SUPL Facility paper

Input to the decadal survey mid term review on dark matter research

Science overview

A national initiative in astroparticle physics not anticipated in the decadal survey is the Centre for Dark Matter Particle Physics and its associated national research infrastructure, the Stawell Underground Physics Laboratory (SUPL).

As the name astroparticle implies, this is an example of a physics discipline (particle physics) entering the astrophysics landscape, and analogies can be made with gravitational radiation astrophysics, arriving in 2016. In fact, the Minister for Education's press release at the CDMPP announcement said as much, asserting that the dark sector was a parallel universe.

What are the synergies with other Decadal Plan priorities?

The two cases are, however, different. On the one hand, astronomers were unwilling to take on responsibility for LIGO detectors until a source was detected. On the other, dark matter research is already deeply embedded in astrophysics in many ways

- N-body modelling of the evolution of structure in the Universe
- Phenomenology such as the bullet cluster, explored using microlensing
- The dynamics of galaxies and clusters of galaxies
- Possible indirect detection in the centre of the Milky Way
- Possible direct detection in the DAMA/LIBRA experiment, but non detection in others
- Possible involvement in the thermal history of the Universe at the end of the Dark Ages.

Although some will argue that great advances have been made in modelling structure and galaxy evolution without any knowledge of the nature of dark matter other than its gravitational properties, others will assert that future advances will require some physics knowledge. This is a prime motivation for astroparticle physics.

How does this the science connect with the priorities set out in the Decadal Plan?

The decadal plan recognizes that dark matter and dark energy as problems of the highest importance.

What is the best engagement model likely to be?

Now that Australia has joined this field, we should expect the planning of research support strategy carried out under the auspices of the Australian Academy of Science to touch on astroparticle physics in surveys coordinated by both the National Committee for Astronomy and the National Committee for Physics. These surveys concern themselves both with demographics & education and with research infrastructure planning. In respect of the latter, we are fortunate that the National Research Infrastructure roadmap of 2016 lumps both physics and astronomy together as Advanced Physics & Astronomy. SUPL finds a place in that roadmap.

It is understood that the NCA MTR will consider astroparticle physics within its working group on High Energy Astrophysics. This is appropriate, as there are strong connections between the MeV to TeV interests of some Australian astro-supporting universities and the technologies employed in astroparticle physics. We note, however, that the mass of the DM particle or particles is completely unknown, and research includes micro-eV (axion) quantum detectors. Axion detectors may have strong

technology spin-offs that will make them particularly attractive to advanced physics applications and industry development.

It is timely that the NCA's MTR coincides with the arrival of CDMPP www.darkmatter.org.au . Since SUPL is being built as a national research facility with astroparticle, ultra low background biophysics, nuclear astrophysics, astrobiology and geophysics users, we ask the MTR to support the case, which will be presented by the University of Melbourne and its partners (SUT, Adelaide, UWA and Sydney) for operations funding from NCRIS at the first possible opportunity. Until that time, SUPL OpEx is expected to be funded by levies on those universities and through ARC LIEF. ANSTO is an important partner in SUPL.

The University of Melbourne is working on a governance plan for SUPL. A likely recommendation is an NCRIS company like Astronomy Australia Limited, but a lot smaller. The Board would delegate non-financial responsibilities to a science advisory committee, a time allocation committee and a public outreach committee. We note that the Australian Synchrotron is operated by a company known as the Australian Light Source, and ALS is wholly owned by ANSTO.

What are the current issues and key risks?

The current issues are completion of construction and commissioning, agreement by the partner universities and ANSTO to pay up to $1m OpEx per year from 2020 until NCRIS can take over, engagement with the NCRIS planning process and funding of experiments, such as sub-GeV (cryogenic) direct detection, which follow on from the LIEF funded SABRE experiment, and are planned by CDMPP during its 7 year life. An industry engagement program will be important to SUPL. Educational outreach is supported by CDMPP. Although Stawell Gold Mines foresee at least 5 years of activity and ore extraction/processing, sale or closure of the mine is a risk to OpEx, as maintenance costs are currently shared. Safety risks are reduced by an international network of a dozen underground physics labs who have established a code of practice and communicate regularly.

What are the approximate costings - a) for the remainder of the decade; b) 2025+? Indicate the level of (un)certainty.

SUPL OpEx of $0.5m is anticipated in 2020 and $1m/year for 2021-2025. This is close to the normal ratio for operating costs to capital costs for astronomical facilities. Costs include safety, road, power, internet, consumables and spare parts for pumps and aircon. In the following decade an expansion might take place, but only if more capital is raised to effectively replicate the existing $10m facility in an adjacent but separate part of the mine.

Users from universities or research organisations which are not contributing to OpEx may be asked to pay (according to the floorspace and time they occupy SUPL) any part of those costs which is not paid by NCRIS.