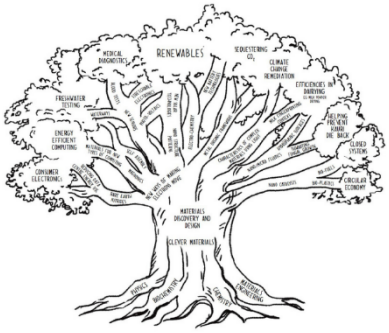
The MacDiarmid Institute
for Advanced Materials and Nanotechnology

Update and Research Programmes



We hope you and your whānau are safe and well during these lockdowns. As expected, 2021 is turning into another unpredictable year for many, including for our MacDiarmid Institute researchers and students.

This is our first update since starting our new contract and our first chance to let you know about our new Research Programmes (which began on 1 July 2021 and continue to the end of December 2028). Our research programmes address some of the greatest challenges facing New Zealand today; turning our attention towards zero carbon, zero waste and low energy tech.

Towards Zero Waste

Using nature as an inspiration for next-generation sustainable materials we will develop:

a. *reconfigurable* systems - self-regulating, self-repairing systems inspired by nature;

b. new materials that are *recyclable or reconfigurable.*

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Towards Zero Carbon

We will support New Zealand's goal for 'net zero' carbon emissions by 2050 by exploring new materials that will:

a. *Catch* CO_2 from air and waste streams, through clever chemistry that attracts CO_2 to the surfaces of 3D spongelike materials (such as metal-organic frameworks (MOFs);

b. *Decarbonise the energy sector* by designing new catalysts that will transform captured CO_2 into green fuels using renewable energy inputs.

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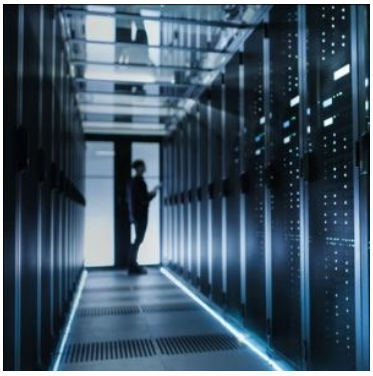


[Towards Low Energy Tech]
We will develop:

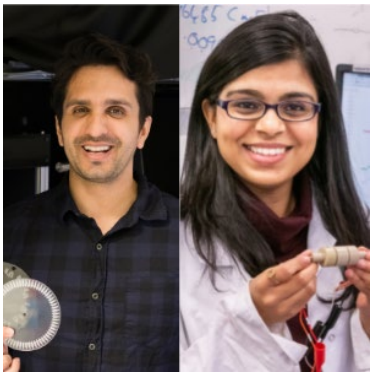
1. Computers able to process information more like the brain. We'll be studying how to reproduce some of the properties of biological neurons using molecular electronics, nanomaterials, and soft matter.
2. Computing that uses far less energy compared to conventional electronics, based on quasiparticles using superconductivity, spin order (magnetism), or topological order within a solid material.

Crosscutting these three Research Programmes sits our Mātauranga Māori Research Programme. This programme provides a platform for the other three research programmes, intersecting with the theme of sustainability. We will explore old and new knowledge to grow innovative approaches and techniques based on mātauranga Māori.

News

In July we celebrated our partnership with Whakarewarewa Village by signing a second MOU and a Statement of Intent. For the MacDiarmid Institute a key goal will be to build on the collaboration over the past three years, explore further synergies between the two knowledge systems mātauranga Māori and materials science and continue the co-design of a mātauranga science education centre

DiscoveryCamp and NanoCamp 2022 – applications close 17 September
Our annual NanoCamp and DiscoveryCamp 2022 is open for applications from students in year 12 and 13 until 17 September. The all-expenses-paid camp takes place from 16-21 January 2022 in Auckland (NanoCamp) and Wellington (DiscoveryCamp). You can read more about DiscoveryCamp on The Spinoff.



Two MacDiarmid alumni are shortlisted for the KiwiNet Awards - Dr Matheus Vargas of Orbis Diagnostics, and Dr Shalini Divya of TasmanIon, are shortlisted finalists for the 2021 KiwiNet Breakthrough Innovator Award. Both Orbis Diagnostics and TasmanIon are MacDiarmid Institute affiliated spinout companies

$$H_N = t_1[\cos(k_x) + \cos(k_y)] - \mu + \alpha_R \tau_z [\sin(k_x)\sigma_y - \sin(k_y)\sigma_x]$$
$$+ t_{c,1}\tau_x \cos\left(\frac{k_z}{2}\right)\cos\left(\frac{k_x}{2}\right)\cos\left(\frac{k_y}{2}\right) + t_{c,2}\tau_y \sin\left(\frac{k_z}{2}\right)\cos\left(\frac{k_x}{2}\right)\cos\left(\frac{k_y}{2}\right)$$
$$+ \lambda\tau_z\sigma_z \sin k_z(\cos k_x - \cos k_y)\sin k_x \sin k_y.$$

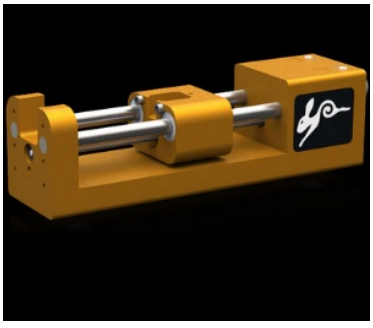
A new paper in Science by Associate Investigator, Dr Philip Brydon, reports a new superconducting material that can withstand remarkably high magnetic fields - more than 25 times larger than what the standard theory predicts. This material, called $CeRh_2As_2$, appears to have a rare transition between two distinct superconducting states as a function of the magnetic field. There are only a handful of other materials where this has been reported.

Physics Symposium in Honour of Joe Trodahl's 80th birthday – 27-29 January 2022 at the Rutherford Hotel in Nelson. You are invited to join for a lively program of physics across a wide range of topics, presented in our poster and oral sessions. This symposium will both showcase some of the most recent advances in physics and celebrate the life's work of Professor Joe Trodahl.

We have increased our PhD Scholarship stipend by $3000 NZD to $33,000 NZD per annum as we recruit for over 30 new PhD candidates as part of our new Research Programmes.

In 2022 we will award a third round of Discovery Scholarships for Māori and Pacific Island undergraduate students. We are looking to grow our scholarship programme and seeking sponsorship from interested organisations and companies. If you are interested in being part of this please email us.

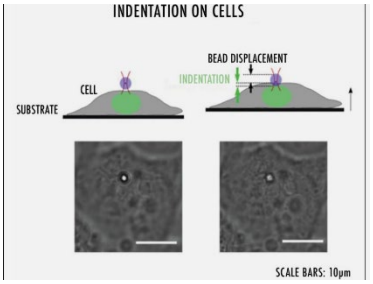
Annual Report 2020 and Media



2020 saw MacDiarmid researchers develop new patents and spin out another new startup company.about the periodic table.

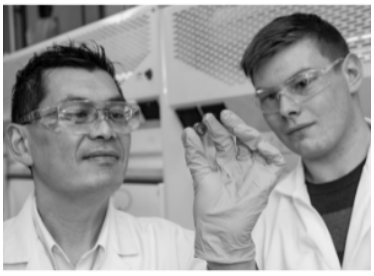
Te Ao Pūtaiao Me Te Ao

Discovery Camp alumna Isitokia Paasi interned with our Stakeholder Partner Iwi Diane Bradshaw and Dr Karyne Rogers at GNS Science, evaluating the geological and geochemical whakapapa, and cultural connections of stone artefacts from the Kawhia Museum

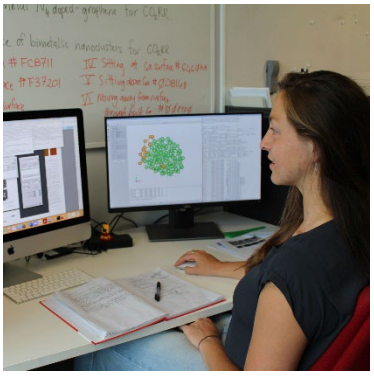


We tend to think of medicine as the realm of biology rather than physics. But physics-biology collaborations are forging a new field – mechanobiology – a research area key to understanding health and disease, led within the Institute by Principal Investigator, Professor Bill Williams.

Principal Investigator, Dr Anna Garden talks about renewable energy, hydrogen and why platinum sits in the Goldilocks zone.



Robinson Research scientist, Associate Investigator Dr Shen Chong is pursuing new types of superconductors, understanding how they work, and optimising their physical properties to make them cheaper.



Liquid metals that create nanostructure - it's the little details that count

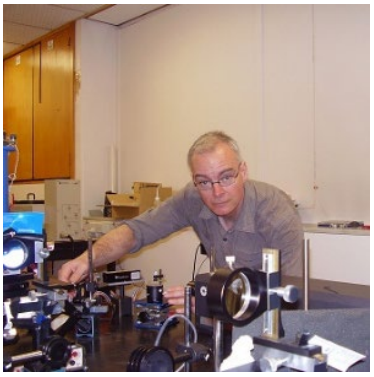
MacDiarmid Institute PhD candidate Stephanie Lambie successfully kick-started a new collaboration with FLEET. Looking at the properties of liquid metals, in this case, bismuthgallium alloys, which create nanoscale patterns, that could be useful in nanoelectronics, or that could play a role as catalysts to speed up chemical processes using low amounts of energy.

RadioNZ Nights' Materials: Fact or Fiction

In our partnership with RadioNZ Nights, Emily Kendall, a PhD Student from the University of Auckland's Department of Physics gave us her scientific take on the Proton Pack from Ghostbusters, and Principal Investigator, Professor Duncan McGillivray also from the University of Auckland, related the liquid metal from Terminator 2.

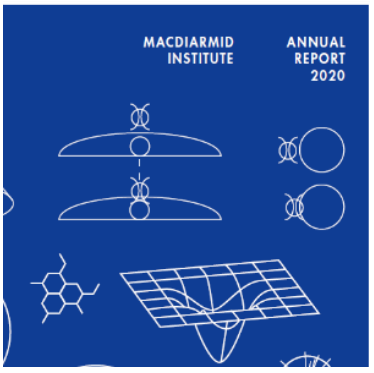
[How to eliminate C02 emissions from industrial materials]
Principal Investigators and a Principal Scientist at the Robinson Research Institute of Victoria University of Wellington, Dr Chris Bumby spoke with RadioNZ's Jesse Mulligan on eliminating carbon dioxide emissions from steel-making. See the full interview here.

Principal Investigator Associate Professor Charles Unsworth receives $1.2M Health Research Council grant titled “Neural chip platforms for drug translation in paediatric brainstem gliomas”.



Professor Keith Gordon is this year’s recipient of the University of Otago Distinguished Research Medal 2021.

Housed in a custom-made box under protective yellow light at the University of Canterbury’s Nanolab is a new world-leading Nanoscribe 3D printer. The Nanoscribe Photonic Professional GT2 3D printer – is unique to New Zealand and represents a big step forward in research at this tiniest scale.



You can read our annual report online here.

That’s all from us. We’ll be in touch again soon. In the meantime take care and He manaakitanga haumaru te noho (stay safe at home).