

High Energy Astronomy in Australia - 2018

Capabilities and Opportunities

Australia has involvements in the world-leading facilities in X-ray, gamma-ray, cosmic-ray and neutrino astronomy. They all offer complementary ways to probe extreme astrophysical environments (e.g. black holes, neutron stars, cataclysmic events) and dark matter properties.

In X-ray astronomy, Australian astronomers access the leading missions XMM-Newton, Chandra, NuSTAR, INTEGRAL and *Gehrels-Swift* via competitive proposals and/or public archives. Australia has access to the forthcoming *e-ROSITA* mission data (launched early 2019) via an MoU managed by Astronomy Australia Ltd. The MoU (with the *e-ROSITA* team at MPI Munich) will enable Australian participation in key survey proposals and access to data from the southern sky.

At gamma-ray energies, the Fermi-LAT space mission (GeV energies) makes its data products publicly available almost immediately after data taking. Fermi data have been important for Australian transient/variable source studies (e.g. AGN, GWs, FRBs). Fermi's NASA funding runs until the end of 2019 and a review will determine funding for 2020-22.

At TeV gamma-ray energies, access to the current major facility, H.E.S.S., is via the Uni. Of Adelaide and published H.E.S.S. results/data are publicly available. Linkages (MoU based) with MWA, Parkes-SUPERB and aLIGO/VIRGO have been established with H.E.S.S. for transients, variable sources, and continuum studies. H.E.S.S. operations are funded until 2019 and extensions to ~2022 are under discussion. H.E.S.S. membership funds for 2020+ from Uni. Adelaide are being sought. Six Australian institutes are involved in the next generation TeV Cherenkov Telescope Array (CTA). An ARC LIEF funds the construction and NCRIS/AAL funds the governance and engagement. CTA's science is intimately linked to many aspects of SKA science and that of optical astronomy (non-thermal physics, transients, dark matter). Australian CTA construction costs (to 2021) and CTA membership (to FY18/19) are funded. Future CTA operational costs could be met by a multi-year LIEF of similar scale to that already funded, but long term (>5-10 yr) CTAO membership costs is an issue to be solved (CTA has a >20 year lifetime). A southern version of the HAWC wide-field TeV gamma-ray observatory complementary to CTA, is also being considered.

For cosmic-rays (energies >1000 PeV), the University of Adelaide has a leading role in the Pierre Auger Observatory (Argentina site) which is undergoing a major upgrade to enhance its performance in discriminating elemental species of cosmic-rays. Adelaide's membership funding is via an ARC LIEF (2018) and DP (2015-19). Auger has recently shown, for the first time, the highest-energy cosmic-ray sky to be non-uniform, and perhaps, linked to star-burst galaxies.

For neutrinos (TeV to PeV energies), Uni. Adelaide is strongly involved in the IceCube Observatory at the South Pole with funding in part from ARC DPs. The recent discovery of neutrinos from a distant blazar, with gamma-ray observations, finally opens up neutrino-led multi-messenger astronomy. Previously, the TANAMI project used IceCube's public neutrino alerts in their ATCA radio AGN studies. The IceCube Upgrade (a pathfinder towards IceCube-Gen2) is funded, which within a few years, will greatly enhance IceCube's capabilities (improved angular resolution and energy threshold). The Mediterranean neutrino telescope, KM3Net, is also entering its first phase.

Long term membership fees for Auger and IceCube (about \$50k and \$20k per annum respectively) remain a major challenge as they rely on ARC grants (Auger previously received NCRIS/AAL funds). Such funding is required to ensure continued Australian influence in both projects (which are expected to operate for another 10 years at least). The forthcoming improvements to Auger and IceCube will present new opportunities to tie in with major Australian investments in radio and optical astronomy, now that these two new areas of astronomy are finally established.