QICS

QUANTUM INFORMATION CLASSIFICATION SCHEME

Classification Scheme for QIST related topics

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WorkPackage 1 website: http://iqoqi003.uibk.ac.at/qist
http://qist.ect.it

QUANTUM INFORMATION CLASSIFICATION SCHEME (QICS)

One of the tasks of the ERA-Pilot QIST WP1 aims at a survey of European QIST related structures. To achieve this goal it is essential to elaborate a list of QIST topics that can be widely accepted by the QIST community, which indicates what techniques are part of QIST, where are the borders to other scientific and technological areas, etc.

This document represents the Quantum Information Classification scheme (QICS) elaborated by the ERA-Pilot QIST WP1.

We have identified 5 broad categories, which we divide into 25 major topics. Each topic was then split up into different fields which could possibly show an ulterior division into sub-fields. The following illustrates the structure of this classification scheme (that is evidently inspired to the APS PACS) showing all the possible subdivisions.

10. QUANTUM COMPUTATION ← **Broad category**

15.	**Implementations: Quantum Optics**	←	**Major topic**
15.10.-p	**Quantum Optics: Physical qubits**	←	**Field**
15.10.El	Electrons	←	Sub-field
15.10.Ie	Ions: electronic states		
15.10.Iv	Ions: vibrational states		
15.10.Ne	Neutral atoms: electronic states		
15.10.Nv	Neutral atoms: vibrational states		
15.10.Ry	Rydberg atoms		
15.10.Ph	Photons		
15.10.Qd	Quantum dots		
15.10.En	Atomic ensemble		
15.10.Mo	Molecules		
17.	**Other implementations**		
17.10.+n	**Nanotubes and nanowires**		

Each code is constructed as follows: the first two digits refer to the category, while the second two to the topic; the last two letters refer instead to the field or the sub-field. In the case of a field, a "+" followed by a letter means that the field does not have sub-fields, while a "-" followed by a letter would indicate that sub-fields are present for that particular code. Finally, in the case of sub-fields, the two letters are chosen (when possible) among the initial letters of the most important key-words present in the code description.

This is a 'living document': if you think that some QIST subjects are missing, or that a new promising field has opened up, please send the suggested field/sub-field together with a proposed code (constructed following the aforementioned rules) to qist@ect.it. Valid codes will be included in subsequent updates of the QICS.

00. QUANTUM INFORMATION SCIENCE

01. Physics and information science

01.10.+i Encoding, processing and transmission of information via physical systems

01.20.+e Reversibility and irreversibility in information processing

01.30.+r Quantum states and dynamics as a resource for information processing

01.40.+n Entanglement as a resource for information processing

01.50.+e Entropy and other measures of information

02. Fundamental problems

02.10.+t Quantum-Classical Transition

02.20.+c Mesoscopic and Macroscopic Quantum Coherence

02.30.-n Entanglement, nonlocality, complementarity

02.30.Bi Bell inequalities

02.30.An Bell theorem without inequalities

02.30.Lh Loopholes in Bell-type experiments

02.40.+d Interaction with environment

02.50.+r Reference frames in quantum mechanics

02.60.+g Geometric/topological phases

02.70.+a Theories alternative to quantum mechanics

02.80.+i Fundamentals of quantum interference (quantum eraser, which-way information, etc.)

02.90.+f Foundational issues of quantum mechanics

03. Entanglement

03.02.+s Separability properties

03.05.+c Characterization and classification of entanglement

03.10.+m Entanglement measures

03.20.+w Entanglement detection/witnesses

03.25.+y Entanglement catalysts

03.30.+e Entangling/Disentangling power of quantum evolutions and transformations

03.40.+t Thermal/mixed state entanglement

03.50.+b Bound entanglement

03.60.+i Entanglement of identical particles and statistics

03.70.+c Entanglement versus correlation

03.80.+p (Theory of) purification, distillation, concentration

03.90.+m (Other) mathematical aspects of composite quantum systems

04. Entanglement in Many-Body Systems

04.10.+s Entanglement in spin models/oscillator chains

04.20.+b Squeezing and entanglement in quantum degenerate gases and BCS model

04.25.+l Entanglement in solid state systems, Luttinger liquids, etc.

04.30.+p Entanglement in phase transitions

04.40.+c Entanglement, chaos and disorder

04.50.+m Efficient simulation of quantum many-body systems

04.60.+s Entanglement in mesoscopic/macroscopic systems

04.70.+m Multi-particle/multi-photon entanglement

04.80.+d Entanglement dynamics in composite quantum systems

04.90.+t Entanglement transfer

05. Cross disciplinary links

05.05.+r Quantum information & relativity/cosmology

05.10.+s Quantum information & quantum statistics

05.20.+c **Quantum information & quantum chaos**

05.30.+t **Quantum information & thermodynamics**

05.40.+n **Quantum information & neural networks**

05.50.+a **Quantum information & adaptive learning and feedback control**

05.60.+c **Quantum information & chemistry**

05.70.+o **Quantum information & quantum control**

05.80.+m **Quantum information & complex systems**

05.90.+p **Quantum information & quantum field theory/particle physics**

06. Quantum measurements

06.10.+d **Dynamics of the measurement process**

06.15.+e **Measurement-induced transformations**

06.20.+m **Quantum measurement theories**

06.25.+n **Quantum non-demolition measurements**

06.30.+p **Positive Operator Valued Measurements (POVM's)**

06.35.+w **Weak measurements**

06.40.+z **Quantum Zeno effect**

06.50.+t **Tomographic state reconstruction**

06.60.+r **Non-tomographic state reconstruction/estimation**

06.70.+e **Phase estimation**

06.80.+s **Quantum state discrimination**

06.85.+o **Quantum operator discrimination/reconstruction**

06.90.+m **Parameter estimation**

07. Mathematics of Hilbert space

07.10.+r **State representations (quasi-probability distributions, Poincare' sphere, Stokes parameters, etc.)**

07.20.+b **Properties of special bases**

07.30.+o **Properties of operators**

07.40.+d **Distance between states**

07.50.+n **No-go theorems**

07.60.+s **Special states (graph states, cluster states, etc.)**

10. QUANTUM COMPUTATION

11. Algorithms

11.10.+c **Quantum complexity theory**

11.20.+a **Role of entanglement in quantum algorithms**

11.30.+h **Factoring, hidden subgroup**

11.40.+s **Quantum search**

11.50.+m **Quantum maps, quantum chaos**

11.60.+g **Quantum games, strategies**

11.70.+w **Quantum random walks**

11.80.+e **Spectral evaluation**

11.90.+m **Quantum template matching**

11.95.+o **Other algorithms**

12. Simulations

12.10.+i **Simulations of many-body interactions**

12.20.+h **Optimal simulation of few-qubit Hamiltonians**

12.30.+u **Universal quantum simulators with specific systems (e.g. trapped ions, optical lattices, etc.)**

12.40.+e **Efficient classical simulation of quantum computation**

13. Defeating errors

13.10.+n **Effects of noise and imperfections**

13.20.+e **Quantum error correction**

13.30.+t **Fault-tolerant quantum computation**

13.40.+d **Decoherence-free subspaces / noiseless subsystems**

13.50.+d **Dynamical/algebraic decoupling/ recoupling**

13.60.+p **Geometric/topological protection**

13.70.+f **Quantum feedback / filtering and control**

13.80.+a **Errors and chaos**

14. Models and Architectures

14.10.+c **Quantum circuit model**

14.20.+a **Quantum cellular automata**

14.30.+t **Quantum Turing machine**

14.35.+i **Initialization of quantum registers**

14.40.+m **Measurement-based quantum computation**

14.50.+a **Adiabatic quantum computation**

14.60.+g **Geometric/topological and holonomic quantum computation**

14.70.+p **Post-selected quantum computation**

14.80.+f **Quantum computation with fixed couplings**

14.90.+l **Quantum computation with local control**

14.95.+p **Probabilistic quantum computation**

15. Implementations: Quantum Optics

15.10.–p **Quantum Optics: Physical qubits**

15.10.El Electrons

15.10.Ie Ions: electronic states

15.10.Iv Ions: vibrational states

15.10.Ne Neutral atoms: electronic states

15.10.Nv Neutral atoms: vibrational states

15.10.Ph Photons

15.10.Qd Quantum dots

15.10.En Atomic ensembles

15.10.Mo Molecules

15.20.–e Quantum Optics: Experimental system

15.20.Pt Penning traps (planar and circular)

15.20.Lp Linear Paul traps

15.20.Ml Micro-fabricated lithographic traps

15.20.Ol Optical lattices

15.20.Mc Magnetic atom chips

15.20.Oc Optical atom chips

15.20.Lo Linear optics

15.20.Ca Cavity QED

15.20.Ro Readout techniques in quantum optics

16 Implementations: condensed matter

16.10.–p Condensed Matter: Physical qubits

16.10.Ec Electrons in solids: charge

16.10.Es Electrons in solids: spin

16.10.Sc Spin chains

16.10.Is Ions in solids

16.10.Ns Nuclear spins

16.10.Jn Josephson nanodevices

16.20.–e Condensed Matter: Experimental system

16.20.De Electrically realized quantum dots

16.20.Db Band-gap modulation quantum dots

16.20.Sr Electron spin resonance

16.20.Re Rare-earth-ion-doped crystals

16.20.Ln Liquid NMR

16.20.Pd Atomic donors in semiconductor substrates

16.20.Ec Endohedral C60 on surfaces

16.20.Ih Isotopically engineered heterostructures

16.20.Ns QD nuclear spin ensembles

16.20.Cq Charge qubits

16.20.Pq Phase qubits

16.20.Fq Flux qubits

16.20.Sq Superconducting qubits coupled to resonators

16.20.Dc Defect centers in diamonds

16.20.Rc Readout techniques in condensed matter

17 Other implementations

17.10.+n Nanotubes and nanowires

17.20.+m Single-domain magnetic particles

17.30.+e Electrons on helium films

17.40.+d Molecular spin / dipole arrays

17.50.+h Quantum Hall systems

17.60.+r Nanomechanical resonators

17.70.+s Spectral hole burning

17.80.+h Hybrid systems

17.90.+s Surface-acoustic-wave-based quantum computer

18 Decoherence studies

18.10.+b **System-bath interaction (harmonic bath, spin bath)**

18.20.+s **Electron spins in semiconductors (phonons, nuclear spins)**

18.30.+a **Atoms close to surfaces/ in laser fields or cavities**

18.40.+n **Electromagnetic noise on trapped ions**

18.50.+p **Electric and phonon noise in semiconductors**

18.60.+d **Disentanglement via dissipation/dephasing**

18.70.+s **Decoherence in solid state systems**

18.80.+d **Quantum dissipative systems**

20. QUANTUM COMMUNICATION

21. Protocols

21.10.+a **Quantum authentication / identification**

21.20.-s **Quantum secret sharing / data hiding**

21.20.Kl Quantum key distillation

21.20.Kd Quantum key distribution

21.20.Rp Remote state preparation

21.20.Rc Quantum remote control

21.20.Sc Quantum bit-string commitment

21.30.+c **Quantum coding**

21.40.+d **Quantum data compression**

21.50.+t **Teleportation**

21.60.+e **Entanglement based protocols**

21.70.+q **Qudits**

21.80.+c **Quantum cloning**

22. Information security beyond quantum cryptography

22.10.+k **High key rates**

22.20.+d **Continuous variables**

22.30.+c **Quantum codes**

22.40.+p **Privacy Amplification**

22.50.+t **Teleportation as a cryptographical primitive**

22.60.+e **Eavesdropping detection**

22.65.+a **Eavesdropping attacks/strategies**

22.70.+s **Security proofs**

22.80.+p **Plug and play systems**

22.90.+d **Distrustful cryptography**

23. Long-distance quantum communication

23.05.+f **Fiber-based quantum communication**

23.10.+l **Limits for shared entanglement**

23.20.+f **Free-space entanglement**

23.25.+c **Free-space quantum communication**

23.30.+o **Outer-space quantum communication**

23.40.+a **Adaptive optics**

23.50.+s **Feasibility studies for satellite based quantum communication**

23.60.+d **Study of decoherence**

23.70.+s **Space qualified technologies**

24. Sources

24.10.-s **Single photons**

24.10.Od Single photons on demand

24.10.Tw Single photons at telecom wavelength

24.20.-e **Entangled photons**

24.20.Od Entangled photons on demand

24.20.Tw Entangled photons at telecom wavelength

24.30.+s **Squeezed states sources**

24.40.+h **High efficiency sources**

24.50.+m **Multiphoton sources**

24.60.+s **Generation of specific states of radiation**

24.70.+c **Color-center / quantum dot photon sources**

25. Detectors

25.10.+e **Quantum efficiency of detectors**

25.20.+n **Number resolution**

25.30.+c **Clock synchronization**

25.40.+t **Automated state and process tomography**

25.50.+m **Miniaturization**

25.60.+a **Quantum state analyzers**

30. QUANTUM NETWORKS

31. Quantum channels

31.10.+l **Long distance photonic channel**

31.20.+t **Quantum state transport in quantum chains and arrays**

31.25.+d **Decoherence in quantum channels**

31.30.+c **Characterization of quantum channels**

31.35.+i **Dissipative quantum channels**

31.40.+d **Entanglement distribution**

31.50.+m **Quantum channel memory**

31.60.+n **Non-photonic quantum channels**

31.70.+g **Gaussian channels**

31.80.+b **Bosonic channels**

31.90.+e **Entangled channels**

32. Quantum repeaters

32.10.+c **Communication over noisy channels**

32.20.+m **Quantum memories / storage of qubits**

32.30.+s **Entanglement swapping**

32.40.+p **Realization of purification, concentration, and distillation in physical systems**

32.50.-c **Quantum communication complexity**

32.50.Fp Quantum fingerprinting

32.60.+s **Small scale quantum processors**

33. Qubit interfaces

33.10.+a **Cavity QED (atoms or ions)**

33.20.+d **Quantum dots**

33.30.+s **SQUIDs**

33.40.+j **Josephson junctions ⇆ ions**

33.45.+u **Superconducting qubits ⇆ spins**

33.50.+n **Nanomechanical resonators ⇆ quantum dots, superconducting qubits**

33.60.+a **Atomic systems ⇆ mesoscopic conductors**

33.70.+o **Optical systems ⇆ solid-state systems**

33.80.+m **Atomic-ensemble quantum memory for light**

33.90.+e **Entanglement between atoms and photons**

40. QUANTUM INFORMATION TECHNOLOGIES

41. Metrology

41.05.+l **Quantum limits**

41.10.+p **Quantum enhanced measurements**

41.20.+c **Quantum clock synchronization**

41.30.+i **Quantum imaging**

41.40.+s **Precision spectroscopy via entangled states**

41.50.+n **Nanomechanical sensors**

41.60.+s **Single electron spin measurements**

41.70.+a **Aligning reference frames**

41.80.+c **Absolute calibration of detectors**

41.90.+n **New sensor technologies**

41.95.+m **Quantum magnetometry**

42. QIP-related Technologies

42.10.+p **Photonic crystal microcavities**

42.20.+i **Integrated atom optical elements**

42.30.+l **New laser sources**

42.40.+s **Spintronics**

42.50.+n **Nanomechanical devices**

42.60.+t **Miniaturized trap technologies**