MAIN LEARNING RESOURCES in the field of QUANTUM TECHNOLOGIES

As Quantum Technologies appear to be the next frontier for significant investment in human as well as capital resources, in Europe and in the rest of the world, a interested citizen must be aware of a number of (European) main documents that provide perspective in this promising area.

The Quantum Manifesto

One of such influential documents is the *Quantum Manifesto*, which was written by the European quantum community and endorsed by over 3400 supporters: industries, research institutes and scientists in Europe. As stated in the document, it is a call to develop Europe's capabilities in quantum technologies creating a lucrative knowledge-based industry, leading to economic, scientific and societal benefits. It paved the way for the next European Flagship. In May 2016, the (then) EU Commissioner for Digital Economy and Society, Günther Oettinger, announced the investment of one billion Euro in a new *Flagship*[1] on quantum technologies. "Building on the strong support for the Quantum Manifesto, we aim to launch an ambitious, large-scale Flagship initiative to unlock the full potential of quantum technologies, accelerate its development and bring commercial products to the consumer marketplace" (excerpted from the *Report on Quantum Europe 2016*).

The *Quantum Manifesto*, which can be downloaded from https://ec.europa.eu/futurium/en/content/quantum-manifesto-quantum-technologies

[1] *Flagships* are visionary, science-driven; they are large-scale research initiatives addressing grand scientific and technological challenges. They are long-term initiatives bringing together excellent research teams across various disciplines, sharing a unifying goal and an ambitious roadmap on how to achieve it. Flagships run for about ten years, with a total budget of around one billion Euros. Quantum Technology is the third Flagship. The other two, 'Graphene' and 'The Human Brain Project', were launched in January 2013. [Excerpted from the *Report on Quantum Europe 2016*]

The document is essentially a call to launch an ambitious European initiative in quantum technologies, needed to ensure Europe's leading role in a technological revolution now under way. This Manifesto calls upon Member States and the European Commission to launch a €1 billion flagship-scale initiative in Quantum Technology, preparing for a start in 2018 within the European H2020 research and innovation framework programme. It is endorsed by a broad community of industries, research institutes and scientists in Europe. This initiative aims to place Europe at the forefront of the second quantum revolution now unfolding worldwide, bringing transformative advances to science, industry and society. It will create new commercial opportunities addressing global challenges, provide strategic capabilities for security and seed as yet unimagined capabilities for the future. Goals of this initiative are • Kick-start a competitive European quantum industry to position Europe as a leader in the future global industrial landscape. • Expand European scientific leadership and excellence in quantum research. • Make Europe a dynamic and attractive region for innovative business and investments in quantum technologies. • Benefit from advances in quantum technologies to provide better solutions to grand challenges in such fields as energy, health, security and the environment.

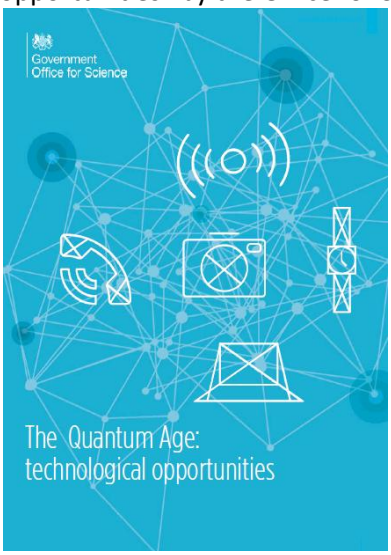
Quantum Technologies: Implications for European Policy

Another significant document is JRC Science for Policy Report entitled "Quantum Technologies: Implications for European Policy" (May 2016) [downloadable from https://ec.europa.eu/digital-single-market/en/news/quantum-technologies-implications-european-policy]. As stated in this document, Quantum Technologies are being promoted as part of the EU's Future and Emerging Technologies (FET) programme that aims at turning Europe's excellent science basis into a competitive advantage. Recently, as part of its Communication on the European Cloud Initiative [COM(2016) 178], the European Commission has proposed reinforcing EU action in this area in line with recent initiatives at Member State level, such as the UK Quantum Technologies Programme and the establishment of the QuTech centre in the Netherlands.

The mission of Europe's Joint Research Centre (JRC) is to support EU policies with independent evidence. As such, JRC has studied the implications of the emergence of quantum technologies on European policies. Through this study, the JRC seeks to indicate possible points of intervention to seize on opportunities and to respond to the new realities that the use of quantum technologies could bring along. In the JRC Report, three generally-recognized application areas have been chosen as initial study cases: (a) secure communication, (b) computing and simulation, and (c) sensing and timing.

The Quantum Age: technological opportunities

Another significant document is the one entitled "The Quantum Age: technological opportunities" by the Office for Science of the UK Government (2016).

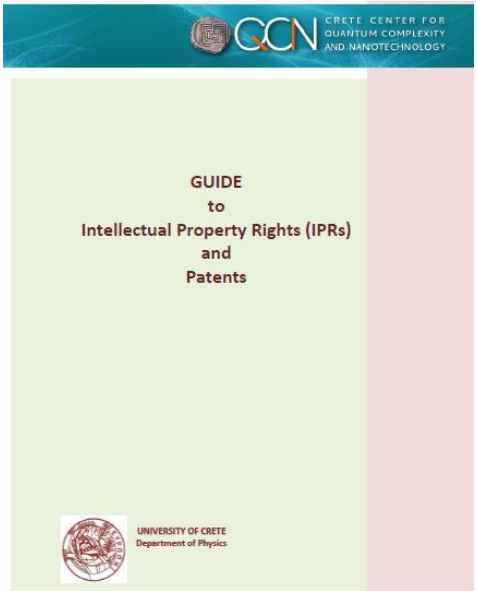


The document can be downloaded from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/564946/gs-16-18-quantum-technologies-report.pdf.
It focuses on ground-breaking capabilities, which will have a profound impact across a range of components including sensors, clocks and microchips. These in turn will support new applications in sectors such as engineering, telecommunications, healthcare, security and finance. In this Report, Professor Sir Mark Walport, the UK Government Chief Scientific Adviser, analyses these developments and their potential for the UK economy, explaining how the convergence of the UK's research base and industry in the (UK) National Quantum Technologies Programme provides a crucial opportunity to capitalize on comparative advantage.
Two additional UK documents are the (a) "National strategy for quantum technologies" (in which is presented the work of the UK Quantum Technologies Strategic Advisory Board [the mission of which is to provide a visible focus for quantum technologies in the UK, to act as a co-ordinating body for UK interests, to have an oversight of the UK National Quantum Technologies Programme and to draw up a strategy for quantum technologies in the UK) downloadable from https://www.gov.uk/government/publications/national-strategy-for-quantum-technologies, and (b) "A roadmap for quantum technologies in the UK" presenting the outcome of the roadmapping workshops which were organized by Innovate UK and attended by representatives of industry, academia and public funders, focusing on five core themes: stimulating application and market opportunities, enabling a strong foundation of capability in the UK, growing a skilled UK workforce in quantum technologies, creating the

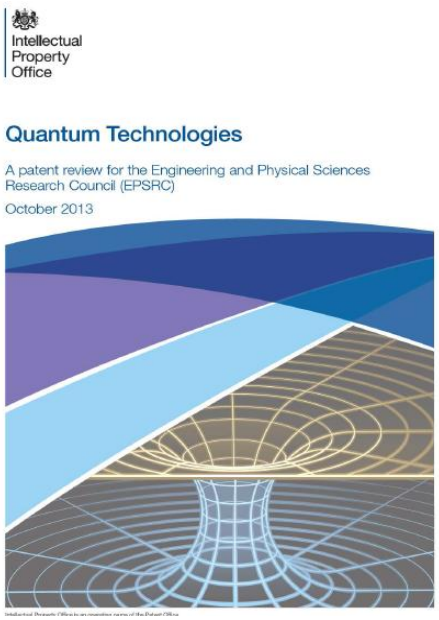
right social and regulatory context, maximizing benefit through international engagement (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/470243/InnovateUK_QuantumTech_CO004_final.pdf).

Patenting activity in the field of Quantum Technologies

A "Guide to Intellectual Property Rights (IPRs) and Patents" has been prepared by the CCQCN project and can be downloaded from http://qcn.physics.uoc.gr.



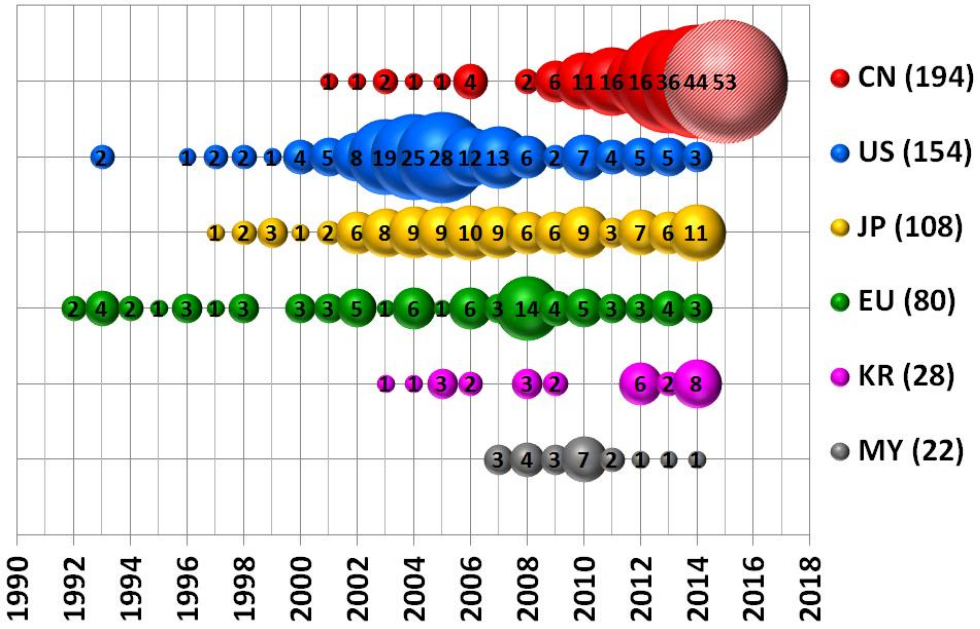
To better focus on the field of quantum technologies, and investigate the patenting trends via the temporal evolution of patenting activity in the main areas in the field, an aspiring researcher should consult the report was prepared by the UK Intellectual Property Office Patent Informatics Team (2013), which analyses the worldwide patent landscapes in the areas of quantum secure communications, quantum metrology and sensors, quantum simulators and quantum computing.



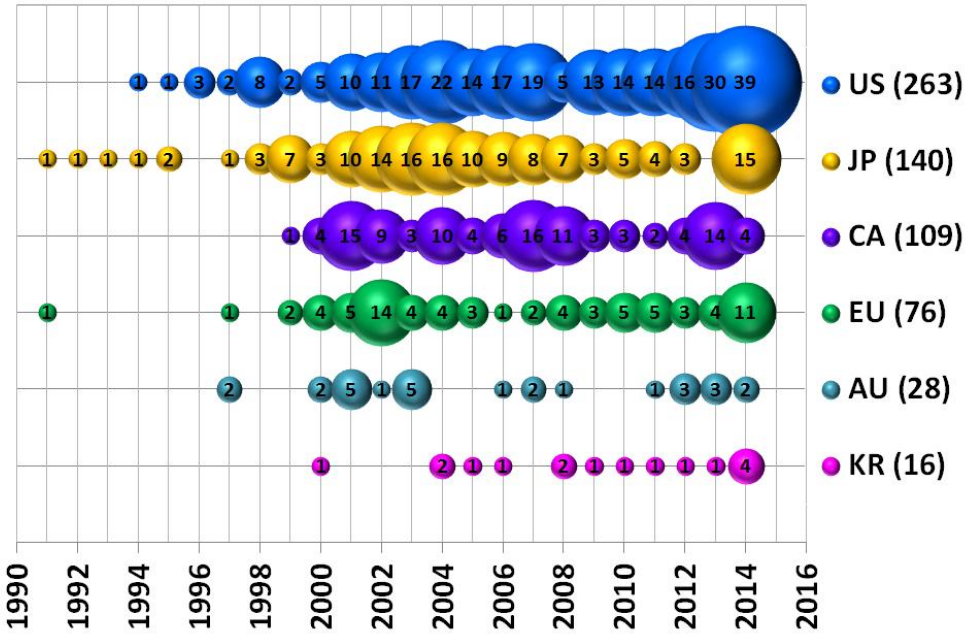
The document is downloadable from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/312693/informatics-quantum.pdf.

Such a worldwide patenting activity helps highlighting global (and regional) trends in the field.

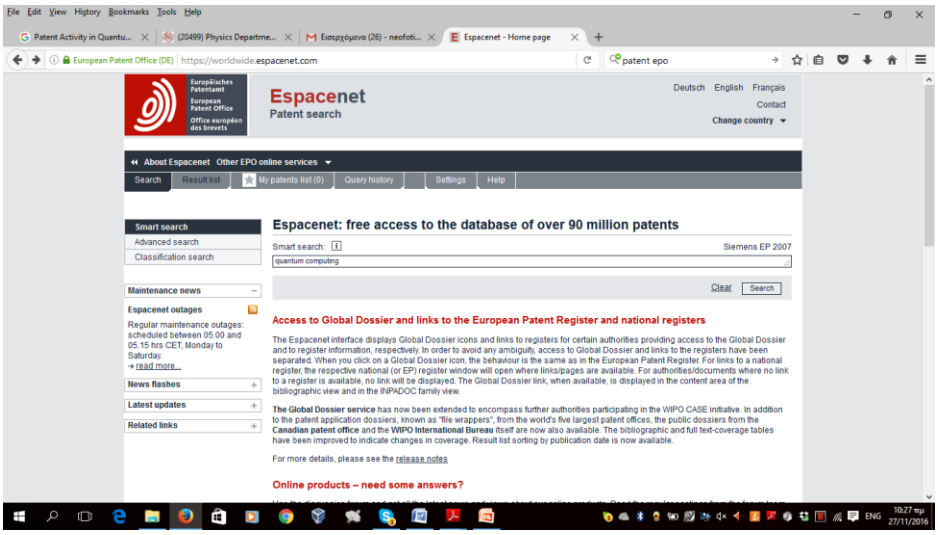
For example, as presented in the Berlin workshop on Quantum Technologies (November 2016) by C. Ferigato, A. M. Lewis, and M. Travagnin (of the JRC) ["Patenting trends in selected Quantum Technologies, with a view on policy implications"], patent activity is in the ~ hundreds range (Quantum Key Distribution ~600, Quantum Computers ~600 [CPC G06N99/002], Sensing: Photon Entanglement~50, Atomic Interferometry ~50), with the quantum key distribution (QKD) patenting activity appearing (in time and "space" [top 6 countries/regions]) as:



and the quantum computing patenting activity appearing (in time and "space" [top 6 countries/regions]) as:



A patent search can be achieved via European Patent Office's (EPO) Espacenet service (https://worldwide.espacenet.com/)



or via the US Patent and Trademark Office (https://www.uspto.gov/)

or via other, related, services.

SOURCE:

GUIDE to Innovation Exploitation

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