Heah Hung Xun

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Research

Petrov–Weyl spectral bounds *Independent work — unpublished draft*

- Apply Gershgorin discs and Brauer Cassini ovals to eigenvalue localisation for a structured Newman–Penrose Weyl matrix. The current note is preliminary: the matrix convention, frame dependence, and proposed radius functional still require a complete invariant audit.

From a WGS84 lollipop to frame-aware control on S^2 *Research note — revised September 2026*

- Modelled localized material removal using anisotropic kernels on the oriented frame bundle; derived an exact overlap formula and the leading response to weak anisotropy.
- Checked holonomy by step-refined integration, the overlap formula by independent quadrature, and finite non-negative fitting by optimality and grid-refinement checks.

Gaussian quantum dynamics on $\mathrm{Sp}(4,\mathbb{R})$ *Ongoing undergraduate research*

- Supervised by Prof. Tomasz Paterek. Use covariance-matrix and symplectic methods, Floquet theory, logarithmic negativity, continuous measurement, and periodic Riccati integration.
- Within the audited quadratic model, constructed a finite-time entangling quench giving $E_N = 0.3625$ bits at $\bar{n} = 0.05$; identified sub-phonon preparation, microhertz trapping, and $\sim$54.5 minutes of coherence as limiting requirements. Independently reproduced Poddubny et al., Fig. 2 before extending the model.

Gaussian-pulse benchmark for Landau–Lifshitz accuracy *PHY204 term paper — coauthored*

- With Xu Ya-Xuan, compared the exact future-weighted, non-runaway Abraham–Lorentz acceleration with the first local Landau–Lifshitz reduction for a smooth Gaussian pulse.
- Derived $D_{\mathrm{rms}} = (\sqrt{3}/2)\epsilon^2[1 - \epsilon^2 + O(\epsilon^4)]$; verified the $O(\epsilon^2)$ law by quadrature and convergence tests over $\epsilon \in [0.01, 1]$, then separated classical truncation error from quantum recoil on an (ϵ, χ_e) diagnostic map. AI assistance disclosed in the manuscript.

Quantum mechanics over non-complex number systems *Self-study note*

- Survey real, complex, and quaternionic Hilbert-space formulations from the division-algebra trichotomy through modern network no-go results; isolate the tensor-product composition rule as the central assumption in the real-versus-complex debate.

Education

B.Sc. in Physics, Xiamen University Malaysia 2023–present

GPA: 3.75/4.00

Selected coursework: Quantum Mechanics I, Electrodynamics, Mathematical Methods, Theoretical Mechanics, Linear Algebra, Differential Equations, Numerical Methods.

Earlier Mathematical Work

Phase-space quantum mechanics — independent pedagogical write-up deriving the Weyl–Wigner correspondence, Moyal product, and Poisson-bracket limit.
Angular momentum to the hydrogen atom — independent write-up using $\mathfrak{so}(3)$, $\mathfrak{su}(2)$, ladder operators, and representation theory.
Quantum random walks — PHY104 course project comparing diffusive and ballistic spreading; implemented discrete- and continuous-time dynamics in Python/QuTiP.

Research Training & Academic Experience

Undergraduate research, quantum control — ongoing work with Prof. Tomasz Paterek; maintain derivation notes, numerical audit trails, convergence tests, and gravity-off controls.
Summer School on the Assumptions of Physics — participant, 2026 virtual programme on operational and mathematical reconstructions of physical theories.
Quantum field theory seminar — systematic study of canonical quantisation, free fields, Fock space, and propagators through a seminar series by Prof. Yi-Zen Chu.

Co-curricular Activities & Leadership

Vice President, Physics Student Council *September 2025–present*

- Coordinate academic events and peer mentoring; founded and host the departmental Physics Forum student journal club.
- Delivered the departmental talk *A Year in Physics*; preparing a workshop on LaTeX and Git.

Vice President, Astronomy Club *September 2025–present*

- Organise telescope sessions and member-led knowledge sharing.

Mathematical Methods

Eigenvalue localisation (Gershgorin, Cassini) · symplectic and covariance-matrix methods · Floquet theory · Hamilton–Jacobi and Madelung formulations · differential geometry, principal and frame bundles, holonomy · Lie groups · spherical harmonics · singular perturbation theory · real and quaternionic Hilbert spaces.

Computational

Languages and tools: Python (NumPy, SciPy, QuTiP), Octave/MATLAB, C++, LaTeX/TikZ. **Numerics:** stiff integrators (Radau, BDF), Riccati integration, validation-first numerical workflows.