

Optical/Infrared Astronomy: Capabilities & Opportunities

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Current Capabilities

Optical/infrared (O/IR) astronomy has historically been one of Australia's major strengths, and it continues to be the primary focus for about one-third of Australian astronomers, with at least a proportionate share of publications and citations. This success has been built on access to world-class large O/IR facilities: from the 1970s, the 4-metre Anglo-Australian Telescope (AAT), and then, from the 2000s, access to 8-metre-class telescopes: first the two Gemini telescopes, then the two Magellan 6.5-metre telescopes and (for some of the community) the two Keck 10-metre telescopes, and now the four 8-metre telescopes making up the European Southern Observatory's Very Large Telescope (VLT). These 'apex' facilities have always been supplemented by a range of smaller facilities providing additional and complementary capabilities, most notably the telescopes hosted at ANU's Siding Spring Observatory, including the UK Schmidt Telescope (UKST), the ANU 2.3-metre telescope, the SkyMapper survey telescope, and a variety of small, specialised facilities. In the new era of Australia's strategic partnership with the European Southern Observatory (ESO), Australian astronomers also have access to all the telescopes of ESO's La Silla-Paranal Observatory, which (besides the VLT) include the VISTA 4-metre survey telescope and the VLT Survey Telescope (VST) at Paranal, and the ESO 3.6-metre and 3.5-metre New Technology Telescope (NTT) at La Silla.

Looming Issues

At present, therefore, with access to ESO's entire suite of telescopes at La Silla-Paranal and all the main SSO telescopes, Australian astronomers have at their disposal an exceptionally powerful set of medium-to-large O/IR facilities. The looming issues relate to how long Australia will continue to maintain access to these capabilities. The AAT only has confirmed funding for 4 years (July 2018 – June 2022), although several universities have indicated a desire to continue supporting the telescope for at least 7 years (i.e. to, and perhaps beyond, 2025). Likewise, Australia's strategic partnership with ESO is a 10-year arrangement: Australia either needs to convert the strategic partnership to full ESO membership during this period or seek large telescope access elsewhere. Thus Australia's current high level of access to O/IR facilities could easily be severely eroded over the next decade. *The mid-term review therefore needs to map out a long-term strategy for the AAT and develop a plan for achieving full ESO membership.*

Next-Generation Capabilities

Looking further ahead to the next generation of 'apex' O/IR facilities, Australia has invested in the 25-metre Giant Magellan Telescope (GMT, in which AAL and ANU both currently hold 5% shares) and could also (if Australia becomes an ESO member state) gain access to ESO's 39-metre Extremely Large Telescope (ELT). It is worth noting that GMT and ELT are both located in Chile and so enhance the capabilities of other southern hemisphere 'apex' facilities such as SKA (in which Australia is a partner), ALMA (to which Australia would have access if it joins ESO) and the Large Synoptic Survey Telescope (LSST, in which Australia already has some limited involvement – see below).

However there are risks in both cases: GMT is not yet fully funded and so the possibility exists that it may not be built; on the other hand, Australia may not join ESO and so may fail to gain access to ELT. Conversely, if Australia *does* make the substantial additional investment and becomes an ESO member state, and if GMT *does* raise the remaining funding that the project requires, then Australian astronomers could be in the unique position of having access to two giant telescopes with highly complementary capabilities. While Australia can to some extent hedge its bets across

these two projects, *the mid-term review should consider these possible scenarios, and develop strategies that optimise outcomes for Australia however these next-generation projects evolve.*

Opportunities for Additional Capabilities

While securing full ESO membership and a successful outcome for GMT are clearly the highest priorities for future facilities, there are several other opportunities to add valuable new O/IR capabilities for Australian astronomy. Some of the most obvious such possibilities include: (1) full national access to the 8-metre LSST, the ‘apex’ O/IR imaging facility for the next few decades; (2) complementary access to an 8-12 metre spectroscopic survey facility, such as the Mauna Kea Spectroscopic Explorer (MSE) or the similar telescope being considered by ESO as the project to follow ELT; and (3) access to a 2-4 metre wide-field O/IR imaging telescope in Antarctica, such as the Australian PILOT concept or the Chinese KDUST facility. *The mid-term review should consider these (and other) potential additional capabilities, prioritise them, and develop plans to engage with these projects as opportunities arise.*

Opportunities for Space-Based Capabilities

All of the facilities mentioned above are ground-based, but Australian astronomers will continue to require some level of access to space-based O/IR facilities. Australia currently only expects to access large O/IR space facilities, such as the Hubble Space Telescope (HST) and the James Webb Space Telescope (JWST), through the ‘open skies’ policy. However the creation of the Australian Space Agency may mean that this situation may change in the foreseeable future, and it certainly should provide greater opportunities for small O/IR space facilities (such as the proposed SkyHopper cubesat telescope), which opens up a wide horizon of interesting new possibilities. *The mid-term review should explore ways in which the advent of the Australian Space Agency may help Australian astronomers to gain better access to O/IR facilities in space.*