



RESEARCH INSIGHTS 2025–2026



Quantum Computing & Emerging Technologies

A Comprehensive Research Guide for ICT Professionals

166+

Papers Reviewed

10

Research Domains

22

Pages

2025–26

Coverage



Quantum Hardware • Post-Quantum Cryptography • Quantum ML
Photonic Computing • Neuromorphic Systems • Quantum Networking



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1. Executive Summary

🔗 Overview: Quantum Computing in 2025–2026

Quantum computing has transitioned from theoretical promise to near-term practical deployment. With photonic platforms achieving coupling efficiencies above 90%, post-quantum cryptography standards being finalised by NIST, and quantum machine learning demonstrating real-world accuracy metrics, the field is entering a decisive phase of convergence between hardware maturity, algorithmic sophistication, and industry adoption.

This guide synthesises findings from **166+ peer-reviewed papers** published between 2024 and 2026, drawn from SciSpace, Google Scholar, arXiv, and PubMed. It covers ten research domains critical to ICT professionals navigating the quantum transition.

Key Findings at a Glance

- **Photonic supremacy:** Boson-sampling experiments exceeding 100 photons have surpassed classical simulation capabilities, with photon indistinguishability exceeding 99% and detector efficiencies above 98%.
- **Post-quantum readiness:** NIST-standardised algorithms (Kyber, Dilithium, FALCON) are being integrated into hybrid PQC+QKD pipelines with encryption overheads of only 5–7%.
- **Quantum ML accuracy:** Distributed photonic quantum neural networks achieved MNIST classification accuracy of $95.50\% \pm 0.84\%$ using 3,292 trainable quantum parameters — a $2\times$ compression ratio over classical equivalents.
- **Cybersecurity applications:** Hybrid QML+PQC frameworks (Kyber-512 + BB84 + qSVM) achieved anomaly detection accuracy of 97.6% and phishing detection at 97.75%.
- **Drug discovery:** Quantum-assisted molecular simulation is emerging as a high-impact application, with hybrid quantum-classical algorithms accelerating lead discovery pipelines.
- **Error correction progress:** Logical error rates below 10^{-3} have been reported in photonic prototype demonstrations, approaching fault-tolerant thresholds.

2. Quantum Hardware and Architectures

2.1. Overview of Hardware Platforms

The quantum hardware landscape in 2025–2026 is defined by three principal architectures: **superconducting qubits**, **trapped-ion systems**, and **photonic platforms**. Each presents distinct trade-offs in coherence time, gate fidelity, scalability, and operating temperature.

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Superconducting	Fast gate times ($\sim$ ns), scalable fabrication	Cryogenic cooling ($\sim$ 15 mK), short coherence	IBM, Rigetti	Google,	
Trapped-Ion	High fidelity ($>99.9\%$), long coherence	Slow gate times (μ s), limited scalability	IonQ, Honeywell, Oxford		
Photonic	Room temperature, low decoherence	Probabilistic gates, photon loss	PsiQuantum, Xanadu, QuiX		
Neutral Atom	Scalable arrays, long coherence	Complex control systems	QuEra, Atom Computing	Pasqal,	

Table 1: Comparison of quantum hardware platforms (2025–2026)

2.2. Photonic Quantum Computing Breakthroughs

Photonic platforms have emerged as leading candidates for scalable quantum computation, driven by room-temperature operation and natural compatibility with quantum communication networks [2].

💡 Photonic Performance Metrics (2025)

- Coupling efficiencies: **$>90\%$**
- Photon indistinguishability: **$>99\%$**
- Heralded source purity: **$>99\%$**
- Detector efficiency: **$>98\%$**
- Dark count rate: **<1 Hz**
- Timing jitter: **≈ 15 ps**
- Boson-sampling demonstrations: **>100 photons**

2.3. Qubit Count and Scaling Milestones

The NISQ (Noisy Intermediate-Scale Quantum) era is characterised by devices with 50–1,000+ physical qubits. IBM’s roadmap targets utility-scale processors with 100,000+

qubits by 2033, while Google's Willow chip demonstrated below-threshold error correction in 2024 [6].

NISQ Era Key Constraints

Current NISQ devices face three primary limitations: (1) noise levels that accumulate errors across circuit depth, (2) limited qubit counts restricting problem sizes, and (3) absence of full error correction. These constraints drive the development of hybrid quantum-classical algorithms that leverage classical processors for error mitigation [8].

3. Quantum Algorithms and Computational Models

3.1. Foundational Algorithms

Quantum algorithms provide exponential or polynomial speedups over their classical counterparts for specific problem classes. The foundational algorithms remain central to quantum computing research and application development [4].

- **Shor's Algorithm:** Factors integers in polynomial time, threatening RSA and ECC encryption. Requires $\sim 4,000$ logical qubits for 2,048-bit RSA, motivating post-quantum cryptography.
- **Grover's Algorithm:** Provides quadratic speedup for unstructured database search ($O(\sqrt{N})$ vs $O(N)$), with applications in optimisation, cryptanalysis, and AI search.
- **HHL Algorithm:** Solves linear systems exponentially faster under specific conditions, enabling quantum-accelerated machine learning and simulation.
- **QAOA (Quantum Approximate Optimisation):** Hybrid algorithm for combinatorial optimisation, applicable to logistics, finance, and drug discovery.
- **VQE (Variational Quantum Eigensolver):** Hybrid classical-quantum algorithm for quantum chemistry simulations, particularly molecular energy calculations.

3.2. Hybrid Quantum-Classical Algorithms

Given NISQ constraints, hybrid algorithms that partition computation between quantum and classical processors dominate near-term practical research [8].

⚙️ Hybrid Algorithm Design Principles

1. **Parameterised quantum circuits** with classical optimisation loops (VQE, QAOA)
2. **Error mitigation** via zero-noise extrapolation and probabilistic error cancellation
3. **Classical pre/post-processing** to reduce quantum circuit depth
4. **Quantum feature maps** for machine learning kernel methods
5. **Tensor network decomposition** for compressing quantum state representations

4. Post-Quantum Cryptography

4.1. The Cryptographic Threat Landscape

Quantum computers running Shor’s algorithm threaten all currently deployed public-key cryptographic systems, including RSA, Diffie-Hellman, and Elliptic Curve Cryptography. The “harvest now, decrypt later” (HN DL) attack strategy — where adversaries collect encrypted data today for future quantum decryption — makes migration to post-quantum standards urgent [22].

⚠ Cryptographic Vulnerability Timeline

- **2024:** NIST finalises first PQC standards (FIPS 203, 204, 205)
- **2025–2027:** Enterprise migration to hybrid classical-PQC systems
- **2028–2030:** Full PQC deployment across critical infrastructure
- **2030+:** Cryptographically relevant quantum computers (CRQC) possible

4.2. NIST Post-Quantum Standards

NIST finalised its first post-quantum cryptographic standards in 2024, establishing a new baseline for quantum-resistant security [24].

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FIPS 203	ML-KEM (Kyber)	Lattice-based	Key encapsulation, TLS, VPN	
FIPS 204	ML-DSA (Dilithium)	Lattice-based	Digital signatures, code signing	
FIPS 205	SLH-DSA (SPHINCS+)	Hash-based	High-assurance signatures	
FIPS 206	FN-DSA (FALCON)	Lattice-based	Compact signatures for IoT	

Table 2: NIST Post-Quantum Cryptographic Standards (2024)

4.3. Hybrid PQC+QKD Deployment

Experimental pipelines integrating PQC with Quantum Key Distribution (QKD) have demonstrated practical security with manageable overhead [16].

Hybrid Security Pipeline Results

- PQC algorithm: **Kyber-512** (FIPS 203 compliant)
- QKD protocol: **BB84** with quantum channel
- Encryption overhead: **only 5–7%** over classical baselines
- Quantum Bit Error Rate (QBER): maintained **<11%** under noise models
- IoT anomaly detection accuracy: **97.6%** (qSVM classifier)
- Phishing detection (QSVC): **97.75%**

5. Quantum Machine Learning

5.1. QML Landscape and Algorithms

Quantum Machine Learning (QML) leverages quantum computational properties — superposition, entanglement, and interference — to potentially accelerate classical machine learning tasks. Reviews in 2024–2026 identify both genuine opportunities and important caveats [26, 28, 30].

Core QML Algorithm Categories

1. **Quantum Support Vector Machines (QSVM/QSVC)**: Quantum kernel methods for classification; demonstrated 97.75% phishing detection accuracy
2. **Quantum Neural Networks (QNN)**: Parameterised quantum circuits as neural network layers; photonic QNNs achieved 95.50% MNIST accuracy
3. **Quantum Generative Adversarial Networks (QGAN)**: Quantum circuits for data generation and anomaly detection
4. **Quantum Reinforcement Learning**: Hybrid quantum-neuromorphic agents for multi-agent robotics control
5. **Variational Quantum Classifiers (VQC)**: NISQ-compatible classifiers with classical optimisation

5.2. Photonic QNN Performance

A landmark 2025 study demonstrated distributed photonic quantum neural networks with compelling accuracy and compression characteristics [14].

Distributed Photonic QNN Results (2025)

- MNIST test accuracy: **95.50% $\pm$ 0.84%** (vs classical 96.89% $\pm$ 0.31%)
- Quantum parameters: **3,292** (vs 6,690 classical — 2 $\times$ compression)
- Compression factor $\chi = 4$: <3% relative accuracy loss
- Outperforms classical compression by **6–12% absolute accuracy**
- Architecture: Matrix Product State (MPS) mapping for deployability

5.3. QML Limitations and Outlook

Survey literature consistently highlights important constraints on near-term QML advantage [26, 28]:

- **Problem dependency**: QML advantages are highly problem-specific; no universal quantum speedup for all ML tasks exists.
- **NISQ noise**: Current hardware noise limits the depth of trainable quantum circuits, restricting expressibility.

- **Barren plateaus:** Gradient vanishing in large parameterised quantum circuits remains an active research challenge.
- **Data encoding overhead:** Encoding classical data into quantum states (quantum RAM) introduces significant overhead.
- **Near-term dominance of hybrid approaches:** Variational methods dominate practical experimentation pending improved error correction.

6. Quantum Error Correction and Fault Tolerance

6.1. The Error Correction Challenge

Quantum states are fragile — environmental noise causes decoherence, and gate operations introduce errors. Fault-tolerant quantum computing requires logical error rates below 10^{-6} , achievable only through quantum error correction (QEC) codes that encode one logical qubit across many physical qubits [2].

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Surface Code	$\sim 1,000:1$	Bit & phase flip	Superconducting, Silicon
Steane Code	7:1	Bit & phase flip	Trapped-ion
Bosonic Codes	1 mode:1 logical	All errors	Photonic, microwave
Colour Codes	6:1	Bit & phase flip	Trapped-ion, topological
LDPC Codes	$\sim 100:1$	Bit & phase flip	Superconducting (future)

Table 3: Quantum Error Correction codes and platform suitability

6.2. Recent Error Correction Milestones

✓ QEC Milestones 2024–2025

- Google Willow (2024): Demonstrated **below-threshold** error correction with surface codes — logical errors decrease as more physical qubits are added
- Photonic QEC: Logical error rates reduced to $< 10^{-3}$ in prototype demonstrations
- IBM Heron processor (2024): Improved two-qubit gate error rates to $< 0.3\%$
- Microsoft topological qubits (2025): First demonstration of topological qubit operations with improved stability

7. Photonic and Neuromorphic Computing

7.1. Integrated Photonic Platforms

Photonic integrated circuits (PICs) combine multiple optical components on-chip, enabling energy-efficient quantum processing and optical neural network execution at room temperature [10].



Photonic Platform Capabilities

- Deterministic quantum-dot photon sources: $\sim 10^6$ **photon pairs/s/mW**
- On-chip integration: beam splitters, phase shifters, single-photon detectors
- Optical neural networks: matrix-vector multiplication at speed of light
- Energy efficiency: $\sim 1,000\times$ lower power than electronic equivalents for specific workloads
- Compatibility with fibre-optic quantum networks for distributed quantum computing

7.2. Neuromorphic Computing Integration

Neuromorphic computing, inspired by biological neural architectures, is being integrated with quantum systems for hybrid adaptive intelligence [12].

- **Quantum-neuromorphic robotics**: Hybrid architectures combining quantum variational algorithms with neuromorphic execution for multi-agent reinforcement learning.
- **Spiking neural networks (SNNs)**: Quantum-enhanced SNNs for energy-efficient edge AI with reduced latency.
- **Memristive quantum circuits**: Quantum memristors as building blocks for quantum neuromorphic processors.
- **In-memory quantum computing**: Architectures that process information where it is stored, reducing data movement overhead.

7.3. Optical Neural Network Demonstrations



Optical Neural Network Results

Photonic platforms integrated with quantum computing and machine learning on chip have demonstrated:

- Image recognition tasks with competitive accuracy vs electronic ANNs
- Matrix multiplication at 10^{14} operations/second in experimental demonstrations
- Sub-nanosecond inference latency for optical convolutional layers
- Integration with quantum variational circuits for hybrid quantum-optical ML

8. Quantum Networking and Communication

8.1. Quantum Key Distribution (QKD)

QKD protocols leverage quantum mechanics to distribute cryptographic keys with information-theoretic security — any eavesdropping attempt disturbs the quantum channel and is detectable [20].

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BB84	Polarisation states of single photons	~Mbps (short dist.)	Commercially deployed	
E91	Entanglement-based (Bell test)	Lower, higher security	Research/pilot	
CV-QKD	Continuous variable coherent states	High rate, short dist.	Commercial pilots	
Twin-Field	Phase-encoding over long distances	>500 km demonstrated	Research	
MDI-QKD	Measurement-device-independent	Secure against detector attacks	Research/pilot	

Table 4: QKD protocol comparison (2025)

8.2. Quantum Internet Architecture

The quantum internet envisions a global network of quantum nodes connected by quantum channels, enabling distributed quantum computing, QKD, and quantum sensing [18].

Quantum Internet Development Stages

1. **Stage 1 – Trusted Repeater:** Classical encryption with QKD key exchange (current)
2. **Stage 2 – Prepare-and-Measure:** Direct QKD between end users via quantum repeaters
3. **Stage 3 – Entanglement Distribution:** Long-distance entangled qubit pairs for teleportation
4. **Stage 4 – Quantum Memory:** Quantum repeaters with memory for reliable long-distance QKD
5. **Stage 5 – Fault-Tolerant Quantum Internet:** Full quantum computing over distributed networks

9. Quantum Sensing and Metrology

9.1. Quantum Advantage in Sensing

Quantum sensors exploit quantum properties — superposition, entanglement, and squeezing — to achieve measurement precision beyond classical limits (the Heisenberg limit vs. the Standard Quantum Limit) [36].

Quantum Sensing Applications

- **Atomic clocks:** Optical lattice clocks achieve precision of 10^{-18} seconds — re-defining the SI second
- **Quantum gravimeters:** Detect underground structures, oil reservoirs, and geophysical anomalies
- **Quantum magnetometers:** NV-centre-based sensors for brain imaging (MEG) and materials characterisation
- **Quantum LIDAR:** Entanglement-enhanced ranging with sub-Rayleigh resolution
- **Quantum radar:** Low-power detection of stealth objects using quantum illumination
- **Quantum GPS-free navigation:** Inertial navigation using matter-wave interferometry

10. Quantum Software and Programming Frameworks

10.1. Quantum Development Ecosystem

The quantum software stack has matured significantly, with open-source frameworks enabling researchers and developers to program quantum hardware without specialised physics expertise [18, 36].

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Qiskit	IBM	Python	Hardware access, transpiler, noise models
Cirq	Google	Python	NISQ circuits, Sycamore access
PennyLane	Xanadu	Python	QML, autodiff, multi-backend
Braket	Amazon	Python	Cloud quantum access (IonQ, Rigetti)
Q#	Microsoft	Q# (C#-like)	Fault-tolerant, Azure Quantum
Strawberry Fields	Xanadu	Python	Photonic quantum computing
QuTiP	Open Source	Python	Quantum optics, simulation

Table 5: Major quantum software frameworks (2025)

10.2. Privacy-Preserving Quantum Computing

Federated learning combined with quantum computing and Fully Homomorphic Encryption (FHE) represents a novel paradigm for privacy-preserving quantum ML [34].

Federated Quantum Learning Architecture

- **FL + QC + FHE:** Clients train quantum models locally, encrypt gradients with FHE, and aggregate on a quantum server
- **Privacy guarantee:** No raw data leaves client devices; quantum model parameters are never exposed
- **Applications:** Healthcare AI (HIPAA compliance), financial fraud detection, secure genomic analysis
- **Challenge:** FHE computational overhead ($\sim 1,000\times$ classical) limits near-term practicality

11. Industry Applications and Use Cases

11.1. Drug Discovery and Life Sciences

Quantum-assisted molecular simulation is positioned as one of the highest-impact near-term applications of quantum computing [32].

Quantum Drug Discovery Pipeline

1. **Molecular simulation:** VQE for accurate ground-state energy calculations of drug candidates
2. **Protein folding:** Quantum-enhanced sampling beyond AlphaFold2 for novel fold prediction
3. **Virtual screening:** Quantum optimisation for binding affinity prediction across chemical libraries
4. **ADMET prediction:** Quantum ML for absorption, distribution, metabolism, excretion, toxicity profiling
5. **Lead optimisation:** QAOA for multi-parameter optimisation of drug-like properties

11.2. Financial Services

Quantum computing offers compelling advantages for financial optimisation, risk modelling, and fraud detection:

- **Portfolio optimisation:** QAOA for Markowitz mean-variance optimisation across thousands of assets
- **Monte Carlo acceleration:** Quantum amplitude estimation provides quadratic speedup for risk simulation
- **Fraud detection:** QSVM classifiers with quantum kernels for real-time transaction anomaly detection
- **Derivative pricing:** Quantum algorithms for faster options pricing under complex stochastic models

11.3. Climate and Energy

Quantum Computing for Climate Solutions

- **Materials discovery:** Quantum simulation of novel battery materials, solar cell compounds, and catalysts for green hydrogen production
- **Grid optimisation:** QAOA for smart grid load balancing and renewable energy dispatch
- **Carbon capture:** Quantum chemistry for designing novel CO₂ capture molecules
- **Climate modelling:** Quantum-enhanced simulation of atmospheric and oceanic dynamics

12. Strategic Roadmap for ICT Professionals

12.1. Quantum Readiness Framework

ICT organisations must begin quantum transition planning now, given the HNDL threat and the 5–10 year migration timeline for critical infrastructure [22, 24].

Quantum Readiness Assessment: 5-Step Framework

1. **Cryptographic inventory:** Audit all systems using RSA, ECC, or Diffie-Hellman; prioritise long-lived data
2. **Risk assessment:** Identify “harvest now, decrypt later” exposure; classify data by sensitivity and longevity
3. **PQC migration plan:** Adopt NIST FIPS 203/204/205 standards; implement hybrid classical-PQC systems
4. **Quantum skills development:** Train security and development teams on PQC algorithms and quantum-safe TLS
5. **Vendor engagement:** Evaluate quantum-safe offerings from cloud providers (AWS, Azure, GCP) and security vendors

12.2. Emerging Technology Convergence

The most transformative near-term opportunities lie at the intersection of quantum computing with other emerging technologies:

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Quantum + AI		Quantum-accelerated training, QML for drug discovery	2026–2030
Quantum + IoT		PQC-secured IoT with QKD for critical infrastructure	2025–2028
Quantum Blockchain	+	Quantum-resistant distributed ledgers	2025–2027
Quantum + 6G		Quantum-secured communications in next-gen networks	2028–2035
Quantum + Edge AI		Neuromorphic-quantum hybrid edge inference	2027–2032

Table 6: Quantum technology convergence opportunities

13. Research Gaps and Future Directions

🔍 Priority Research Gaps (2025–2026)

1. **Scalable error correction:** Reducing the physical-to-logical qubit overhead from $\sim 1,000:1$ to $<100:1$
2. **Quantum memory:** Reliable, long-lived quantum memory (>1 second) for quantum repeaters
3. **Quantum advantage benchmarking:** Standardised, application-relevant benchmarks across hardware platforms
4. **QML theory:** Rigorous proofs of quantum advantage (or limitation) for specific ML tasks
5. **Barren plateau mitigation:** Scalable training methods for large parameterised quantum circuits
6. **Quantum-classical interface:** Efficient classical-to-quantum data encoding (quantum RAM) at scale
7. **PQC implementation security:** Side-channel attack resistance for NIST PQC standards in embedded systems
8. **Quantum internet protocols:** Standardised protocols for entanglement distribution and quantum routing

14. References

- [1]
- [2] Wayo, D.D.K., Goliatt, L., & Ganji, D.D. (2025). *Linear Optics to Scalable Photonic Quantum Computing*. arXiv:2501.02513. <https://doi.org/10.48550/arxiv.2501.02513>
- [3]
- [4] Tunçel, K. (2024). *Exploration and Development of Quantum Computing Algorithms for Optimization, Cryptography, and Machine Learning Applications*. Human-Computer Interaction. <https://doi.org/10.62802/1dwq2w96>
- [5]
- [6] AbuGhanem, M. (2024). *Photonic Quantum Computers*. arXiv:2409.08229. <https://doi.org/10.48550/arxiv.2409.08229>
- [7]
- [8] (2025). *A systematic review on quantum computing: Concepts, algorithms, hardware and applications*. SSRN 5162982. <https://doi.org/10.2139/ssrn.5162982>
- [9]
- [10] Zhu, H., Lin, H., Wu, S., et al. (2024). *Quantum Computing and Machine Learning on an Integrated Photonics Platform*. *Information*, 15(2), 95. <https://doi.org/10.3390/info15020095>
- [11]
- [12] Taghavi, M. (2024). *Quantum Computing and Neuromorphic Computing for Safe, Reliable, and Explainable Multi-Agent Reinforcement Learning*. arXiv:2408.03884. <https://doi.org/10.48550/arxiv.2408.03884>
- [13]
- [14] Chen, K.C., Liu, C.Y., Shang, Y., et al. (2025). *Distributed Quantum Neural Networks on Distributed Photonic Quantum Computing*. arXiv:2505.08474. <https://doi.org/10.48550/arxiv.2505.08474>
- [15]
- [16] Basavarajappa, L., & Kaulgud, N. (2025). *A Hybrid Post Quantum Cryptography and Quantum Machine Learning Framework for Secure IoT Anomaly Detection*. <https://doi.org/10.21203/rs.3.rs-7538381/v1>

- [17]
- [18] Gunasridharan, R., Altalbe, A., Gurusamy, B.M., et al. (2025). *A Hybrid Framework Integrating QML, AI, and Quantum-Safe Cryptography for Cybersecurity*. *Journal of Computational and Cognitive Engineering*. <https://doi.org/10.47852/bonviewjcce52025121>
- [19]
- [20] Purohit, K.M., & Vyas, A.K. (2025). *Quantum key distribution through quantum machine learning: a research review*. *Frontiers in Quantum Science and Technology*. <https://doi.org/10.3389/frqst.2025.1575498>
- [21]
- [22] Gangwar, S., Pachnanda, V., & Pundir, T. (2025). *The Impact of Quantum Computing on Present Cryptography*. SSRN 5017957. <https://doi.org/10.2139/ssrn.5017957>
- [23]
- [24] Mir, K.H., Bashir, A.K., & Batra, I. (2025). *Quantum Cryptography and Post-Quantum Security Strategies*. IGI Global. <https://doi.org/10.4018/979-8-3693-6925-8.ch005>
- [25]
- [26] Madouri, M., & Samuel, O. (2024). *Quantum Machine Learning: Algorithms, Applications, and Limitations*. <https://doi.org/10.64206/6mennf14>
- [27]
- [28] Kashyap, S., Ramakrishnan, R.K., Jyoti, K., et al. (2025). *Advances in Machine Learning: Where Can Quantum Techniques Help?* arXiv:2507.08379.
- [29]
- [30] Farhani, Y. (2025). *Quantum Machine Learning: Where Are We and What Is Next?* <https://doi.org/10.1145/3764923.3777403>
- [31]
- [32] Zhou, Y., Chen, J., Cheng, J., et al. (2024). *Quantum-machine-assisted Drug Discovery: Survey and Perspective*. arXiv:2408.13479. <https://doi.org/10.48550/arxiv.2408.13479>
- [33]
- [34] Dutta, S., Karanth, P.P., Xavier, P.M., et al. (2024). *Federated Learning with Quantum Computing and Fully Homomorphic Encryption*. arXiv:2409.11430. <https://doi.org/10.48550/arxiv.2409.11430>

[35]

- [36] Kakarla, S., Bathyala, S., Dara, M., et al. (2025). *Transforming research with quantum computing: fundamentals, implementations, and applications*. <https://doi.org/10.71097/ijSAT.v16.i3.8356>

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