well as to recognize and utilise east asian operated radio instruments and observatories.

MEASOOC The Malaysia-EAO Observer Consortium (MEASOOC) is a committee recognized by the East Asian Observatory (EAO) via a memorandum of understanding (MOU) signed between EAO and UM on January 17, 2019. By this MOU, EAO invites all members of MEASOOC to be on the Observer Status with the EAO. As Observer, they can access all the facilities, which EAO operates, as well as other facilities which EAO will have access to. EAO acknowledges UM as the official institutional contact point for the collaboration, with the Radio Cosmology Research Lab in UM as the contact point for official communication.

RAFCOM Malaysia is a member of Radio Frequency Committee for Asia Pacific (RAFCAP) region since 2003. Radio Astronomy Frequency Committee of Malaysia (RAFCOM) was setup in April 2021. RAFCOM aims to report on radio frequency interference (RFI) surveys



Figure 1: Left: the HWDA array. Right: the UPSI-UM 7.3m radio antenna.

and radio quiet zones (RQZ) setup, acts as collective approach to MCMC, and discuss contributions and gather information for RAFCAP/IUCAF/ITU, and similar local radio frequency operating related institutions.

International Collaborations We have collaborations with the National Astronomical Observatories (NAOC), Yunnan Observatories (YNAO), Shanghai Astronomical Observatory (SHAO), Xinjiang Astronomical Observatory (XAO) under the Chinese Academy of Sciences (CAS) for the construction of a radio telescope in Malaysia, space geodesy station, VLBI, and solar sciences. We also collaborate with the National Astronomy Research Institute Thailand (NARIT), Peking University, National Central University (NCU), National Research Institute of Astronomy and Geophysics (NRIAG), Institut Teknologi Bandung (ITB), or Nagoya University, among others.

3. Pathfinders on the Road for VLBI

The vision of the Radio Cosmology lab is to make Malaysia an anchor point for south east asian VLBI. Its mission is to lead the country towards excellence in radio astronomy research and instrumentation. In order to achieve this goal, the group has been developing continuous efforts in order to cultivate knowledge towards VLBI capabilities, both in terms of science cases as well as in instrumentation concept. In order to nurture the path for radio instrumentation, a series of step-by-step pathfinder experiments and facilities have been envisioned to train and guide the next generation of Malaysian VLBI astronomers and engineers.

The Half-Wave Dipole Antenna (HWDA) Array The HWDA array was designed by the Chinese Academy of Sciences, Yunnan Astronomical Observatory (YNAO). Through a research collaboration with UM, a replicate of it was constructed in UM at the selected site on its campus. The ultimate goal is to have a VLBI array between the antennas in YNAO and UM.

UPSI-UM 7.3m Radio Antenna The first radiotelescope observatory in Malaysia was constructed at the grounds of Universiti Pendidikan Sultan Idris (UPSI). The 7m diameter L-band radio dish has been used for interferometric fringe testing with China and Japan. This joint research kickstarts Malaysian radio astronomers effort to use VLBI technique together with their East Asian collaborators.



Figure 2: A 180° view of the UM biotechnological Research Center (UMBRC) in Jelevu, where the VGOS antenna is planned to be located.

Table 1: Preliminary VGOS project timeline

2019	MOU UM-SHAO
2020	Location discussions and planning
2020	MOA UM-XMUM-SHAO
2021	Soil investigation and logistic preparations
2022	Site Preparation
2022	VGOS Manufacturing and Delivery
2022-2023	Telescope Assembly
2023-2024	First Light

MYSA-UM 13 m Radio Telescope After the success of the testing of the UPSI-UM radio telescope, in 2022, we ventured into converting the fully-steerable 13 meter satellite dish receiver located at the Malaysian Space Agency’s Temerloh Earth Receiving Station. A Memorandum of Agreement is yet to be signed but early joint collaborations are already underway in order to make this dish into a dual purpose radio telescope-satellite receiver system.

VGOS Radio Telescope The next step is the installation of a VGOS facility in the UM biotechnological Research Center (UMBRC) in Jelevu, one of the driest places in Malaysia. This is a Joint Project lead by Universiti Malaya together with Xiamen University Malaysia and Shanghai Astronomical Observatory aiming for geodetic observations towards ICRF and astrophysical VLBI studies (e.g, masers, AGNs,...). The preliminary project timeline is summarized in Table 1.

4. Activities and Future Plans

The Radio Cosmology Laboratory periodically organizes a series of events and activities in order to boost and enhance collaborations, discussion, and outreach of radio astronomy. A summary of these, including future plans are shown in Table 2. Additionally, we include invited speakers in our journal discussions which are made publicly available for the department, such as a special talk from an invited speaker, Dr. Stefan Duchesne, a researcher from CSIRO, or from Mr. Satyan

Table 2: Activities

11–14 November 2019	1st Malaysian VLBI Workshop
12 February 2020	Nancay Radio Heliograph Data Reduction Workshop
19 November 2020	CASA Pipeline for ALMA data
29 June 2021	1st UM-NARIT Bilateral Symposium
9 September 2021	Exploring Galaxies with MaNGA
31 March 2022	JCMT Malaysia Users Meeting
12 May 2022	EHT Press Conference Watchalong and Q&A With Dr Algaba
3 August 2022	2nd UM-NARIT Online Bilateral Symposium
5–8 September 2022	2nd Malaysian VLBI Workshop
30 January – 3 February 2023	IAU Symposium Monsoon School

Anandkrishnan, a former aeronautics engineer who worked on both the James Webb and Hubble telescopes.

Further mid-term plans include but are not limited to gearing up radio cosmology laboratory topics towards future potential VLBI local users. We intend to activate discussion with the Xinjiang Astronomical Observatory (XAO) for low frequency VLBI and with the Australian Telescope National Facility (ATCA) in preparation for future VLBI with Australia. The new facilities such as the 13m VGOS antenna can collaborate with the European VLBI Network. The long term goals envision Malaysia as a strong VLBI node in the south east asian region in terms of manpower, local experts, facilities, networking and strategic outputs.

Acknowledgments

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References

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