The quantum hype in the scientific sphere: expectations of the future of quantum technology in peer-reviewed literature

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ORIGINAL PAPER

The Quantum Hype in the Scientific Sphere: Expectations of the Future of Quantum Technology in Peer-Reviewed Literature

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Abstract
The increasing medialisation of science introduces media logic into the scientific sphere, encouraging communication strategies to capture attention. In emerging technologies, such practices have been linked to hype. To clarify this phenomenon, we draw on Science and Technology Studies (STS), particularly the concept of expectation, which is central to the communication of emerging technologies. Quantum technology is a suitable case because, despite uncertain impacts, growing attention suggests ongoing hype. We conducted a qualitative content analysis of highly cited papers regarding quantum technologies (2007–2023) to examine how expectations are articulated. Our findings suggest two dominant modes: use case and future projection. The use case frames quantum technology as a solution to (societal) problems, while future projections articulate versions of the future in which quantum technology is mature and adopted, along with the anticipated pathways. We argue that using STS concepts enriches the understanding of medialisation, highlighting the heterogeneity of the scientific sphere. Use cases appear to also be used by scientists further from the core quantum science community. While more distant communities seem not to engage with the development agenda, communities closer to quantum science appear to engage with and shape it by expressing their future projections.

Keywords Hype · Quantum · Expectation · Medialisation

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1 Introduction

As early as 2003, scientists were already imagining the second quantum revolution that will happen if quantum phenomena, such as entanglement and superposition, are used as a base to build technology (Dowling & Milburn, 2003). This technology is now referred to as quantum technology. As an emerging field, quantum technology is accompanied by high expectations regarding its potential societal impact once it matures (de Wolf, 2017; Vermaas, 2017; Gercek & Seskir, 2024). As with other emerging technologies, these expectations can circulate beyond the scientific sphere and elevate anticipation, at times, generating hype (Konrad & Alvial Palavicino, 2017).

In the Science Communication literature, it has been argued that hype is shaped to the practice in the contemporary scientific context (Caulfield & Condit, 2012). In today's research environment, there is increasing pressure to demonstrate the societal relevance of scientific activity. At the same time, the paradigm of science communication is shifting. Science should not only transmit information to the public, but also engage with the public, creating two-way communication between the scientist and society (Schmid-Petri & Bürger, 2019). In this context, scientists may actively participate in public discourse, sometimes contributing to the amplification of benefits and the downplaying of risks.

In the Science and Technology Studies literature, hyping is also regarded as intrinsic to the development of science and technology (Rip, 2006). Communicating expectations about a technology's future state not only conveys its feasibility but also its desirability (Konrad et al., 2016). These expectations are performative in the sense that they attract the attention of both the actors and the resources needed to develop the technology (Van Lente & Rip, 1998).

This paper investigates how expectations surrounding quantum technology are articulated within the scientific sphere. We suspect that scientific publications function not only as a medium to report results and progress, but also as a platform to communicate scientists' expectations of quantum technology (Alvial-Palavicino & Konrad, 2019). Furthermore, the expectations that originate in the scientific sphere can spread into other spheres within society, such as the market, policy and the media (Caulfield & Condit, 2012; Konrad & Alvial Palavicino, 2017). In the next subsection, we discuss the relevant development from both strands, namely Science Communication (SC) and Science and Technology Studies (STS).

1.1 Hype in Science Communication (SC) Literature

Within Science Communication (SC) literature, the deficit model is one of the dominant models used to analyse science communication activity (Schmid-Petri & Bürger, 2019). This model operates on the assumption that the lack of public support for policies involving science is due to public ignorance (Simis et al., 2016). In the deficit model, scientists are assumed to have the necessary scientific knowledge to assess a technology while the public lacks that knowledge. The scientists then have to transmit their knowledge, while the public has to digest it. In other words, it is a one-way communication from the scientific sphere to the public.

The deficit model has also been subject to substantial criticism within the literature. A linear communication process from the scientist to the public is deemed too simplistic to capture the complexities in communication practice (Simis et al., 2016; Schmid-Petri & Bürger, 2019). Scientists and the public are not the only actors involved in the scientific communication process. Scientific institutions, journalists, and news outlets are examples of other actors involved (Caulfield & Condit, 2012). Moreover, due to the digitalisation of the media, it has become easier to engage in two-way communication, not only from scientists to the public but also from the public to scientists (Schmid-Petri & Bürger, 2019). Due to the changing landscape, science communication scholars have developed a new model in which two-way communication, or dialogue, has become central: the public engagement model (Schäfer, 2009).

In the public engagement model, the importance of interaction between science and society is emphasised (Schmid-Petri & Bürger, 2019). This gives rise to a new way of science communication, such as public discussions, stakeholder conferences, and science shops (Schäfer, 2009). In those media, more direct communication between the public and scientists is enabled. To foster such engagement, scientific information is deliberately framed in a way that is relatable to the public. Compared to the deficit model, this public engagement model brings the scientific and public spheres closer together.

Science, media, and the public sphere are also brought together by the adaptation of digital media in science communication. This convergence is captured by the concept of the 'medialisation'[1] of science, as discussed by Bucher and Weingart (Weingart, 2012, 2022; Bucher, 2019). Medialisation refers to the increasing influence of media logic on scientific communication, driven by the need to attract public attention and to foster engagement. As a result, scientific communication has begun to adopt characteristics traditionally associated with mass media, aimed at reaching and resonating with broad audiences. For example, universities are investing more in public relations activities so that their press releases and press conferences align more closely with media expectations (Maeseele, 2013). Not only universities but also scientific journals such as Nature have a separate section called 'News' that seems to target the broader public as its audience (Nature News & Comment, n.d.). This practice of presenting scientific information in a simplified and engaging way is not confined to the Western scientific sphere. Chinese scientific journals maintain social media accounts that serve as a direct channel of dissemination to the public (Cong et al., 2026). Additionally, the members of the public can engage by liking or leaving comments.

Because of this shift, the distinction between scientific communication (such as scientific journals) and the mass media (such as newspapers) has become blurred. Franzen (2012) argued that the top scientific journals have not only scientific rigour as a criterion for publication but also a need for public attention. She further suggests

[1] Medialisation as a concept has appeared in different forms: mediasation, medialisation and mediatisation (Väliverronen, 2021). In this study, we used 'medialisation' that used by Weingart to describe the changing context in science communication since the introduction of new media (Weingart, 1998).

that the need to attract attention encourages scientists to exaggerate their research results.

Similar to the discussion above, Caulfield and Condit (2012) suggested that multiple factors within the contemporary scientific system foster hype and exaggerate the benefits of research while understating the risks. Increasing pressure to publish and commercialise is among those factors. This changing condition encourages scientists to hype their research to communicate their expectations along with their results. Hyland and Jiang (2021) suggested that hyping research results is done to get the attention not only of the lay public but also of external funders and commercial sponsors. Previous studies also indicate that scientists are actively involved in hyping and see it as a strategy to gain professional advantage (Soto-Sanfiel et al., 2025).

The literature also shines light on how scientists hype their research results, for example by the use of promotional language in the scientific publication (Cummings & Rivara, 2012; Millar et al., 2022). Other work (Sumner et al., 2014; Bossema et al., 2019) traced the propagation of hype to the media sphere. However, the question of what is being hyped is less clear. To try to provide more clarity on this, let us turn to the Science and Technology Studies literature.

1.2 Hype in Science and Technology Studies (STS) Literature

Within the Science and Technology Studies (STS) literature, hyping or seeking attention and engagement is seen as a part of the development of science and technology (Rip, 2006), especially when the technology of interest is in the emerging phase. Emerging technology is of interest because, on the one hand, it has advanced such that actors in the field are beginning to associate significant impacts with it. On the other hand, unlike mature technology, uncertainty and ambiguity still loom over both its development trajectory and its expected impact (Rotolo et al., 2015). Previous research suggested that this in-between phase is when hype can occur (van Lente et al., 2013).

In the literature, hype is often studied through the lens of expectation (Borup et al., 2006). Expectation can be defined as ‘statements about a future condition or development that imply assumptions about how likely these are supposed to be and that travel in a community and public space’ (Konrad et al., 2016, p. 466). In the context of emerging technology, expectation is rarely neutral as a whole. It is usually implicitly, if not explicitly, optimistic or pessimistic. Optimistic in the sense that it contains potential benefits that invite actions to realise those potentials (van Lente, 2016). Pessimism is the opposite; it warns us about potential negative impacts and invites action to avoid them.

In the context of emerging technology development, expectations have performative power that can attract new innovation actors, legitimise resource allocation, and provide structure to societal debate around emerging technology, which can result in hype (Konrad & Alvial Palavicino, 2017). A seemingly open-ended expectation from a particular scientific field can be adopted by scientists in adjacent fields, possibly becoming an umbrella term that can also be picked up by people in the policy and business spheres (Rip & Voß, 2013).

However, as van Lente and Rip argued, an expression of expectation does not automatically translate to hype (Van Lente & Rip, 1998). Previous research has indicated that the environment and conditions in which expectations are shared, shape the hype (van Lente et al., 2013). They argued that hype flourishes in an environment in which various societal actors, such as research, business, and policy, can engage with and shape the expectation. Furthermore, Konrad and Alvial Palavicino argued that the emergence of hype is not inevitable but results from diverse strategies deployed by innovation actors, interlinking the scientific, media, business, and policy spheres in thesociety (Konrad & Alvial Palavicino, 2017).

Although communicating expectation does not necessarily translate into hype, expectation remains a useful lens for analysing hype, as it puts the desired future into focus. Van Lente and others have used the concept of expectations to analyse the hype cycle across three different technologies (van Lente et al., 2013). They used the concept of expectation to analyse the forward-looking statements about these technologies in the mass media and scientific journals. They further divided expectations into ‘generalised expectations’ and ‘project-specific expectations’ (van Lente et al., 2013, tbl. 3). Generalised expectations refer to the expectations of a general feature of the technology supported. These kinds of expectations are usually expressed in terms of the technology’s potential use cases or applications and include the possible impact on society. ‘Project-specific expectations’ refers to the expectation in a smaller, thus more specific scope. These project-specific expectations refer to expected hardware developments that support the attainment of the general expectation.

Using this concept of expectation, we strengthen our question in the previous section on what is being hyped. In the context of emerging technology, expectations about the use or application of technologies are often subject to hype, often accompanied by the potential impact, positive or negative, on society. This general expectation gives rise to the smaller project-specific expectations that describe the expected development progress.

1.3 Hype in Quantum Technology, What is it About?

Following the discussion of two strands of literature above, we conceptualise hype as more than an exaggeration of scientific results. Our working definition of hype rests on three strands of STS literature. Firstly, Dedehayir and Steinert (2016) suggested that an increasing number of scientific articles on a topic is one indicator of an ongoing hype. Secondly, hype can not only connect and mediate one scientific field to others, but also the scientific sphere and other spheres in society, for example, policy and business (Rip & Voß, 2013; Konrad & Alvial Palavicino, 2017). Thirdly, we follow Van Lente and Rip (1998), who suggest that hype can build agendas that scientists and other innovation actors can follow.

Quantum technology is a class of technologies that use quantum-mechanical phenomena such as superposition and entanglement (Dowling & Milburn, 2003). Scholars expect that quantum technology will impact society once it matures (de Wolf, 2017; Vermaas, 2017; Gercek & Seskir, 2024). Based on our working definition above, we suspect that there is an ongoing hype around quantum technology. First, in a bibliometric study, Seskir and Aydinoglu (2021) indicate that the number of published scientific articles per year is increasing. Second, previous research suggests that expectations of quantum technology have spread to other spheres of society. In the policy sphere, previous studies suggested that countries are beginning to govern quantum technology development under the pretext that it will help to secure technological leadership and economic prosperity (Atladóttir et al., 2025; Pöhlmann et al., 2025). Third, we see the EU's Quantum Flagship program as an example of an agenda driven by hype in the field (European Committee, 2016). Furthermore, AWO observes that such an agenda to support research and development has also been created in countries in the global south (AWO, 2024).

The development of hype aligns with the Science Communication literature discussed in Sect. 1.1, which suggests that, due to the increasing need to engage with society, scientists may be encouraged to hype their research. In Sect. 1.2, we argued that we can use the concept of expectation to clarify what is being hyped. In this research, we follow Franzen, who suggests analysing the medialisation at the core of the scientific sphere, namely scientific publication (Franzen, 2012). Our goal is to identify the expectations that scientists communicate through peer-reviewed scientific publications.

2 Methodology

To identify the expectations that scientists communicate in quantum science and technology research, we conducted a qualitative research methodology of highly cited peer-reviewed scientific articles. We chose to focus on the most cited articles per year because they are likely to reflect the state of the art of the domain and expectations that are shared by other scientists in the field.

2.1 Data Collection

In this study, we collected peer-reviewed scientific articles through the Web of Science (WoS) Core Collection database. The overall process of data collection is shown in Fig. 1. We started the data collection process with a familiarisation with the source to obtain a deeper understanding of terms that are used in publications about quantum technology. After several rounds of assessment, our query is 'quantum technolog*' or 'quantum computing' or 'quantum sensing' or 'quantum communication' or 'Quantum Metrology' or 'Quantum Simulation' or 'quantum cryptography'.

Since WoS does not index the full article, we focused on the expectations the authors mention in their abstract, assuming these expectations would be discussed in the full article. Previous research has noted that certain words signify the need for emerging technology (van Lente, 2016). For our purpose of eliciting the expectation, we found that some words such as 'application' and 'use' can be used as a signifier of future use cases being discussed. Finally, we added these signifier word so that our search query became 'quantum technolog*' or 'quantum computing' or 'quantum sensing' or 'quantum communication' or 'Quantum Metrology' or 'Quantum Simulation' or 'quantum cryptography' and 'Application$' or 'Use*' or 'Usage' or 'Implement*'.

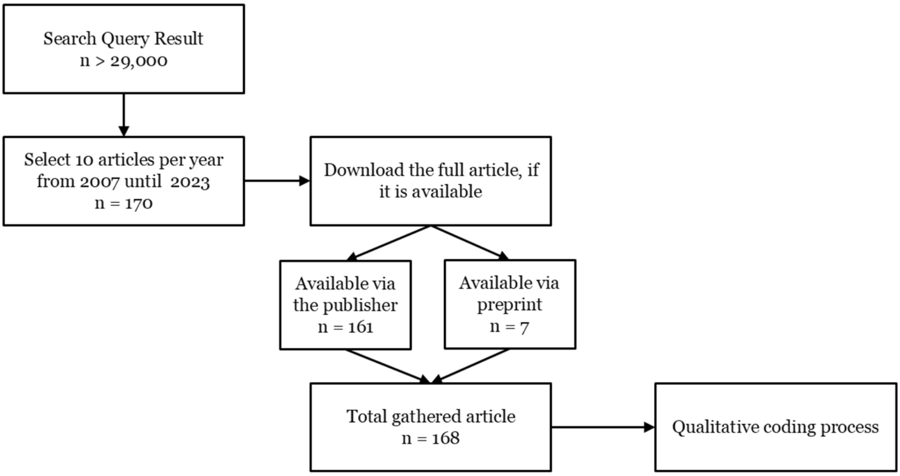

Fig. 1 Article selection diagram leading to the qualitative coding process

Finally, we used our final search query to search the WoS Core Collection database from 2007 to 2023. For each year, we selected the top 10 cited articles for further analysis. We downloaded the full articles via the publisher if available. If this was not possible, we consulted the pre-print version. This selection of top-cited articles is both deliberate and pragmatic, in that highly cited papers are more influential in directing and shaping research than implied by their citation counts (Teplitskiy et al., 2022). Through our sampling strategy, we can capture the variety of research discourses regarding quantum science and technology. In the end, the total number of articles used as the source for the qualitative analysis was 168 (list available in the Appendix).

We used the WoS database because it is a widely used, highly curated bibliographic database for publication analysis (Harzing & Alakangas, 2016) and our institution provides access. WoS is known to be biased as journals from the Global South and non-English publications are underrepresented (Asubiaro et al., 2024). However, this bias is unlikely to affect our findings since the highly cited publications tend to be in English (Ammon, 2007; Pradier et al., 2026).

2.2 Data Analysis

We analysed the selected peer-reviewed articles using a two-step iterative qualitative content analysis method assisted by Atlas Ti 24 (Skjott Linneberg & Korsgaard, 2019). We started with open coding, keeping the research questions in mind. We only focused on the segment of the article that is relevant to answering our research question, the quotation. We coded each of these quotations. We tried to keep the name of the codes relatively close to the language that the authors themselves used in their articles to capture the variety of the expectations. Secondly, we performed axial coding to group the seemingly related codes under subcategories and categories. Thirdly, we applied selective coding to select codes, subcategories, and categories that are relevant to answer the research question. Additionally, we also use the occurrence frequency of the code to guide our analysis (Nicmanis, 2024). The above analysis process resulted in a coding scheme which was then further tested with a second coder who coded 10% of the quotations. Disagreement leads to further discussion and refinement of the coding scheme. After two rounds of testing and refinement, an agreement of 75% between the coders was reached.

3 Findings

The final data set consisted of 84 original research articles and 84 review articles. The general structure of the final coding scheme is given in Table 1. At the highest level it has three categories: ‘Quantum Technology Sub-Type’, ‘use cases’, and ‘Future Projection’. The first category, ‘Quantum Technology Sub-Type’, captures the kind of quantum technology discussed and described in the coded article.

The latter two categories capture the kinds of expectations communicated in the article. The ‘Use case’ category captures expectations that take the form of possible applications or use cases in the future. The notion of ‘Use case’ also captures the implicit intention to pose quantum technology as a solution to society’s problems. Interestingly, the problems that quantum technology is expected to solve are not only contemporary problems, but also potential problems that assumed to emerge in the future.

The last category of ‘Future projection’ captures the instances in which the author sketches their version of the (near) future of quantum technologies—specifically, what developments they are expecting and in what form quantum technologies are expected to become established. In the following subsection, we will discuss our findings per category.

3.1 Use Case

The code ‘Use case’ is applied when the coded text involves authors’ expectations in terms of possible use cases in the future. These use cases are related to the general notion that quantum technology can potentially solve society’s problems. The most

Table 1 The coding scheme showing only the two highest levels, categories and subcategories (the full coding scheme is included in the Appendix)

Categories – Subcategories	Frequency
• Future projection	205
• Future projection - goal	171
• Future projection - milestone	99
• Use case	152
• Use case - not specific	86
• Use case - rather specific	53
• Use case - specific	13
• QT subcategory	272
• Quantum communication	60
• Quantum computing	164
• Quantum information processing	59
• Quantum sensing	29

frequent subcategory within this category is the ‘use case - not specific’, which captures the vagueness regarding the possible use case of quantum technology. The most frequent code is ‘faster computation in certain tasks’, which refers to the potential for quantum computers to outperform classical computers in specific tasks. However, they often seem to avoid detailing what these specific tasks are. We can infer that this vagueness stems from the belief that the use case where quantum computers outperform classical ones is still far in the future. For example, in a review article published in the journal *Nature Photonics*, the authors make this connection between vagueness and the distant future explicit by stating:

> Perhaps the most profound (and distant) anticipated future technology is the quantum computer, which promises exponentially faster operation for particular tasks such as factorizing, searching databases and simulating important quantum systems. [Document 28]

The least frequent subcategory is the ‘specific use case’, accounting for less than one-tenth of the total quotation in the ‘use case’ category in this subcategory, the authors are very specific when discussing a possible future use case. This might be related to the topic of the journal in which the article is published. For instance, in the journal of *International Journal of Molecular Science*, a group of researchers from South Africa published a review article that discusses a very specific use case of quantum computing in the drug discovery process. Towards the end of the article, they state that they expect that:

> In future the use of quantum computing, computational software and databases in modelling molecular interactions and predicting features and parameters needed for drug development, such as pharmacokinetic and pharmacodynamics, will result in few false positive leads in drug development. [Document 112]

As the quotation above indicates, the authors use specialised terms, such as ‘pharmacokinetic’ and ‘pharmacodynamics’, suggesting that their expectation is very specific. It is also worth considering that this scientific journal mainly publishes articles on the topic of molecular research in chemistry, so these authors focus on this specific field in their efforts to resonate and engage with the journal’s audience, which is beyond quantum scientists.

After discussion among the coders, we decided to add the ‘rather specific’ subcategory to capture the granularity of our dataset. The most frequent code in this rather specific subcategory is ‘quantum chemistry’. It is implicit in the quotes coded under this subcategory that quantum chemistry is one of the particular tasks at which quantum computers might excel. For example, in a publication in the *Reviews of Modern Physics* journal, a group of researchers wrote: ‘One of the most promising suggested applications of quantum computing is solving classically intractable chemistry problems’ [Document 132]. This example illustrates a more specific use case than a general assertion that quantum computers outperform classical computers. However, it is less specific than the use case in drug discovery. Based on this, we place it under the rather specific subgroup.

In this 'use case' category, it is central that quantum technology is depicted as a solution to problems. One can perhaps use Hughes' lens of large technological system as scientists put a selected set of problems in the foreground (Hughes, 2012). Looking through this lens, on the one hand, the expected use cases are socially constructed, as scientists expect that problems in their field would be solved by quantum technology. On the other hand, these use cases also shaped society by putting a specific problem at the centre of public discourse while pushing other issues out of focus. As these expectations are picked up by the media and engaged by the public, it is important for scientists to be reflexive of their expected use case, as the public might have a different stance towards quantum technology and therefore different expectations (Roberson, 2020).

3.2 Future Projection

The second category that emerges from this dataset is 'future projection'. This category is related to the envisioned future state of quantum technology as discussed by the authors. We divided 'future projection' into two subcategories: 'goal' and 'milestone'. This categorisation reflects that scientists report not only on the expected end goal of quantum technology development but also on smaller intermediate goals. The origin of this division can be traced back to a disagreement within the coding team, which seems to indicate that there are two kinds of future.

The most frequent subcategory is 'goal'. This subcategory captures instances where the authors discuss what they perceive as the overarching goal of research in quantum technology. This 'goal' can be interpreted as the future entrenched state of quantum technology that the authors find desirable and plausible. The most frequent code within this subcategory is the 'realisation of a quantum computer'. As the name suggests, this code captures the authors' expectation that quantum computers can be built in the future. In articulating this expectation, the authors framed it as a shared expectation among fellow researchers. For example, a group of researchers from five different research institutes around the world wrote in a review article in the *Physics Reports* journal:

> Researchers expect that quantum sampling with a 7 × 7 lattice of superconducting qubits can become the first example of quantum supremacy (a quantum computation surpassing a conventional computer), perhaps as early as 2017. [Document 100]

Another code within the 'goal' subcategory is related to the integration of quantum computers with existing classical computers, 'combining classical and quantum computers'. As the name suggests, the desirable future involves combining quantum computers with classical computers. As discussed in the previous subsection, quantum computers are expected to excel only in specific tasks. In other words, quantum computers are expected to complement classical computers. For instance, a group of scientists, writing a review article on quantum chemistry in *Chemical Reviews*, suggest that integrating classical and quantum computation is key to advancing the field. They suggest that:

> We will describe how quantum computing methods can be used to replace or augment classical quantum chemistry methods and survey an array of state-of-the-art quantum computing techniques that may, one day, become as commonplace as density functional theory. [Document 122]

Similar to the previous section, it is worth noting that *Chemical Reviews* mainly publishes reviews related to chemistry. This again indicates the authors' effort to resonate with and engage scientists beyond quantum science. This intention to bring the two seemingly separate quantum science and chemistry fields even made explicit by the authors, who aim 'to be pedagogical to scientists from each background to bridge this gap and stimulate new developments' [Document 122]. This invitation to engage and contribute to the development process to reach the goal contrasts with our findings in the previous section, which suggest that scientists outside quantum science are perceived not only as users but also as developers.

The second subcategory that emerges is 'milestone'. This subcategory captures instances where the authors discuss the next steps required to reach the goals discussed in the previous paragraph. One frequent code in this subcategory is 'scalable quantum hardware'. Although not all the quotations we found explicitly mention the goals, some do. For example, a review article published in *Reports on Progress in Physics* discusses in the introduction both the goal and the way to achieve it. The author perceives that the goal of the field is:

> … to achieve the long-term goals of useful quantum computing. To this end, investigations of quantum device physics have been essential for the present efforts to scale up multi-qubit platforms. [Document 109]

Moreover, from the quote above we can infer that the author perceives that the future goal (in this example, the realisation of useful quantum computing) legitimises present action (in this example, efforts to scale up quantum hardware). This finding is in line with what Beckert argues, namely that 'images of the future … shape present decisions' (Beckert, 2013, p. 221).

3.3 Quantum Technology Sub-Type

In this section, we will further elaborate on the evolution of terms used by scientists to refer to quantum technology. Recent publications have generally divided quantum technologies into three subcategories: quantum computing, quantum communication, and quantum sensing (de Touzalin et al., 2016; European Commission, 2016; Rathenau Instituut, 2023). These three subcategories serve as the starting point for our analysis.

During our analysis, we found another term that scientists used in their publications, namely 'quantum information processing'. Table 2 contains the final coding scheme for this category along with the associated frequency. Notably, quotations within this category may be assigned multiple codes, reflecting the interdisciplinary nature of the field and the porousness of the demarcation of the subtype.

Table 2 Quantum technology subtype coding scheme

Code	Frequency
• QT sub-type	272
• Quantum communication	60
• Quantum computing	164
• Quantum information processing	59
• Quantum sensing	29

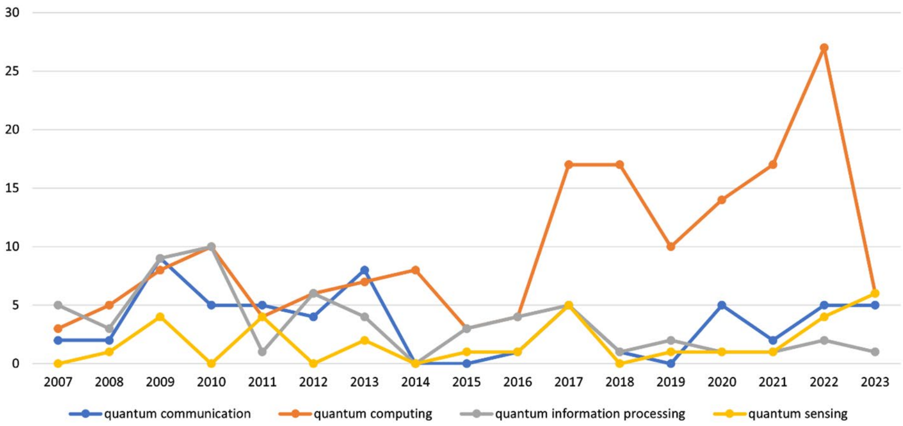

Fig. 2 Quantum technology sub-type trend per year from 2007 until 2023

Our findings indicate that quantum computing is the most frequently referenced subcategory, accounting for more than half of the quotations coded. This suggests that quantum computing currently garners the greatest attention. Figure 2 below captures the frequency of the codes per year. It is noticeable that the code about quantum computing is found more common in the latter years (2016 and later). Somewhat less noticeable but also interesting is that the code about quantum information processing is less commonly found in the latter years compared to the former years (2016 and earlier).

3.3.1 Quantum Computing

We applied the quantum computing code to quotations that explicitly reference quantum computers, quantum simulators, or other related terms, including analogue quantum computers, hybrid quantum computers, and NISQ (noisy intermediate-scale quantum) computers. Additionally, quotations discussing quantum algorithms were also coded with 'quantum computing', given their intrinsic connection to the development and operation of quantum computational systems.

As we touch upon above, quantum computing arguably attracts the most attention. In Fig. 3, we can see that the 'quantum computing' and the 'faster computation in certain tasks' codes co-occur relatively more than the other pairings. This is consistent with the widely held expectation that quantum computers will outperform classical computers in specific computational tasks. A group of Austrian and American scientists started their review article in 2008 in *Physics Reports* by stating: 'Quantum

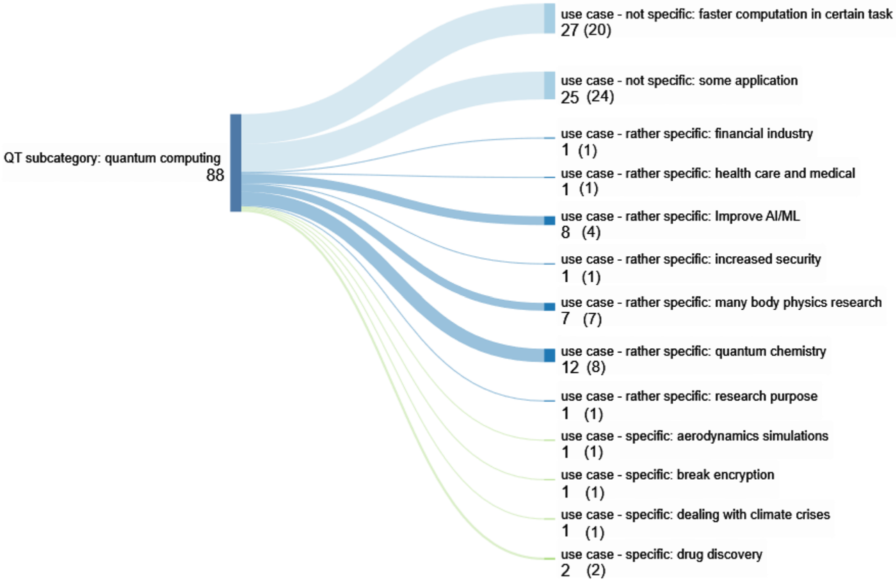

Fig. 3 Co-occurrence of 'quantum computing' and 'use case'. The numbers outside parentheses indicate the number of associated quotes. The numbers inside parentheses indicate the number of associated articles

computers hold the promise of solving certain computational tasks much more efficiently than classical computers.' [Document 17]. Given the nature of review articles and the directness of this statement, it is plausible that such expectations were already circulating within the scientific community prior to 2008. It is also worth noting that the corresponding author of this review is affiliated with an institute specialising in quantum optics and quantum information in Austria. This affiliation suggests that the expectation surrounding quantum computing was already well-established within research circles closely related to quantum science.

Our analysis suggests that in the latter years, this kind of expectation further propagated and spread to other research fields. For example, in 2023, a group of scientists from India, Vietnam, Australia, and Lebanon wrote an article in *IEEE Access* about various enabling technologies in the healthcare sector. Notably, they included a chapter titled 'quantum computing', which they perceive as one of the enabling technologies. They expect that: 'Quantum computing is capable of tackling various computational tasks. Quantum computing helps in making critical decisions significantly quicker than classical computing'. [Document 160]. *IEEE Access* is an electrical engineering journal which leans towards publishing more application-oriented articles. Furthermore, the reported article lists two corresponding authors whose research backgrounds are in computer systems and machine learning—fields that are relatively distant from core quantum science. In contrast to the 2008 review article discussed earlier, the expertise of the author of the *IEEE Access* article seems to be more distant from quantum science.

When the expectations reach different research fields, they also evolve accordingly to fit within the context of those fields. For example, in Fig. 3, it can be seen that there are more specific use cases associated with quantum computing, such as the code ‘rather specific – improve AI/ML’. In 2022, a group of mostly computer scientists from all over the world published a review article in the *Internet of Things* journal about the use of AI (Artificial Intelligence) in the next generation of computing. They dedicated a section to their expectations of quantum computing with regard to the development of AI. The authors opened this section with:

> Quantum computing promise is to be the one technology that has the potential to fundamentally alter AI. … With the enormous influence AI is having, all across the world, the combination with Quantum computing may have a multiplier effect to trigger a revolutionary effect on AI. [Document 153].

We can infer from this quotation that these computer scientists have the general expectation that quantum computers excel at certain problems and contextualise it to their research field, in this case AI.

In short, we infer that not only are the expectations about quantum computing more frequent in the latter years, but also that they propagate and evolve even within the scientific sphere. Expectations that originate from quantum physicists also reach other research fields, where they are aimed more towards applications, as indicated by the presence of quantum computing expectations in journals with electrical engineers and computer scientists as the main audience.

3.3.2 Quantum Communication

We applied the ‘quantum communication’ code if a quotation is about quantum communication, including quantum networks and communication as well as quantum cryptography (Wehner et al., 2018). As depicted in Fig. 2, we do not observe any significant increase in frequency of the code as compared with ‘quantum computing’. Rather, the frequency of quantum communication fluctuates through 2007–2023.

As shown in Fig. 4, we do observe that the expected use cases of quantum communication revolve around security problems, which we coded with ‘increased security’, ‘secure communication’, and ‘enable QKD’. This security-themed expectation can also be found in a review article written by Wehner et al. In that article, they expressed the expectation that a simple quantum communication between two quantum machines will be broadened in scope, becoming quantum networks that connect many machines. They called this quantum internet (Wehner et al., 2018).

In the coding scheme, we decided to stay close to the data and made a differentiation between ‘increased security’ and ‘secure communication’. We used ‘increased security’ when the quotation literally reads that quantum communication is more secure than the classical communication. In this context, classical communication refers to the digital communication that serves as the foundation of today’s internet. For example, in a multi-author roadmap article published in *Journal of Physics: Photonics*, two scientists contributed a dedicated chapter on quantum cryptography. They open their contribution with ‘Quantum cryptography encompasses primitives

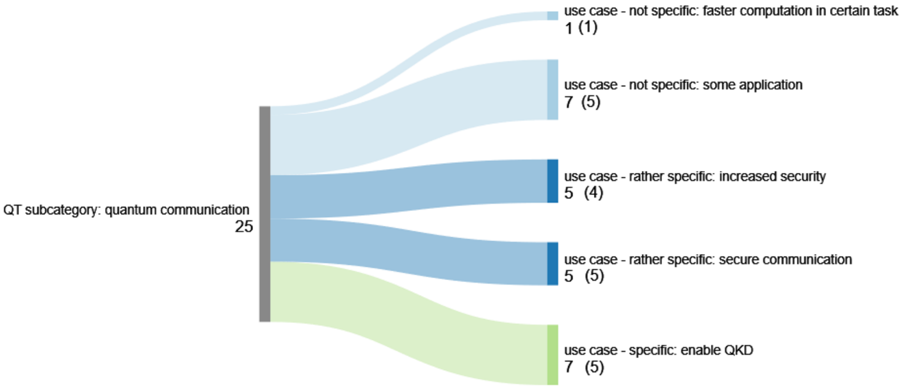

Fig. 4 Co-occurrence of ‘quantum communication’ and ‘use case’ codes. The numbers outside parentheses indicate the number of associated quotes. The numbers inside parentheses indicate the number of associated articles

that use the properties of quantum mechanics to offer new cryptographic services or provide security advantages with respect to their classical counterparts.’ [Document 154]. In this quotation, the authors communicated their expectations of more secure quantum communication by comparing it to classical communication.

In contrast, the ‘secure communication’ code is used when the quotation does not make an explicit comparison between quantum communication and classical communication. It is expected that quantum communication will provide an unconditionally secure means of communication which cannot be tampered with or eavesdropped on by a malicious party. This expectation of unconditionality is conveyed by three Chinese scientists writing in *Science Bulletin* in 2021. They open their article by writing: ‘Quantum communication can ensure the unconditional security of communication’ [Document 152].

However, while the ‘secure communication’ code does not explicitly include a comparison, we can interpret it as making implicit comparisons to today’s classical communication. By conveying that quantum communication is theoretically secure communication, it implies that in theory, classical communication is not secure. This could infer that both codes are similar in stating that quantum communication is more secure than its classical counterpart. Through this notion of more secure, it also implies the desirability to have more secure communication that is enabled by quantum communication.

The third code on security is ‘enable QKD’. Quantum Key Distribution (QKD) is a protocol in which a quantum channel is used to exchange a secret key. This secret key is then used to encode a classical communication channel. In the same vein with the above two codes, it is expected that due to the use of the quantum channel, it will provide more secure communication. The difference is the specificity of the expectation. In the above, it is not specified in which application it would bring more secure communication. By contrast, in the ‘enable QKD’ code it is quite specific that QKD is the use case that will provide improved security.

Compared to the previous section on quantum computing, it seems that the expectations of quantum communication are not meaningfully engaged by scientists beyond quantum science. For example, we found a quantum communication expectation in *IEEE Access* that reviews the healthcare sector, quantum communication—specifically QKD—is only mentioned in passing in a section dedicated to security. In a discussion about providing the best security for patient data, the authors expect that '… quantum key distribution is a promising solution ensuring security by design mechanisms …' [Document 160]. In contrast, the same article dedicates a separate chapter to quantum computing.

Therefore, The expectations for quantum communication seem to circulate within the quantum science community. Furthermore, they appear to subscribe to the expectation that quantum communication will be realised in the future. We deduced this through the quotations in which quantum communication and goal codes co-occur, see Fig. 5. The two codes within the 'goal' subcategory are 'realisation of quantum technologies' and 'realisation of quantum network'. In this co-occurrence context, the former code captures the instances in which the authors perceive that building quantum communication devices is part of a bigger goal to build a working quantum technology, while the latter code refers to the quotations in which building a quantum network is a stand-alone goal. More importantly, both codes seem to indicate that the expectation to have a worldwide quantum network in the future is circulating in the scientific sphere. In an article published in *Nature*, a group of scientists reported their experiment of demonstrating information transfer using quantum communication that combines ground-to-ground and space-to-ground connections chose to end their article by expressing their expectation that 'a global quantum network can be realised by connecting more national quantum networks from different countries via ground connections or ground-to-satellite links.' [Document 146].

The latter subcategory 'milestone' includes codes related to intermediate goals supporting the main goal: realising a quantum network. All the codes in this subcategory are related to the development of quantum hardware needed to establish quantum communication. The scientists expect that a range of functional hardware

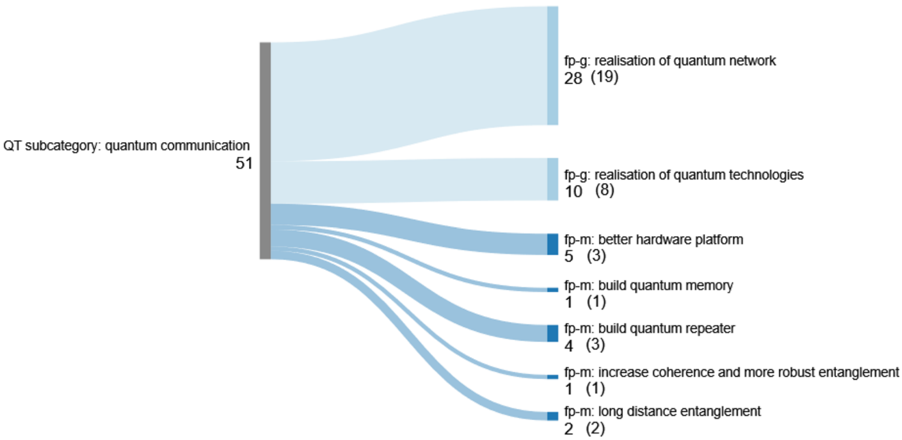

Fig. 5 Co-occurrence of 'quantum communication' and 'future projection' codes. fp-g is future projection - goal and fp-m is future projection milestone. The numbers outside parentheses indicate the number of associated quotes. The numbers inside parentheses indicate the number of associated articles

will be needed, captured by 'better hardware platform', 'build quantum memory', and 'build quantum repeater' codes. The scientists also expect that the performance of this hardware will become better over time, as captured by the other two codes.

In short, the expected use case for quantum communication centres on security. The expectation that quantum communication offers better security than today's classical communication makes it relevant to other research fields where security is an issue. Despite this relatability, the expectation is not as widely held as that of quantum computing, as our data does not indicate that this expectation travels beyond the journals traditionally associated with quantum science. Nevertheless, quantum scientists seem to subscribe to the expectation that a worldwide quantum network (or the 'quantum internet' (Wehner et al., 2018)) would be realisable in the future, legitimising their research effort.

3.3.3 Quantum Sensing

We applied the 'quantum sensing' code if a quotation is clearly about quantum sensing, including other related term such as quantum measurements and quantum metrology. We also coded implicit statements that suggest that the scientist applied quantum phenomena to achieve more accurate measurements. After all, the concept of quantum sensing boils down to the idea of using quantum techniques to perform measurements of physical quantities (Giovannetti et al., 2011; Degen et al., 2017).

Figure 2 shows that expectations about quantum sensing are not as common as the other quantum technologies: expectations of quantum sensing are least discussed in our data, while quantum sensing currently has a higher Technological Readiness Level (TRL) compared to the other subtypes (de Jong, 2025, p. 14). In our dataset, a research team published a review about quantum sensing in *Reviews of Modern Physics* that reflects this contradiction in their closing chapter by remarking that '… quantum sensing is an excitingly new and refreshing development advancing rapidly along the sidelines of mainstream quantum engineering research.' [Document 106]. We infer from this statement that quantum sensing is perceived to be a less hyped topic compared to the other quantum technology subtype.

Given the context that quantum sensing has a higher TRL compared to other quantum technologies, one might expect to find more specific use cases. However, from analysis, depicted in Fig. 6, it follows that expectations of quantum sensing are mostly categorised in the 'not specific' and 'rather specific' subcategory. Despite the lack of specificity of the use cases, the majority of the use cases are related to the expectation that quantum sensing will offer a superior measurement capability compared to today's sensor.

One type of sensor that is expected to gain in performance is a biomedical sensor used in the healthcare and medical setting. A group of scientists writing an article in *Nature Review Physics* to review the potentials of quantum sensing to improve biomedical sensors seem to be quite optimistic that there is 'a promising direction for a new generation of biomedical sensors with greatly enhanced performance that comes from advances in quantum science and technology.' [Document 167].

Optimism also coloured the scientists' expectations towards the broad adaptation of quantum sensing-based technology in the future. Projecting from the fact that

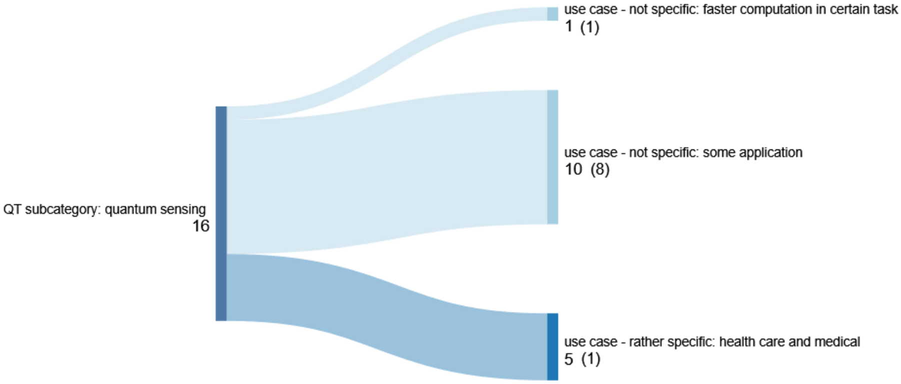

Fig. 6 Co-occurrence of 'quantum sensing' and 'use case' codes. The numbers outside bracket indicate the number of associated quotes. The number inside bracket indicates the number of associated articles

quantum-based sensors are already used in niche applications, scientists expect that the usage will be widespread. In the same review article, the scientists close their *Nature Review Physics* review article by writing: 'Taking the impact quantum magnetometers and atomic clocks had in their particular discipline, it can be expected that quantum sensors will penetrate much of the 21st century technology and find their way into both high-end and consumer devices' [Document 167].

However, given the seemingly versatile and optimistic expectations of quantum sensing which revolve around the aim to improve the current measurement capabilities of sensors used in various contexts, we did not find any instance in our data that this expectation is spreading beyond the circle of quantum physicists. This analysis indicates that, in contrast to the expectation of quantum computing and quantum communication, the expectations of quantum sensing might circulate mainly in the quantum scientist sphere. This again suggests that quantum sensing is less hyped than the other quantum technologies.

It seems that, quantum sensing's higher TRL than the other subtypes makes it less susceptible to speculative expectations (de Jong, 2025). This is in line with Rotolo et al., who suggest that as an emerging technology moves towards maturity, the uncertainty and ambiguity surrounding it decrease relative to earlier stages (Rotolo et al., 2015), which means it loses the interpretative flexibility that makes it relatable to other scientific fields and therefore less hyped.

However, in line with Pinch and Bijker (2012), we do not suggest that TRL is the only factor here, as technology development is not linear. As the technology becomes more mature, actors outside the scientific sphere may engage with it, and different expectations may emerge. As expectations are reinterpreted by, for example, people in the business and policy spheres, hype might emerge (van Lente et al., 2013).

3.3.4 Quantum Information Processing

Besides quantum computing, communication and sensing, we found instances in which scientists describe 'quantum information science' as a branch of science that involves storing, manipulating, processing, and measuring information using quantum mechanical effects and objects (O'Brien et al., 2009; Eisaman et al., 2011). We added the code 'quantum information processing' to our analysis because the term suggested that a new class of technology—quantum technology—could be built if quantum information could be processed. This aligns with a previous bibliometric study suggesting that quantum information science is the foundation of quantum technology, as influential publications in this subcategory are widely cited by publications in other subcategories but not vice versa (Scheidsteger et al., 2022). Furthermore, in a review article about photonics technology, a group of scientists noted the close relationship between quantum information science and the possibility of developing technology based on it by writing that:

> Quantum information science has emerged over the past several decades to address the question of whether we can gain new functionality and power by harnessing quantum mechanical effects through storing, processing and transmitting information encoded in inherently quantum mechanical systems. Fortunately, the answer is yes. [Document 28].

Figure 2 shows that in the context of conveying the expectation of quantum technology, the term quantum information processing is used less in the latter years compared to earlier years. Combined with our previous observation that the term quantum computing is used more in the latter years, this signals a shift in how expectations are being communicated. More applicative terms such as quantum computing are used more frequently.

In the same vein that quantum information processing is the foundation to build quantum technology, we observe that the code 'quantum information processing' often co-occurs with the 'realisation of quantum technologies' code, as can be seen in Fig. 7. In other words, advances in quantum information processing are expected to contribute to the effort to realise the three subtypes of quantum technology. In a review of advances in photonics published in *Journal of Physics: Photonics*, a group

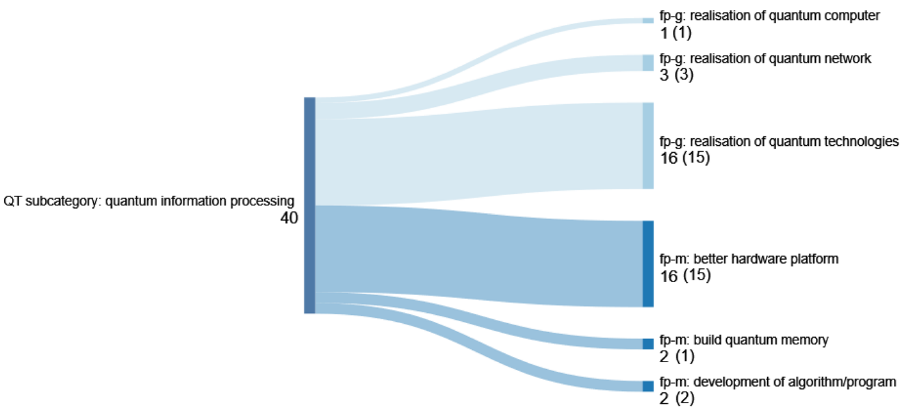

Fig. 7 Co-occurrence of 'quantum information processing' and 'future projection'. The numbers outside parentheses indicate the number of associated quotes. The numbers inside parentheses indicate the number of associated articles

of scientists seem to share this expectation by opening their contributed chapter by projecting that:

> Integrated photonic technologies will play a central role in advancing the frontiers of quantum information science and in the full realization of quantum processing, sensing, and communication applications. [Document 154].

The above quotation also provides an insight into another feature in Fig. 7, which is the co-occurrence of the codes 'quantum information processing' and 'better hardware platform'. This also suggests a general expectation that the development in quantum processing hardware—in that case integrated photonics—will contribute to the roadmap of realising quantum technology.

In short, quantum information processing is used to express the expectation that the ability to process quantum information is fundamental to building working quantum technology. The loss of popularity of using quantum information science terms to express expectations can be attributed to the perception that they are fundamental to the other three subcategories. Although this term lost popularity in the later years, it is used when the authors expect that their research, which mainly focuses on hardware development, is essential to achieving useful quantum technology in the future.

4 Discussion

Let us revisit the concepts that we have touched upon in the introduction. Firstly, the paradigm of communicating science is shifting. This shift towards two-way interaction with the public means that research has to be disseminated in a way that makes it possible for the public to relate to and engage with. Secondly, the medialisation concept suggests the increasing presence of media logic in science communication which can encourage scientists to hype their research. Thirdly, the concept of expectation offers a framework for analysing future-oriented statements, particularly in the context of an emerging technology. In this study, these three concepts serve as an analytical lens through which we examine the expectations articulated in highly cited peer-reviewed articles on quantum science and technology.

We found two distinct ways of articulating expectation: use case and future projection. Reflecting on the concepts above, our findings suggest that each type of expectation is directed towards a different audience. Firstly, in our analysis, the expectation of use cases is likely to be related to the framing of quantum technology as a solution to society's (future) problems. This problem-solving narrative provides a shared reference point for the broader public, especially the non-expert public, to engage with. Schäfer (2011) suggested that the media are more inclined to cover science news if it contains a relevant feature of everyday life, such as a problem-solving narrative. Therefore, we argue that while scientific articles are primarily directed towards fellow scientists, a use-case type of expectation is directed towards the broader public. While it is not uncommon for emerging technologies to be presented as the solution to (societal) problems (Van Lente & Rip, 1998, sect. B), we argue that this narrative strategy could be both a strategy and result of medialisation in the scientific sphere as the journals are more oriented towards the media (Franzen, 2012).

This tendency to communicate the practical use case of scientific publication might indicate that the medialisation of science is ongoing (Weingart, 1998). Väliverronen noted that this tendency to include expected use cases in scientific publishing stems not only from the intrusion of media logic, but also from changes in how scientific institutions are run and evaluated (2021, p. 13). Contemporary science evaluation practice places a strong emphasis on 'impact', which incentivises scientists to hype practical benefits and use cases in their narrative when writing an article for publication. As a result, communicating use cases in scientific publications may be both a strategic response to the media dynamic (Soto-Sanfiel et al., 2025) and a reflection of contemporary academic norms.

Secondly, in our analysis, the category of future projection embodied the imagined future form of quantum technologies and the perceived steps needed for their realisation. In contrast to the use cases, the future projection is aimed more at fellow scientists and science funders. This orientation is reflected in the use of more technical terminology such as 'quantum algorithm', 'quantum memory', and 'quantum repeater'. Given the inherently argumentative nature of scientific publications, they also become the arena in which expectation, particularly in the form of future projection, can be engaged with and criticised. Previous research indicated that this articulation of expectation can engage other scientists and foster alliances which support a particular future projection (Van Lente & Rip, 1998). Over time, as these alliances grow, future projections can also become requirements that steer the technology's development (van Lente, 2016).

This practice of communicating a technical goal and the steps towards it can also be analysed using the lens of medialisation. In this case, it is not the attention of the public that scientists compete for, but the attention of their colleagues closer to the scientific sphere who are involved in technology development. However, medialisation is not the only factor. Ampuja and colleagues propose the concept of 'weak form of medialisation', which situates media logic within the broader processes of commercialisation and industrialisation unfolding in the scientific sphere (2020). These future projections have an important role in resolving the uncertainty and ambiguity inherent in technology development (Belsunces, 2025, p. 2). By resolving uncertainty, these future projections enable consensus to be reached among actors which later helps legitimise the allocation of resources to the development of the envisioned technology.

These two potential motivations for communicating expectations—engaging with the non-expert public and informing fellow scientists—may also be influenced by the type of article being published. Broadly, scientific articles can be categorised into two types: original research and review articles. Original research articles typically present novel findings and empirical data, whereas review articles synthesise recent developments in a particular field. Notably, review articles not only summarise existing knowledge but also allow authors to propose specific viewpoints and speculate on future directions for the field (Content Types | Nature Photonics, no date, n.d.). We found that expectations are communicated in both types of articles, although two-thirds of them are in the review articles. We also found that both forms of expectation are communicated in both types of articles. This suggests that the articulation of expectations is a practice embedded within the broader scientific publishing system, regardless of the intended audience or article format. This is also in line with previous studies that argue that the practice of communicating expectation (or hyping) cannot be attributed only to particular actors but is pervasive in contemporary scientific practice (Caulfield & Condit, 2012), which is partially caused by the medialisation of science (Weingart, 1998; Väliverronen, 2021).

The next aspect we would like to discuss is the relation of scientists' proximity to quantum science and their engagement. In our findings, using the journal's name as a proxy, we indicated that scientists outside the traditional quantum physics circle also expressed their expectations for quantum technology, particularly quantum computers. This propagation of quantum computing terms that reaches scientists who publish in *IEEE Access* can be analysed through the lens of 'umbrella terms' (Rip & Voß, 2013). Our data indicate that the term quantum computer has become an umbrella term as other scientific disciplines come under it and engage with it. The uncertainty surrounding the use case (as captured by our 'use case – not specific' and 'rather specific' subcategories) helps scientists outside quantum science adopt the term. Since quantum computers are expected to have an advantage over classical computers in solving certain problems, scientist from other fields then engage with the possibility that some of those problems are in their field.

While our data show that both fields further from quantum science (as indicated by expectations expressed by engineers in *IEEE Access*) and those closer (as indicated by expectations expressed by chemists in *Chemical Reviews*) engage with quantum computer expectations, we noticed a difference. It is that the closer field engages more meaningfully by also contributing to its future projection. One possible explanation for this is the knowledge gap between the scientists' own field and quantum science. The closer one is to quantum science, the more meaningful engagement can be done.

This difference also revealed that the scientific sphere is best viewed as a heterogeneous community, in contrast to established science communication models that treat it as homogeneous. Quantum computing, as an umbrella term, provides a space where scientists from various fields can communicate and engage with one another. The engagement can differ depending on one's proximity to quantum science. The further away one's field is, the shallower the engagement would be, for example, by relating the use case to a problem in one field. The closer one's field is, the more meaningful engagement can be made, for example, by contributing to the roadmap and development agenda.

One limitation of this study is its reliance on the expression of expectations in the abstracts. As we already touched upon above, this might bias towards the review articles, which we also observe in our dataset. This, along with our choice to focus on highly cited articles, means we capture only a subset of the scientific discourse. However, this bias also has advantages. First, it enables us to capture agenda-building in more detail through the 'future projection' code. Second, it enables us to capture the layers inside the scientific sphere, as our dataset also includes review articles from outside the quantum science community. These layers might not be revealed if we do not focus on the expectation in the first place.

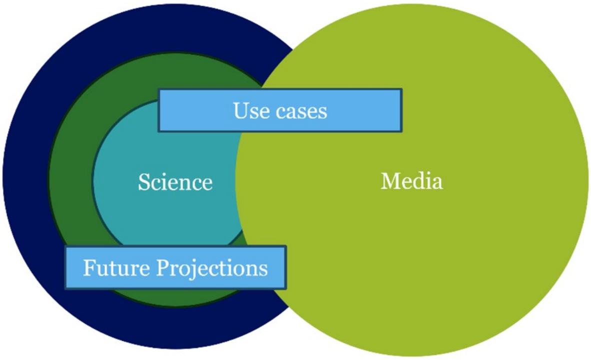

Fig. 8 Position of use case and future projection within the coupled science and media sphere

Although we touched upon temporality, we believe that future study should put this factor in focus. While this study supported previous studies that medialisation in the scientific sphere is ongoing (Caulfield & Condit, 2012; Franzen, 2012; Weingart, 2022), our analysis doesn't permit us to claim that expressing expectation has become more common in peer-reviewed publications. Temporal analysis should provide a more detailed account of this shift.

As we suggest that the scientific sphere is heterogeneous, this also implies that publication practices may differ across fields. Future study could focus on other technologies, for example, Artificial Intelligence, which is expected to have a wide range of applications (Mökander, 2023). Alternatively, other fields of science where developing technology is not the main goal, for example, astrobiology (Albergaria et al., 2025).

5 Conclusion

We applied the concept of expectation to analyse what is being hyped in the scientific sphere. We found that peer-reviewed articles communicated not only research results, but also forward-looking expectations. As this study is situated within the scientific sphere, it contributes to the implicit understanding in the literature that scientific articles serve as arenas where expectations are negotiated and exchanged (Weingart et al., 2000; Konrad & Alvial Palavicino, 2017).

Using the concept of expectation, we are able to provide clarity on the hype that is currently ongoing in the field of quantum science and technology. This concept of expectation provides a valuable lens through which to examine the process of the medialisation of science. Building on the notion of medialisation, which suggests a coupling between the spheres of science and media, Fig. 8 illustrates how expectations, communicated in the form of use cases and future projections, are positioned within these coupled spheres.

Our analysis indicates that expectations, in the form of use case and future projection, function as affordances that facilitate audience engagement. Use case, often framed as solutions to (societal) problems, tends to resonate with non-expert audiences, suggesting that media logic increasingly shapes the practices surrounding scientific communication. Conversely, future projection is directed towards actors involved in technological development, such as fellow scientists and potential funders, to engage and influence the research field. This latter characteristic underscores the entanglement of medialisation with processes of commercialisation and industrialisation, which appear to be driving forces in contemporary scientific practice (Weingart, 1998, 2022; Ampuja et al., 2020).

Also, by drawing on expectations, we can add nuance to the discussion of medialisation. That is the scientific sphere is better viewed as heterogeneous, illustrated by the difference layer in the scientific sphere in Fig. 8. Use cases appear to be engaged by scientists further away from the core quantum scientist community. While the further community seems not to engage with the development agenda, communities closer to quantum science, such as computational chemistry, also appear to engage and shape the agenda by expressing their future projections.

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Author Contributions MUK: Writing – Original draft, Formal analysis, Investigation, Conceptualisation, Data curation, Methodology. JC: Writing – Review & editing, Funding acquisition, Supervision, Methodology

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Data Availability The data on which the empirical work was based are included in the table in the Appendix.

Declarations

Competing Interests The authors declare no competing interests.

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