Response to Selection Criteria

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SUMMARY

I am a theoretical condensed matter physicist who has developed an **independent research program linking quantum-material discovery, fundamental theory and low-energy device design**. Following my Monash PhD, I established my own research direction within FLEET, originating materials concepts and developing them through sustained theoretical and experimental collaboration. My aim is to understand how topology, quantum geometry and disorder can be used to control the properties of real materials.

That research ownership is reflected in the five-year Bismuth program, a US transistor patent application as lead inventor, and an **A$650,000 AEA Ignite project that I conceived and lead**. My broader record includes 43 refereed articles, contributions to approximately A$3.4 million in funding since 2024, course design and delivery, and mentoring or co-supervision of nine PhD candidates. At Melbourne, I would build a distinctive theory group that connects the School's strengths in condensed matter physics, optics and quantum devices, while developing students as independent researchers.

LEVEL OF APPOINTMENT
Lecturer (Level B)

RESEARCH AREA WITHIN SCOPE
Theoretical condensed matter physics of quantum materials

CONNECTS WITH
Condensed matter · Quantum devices · Optics
CQC2T · TMOS · QUBIC · IBM Quantum Hub

My research identity is in theoretical condensed matter physics, grounded in materials-science training and developed through seven years in FLEET and an appointment spanning Materials Science and Engineering and the School of Physics and Astronomy. I would bring Melbourne an established direction in topological and quantum-geometric materials, together with the methods, partnerships and project-leadership experience to build an independent group. The School's breadth in condensed matter, optics and quantum technology offers the setting to develop this program and its experimental connections.

ALIGNMENT WITH THE ADVERTISED SCOPE — QUANTUM AND OPTICAL PHYSICS AND RELATED TECHNOLOGIES

ADVERTISED SCOPE · MY FOCUS	FIT	EVIDENCE FROM MY RECORD
Condensed matter physics — topological and quantum-geometric matter	■■■	Nine years of first-principles, Wannier tight-binding and transport theory of topological insulators, Weyl magnets and 2D bismuth.
Condensed matter physics — magnetism and spin dynamics	■■■	Berry curvature, quantum metric, spin–orbit torque and spin-wave theory for Heusler and kagome magnets, tested in experiment.
Quantum device design	■■■	Lead inventor on a transistor patent application; Lead CI prototyping a low-energy transistor; topological-transistor ARC Linkage.
Optical physics — magneto-optics and light–matter response	■■□	Band-structure origin of giant ultraviolet circular dichroism in Heusler films; theory for optical probes of atomic disorder.

■■■ core expertise ■■□ strong, demonstrated ■□□ emerging / building 3 of 5 advertised areas shown

2.1 EDUCATION / QUALIFICATIONS

1 *The appointee will have a PhD in physics or a related discipline.*

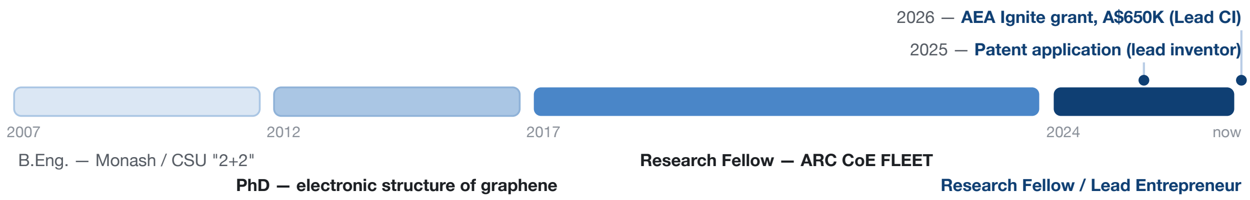
RESPONSE

I hold a **PhD in Materials Science and Engineering from Monash University**, awarded for research on tailoring graphene's electronic structure through molecular adsorption. My doctoral work used density functional theory to investigate charge transfer, molecular dipoles and electronic bands, establishing a strong foundation in condensed matter physics.

Since my PhD, I have developed an **independent research direction in topological and quantum materials** within FLEET's broader low-energy electronics agenda. I independently proposed topological semimetals with unconventional surface spin textures and developed computational frameworks for atomically thin materials under disorder and electric fields. These ideas have grown into sustained research programs, lead-author publications and device-oriented intellectual property.

Seven years in FLEET and my subsequent appointment spanning Materials Science and Engineering and the School of Physics and Astronomy have shaped my identity as a theoretical condensed matter physicist. I now bring the scientific judgement, research ownership and collaborative experience needed to establish my own group in the School of Physics.

CAREER AT A GLANCE



2.2 ESSENTIAL CRITERIA

KNOWLEDGE & SKILLS PROFILE

THEORETICAL METHODS
- Density functional theory (DFT)
- Wannier tight-binding models
- Quantum transport & device modelling
- Large-scale HPC (NCI & Pawsey; >3M SU as Lead CI)

TOPOLOGICAL QUANTUM MATTER
- Topological insulators & semimetals
- 2D bismuth allotropes & edge states
- Magnetic topological insulators
- Topological phonons

MAGNETISM & OPTICS
- Weyl ferromagnets (Co_2MnX)
- Berry curvature & quantum metric
- Magneto-optics & circular dichroism
- Spin waves & spin–orbit torque

TEACHING & SCHOLARLY PRACTICE
- Curriculum design & tertiary teaching
- HDR supervision (9 PhD candidates)
- Grant writing & manuscript preparation
- Peer review & research translation

2 *Demonstrated experience and achievements in an area of physics within the scope of quantum and optical physics.*

RESPONSE

I have established a coherent research program around a central question: how can we control the quantum properties of real materials to enable low-energy technologies? My contribution combines the conception of new materials physics, development of theoretical methods and sustained collaboration with experimentalists. I use first-principles calculations, Wannier tight-binding models and quantum-transport theory to connect fundamental mechanisms with measurable responses.

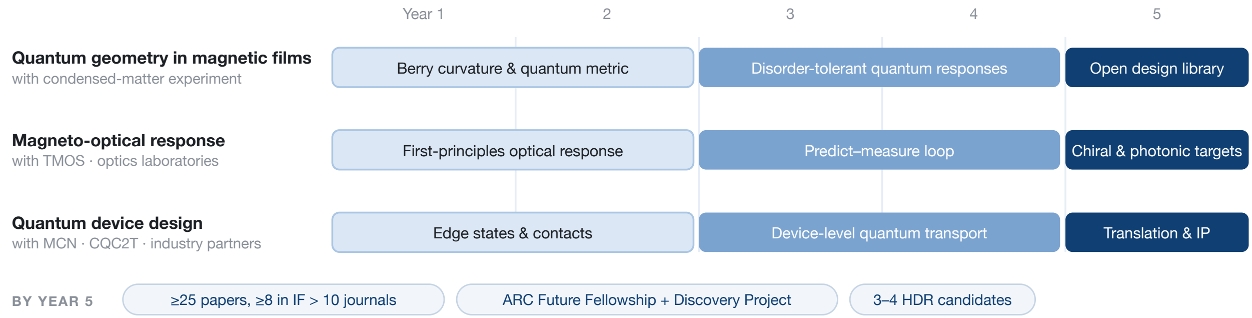
An independent direction in topological matter. Following my PhD, I independently proposed pyrite-type OsX_2 (X = Se, Te) as topological materials with controllable surface spin currents (*npj Quantum Materials*, 2019, first author). I then led the five-year **Bismuth trilogy**, developing the theoretical framework for two-dimensional bismuth allotropes and pursuing the questions it opened about spin texture and topological edge-state control (*New Journal of Physics*, 2021; *Materials Today Physics*, 2023 and 2025). This progression demonstrates my ability to originate a research direction, sustain it and develop its implications for quantum devices.

Quantum geometry under realistic conditions. My work on Co_2MnGa connects Berry-curvature transport with thickness and structural disorder. As co-first author, I helped establish that **giant Berry curvature survives complete structural disorder** (*Matter*, 2025). This finding motivates a direction I would lead at Melbourne: treating disorder as a controllable variable in quantum-material design. My theoretical modelling of the room-temperature quantum metric effect in $TbMn_6Sn_6$ (*Nature Communications*, 2025) broadens this agenda beyond Berry curvature.

Connecting optical physics with device design. I led the electronic-structure analysis explaining giant, temperature-independent ultraviolet circular dichroism in Heusler films (*Physical Review Applied*, 2025). This work provides a basis for investigating how optical measurements reveal quantum-geometric electronic structure. Alongside it, my role as lead inventor on a US transistor patent application and Lead CI of an **A$650,000 AEA Ignite project** demonstrates my ability to take materials concepts towards device development.

At Melbourne, I would build an independent theory group linking quantum geometry, magneto-optics and quantum-device design. The roadmap below sets out how I would develop this program through experimental partnerships, competitive funding and HDR training.

THE RESEARCH PROGRAM I WOULD BUILD IN THE SCHOOL OF PHYSICS — THREE STREAMS, ONE SHARED THEORY-AND-COMPUTATION PLATFORM



3

> *Demonstrated experience and evidence of high-quality education delivery (Level C), or the potential for high-quality education delivery (Level B), relative to opportunity, in developing engaging undergraduate and/or graduate teaching programs.*

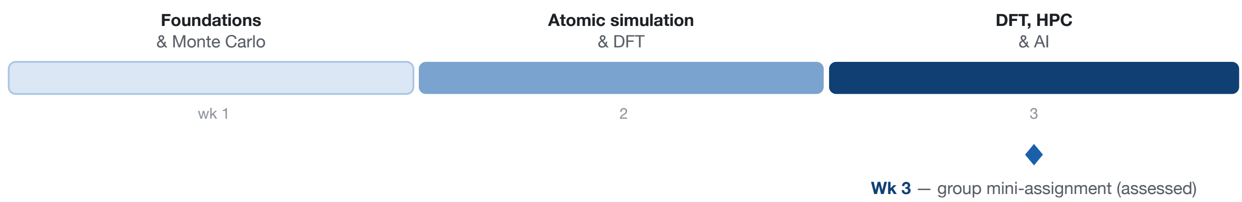
RESPONSE

My teaching is grounded in the same principle as my research: students should learn to formulate questions and exercise scientific judgement. Within research-focused appointments, I have taken responsibility for designing and delivering a complete university course and developing graduate research training.

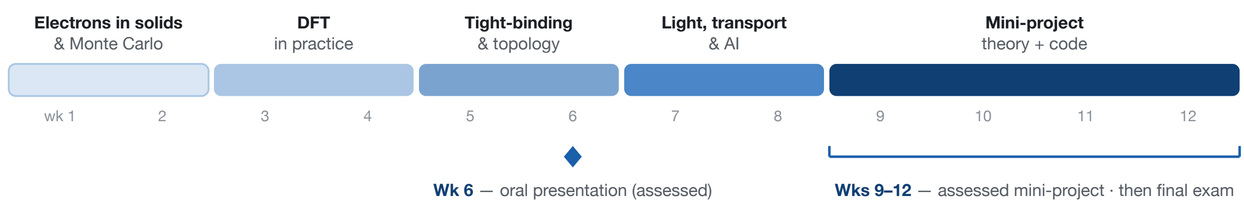
For the Monash–Central South University “2+2” program, I designed *Computational Materials Science* from the ground up and taught it in 2017–2019 and 2023–2024. I developed the curriculum, lectures, tutorials and assessments, connecting condensed-matter fundamentals with density functional theory, high-performance computing and applied modelling. An assessed group mini-assignment requires students to bring these elements together. The complete materials are openly available on GitHub.

At Monash, I regularly deliver DFT workshops and tutorials for Master's and PhD students. I teach students to select, justify and validate methods for their own research questions, using visualisation, worked examples and physical reasoning to make abstract concepts accessible. This experience provides a strong foundation for teaching quantum mechanics, condensed matter and computational physics, and for taking responsibility as a subject coordinator.

“COMPUTATIONAL MATERIALS SCIENCE” — THE INTENSIVE 3-WEEK STRUCTURE I DESIGNED AND DELIVERED



RE-DESIGNED AS A 12-WEEK PHYSICS SUBJECT — COMPUTATIONAL CONDENSED MATTER PHYSICS (PROPOSED FOR THE SCHOOL)



The proposed 12-week graduate subject above shows how I would extend my existing curriculum into computational condensed matter physics. I would welcome subject coordination and tutor supervision, bringing the same ownership to education that I bring to research.

I see AI as an opportunity to deepen physics education. I would integrate AI-assisted literature study and calculation checking while placing greater emphasis on derivation, physical intuition and critical evaluation in assessment. My goal is to prepare students who can use evolving computational tools creatively and judge the reliability of the answers they produce.

4 *A verifiable track record of high-quality research, with an internationally excellent publication record in relevant areas, commensurate with experience and opportunities.*

RESPONSE

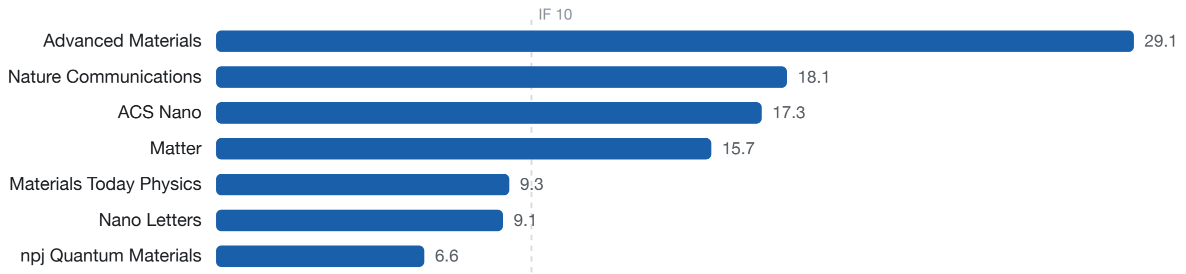
My publication record demonstrates a developing independent research identity, sustained intellectual leadership and increasing international visibility. Across 43 refereed articles, my distinctive contribution is to formulate materials-physics questions, develop the theoretical framework and connect its predictions with experiment.

The **Bismuth trilogy** is a clear example of research ownership. Over five years, I developed a connected line of inquiry from foundational tight-binding theory to unconventional spin texture and topological edge-state control, progressing to corresponding authorship on the 2025 study. Sustaining this sequence required me to identify the next scientific question and direct the methodology as the program developed. My first, co-first and corresponding-author work in *npj Quantum Materials*, *Matter*, *Nature Communications*, *ACS Nano* and *Materials Today Physics* demonstrates the reach of this approach.

The program has gained momentum: **15 papers in the past three years**, six in journals with impact factors above 10, and a citation count that more than doubled over that period. My record now exceeds **1,200 citations, with an h-index of 19**, verifiable through Google Scholar. Peer review for *Nature Communications* and *Communications Physics* provides further recognition of my expertise.

Built within research-fellow appointments, this record gives me a strong foundation for leading an internationally visible group at Melbourne. My ambition is to establish a distinctive program in the theory and design of quantum materials, supported by competitive grants, strong experimental partnerships and researchers trained to develop their own ideas.

SELECTED VENUES OF MY REFEREED PUBLICATIONS — JOURNAL IMPACT FACTOR



	LAST 3 YEARS				
43 ORIGINAL RESEARCH ARTICLES	**15** SINCE 2024	**6** IF > 10 SINCE 2024	**6** FIRST / CORRESPONDING	**1,211** CITATIONS	**19** H-INDEX

5 *Experience in supervising research students.*

RESPONSE

Developing independent researchers is central to the group I want to build. I have mentored or co-supervised nine PhD candidates, including five graduates and four current candidates, supervised three Bachelor's and Master's research students, and examined two departmental PhD theses. This experience has prepared me to take responsibility as a principal supervisor.

I provide close guidance during a student's first project, then progressively transfer responsibility for research questions and methodological decisions. We agree milestones and review progress regularly, while testing the assumptions and limitations behind each result. My aim is for students to develop the confidence to propose, evaluate and defend their own ideas.

Researchers I have mentored have progressed to **first-author publications in Advanced Science, ACS Nano and Nano Letters**; one former candidate now holds a joint postdoctoral appointment at the **University of Cambridge and King's College London**. These outcomes reflect my commitment to both research quality and career development.

At Melbourne, I would build a focused group of three to four HDR candidates within five years, with co-supervision across theory and experiment. I would give each student ownership of a defined question within the broader program and support them in developing an independent scientific voice.

HIGHER DEGREE RESEARCH SUPERVISION AND EXAMINATION TO DATE

5 — PhD graduated
co-supervised / mentored

4 — PhD in progress
currently mentoring

3 — Bachelor's / Master's
research projects supervised

2 — PhD theses examined
Departmental examiner

Mentees have first-authored papers in Advanced Science, ACS Nano and Nano Letters.

One graduate now holds a joint postdoctoral appointment at the University of Cambridge and King's College London.

6 *Excellent interpersonal and communication skills including the ability to build positive, professional relationships with staff, collaborators and students.*

RESPONSE

My ability to lead collaborative research rests on making complex ideas clear and giving colleagues a shared sense of purpose. I currently coordinate a 10-person experimental and theory team across two Schools and TQ Transistors. My role involves establishing shared research questions, connecting computational predictions with fabrication requirements and helping partners agree on practical next steps.

I adapt my communication to physicists, engineers and intellectual-property professionals, using interactive visualisations and schematics to explain the underlying physics. I listen to each participant's priorities before presenting my assessment and communicate the limits of the modelling openly. This approach supports a sustained partnership that has produced a US patent application and funded research projects.

I bring the same preparation and openness to relationships with students and professional staff: clear expectations, constructive feedback and reliable follow-through. Through FLEET's Melbourne Knowledge Week activities and public-facing content, I have also communicated quantum science beyond specialist audiences. At Melbourne, I would use these skills to build a research group that is intellectually ambitious, approachable and effective across disciplinary boundaries.

2.4 DESIRABLE CRITERIA

7 *A potential or demonstrated capacity to conduct research activities in collaboration with industry and/or government.*

RESPONSE

Research translation is an integral part of my independent program. I want the materials concepts I develop to inform technologies that can be fabricated and tested, and my partnership with TQ Transistors has given me direct experience of that process.

Within this partnership, I have contributed materials-design expertise and developed a transistor architecture as **lead inventor on US patent application US63/848,509**. The collaboration has attracted **A$1.04 million in direct industry investment** and underpins the AEA Ignite and ARC Linkage projects. Conceiving and leading the Ignite project has extended my responsibility from theoretical development to coordinating research against scientific and commercial milestones.

I have also helped establish a new route for university–industry collaboration through Monash's partnership with Jiangxi Copper, progressing the relationship to an August 2024 Memorandum of Understanding and towards a first thin-film-growth project.

These experiences have shaped my approach to industry research: understand the partner's problem, identify where fundamental physics can make a difference and agree achievable stages of development. At Melbourne, I would bring this combination of intellectual ownership, partnership experience and translational ambition to the School's quantum-device research.

8 *A demonstrated capacity for developing and maintaining collaborative research networks in quantum or optical physics.*

RESPONSE

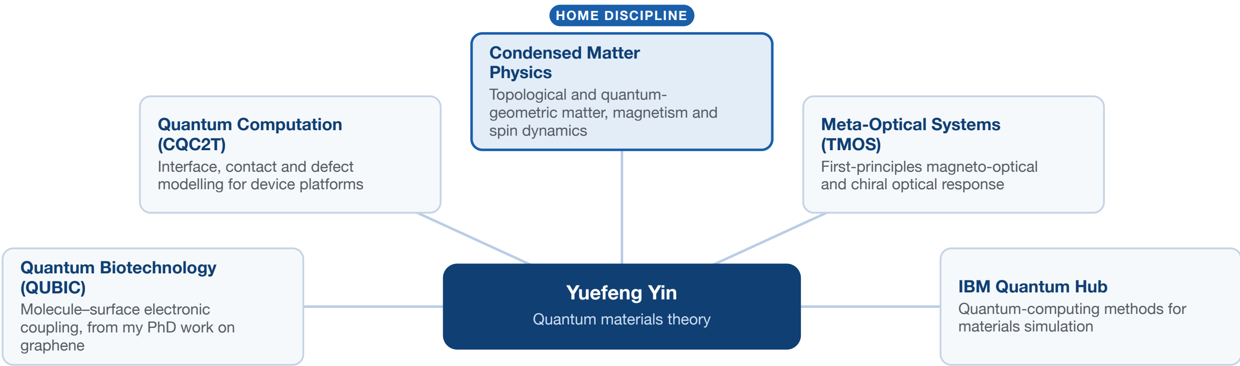
I sustain collaborative networks by developing new scientific questions that keep the partnership productive. My program with Dr Simon Granville at Victoria University of Wellington's Robinson Research Institute and the MacDiarmid Institute illustrates this approach. We connect thin-film growth, transport and magneto-optics with theory to understand Weyl ferromagnets and their potential applications.

My contribution includes electronic-structure and quantum-response modelling, supported by regular communication, reciprocal visits and sharing of code and data. The partnership has developed across Berry-curvature transport, optical responses and spin dynamics, producing joint papers in *npj Quantum Materials*, *Matter*, *Nano Letters*, *Physical Review Materials* and *Advanced Materials*. Its breadth demonstrates how a focused collaboration can grow into a sustained research program.

My FLEET network also includes continuing links with Prof. Michael Fuhrer's group at Monash and collaborators at RMIT, alongside international groups working on magnonics, spin–orbit torque and quantum-geometric transport.

At Melbourne, I would connect these partnerships with the School's strengths in condensed matter and optics. I would contribute a defined theoretical agenda and develop shared projects with experimental colleagues, giving my group both an independent research identity and strong integration into the School's quantum and optical physics community.

HOW MY RESEARCH WOULD CONNECT WITH THE SCHOOL'S CENTRES AND RESEARCH STRENGTHS — WHAT I WOULD BRING TO EACH



2.5 OTHER JOB-RELATED INFORMATION

9 *Occasional work out of standard working hours, including job-related travel to outreach activities, workshops and conferences.*

RESPONSE

I am available for occasional work outside standard hours and job-related travel. I have undertaken international conference travel, research visits across Australia and New Zealand, Melbourne Knowledge Week outreach, Open Day activities and meetings across time zones with international collaborators.

10 *Demonstrated time management skills that ensure timely delivery of job-related duties.*

RESPONSE

Leading a research program requires disciplined choices about priorities, resources and delivery. I manage concurrent AEA Ignite, ARC Linkage and industry commitments alongside national computing allocations, PhD mentoring and teaching.

I plan backwards from external deadlines, assign clear milestone owners and review progress regularly. I budget computing resources across each allocation period and raise risks early, giving collaborators time to adjust. This approach has supported 15 publications over the past three years and delivery of an intensive course on schedule. At

Melbourne, I would apply the same discipline to balancing research leadership with teaching, supervision and School service.

11 *This position requires the incumbent hold a current and valid Working with Children Check.*

RESPONSE

I will hold a current, valid Employee Working with Children Check before commencing and maintain it throughout my employment. I support the University's commitment to child safety under the Victorian Child Safe Standards.