Under One Sky: The IAU Centenary Symposium
Proceedings IAU Symposium No. 349, 2019
C. Sterken, J. Hearnshaw & D. Valls-Gabaud, eds.

doi:10.1017/S1743921319000449

Developing Astronomy in Madagascar – the impact of the IAU Support

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Abstract. During its XXXth General Assembly, the International Astronomical Union (IAU) welcomed the island of Madagascar, under the Malagasy Astronomy & Space Science (MASS), as one of its new National Members. Founded in 2016, MASS is a non-profit association, a community of young professional astronomers and graduate students from Madagascar. As various organizational structures are gradually being established towards the development of Astronomy & Astrophysics in the country, the IAU has played a vital role and is still actively involved in achieving such ambitious goals.

1. The Genesis of astronomy in Madagascar

Madagascar is a red island off the southeast coast of Mozambique with Antananarivo, its capital city. Because of its fertile land and its prime location in the Indian Ocean, the country had served as a stopover for ships and a land of opportunity for settlement and agricultural production way before the French colonization in 1896 (Hooper 2017).

The Jesuits were one community that settled in the highlands of Madagascar in the 1830s. These missionaries did not only evangelise, but they also established the Astronomical Observatory of Ambohidempona in 1889 (Combeau-Mari 2011). This scientific institute, currently known as the Institute and Observatory of Geophysics of Antananarivo, focused on research in astronomy, meteorology, geodesy and terrestrial magnetism. It had a large dome with an Eichen telescope 20 cm in diameter (Udias 2014).

Unfortunately, budget constraints and the independence of Madagascar in 1960 worsened the decline of the scientific work of the Observatory. The Jesuits ultimately left the institute and it was incorporated into the University of Antananarivo in 1967 (Udias 2014). Nowadays, the institute is mostly dedicated to teaching and conducting research activities in the field of Earth Sciences.

2. Year 2006: a revival in the advancement of astronomy

In 1993, the International Union of Radio Science established a working group to develop a next generation radio observatory. Following global meetings and discussion on the scientific goals and technical aspects of the future observatory emerged the Square Kilometre Array or SKA project (Carilli & Rawlings 2004; Ekers 2012). This international initiative aims to build the world's largest radio telescope with a collecting area over 1 km^2.

It was decided in 2012 that South Africa and Australia will co-host the SKA Observatory to be built in two phases. During SKA Phase 2, a portion of the mid-frequency antennas could be implemented in eight other African partner countries, including Madagascar. These countries initiated their collaboration with the South African SKA

Figure 1. A local Intelsat station to be converted into a radio dish as part of the AVN project.

Project in 2006 to train the next generation of scientists in the continent. In 2007, the first batch of Malagasy students arrived in South Africa to pursue postgraduate bursaries awarded by the SKA *South African Human Capital Development Programme* (HCDP). Concurrently, potential sites were identified to host the future SKA stations in the country.

To date, the HCDP has awarded grants to 13 Malagasy students for studies in astronomy or engineering in South Africa. Ten of the scholars have already earned their PhD degrees and they are currently early-career researchers who are mostly based in South Africa.

3. Professional astronomy activities in Madagascar

Because of the exponential growth of the interest in astronomy and given the country's involvement in the global SKA project, Professor Minoson Rakotomalala from the Department of Physics of the University of Antananarivo initiated the Astrophysics postgraduate programme in 2014. The dissertation component of the MSc degree is being supervised by the Malagasy PhD holders and the research topics cover a wide range of subjects such as stellar astrophysics, extragalactic astronomy, cosmology and engineering.

In terms of astronomical facilities, Madagascar established the Malagasy Radio Astronomy Observatory (MRAO) in late 2016 to coordinate and monitor the renovation and conversion of a redundant 32-m diameter communications antenna into a radio telescope (Fig. 1). The project is part of the African VLBI Network (AVN) which aims to build a VLBI network of self-sufficient radio telescopes on the African continent. Since 2017, the Development in Africa with Radio Astronomy (DARA) project also runs in Madagascar. DARA aims to train (astro)physics students in all AVN countries at least during the period of 2017–2020.

The first-ever international astronomy conference themed "SKA-driven Big Data challenge in Africa" was held in May 2018 in Nosy Be, an island off the northwest coast of Madagascar. Organizing such a high-profile event that brought together graduate students, data scientists, researchers and various stakeholders is an effective way to promote astronomy in the country and to discuss the opportunities and challenges of the era of Big Data in Africa.

https://doi.org/10.1017/S1743921319000449 Published online by Cambridge University Press

Figure 2. Prof. Piero Benvenuti, the 2015–2018 General Secretary, introduces Madagascar as one of the potential new IAU members during the GA held in Vienna.

Finally, in an effort to coordinate the support and basic trainings offered to the Astrophysics students and in order to promote astronomy in the country, a group of early-career researchers and graduate students established the Malagasy Astronomy & Space Science (MASS) in 2016. Regular astronomy workshops and computational trainings are organized and delivered by the non-profit association professional members (anyone with a PhD degree) to help the local students acquire the necessary skills required in completing their research.

4. The impact of the IAU support

Although MASS has been running noteworthy initiatives since its inception, support from the IAU since 2009 has been extremely valuable in shaping the academic performance of the current professional members of the association. By providing travel grants to attend the IAU General Assemblies, Symposia and Regional Meetings, the Union offers an international platform for the grantees to network, to look for new collaborations, and to discuss their work with experts in their field. In fact, the young Malagasy researchers regularly publish scientific papers and between 2010 and 2018, they published at least 46 papers in international peer-reviewed journals (e.g. MNRAS, ApJ, AJ, A&A) with 23 of them as first author.

Through the established IAU offices, the Union extends its support to the promotion of publich outreach, astronomical research and using astronomy for development in the country. See below for some highlights of Madagascar's involvement within these entities:

- *The Office of Astronomy for Development (OAD):* Dr Solohery Randriamampandry was appointed by the Southern African Regional OAD as its country coordinator in 2016. A year later, the OAD funded a workshop on Python programming (MadaAstroPy) for local students with a physics background.
- *The Office for Young Astronomers (OYA):* during the 2017 International School for Young Astronomers (ISYA) in Ethiopia, two students from Madagascar were amongst the participants for the first time. Two other students were selected as well to participate in the 2018 ISYA in Egypt.
- *The Office for Astronomy Outreach (OAO):* Dr Zara Randriamanakoto was appointed to become the National Outreach Coordinator of Madagascar since 2017. She is also in charge of coordinating the IAU centenary celebration in the country.

To recognize the effort made by the Malagasy community in steadily developing astronomy in the country, the IAU welcomed Madagascar (under MASS) as one of its new national members (category: observer) during its 30th General Assembly (GA) on August 21, 2018 (Fig. 2). The news was widely publicized by renowned newpapers that

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MASS gained visibility at the national level. The Union also admitted seven early-career researchers of Malagasy citizenship to become IAU junior members. This new category of membership was approved during the GA as part of the IAU Strategic Plan 2020–2030.†

The Red Island has definitely shown a good progress towards advancing astronomy in various areas (research, outreach, education). Thanks to the continuous support from the IAU and other partners such as the South African Radio Astronomical Observatory. Nevertheless, there are still outstanding challenges (e.g. lack of funding and operational astronomical facilities) that hinder carrying out professional activities in the country. Madagascar's participation in the IAU over the next 100 years and beyond will definitely contribute to overturn this situation.

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