KERYM MAKRAINI

Independent Researcher — Control of Integrated Photonic Systems & Itinerant Temporal Modes

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PROFILE

Self-trained researcher working at the interface of mathematical physics and photonic engineering: state estimation for drifting photonic circuits, linear receivers for distorted single-photon temporal modes, and operator-theoretic methods. I work outside an institution, so every result is released with code, data, tests and a DOI so that a third party can verify it without trusting me. Negative results are published alongside positive ones.

RESEARCH & DEVELOPMENT

Founder & Lead Researcher

AGE Quantum Gates Engine S.L. — independent research

2023 – present · Spain

- **Photonic drift estimation.** Joint estimation of thermal detuning in WDM microring banks under serial (round-robin) monitoring, separating common and local dynamics in a state-space/Kalman model. Reproducible benchmark: 1.80× RMS-error reduction in simulation (16 channels, 8 h, 60 runs); single-ring filtering alone gives 1.06×, reported as a negative control.
- **Itinerant temporal modes.** Minimum-norm zero-forcing receivers for distorted photon wavepackets: overlap-matrix formulation, selectivity–efficiency trade-off, receiver linewidth ceiling, and control-pulse realizability, checked in a cascaded two-node (chiral) input–output model.
- **Gate-sequence error analysis.** Second-order error cancellation (BCH) in symmetric commutator-based sequences; Suzuki–Yoshida hierarchies verified numerically.
- **Validation practice.** Held-out time segments, sealed (SHA-256) forecast protocol, automated test suites, MIT licence, Zenodo archiving.
- US provisional patent application (USPTO), sole inventor — pending.

Status: results are simulation-based; validation on measured foundry data is the next milestone.

INTEGRATED PHOTONICS

Self-directed study, applied in the projects listed.

Foundations

- Waveguide modes, effective index, group index and dispersion.
- Microring resonators (FSR, Q, coupling regimes), MZIs, directional couplers, WDM filter banks.
- Thermo-optic tuning (SOI, SiN), electro-optic tuning (TFLN), thermal crosstalk.
- PDK and MPW workflow: SOI-220 (CORNERSTONE), SiN, TFLN; design-rule checks.

Specialised

- State-space drift models (OU, random walk, creep); Kalman estimation under sparse monitoring.
- Platform parametrisation from published characterisation data.
- FDTD (Meep) and band-structure (MPB) simulation; GDS layout generation.

TEMPORAL MODES & QUANTUM OPTICS

Foundations

- Input–output theory, cavity QED, single-photon wavepackets.
- Open quantum systems: master equations, QuTiP.

Specialised

- SLH formalism, cascaded (chiral) quantum networks, photon emission–absorption transfer.
- Temporal-mode overlap theory, detuning and distortion compensation.
- Linear receiver design: zero-forcing, regularisation, Pareto frontiers.

PUBLICATIONS & OUTPUTS

Peer-reviewed

journal **Emergent Lorentzian spacetime and gauge dynamics from twistorial spectral data.** *Next Research* (Elsevier), 2026. doi:10.1016/j.nexres.2025.101114

Manuscripts, preprints & technical notes

- manuscript Minimum-norm zero-forcing receivers for distorted itinerant temporal modes (2026). Code: doi:10.5281/zenodo.21772919
- preprint Algebraic re-diagonalization of distorted itinerant temporal modes: overlap theory, control-pulse realizability, and a single-node dynamical check (2026). doi:10.5281/zenodo.20597552
- tech. note AGE-PN-001: Structured estimation of thermal drift in WDM microring banks (2026). Code & data at age-quantum.org/evidencia
- preprint A spectral exclusion principle for emergent spacetime from a non-commutative twistor geometry (2025). doi:10.5281/zenodo.17220918
- preprint On the necessity of internal degrees of freedom in conformally invariant structures (2025).
- working papers Four working papers in spectral theory and operator analysis (2026), ResearchGate DOIs.

Research software (DOI-archived)

- AGE Temporal Modes v1.2 doi:10.5281/zenodo.20622186
- `age-photonic-stability` — WDM drift benchmark, 16 automated tests
- 20+ public repositories (simulation, verification suites, reproduction code): github.com/KerymMacryn

PROFESSIONAL EXPERIENCE

Professional Enlisted Service (Tropa y Marinería)

Spanish Ministry of Defence

Nov 2001 – Nov 2016 Melilla, Spain

15 years of continuous service. Discipline, reliability under procedure, and teamwork in a regulated environment.

Independent Developer — Algorithmic Trading Systems

Freelance, in parallel with service

2009 – 2015 Remote

- Automated decision systems in MQL4/5 on tick-level data (Dukascopy); latency, numerical stability, fault tolerance.
- Public profile: mql5.com/en/users/systemfx

Independent Web & Systems Developer

Freelance

2001 – present Spain

Back-end (PHP, SQL), e-commerce platforms, secure deployment and reproducible pipelines; cybersecurity-aware configuration.

MATHEMATICS

- Functional analysis, C^*-algebras, GNS; Krein spaces (indefinite inner products).
- Lie groups and representations (SU(N), compact groups); Jordan form.
- Complex geometry: holomorphic bundles, sheaf cohomology; twistor theory.
- Holonomic control: Berry and Wilczek–Zee phases.

COMPUTING

Scientific: Python (NumPy, SciPy, QuTiP, Meep/MPB), C++, MATLAB, LaTeX

Systems & web: PHP, JavaScript, HTML5/CSS3, SQL, Bash, MQL4/5

Practice: Git, pytest, Zenodo/DOI, reproducible pipelines

EDUCATION

Undergraduate studies in Mathematics and Physics

UNED — Spanish National Distance University

2017 – present

Part-time and intermittent, alongside work; degree not completed. Coursework in analysis, linear algebra and physics; research training is self-directed.

Technician in Electronics (Vocational Training, FP II)

IES Reina Victoria Eugenia, Melilla

1996 – 2001

Certifications

- JavaScript Algorithms & Data Structures — freeCodeCamp, 300 h (2025)
- Responsive Web Design — freeCodeCamp, 300 h (2025)
- MF0486_3 Security in IT Equipment — certificate module (2025)

LANGUAGES

Spanish (native) ●●●●●

French (C1) ●●●●◐

English (C1) ●●●●○

Moroccan Arabic ●●●●○