Condensed matter physics in New Zealand

We (too) come from a land down under – an intro to condensed matter physics in New Zealand

The condensed matter physics community in New Zealand is small and widely separated, but our separation - across several universities and CRIs (Crown Research Institutes – think CSIRO but split into 7 institutions, soon to merge into 3) - has not prevented us from building those close links that lead to rewarding and excellent scientific careers. The smaller size of our physics departments and research centres means too that the resources and facilities needed are not often all available in any one place, and it's one of those distinctive features of NZ physicists that we have become very good at sharing and supporting one another.

Institutions

NZ condensed matter physicists are located mostly within the universities that have academic schools of physics – chiefly the University of Otago https://www.otago.ac.nz/physics/research, University of Canterbury https://www.canterbury.ac.nz/study/academic-study/science/-science-research/physical-and-chemical-sciences-research, Victoria University of Wellington https://ww-w.wgtn.ac.nz/scps and Auckland University https://www.auckland.ac.nz/en/science/about-the-facul-ty/department-of-physics/physics-research.html. The research-focused Paihau-Robinson Research Institute https://www.wgtn.ac.nz/robinson at

Victoria University of Wellington and Massey University's Institute for Advanced Study https://www.nzias.ac.nz/index.html are also hosts to condensed matter physics research. Outside the universities, there are clusters within the CRI GNS Science, around the van de Graaf particle accelerator at the Rafter Research Centre https://www.gns.cri.nz/part-ner-with-us/labs-and-facilities/ion-beam-materials-and-analysis-laboratory/, and the Measurement Standards Lab https://www.measurement.govt.nz/, New Zealand's national metrology institute. With our small numbers at any one location, however, condensed matter physicists and physics research are most importantly organized within some nation-wide networks. The predominant organization for condensed matter physics in NZ is **Te Mana Tangata Whakawhanake – the MacDiarmid Institute for Advanced Materials and Nanotechnology** https://www.macdiar-mid.ac.nz/. The MacDiarmid Institute is one of a number of Centres of Research Excellence (CoREs), very similar to the Australian Research Council (ARC) Centres of Excellence, supporting a geographically-dispersed network of researchers and postgraduate students.

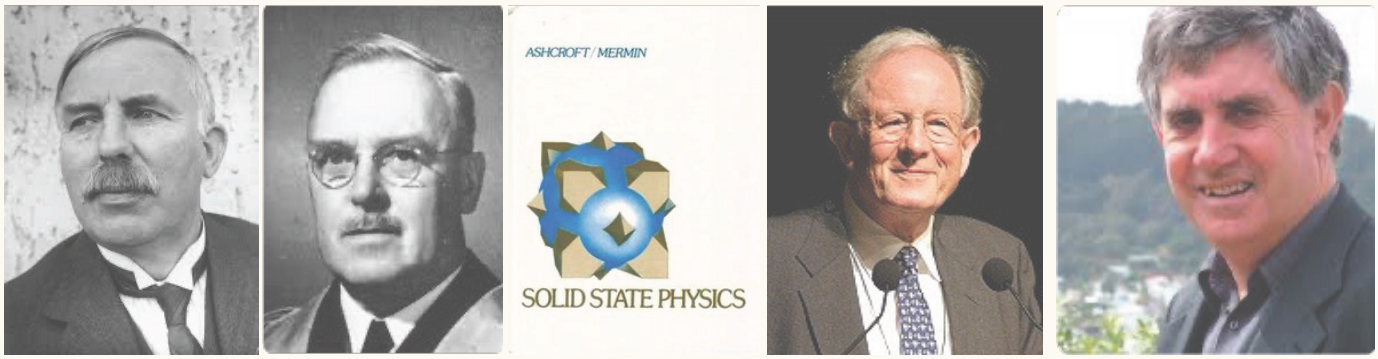
Established in 2002 as one of the first CoREs and named after late chemistry Nobel laureate Prof. Alan MacDiarmid, the MacDiarmid Institute was formed as a multi-disciplinary collaboration between materials-focused physicists – and some chemists –at Victoria University of Wellington and the University of Canterbury in Christchurch. Since then the MacDiarmid Institute has survived 3 successive contestable rounds and has grown to include Investigators in physics, chemistry, biology, engineering, materials science and sustainable materials based on mātauranga Māori (the knowledge and world view of the Māori people), involving also the Universities of Otago and Auckland, Massey University, Auckland University of Technology and the Geological and Nuclear Sciences CRI. The MacDiarmid Institute's research is across 4 programmes; Future Computing, Reconfigurable Systems, Mātauranga Māori and Catalytic Architectures. Condensed matter physicists are involved in all programmes, but most concentrated in the first two, with strengths in nanoparticles and nanowire networks, high temperature superconductivity, spintronics and magnetic materials, thin film growth, and oxide semiconductors.

A second CoRE that includes condensed matter physics research is **Te Whai Ao - the Dodd-Walls Centre for Photonic and Quantum Technologies** https://www.doddwalls.ac.nz/. The Dodd-Walls Centre, first funded in 2015, is organized around three research 'Beacons' – quantum systems and sensing; many-body systems; and optical imaging, spectroscopy and sensing. The Dodd-Walls Centre also manages Quantum Technologies Aotearoa https://qta.otago.ac.nz/, a strategic research project supporting NZ to foster international collaborations in quantum technologies.

Also important is the New Zealand Institute of Physics (NZIP) https://nzip.org.nz/, the institute for professional physicists, which includes college teachers, university lecturers, students studying to be physicists, CRI scientists, industry scientists and more. NZIP has 100-120 professional members and a very strong community of physics teachers, amounting to 350 of the ~375 secondary schools in New Zealand.

Some important and influential NZ physicists

There's obviously **Ernest Rutherford** https://teara.govt.nz/en/biographies/3r37/rutherford-ernest, the 1908 Nobel laureate (though it was the chemistry Nobel) who memorably 'split the atom'. He was born in Nelson and educated in Christchurch before moving to Cambridge and then Canada, and his work studying radioactive decay largely established the model of nuclear structure essential to condensed matter and atomic physics today. In NZ we honour him by naming many scientific fellowships after him and he is on the NZ$100 bill. Another Ernest, **Sir Ernest Marsden** https://teara.govt.nz/en/biographies/4m41/marsden-ernest, worked with Rutherford on his famous gold-foil experiment and was later instrumental in setting up NZ's government science organization, the since restructured-out-of-existence Department of Scientific and Industrial Research DSIR. NZ's pre-eminent investigator-led research fund, the Marsden Fund, is named after him. **Neil Ashcroft** https://www.roy-alsociety.org.nz/who-we-are/our-people/our-fel-lows/obituaries/obituaries-of-honorary-fellows/professor-neil-ashcroft-hon-frsnz/, co-author of Solid State Physics (aka 'Ashcroft & Mermin', the textbook recognized by most condensed matter physics students around world), moved to NZ when he was a child, and he was a major supporter of condensed matter physics in NZ, with special research interests in the high temperature superconductivity research here, as well as involvement in the MacDiarmid Institute. Lastly, Sir Paul Callaghan was a world-leading physicist in nuclear magnetic resonance and one of NZ's most prominent and influen-tial scientists in recent times. He used his combination of top-level science talent and strong advocacy for NZ science and environmental issues to get a lot of cut through with scientists, government and the public. Sir Paul's views and ideas are still at the centre of conversations today about how science can benefit NZ, over 10 years after his untimely death.



Left to right – Ernest Rutherford; Sir Ernest Marsden; Solid State Physics; Neil Ashcroft; Sir Paul Callaghan

BIO

Institutional connections to Australia

Many NZ-based condensed matter physicists naturally have close collaborations with those in Australia. Apart from the personal connections, there are strong institutional links to Australia's important facilities as well. New Zealand pays to support the Australian Synchrotron, such that NZ researchers are able to take advantage of dedicated access to beamtime https://synchrotron.royalsociety.org.nz/, and NZ researchers make sufficient use of the Lucas Heights OPAL research reactor that the biennial ANBUG-AINSE Neutron Scattering Symposium (AANSS) is officially the symposium of the Australian and New Zealand neutron scattering community. NZ Centres of Research Excellence have had partnership arrangements in the recent past, including with the ARC Centre of Excellence Future Low-Energy Electronics Technologies FLEET and the Australian National Fabrication Facility ANFF.

Future Endeavours

As of March 2025 the NZ science and university sectors are entering a period of considerable change, with major reviews of both currently under way. While there is consternation that some areas of research, particularly the humanities and social sciences, have lost resources, the natural and applied sciences have reason to be cautiously optimistic. Changing government priorities - towards space and Earth observation, biotechnologies and quantum technologies - may present opportunities for condensed matter physics in the near future, as well as with the planned establishment of a new Public Research Organisa-tion on advanced technologies. Whatever the results, NZ condensed matter physicists will continue doing what they do best, and anticipating the day that a NZ team can finally defend that 2020 win of the Lindsey Davis Cup.

If you are interested in making a connection to the NZ condensed matter physics community

Dr Simon Granville
simon.granville@vuw.ac.nz
Principal Scientist, Robinson Research Institute, Victoria University of Wellington
Principal Investigator and Programme Leader, MacDiarmid Institute for Advanced Materials and Nanotechnology
Council Member and IUPAP representative, New Zealand Institute of Physics