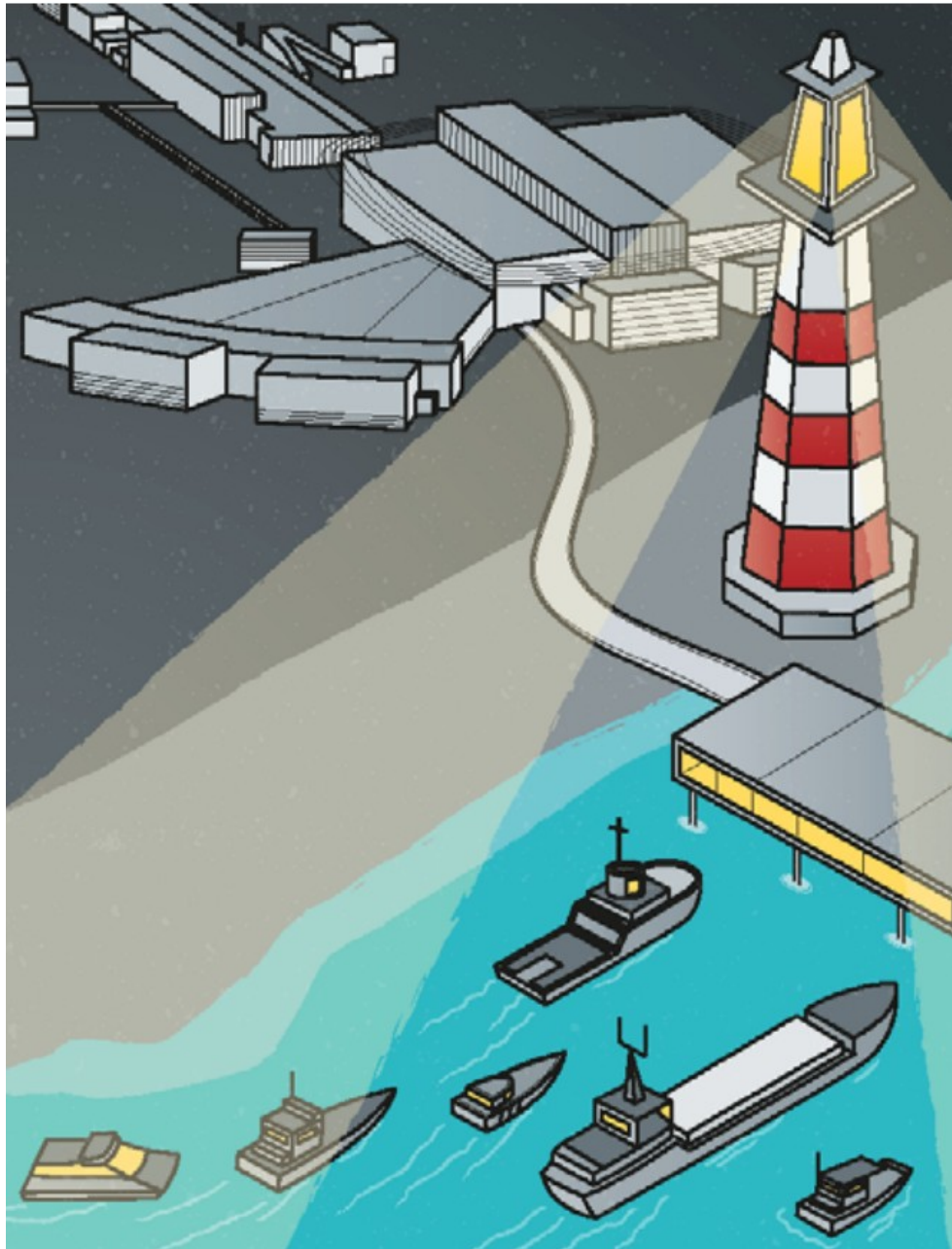


ESS Lighthouse: Magnetism and Quantum Materials (Q-MAT)

2022 Annual Report

The ESS Lighthouse Q-MAT is financed by the Danish Government through the National Committee for Research Infrastructure (NUFI) and contains the Danish neutron- and ESS-related activities within the fields of Magnetism and Quantum Materials. Q-MAT was officially opened December 1st, 2020, and its first proper annual report (for 2021) was written in Danish. For this reason, this report in English contains all activities within Q-MAT since its inauguration, and till the end of 2022.



1. Partners and Management

We here list the institutions and scientists in Q-MAT and emphasize the changes that has taken place since the inauguration of the Lighthouse.

1.1 Partners

Q-MAT is made up of six partner institutions.

- AAU (University of Aalborg), Department of Materials and Production
- AU (University of Aarhus), Department of Chemistry
- SDU (University of Southern Denmark), Department of Physics, Chemistry, and Pharmacy
- RUC (Roskilde University), Department of Science and Environment
- DTU (Technical University of Denmark), Department of Energy Conversion and Storage; Department of Chemistry; Department of Physics
- KU (University of Copenhagen), Department of Geosciences; Department of Chemistry; Niels Bohr Institute

and the additional partners (observers)

- ESS Science Division, Lund
- ESS Data Management Center, Copenhagen
- DTI (Danish Technological Institute)

1.2 Daily Management

The day-to-day management group (in Danish known as “Fyrmestre”) consists of:

- Ulla Gro Nielsen (SDU)
- Niels Bech Christensen (DTU Physics)
- Jesper Bendix (KU Chemistry)
- Henrik M. Rønnow (KU NBI and EPFL)
- Brian Møller Andersen (KU NBI)
- Kim Lefmann (KU NBI)

under the directorship of Kim Lefmann and Niels Bech Christensen as Vice-Director. Administrative support by Gitte Michelsen (KU, NBI).

This group has met, virtually, over 20 times during 2020-2022.

1.3 The Steering Group

Consolidated on 18th December 2020, the Steering Group includes most of the scientists active in Q-MAT. In addition to the Management Group members, these are:

- Lars Diekhöner (AAU)
- Mogens Christensen, Dan Mannix, and Bo B. Iversen (AU)
- Dorthe Posselt (RUC)
- Thomas Olsen, Cathrine Frandsen and Rasmus Toft-Petersen (DTU, Physics)
- Kasper Steen Pedersen (DTU, Chemistry)
- Nini Pryds (DTU, Energy)
- Peter Krogstrup Jeppesen (KU, NBI)
- Kirsten M. Ø. Jensen (KU, Chemistry)
- Kristoffer Szilas (KU, Geoscience)
- Andreas Kreisel, assistant professor (KU, NBI)

Furthermore, as observers:

- Jacob Overgaard (Danish Technological Institute, DTI)
- Pascale P. Deen (ESS)
- Greg Tucker (ESS-DMSC)

Thomas G. Pedersen (AAU), Jens-Erik Jørgensen (AU), and Jonathan Taylor (ESS-DMSC) withdrew from Q-MAT in 2021, while Tonci Balic-Zunic (KU) and Hossein Alimadadi (DTI) withdrew in 2022. Jacob Overgaard moved from AU to DTI but continues in Q-MAT,

In 2023, the group will be enriched by two additional hires, in Q-MAT:

- NN1, post doc (DTU, Physics)
- NN2, assistant professor (KU, Chemistry)

1.4 The Reference Group

This group represents the political level at the partners and ensures the anchoring of Q-MAT within the partner organizations:

- KU: Jan W. Thomsen (NBI)
- DTU: Jane H. Nielsen (Physics)
- RUC: Dorthe Posselt
- SDU: Lars P. Christensen
- AU: Mogens Christensen
- AAU: Kjeld Pedersen, to be replaced in 2023
- DI (Danish Industry): Richard Larsen

This group has met twice; April 2021 and November 2022.

1.5 The International Advisory Board

This Board gives independent scientific advice to Q-MAT and consists of international experts in the field:

- Sian Dutton (University of Cambridge)
- Helen Walker (ISIS neutron facility, UK)
- Collette Boskovic (Melbourne University)
- Michael Baker (University of Manchester)
- Olav Syljuåsen (University of Oslo)
- Johan Chang (University of Zürich)

The board was established after the inauguration of Q-MAT and met for the first time in February 2023.

2. Activities in Q-MAT, Organization and Budget

In the initial phase of the Lighthouse, the most important activities were recruitment, administration, and networking. Unfortunately, the pandemic limited the number of physical meetings.

In 2022 we expanded our activities, such as meetings and facility experiment and, as such, started the planned scientific program within Q-MAT.

2.1 Plenary meetings

During the recruitment processes a large number of smaller meetings were held between partners in Q-MAT. Subsequently, partners have met in relation to supervision of the Q-MAT students, who all have at least two supervisors from different institutions. Below, we report only on plenary meetings.

2.1.1 Virtual kick-off and Steering Group meeting, 18 December 2020

The kick-off meeting was held online. About 40 participants in the Lighthouse met to present current activities and discuss future collaborations. Many partners invited the Lighthouse members to collaborations, both on research projects and the use of experimental equipment. We had an on-line brainstorm on future projects and fundraising, led by Christian Rischel, Manager of Innovation in Novo Nordisk, followed by lively discussions.

The kick-off meeting was followed by a short meeting in the Steering Group, where Kirsten M. Ø. Jensen (KU, Chem) was accepted as a new SG member.

2.1.2 Virtual Reference Group Meeting, 20 April 2021

At this online meeting, the early upstart of Q-MAT was presented together with plans for the future. The Reference Group backed up the progress and future directions.

The Reference Group recommended Q-MAT to increase visibility, e.g., by hosting a major international conference or workshop. It was also recommended to contact the energy provider Ørsted, e.g., through Jan Thomsen (KU NBI) or Richard Larsen (DI) about the potential for utilization of superconductivity.

2.1.3 Virtual Steering Group meeting, 27 August 2021

The recruitment process was discussed in detail. Input from the Reference Group was discussed, and the suggestion for an international conference was considered. A decision was made to set up an International Advisory Board.

The November kick-off meeting was planned in detail.

2.1.4 Physical kick-off and Steering Group meeting, 16-17 November 2021

This meeting was held at KU with approx. 35 participants.

The individual partners had short presentations on their activities. In addition, there was a presentation from Helmuth Schober on the status of ESS, and a presentation from Stergios Piligkos on a facility at KU Chemistry for pulsed ESR spectroscopy (NNF Infrastructure Grant).

A few possibilities for common projects were discussed in smaller groups.

At the Steering Group meeting was discussed the potential in a common summer school for Q-MAT, and perhaps for all Lighthouses.

2.1.5 Annual Meeting and Steering Group Meeting, 1-2 November 2022, held at Rødvig

This meeting was held at Hotel Klitten in Rødvig, Stevns. Due to the pandemics, this was the first Q-MAT outing, having 37 participants. 7 students presented their projects, the Assistant professor Andreas Kreisel presented the scientific directions for his theoretical work, Ulla Gro Nielsen (SDU) presented the complementary technique of solid-state NMR, and Rasmus Toft-Petersen gave an update on ESS and BIFROST. In addition, there was a brainstorm on opportunities for future common funding. The atmosphere was in general lively and collaborative. The adjacent SG meeting confirmed the adjustment of SG members and discussed the formation of the International Advisory Committee. Meanwhile, the students held a separate meeting, planning a dedicated student outing in spring 2023.

2.1.6 Virtual Reference Group Meeting, 23 November 2022

First, there was a follow-up on previous recommendations from the Reference Group. Q-MAT presented the plans for hosting the International Conference on Neutron Scattering in Copenhagen/ESS in 2025. There was strong support for this initiative. Richard Larsen elaborated on previous discussion on strategic contact about superconductivity and offered to make contact to energinet.dk; (replacing Ørsted from the previous suggestion). Visibility towards the ESS has been improved with a) two Q-MAT student presentations on the ESS Science Day in May 2022, b) three ESS staff present at the Q-MAT annual meeting in November 2022, c) association of Helmut Schober to the Lighthouse.

Q-MAT presented the recruitment status, with an emphasis on the three missing hirings. Filling the associate professor at KU Chemistry has been difficult, since the first two announcements ended without success- the candidate declined during the contract negotiations. The Reference Group accepted that this has led to underspending in Q-MAT.

The group was positive about the establishment of an International Advisory Panel, and to the good turn-up at the Annual Meetings. Furthermore, it suggests:

- Stenghtened collaboration between the 3 Danish Lighthouses
- Elaborate on industrial contacts
- Clarify how the planned extension of the Lighthouses in years 6-10 will happen without (guaranteed) external financing.

2.2 Recruitment at Q-MAT

In 2021, we have had a strong focus on recruitment, especially of PhD students. Much time has been put into recruiting and detailing projects for these students. The status of the planned appointments within the Q-MAT budget is seen in the table below.

Name	Position	Partner	Topic	Start date -End date
Francesco Zamboni	PhD student	AAU	Single Molecule Magnets	Sept. 2021 - Aug. 2024
Jack Thomas-Hunt	PhD student	AU	Spin Seebeck effect	Mar. 2022 - Feb. 2025
Hannah H Nielsen	PhD student	AU	Single Molecule Magnets	Feb. 2021 - Jan. 2024
Mickey Pedersen	PhD student	SDU	Frustrated Magnetism	Apr. 2022 - Mar. 2025
Christian K. Kristensen	PhD student	RUC	Magnetic Polymers	Jan. 2022 – Dec. 2024
Lise G Hanson	PhD student	DTU Physics	Magnetic Nanoparticles	Oct. 2022 – Sept. 2025
NN	PhD student	DTU Physics	Magneto-electric materials	2023 - 2026
NN	Postdoc	DTU Physics	Q-MAT experiments	2023 - 2025
Naoki Eguchi	PhD student	DTU Chem.	Frustrated Magnetism	Sept. 2022 – Aug. 2025
Clara Neerup Breiø	PhD student	KU NBI	Theory of superconductivity	Sept. 2020 – Aug. 2023
Kristine M L Krihaar	PhD student	KU NBI	Superconducting and ESS instrumentation	Apr. 2022 – June 2026
Emma Y Lenander	PhD student	KU NBI	Frustrated Magnetism	Jun. 2022 – June 2026
Andreas Kreisel	Assistant Professor	KU NBI	Q-MAT Theory	Sept. 2022 – Dec. 2025
NN	Tenure track Professor	KU Chem.	Q-MAT material development	Sept. 2023 -

The essential position at KU Chemistry within Materials Development was initially planned as an assistant professorship, but the department has shown great goodwill towards Q-MAT and upgraded the position to a tenure track professorship. Unfortunately, the position was not filled at the first two announcements, but there are many qualified applications in the 3rd announcement, and interviews will be held in June 2023.

2.3 Staff associated with Q-MAT

In addition to participants in the Steering Committee and mentioned observers, Q-MAT includes the following permanent employees.

- KU NBI: Jens Paaske
- KU Chemistry: Høgni Weihe, Stergios Piligkos
- DTU Energi: Jean-Claude Grivel

Around 30 young researchers in temporary positions are affiliated with Q-MAT but not financed by the grant. An overview of these positions is given in appendix A.1.

In 2022, we had an increase in the number of Master's and Bachelor's students working on Q-MAT projects. The lists of the current students in the Lighthouse is given in appendix A.2 and A.3.

The PhD position in collaboration between KU NBI and Microsoft was initially to be funded by Q-MAT, while the PhD position in Frustrated Magnetism was to be financed externally. However, it proved easier to reverse the financing of these two projects, since the first mentioned project could be funded by an EU grant through the ILL. The Steering Group chose to support this solution.

2.4 External grants in 2020, 2021, and 2022

Several of the partners in Q-MAT have obtained external grants related to the topics of the Lighthouse.

- AU, Chemistry: METEOR, DFF, FTP, 6.2 MDKK
- AU, Chemistry: COMPASS, DFF, Green Transitions 6.2, MDKK
- AU, Chemistry: EBSD Detector, Carlsberg instrumentation, 1 MDKK
- AU, Chemistry: Metal Coordination Complexes in Technology and Biomedicine, Novo Nordisk NERD, 14 MDKK
- KU, Chemistry: Mirror furnace for growth of single crystals, Carlsberg Instrumentation, 1 MDKK
- KU, Chemistry: Equipment for pulsed ESR, Novo Nordisk Infrastructure, **XX MDKK**
- KU, NBI: Spintronics, Carlsberg post doc, 1.8 MDKK
- KU, NBI: Proximity effects in magnetic and superconducting thin films, EU InnovaXN project, 1.5 MDKK
- DTU Energy: Magnetoelectrical materials, Novo Nordisk Challenge, 1.6 MDKK 2022
- SDU: Ulla Gro Nielsen, A magic-angle spinning NMR probe for in-situ and operando studies, Carlsbergfondet 0.6 MDKK

2.5 Budget and spending in Q-MAT

In the Q-MAT budget, the project start was September 2020, and here the largest part of the 2 MDKK Chemistry lab was placed. The later start of Q-MAT, the pandemic, and the major delays in hiring the associate professor at KU Chem led to a minimal spending in 2020: 56 kDKK. The total difference between budget and spending was 1842 kDKK.

In 2021 the recruitment of PhDs was delayed due to the pandemic. In addition, the very important position of Associate Professor at Chemistry, with attached laboratory, remained vacant. All this led to a low spending in 2021: 1365 kDKK, which is significantly smaller than the budgeted amount of 6206 kDKK. Details of the budget and spending for 2021 are found in the table below.

In 2022, the spending increased to 3690 kDKK, which is just below half of the budget value of 7995 kDKK. Again, the reason is the delays in hires. For the years 2021 and 2022 together, the table reveals that we have delayed employment with in total 105 person months, corresponding to around 6000 kDKK. Adding around 1000 kDKK in delayed taximeter and around 3000 kDKK for the delayed Chemistry lab, these three posts almost fully explain the total 10988 kDKK underspending.

Since we have yet to fill all positions at the beginning of 2023, we will face a (minor) underspending on this budget string, also in 2023, while the expected establishment of the Chemistry lab will give an

nominal overspending in 2023. We thus expect the total spending of 2023 to balance around the budget value of 9109 kDKK.

For the two last years of the Lighthouse, our total budget is 9593 kDKK, to which we need to add the underspent approx. 11000 kDKK of the first years, or around 10000 kDKK annually. Special focus will be given in the Q-MAT management to ensure spending of the full amount. One option that has already been discussed in this forum is to apply to NUFU for an extension of the grant, accompanied by a total rebudgeting.

None of these underspendings give rise to re-distribution of funds between partners.

Institution	Position	Planned start	Actual start	Budget 2021 (kkr)	Spending 2021 (kkr)	Diff. 2021 (kkr)	Budget 2022 (kkr)	Spending 2022 (kkr)	Diff. 2022 (kkr)
RUC	PhD	Mar. 2021	Jan. 2022	368	0	368	517	361	156
AAU	PhD	Mar. 2021	Sept. 2021	406	168	238	592	498	94
SDU	PhD	Mar. 2022	Apr. 2022	122	1	121	406	404	2
AU	PhD 1	Mar. 2022	Mar. 2022	528	188	340	998	746	252
	PhD 2	Mar. 2021	Feb. 2021						
DTU Physics	Postdoc	Sept. 2020	-	1500	62	1438	2062	327	1735
	PhD 1	Mar. 2022	-						
	PhD 2	Mar. 2021	Sept. 2022						
DTU Chem	PhD	Mar. 2022	Sept. 2022	122	0	122	392	109	283
DTU Energy	-	-		58	0	58	58	0	58
KU Geosci	-	-		29	33	-4	29	52	-23
KU Chem	Assoc. Prof	Sept. 2020	-	1536	137	1399	1346	10	1336
KU NBI	PhD 1	Mar. 2021	Sept. 2020	1538	775	763	1595	1182	413
	PhD 2	Mar. 2022	Mar. 2022						
	PhD 3	Mar. 2022	June 2022						
	Ass. Prof	Sept. 2022	Oct. 2022						
Sum	-	-	-	6206	1365	4841	7995	3690	4305

All amounts include 44% overhead.

2.6 Relation to the ESS

Q-MAT maintains its strong connection to ESS:

- Mogens Christensen and Dan Mannix (AU) are PIs and instrument scientists for HEIMDAL.
- Niels Bech Christensen and Rasmus Toft-Petersen (DTU) are PIs and instrument scientists for BIFROST.
- Pascale P. Deen (adjoint to KU, NBI) is an Instrument Scientist for C-SPEC. All 3 instruments will play an important role for future activities related to Q-MAT
- Gregory Tucker and Simon Ward of the ESS-DMSC participated in both annual meetings of Q-MAT.
- As a very prominent development, the ESS CEO Helmut Schober was in 2021 announced adjoint professor at DTU, Physics and associated with Q-MAT.

2.7 Q-MAT home page

A web page for Q-MAT has been established on the address <https://www.q-mat.nbi.ku.dk/> containing general information on Q-MAT; a list of related staff; Broad-brush description of the research areas; List of publications; News and Events; Job postings. It is maintained and updated by the Q-MAT admin.

3. Activities in Q-MAT, Scientific

We here list a summary of the scientific activities in Q-MAT from December 2020 to the end of 2022.

3.1 Highlights 2022

KU, NBI

Machteld Kamminga

February 2023, Machteld moved from Q-MAT to start a tenure-track professorship within materials discovery of quantum materials at University of Utrecht. This development of our young staff is something Q-MAT is proud of.

Brian M. Andersen

The origin of superconductivity in heavy-fermion systems remains an open question. The gap symmetry of CeCoIn₅ is strongly suspected to be d-wave which points to an unconventional pairing mechanism. Recently, new experimental reports have pointed to orbital order also being present in CeCoIn₅. We have investigated the interplay between d-wave superconductivity and orbital order through a collaboration with the group of Prof. Séamus Davis at Oxford University on superconductivity-assisted detection of hidden orbital order in the heavy-fermion compound CeCoIn₅.

By comparison to our theoretical calculations we were able to understand why orbital order and superconductivity coexist favorably in this material. Our work has been accepted for publication in Nature Communications.

Several unusual and timely superconducting materials exhibit time-reversal symmetry breaking (TRSB) setting in right at their respective critical superconducting transition temperatures. Such behavior is normally associated with chiral superconductivity. In Sr₂RuO₄ and UTe₂, however, the superconducting order seems not to be chiral. Instead strong magnetic fluctuations exist in these systems. This motivated our hypothesis that disorder in conjunction with magnetic fluctuations may induce TRSB in unconventional superconductors such as Sr₂RuO₄ and UTe₂. Through explicit real-space modelling of unconventional superconducting order, we have demonstrated that indeed this path provides a mechanism for generating TRSB. Our first work was published in Phys. Rev. B in 2022. Currently we are investigating dislocations and their effect for TRSB. We expect to write up the second paper and submit it for publication within the next few months.

Kim Lefmann

Bloch oscillations is the name for the quantum mechanical effect that an electron in e.g. a semiconductor, when placed in an electrical field will counterintuitively perform oscillations. It was predicted in the 1990's that a similar effect could happen for domain walls of a one-dimensional ferromagnet in an applied magnetic field. These, so-called, Magnetic Bloch Oscillations (MBO) were sought experimentally by a number of groups without proof. Recently, in her PhD work, Ursula B. Hansen from KU NBI (now ILL) found the signature of these MBO's in experiments at NIST on a crystal of CoCl₂·2D₂O. Conclusive evidence was found at experiments at ILL in 2021. The work was published in Nature Communications in 2022.

KU Chemistry

Jesper Bendix

An electron diffractometer has been funded by the Novo Nordisk Foundation by 17 MDKK. In the application, 3 of 6 core-users, and 6 users in total, are from QMAT. We expect this equipment to play a large role for projects within the Lighthouse in the coming years.

AU, Chemistry

Mogens Christensen

Development of lanthanide-free permanent magnets has been the focus of intensive research for the past decade. Exchange-spring nanocomposite magnets composed of interacting magnetic hard and soft phases are predicted to exhibit superior performance. In this study, we investigated the effects of nanoscale mixing by two techniques (physical powder blending and chemical nanocoating) on nanocomposites. Detailed atomic-/nano-scale structural characterizations of these nanocomposites were performed by combining neutron and X-ray powder diffraction analysis with transmission electron microscopy. Macroscopic magnetic properties and exchange-coupling (recoil magnetization) were

investigated by vibrating sample magnetometry. The results show that exchange-spring magnets are practically extremely difficult to prepare.

Bo B. Iversen

A project on a four coordinated Co (II) molecular magnet in collaboration with Franc Meyer in Göttingen has been the main project in 2022, with analysis of the magnetic anisotropy with both charge density methods and polarized neutron diffraction. The project has led to an accepted paper in J. Am. Chem. Soc.

DTU Physics

Niels Bech Christensen

The origin of high temperature superconductivity in copper oxide superconductors remains a mystery. One possibility is that it is related to the existence of modulated spin and/or charge ordered states in the same materials. In two papers employing x-ray and neutron scattering, Q-MAT scientists, collaborating with colleagues from the Paul Scherrer Institute and University of Zürich, showed how uniaxial pressure allows to tune intertwined spin and charge order domains in the high temperature superconductor $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$. Effectively, these two works provide conclusive proof that the electronic state competing with and perhaps driving, superconductivity in this material is inherently 1-dimensionally modulated.

DTU Energy

Nini Pryds

We concentrated on establishing the new national research facility E-MAT, soon to be ready.

3.2 Publications within Q-MAT, 2021-2022

Only 1 publication in 2021 was directly related to Q-MAT funding. This is related to the fact that in general PhD students would need to first be recruited, then start up their projects. In total, the Q-MAT partners had 37 Q-MAT-related publications in 2021; the full list can be seen in the appendix B.1

Q-MAT had in 2022 in total 28 publications, of which 4 were directly related to the funding. This shows that the publication of the Q-MAT PhD students is slowly building up. The full list can be seen in the appendix B.2

3.3 Beamtimes

Even though many facilities were closed due to the pandemic, many Q-MAT partners had (possibly virtual) beamtime activities in 2021 at neutron facilities:

- SINQ (KU NBI, SDU, DTU Physics)
- ILL (KU NBI, AU, DTU Physics)
- HFIR (AU)
- ANSTO (AU)

and at X-ray facilities:

- PETRA (AU, DTU Physics)
- MAX-IV (AU)

In 2022, the utilization of beamtime increased for neutron facilities:

- SINQ (KU NBI, DTU Physics)
- JPARC (KU NBI)
- ISIS (KU NBI)
- ILL (AU)
- HFIR (AU Chem)
- BNC (DTU Physics)

for X-ray facilities:

- PETRA (AU, DTU Physics)
- ESRF (AU)
- MAX-IV(AU)
- DIAMOND (AU, DTU Physics)
- SPring8 (AU Chem)

and for muon facilities

- S μ S (KU NBI)

3.4 Patents

Both in 2021 and 2022, one patent was filed within the Q-MAT topic, see appendix C.

3.5 Student degrees

From December 2020 to the end of 2021, the Q-MAT faculty has supervised theses corresponding to 2 B.Sc. 8 M.Sc. degrees and 5 Ph.D. degrees. See list in appendix D.1

In 2022, the corresponding number was 12 B.Sc. degrees, 7 M.Sc. degrees and 4 Ph.D. degrees. See list in appendix D.2

4. Summary

The Lighthouse Q-MAT has, in its first two years, focused on recruitment, networking and start-up of scientific projects; particularly the PhD projects. The important position as tenure-track professor in Chemistry at KU has, however, been delayed, as well as two other positions at DTU. Nevertheless, the recruitment process is ongoing, and we expect all three positions to be filled in 2023.

Q-MAT has at this point in time an total underspending of around 11 MDKK. While this can all be understood in terms of delayed filling of positions, this issue will be in focus for the management at present and in the time to come.

Two virtual meetings and two physical meetings have been held for all partners in Q-MAT. The number of physical meetings will now increase to twice per year.

One publication in 2020-2021 related directly to Q-MAT-financed activities. The partners published 37 Q-MAT relevant publications in 2021, which is a most satisfying number.

In 2022, 4 Q-MAT funded publications appeared of a total of 28 publications. While the total number is somewhat lower than 2021, it still witnesses a significant activity. It is evident that the Q-MAT funded activities now are starting to result in publications. We expect an increase in publications for 2023.

The partners in Q-MAT have in 2020-2022 attracted considerable external funds to the research area of the Lighthouse.

Q-MAT maintains close connections to ESS in general, and to the DK-led instruments BIFROST and HEIMDAL, but also to C-SPEC. Importantly, links with the ESS-DMSC has been established and the ESS CEO Helmut Schober has been affiliated with the Lighthouse.

Appendix

A.1 Researchers in temporary positions affiliated with Q-MAT (Jan. 2023)

Name	Position	Partner	Topic	Financing	Start date	End date
Vijay Singh Parmar	Postdoc	AU Chem	Single molecule magnetism	NNF	Sept 2021	Sept 2023
Kamaldeep Dalal	Phd Student	KU NBI & Microsoft	Magnetic proximity in thin films	EU via ILL (F)	Sept. 2021	Aug. 2024
Lise Ø. Sandberg	PhD student	KU NBI	Frustrated Magnetism	Nordforsk	Aug. 2017	Dec.2021
Henrik Jacobsen	Postdoc	KU NBI	Spintronics	Carlsberg	Sept. 2021	Aug. 2024
Machteld E Kamminga	Postdoc	KU NBI	Development of new super leaders	EU Marie Curie	Nov. 2020	Jan. 2023
Sonja Holm-Dahlin	Postdoc	KU NBI	Topological magnetism	Carlsberg	Sept. 2020	Apr. 2024
Astrid Tranum Rømer	Postdoc	KU NBI	Superconductivity theory	DFF	Aug. 2021	June 2022
Hano Sura	Phd Student	KU NBI	Superconductivity theory	DFF	Aug. 2021	July 2024
Morten Holm Christensen	Post doc	KU NBI	Superconductivity theory	EU Marie Curie	Aug. 2021	XX
Malvika Tripathi	Postdoc	KU NBI	Magnetic proximity in thin films	EU Synergy	Nov. 2020	March 2023
Yu Liu	Assistant Professor	KU NBI	Magnetic proximity in thin films	EU Synergy	2018	June 2023
Christian D. Buch	Post doc	KU Chem	yy	yy	yy	XX
Niels A Bonde	Phd Student	KU Chem	Single-ion magnets	ILL (F)	2021	XX
Sofie Holm-Janus	Post doc	DTU Physics	Magneto-electric materials	Villum	Mar. 2021	Apr. 2024
Adheena Painganoor	Phd Student	DTU Physics	Magneto-electric materials	ILL (F)	Feb. 2023	Jan 2026
Frederik Durhuus	Phd Student	DTU Physics	Theory for hysteresis heating of magnetic nanoparticles	Diverse	Jan. 2022	Dec. 2024
Joachim Søderquist	Phd Student	DTU Physics	Theory of magnetic interactions	Villum	Mar. 2021	Feb. 2024
Mads Kruse	Phd Student	DTU Physics	Theory for multiferroic materials	DFF	Jan. 2020	Dec. 2022
Mathias Zambach	Phd Student	DTU Physics	Nanostructure in magnetic materials	DFF	Oct. 2020	Sept. 2023
Thomas Veile	Phd Student	DTU Physics	XX	XX	XX	XX
Miriam Varon	Research Engineer	DTU Physics	Material synthesis	Diverse	Dec. 2016	N/A
Thorbjørn Skovhus	Phd Student	DTU Physics	Theory of magnetic excitations	Villum	Sept. 2018	Oct. 2021
Paola Forino	Phd Student	DTU Physics and EPFL Lausanne	Magneto-electric materials	Diverse and EPFL	Dec. 2020	XX
Martin Ovesen	Phd Student	DTU Physics	Antiferromagnetism in 2D	Villum	1 Jun	311 May

				fonden	2022	2025
Varun Rajeev Pavizhakumari	Phd Student	DTU Physics	Thermodynamic properties of 2D magnets	Villum fonden	1 Nov 2022	31 Oct 2025
Pia Jensen Ray	PhD Student	KU NBI	Superstructure in O-doped LCO superconductor	N/A	N/A	N/A
Daniil Kudrin	Visiting M.Sc. student	KU NBI / University of Leipzig			Sept. 2022	Feb. 2023

A.2 MSc students affiliated with Q-MAT (as of Feb. 2023)

KU, NBI and ESS-DMSC (2)

- Petroula Karakosta, *McStas Union*
- Xiaoyu (Dorothy) Wang, *McStas Union*

KU, NBI and SDU (2)

- Lukas Machua-Beier, *Neutron spectroscopy of Jarosites*
- Peiyuan Liu, *Susceptibility of jarosites*

KU, NBI and Microsoft (1)

- Søren Birkemose, *Proximity In Magnetic-Superconducting-Semiconducting Layers*

KU, NBI (3)

- Thomas Sahl Christensen, *Cryostat, Frustrated Magnetism*
- Mads F. Engholm, *ClassiC*
- Daniil Kudrin, *Theory of superconductivity*

AAU (3)

- Simon Ragner Sørensen
- Martin Vigh
- Lars Nørskov Nielsen

AU (1)

- Jesper Simonsen, *Synthesis study of phase pure and nanosized X-type hexaferrite*

A.3 BSc Students affiliated with Q-MAT (as of Feb. 2023)

KU, NBI and SDU (3)

- Christine Pløger Lauritzen and Niels Anders Lyngsø Bærentzen, *High-Entropy Superconductors*
- Asbjørn Frede Lyngholm Preuss, *Magnetic Disorder in Bi₂Fe₄O₉* (co sup Emma Lenander)

KU, NBI and ESS (2)

- Karen Rosberg Ovesen and Jeppe Breum Jacobsen, *Magnetic Disorder In Frustrated GAG*

KU, NBI (1)

- Daniel Lomholt Christensen, *Optimizing SALSA at ILL*

B.1 Publications related to Q-MAT topics, 2021

AU, Chemistry (7)

- H. Vijayan, C. G. Knudsen, M. Mørch, M. Christensen, *Ultrathin Nanoplatelets of Six-Line Ferrihydrite Enhances the Magnetic Properties of Hexaferrites*, Mater. Chem. Front., **5**, 3699-3709 (2021)
- H. Tang, M. Mamakhel, and M. Christensen, *High coercivity SmCo₅ synthesized with assistance of colloidal SiO₂*, Sci. Rep., **11**, 4682 (2021)
- J. V. Ahlburg, Z. Menhinnitt, J. Thomas-Hunt, M. Saura-Múzquiz, M. Christensen, *Synthesis and characterisation of a magnetic ceramic using an easily accessible scale setup*, J. Chem. Educ., **98**, 8, 2632–2637 (2021)
- C. M. Legendre, E. Damgaard-Møller, J. Overgaard, D. Stalke, *The quest for optimal 3 d orbital splitting in tetrahedral cobalt single-molecule magnets featuring colossal anisotropy and hysteresis*, Eur. J. Inorg. Chem. **30**, 3108 (2021)
- S. Tripathi, S. Vaidya, N. Ahmed, E. A. Klahn, H. B. Cao, L. Spillecke, C. Koo, S. Spachmann, R. Klingeler, G. Rajaraman, J. Overgaard, M. Shanmugam, *Structure-property correlation in stabilizing axial magnetic anisotropy in octahedral Co(ii) complexes*, Cell Rep. Phys. Sci., **2**, 100404 (2021)
- E. A. Klahn, A. M. Thiel, R. B. Degn, I. Kibalin, A. Gukasov, C. Wilson, A. B. Canaj, M. Murrie, J. Overgaard, *Magnetic anisotropies of Ho(iii) and Dy(iii) single molecule magnets experimentally determined via polarized neutron diffraction*, Dalton transactions **50**, 14207 (2021)
- E. A. Klahn, E. Damgaard-Møller, L. Krause, I. Kibalin, A. Gukasov, S. Tripathi, A. Swain, M. Shanmugam, J. Overgaard, *Quantifying magnetic anisotropy using X-ray and neutron diffraction*, IUCrJ, **8**, 833 (2021)

KU, NBI (15)

- * Y. D. Liao, J. Kang, C. N. Breiø, X. Y. Xu, H. Q. Wu, B. M. Andersen, R. M. Fernandes, Z. Y. Meng, *Correlation-induced insulating topological phases at charge neutrality in twisted-layer graphene*, Phys Rev X **11**, 011014 (2021)
- H. Jacobsen, O. Florea, E. L'hotel, K. Lefmann, O. Petrenko, C. S. Knee, T. Seydel, P. F. Henry, R. Bewley, D. Voneshen, A. Wildes, G. Nilsen, P. P. Deen, *Spin dynamics of the director state in frustrated hyperkagome systems*, Physical Review B **104**, 054440 (2021) With ESS
- L. Ø. Sandberg, R. Edberg, I.-M. B. Bakke, K. S. Pedersen, G. Balaskrishna, M. C. Hatnean, L. Mangin-Thro, A. Wildes, B. Fåk, G. Ehlers, G. Sala, P. Henelius, K. Lefmann, and P. P. Deen, *Quantum spin liquid behaviour in the frustrated magnet YbGa garnet*, Physical Review B **104**, 064425 (2021) With DTU-Chem, ESS
- S. Janas, J. Lass, A.-E. Tutueanu, M. L. Haubro, C. Niedermayer, U. Stuhr, G. Xu, D. Prabhakaran, P. P. Deen, S. Holm-Dahlin, and K. Lefmann, *Classical spin liquid or extended critical range in h-YMnO₃ ?*, Physical Review Letters **126**, 107203 (2021) With ESS
- A.-E. Tutueanu, H. Jacobsen, P. J. Ray, S. Holm-Dahlin, M.-E. Lacatusu, T. B. Tejsner, J.-C. Grivel, W. Schmidt, R. Toft-Petersen, P. Steffens, M. Boehm, B. Wells, L. Udby, K. Lefmann, A. T. Rømer, *Nature of the magnetic stripes in fully oxygenated La₂CuO_{4+y}*, Phys Rev. B **103**, 045138 (2021) With DTU-Energy, DTU-Physics
- K. Björnson, A. Kreisler, A. T. Rømer, B. M. Andersen, *Orbital-dependent self-energy effects and consequences for the superconducting gap structure in multiorbital correlated electron systems*, Phys Rev B **103**, 024508 (2021)

- A. T. Rømer, P. J. Hirschfeld, B. M. Andersen, *Superconducting state of Sr₂RuO₄ in the presence of longer-range Coulomb interactions*, Phys Rev B **104** 064507 (2021)
- M. H. Christensen, T. Birol, B. M. Andersen, R. M. Fernandes, *Theory of the charge density wave in AV₃Sb₅ kagome metals*, Phys Rev B **104**, 214513 (2021)
- D. Steffensen, A. Kreisel, P. J. Hirschfeld, B. M. Andersen, *Interorbital nematicity and the origin of a single electron Fermi pocket in FeSe*, Phys Rev B **103**, 054505 (2021)
- M. H. Christensen and A. V. Chubukov, *Dynamical vortices in electron-phonon superconductors*, Phys Rev B **104**, L140501 (2021)
- D. Steffensen, B. M. Andersen, P. Kotetes, *Trapping Majorana zero modes in vortices of magnetic texture crystals coupled to nodal superconductors*, Phys Rev B **104**, 174502 (2021)
- T. Qian, M. H. Christensen, C. W. Hu, A. Saha, B. M. Andersen, R. M. Fernandes, T. Birol, N. Ni, *Revealing the competition between charge density wave and superconductivity in CsV₃Sb₅ through uniaxial strain*, Phys Rev B **104**, 144506 (2021)
- X. Y. Wang, M. H. Christensen, E. Berg, R. M. Fernandes, *Strong-coupling expansion of multi-band interacting models: Mapping onto the transverse-field J₁-J₂ Ising model*, Annals of Physics **435**, 168522 (2021)
- D. Chatzopoulous, D. Cho, K. M. Bastiaans, G. O. Steffensen, D. Bouwmeester, A. Akbari, G. Gu, J. Paaske, B. M. Andersen, M. P. Allan, *Spatially dispersing Yu-Shiba-Rusinov states in the unconventional superconductor FeTe_{0.55}Se_{0.45}*, Nature Comm **12**, 298 (2021)
- N. Heinsdorf, M. H. Christensen, M. Iraola, S. S. Zhang, F. Yang, T. Birol, C. D. Bastia, R. Valenti, R. M. Fernandes, *Prediction of double-Weyl points in the iron-based superconductor CaKFe₄As₄*, Phys Rev B **104**, 075101 (2021)

KU, Chemistry (6)

- C. D. Buch, S. H. Hansen, D. Mitcov, C. M. Tram, G. S. Nichol, E. K. Brechlin, S. Piligkos, *Design of pure heterodinuclear lanthanoid cryptate complexes*, Chemical Science **12**, 6983 (2021)
- J. Dreiser, C. Wackerlin, M. Buzzi, K. S. Pedersen, J. Bendix, *Island formation of Er(trensall) single-ion magnets on graphene observed on the micrometer scale*, RSC Advances **11**, 9421 (2021)
- H. M. O'Connor, S. Sanz, A. J. Scott, M. B. Pitak, W. T. Klooster, S. J. Coles, N. F. Chilton, E. J. L. McInnes, P. J. Lusby, H. Weihe, S. Piligkos, E. K. Brechin, *(Cr₈Ni₆II)-Ni-III(n⁺) heterometallic coordination cubes*, Molecules **26**, 757 (2021)
- H. W. L. Fraser, E. H. Payne, A. Sarkar, L. R. B. Wilson, D. Mitcov, G. S. Nichol, G. Rajaraman, S. Piligkos, E. K. Brechin, *(VO-O-IV)₂M-5II M=Ni,Co Anderson wheels*, Dalton transactions **50**, 12495 (2021)
- A. J. Scott, J. Vallejo, A. Sarkar, L. Smythe, E. R. Marti, G. S. Nichols, W. T. Kloster, S. J. Coles, M. Murrie, G. Rajaraman, S. Piligkos, P. J. Lusby, E. K. Brechlin, *Exploiting host-guest chemistry to manipulate magnetic interactions in metallosupramolecular M₄L₆ tetrahedral cages*, Chemical Science **12**, 5134 (2021)
- R. F. Pflieger, S. Schlittenhardt, M. P. Markel, M. Ruben, K. Fink, C. E. Anson, J. Bendix, A. K. Powell, *Terminal ligand and packing effects on slow relaxation in an isostructural set of [Dy(H₂dapp)_{x-2}]⁺ single molecule magnets*, Chemistry – a European Journal **27**, 15085 (2021)

DTU, Physics (7)

- F. L. Durhuus, L. H. Wandall, *Simulated clustering dynamics of colloidal magnetic nanoparticles*, Nanoscale **13**, 1970 (2021)

- M. R. Almind, M. G. Vinum, *Optimized nanoparticle composition for Curie-temperature-controlled induction-heated catalysis*, ACS Applied Nano Materials **4**, 11537 (2021)
- T. Skovhus and T. Olsen, *Dynamic transverse magnetic susceptibility in the projector augmented-wave method: Application to Fe, Ni, and Co*, Phys Rev B **103**, 245110 (2021)
- T. Olsen, *Unified treatment of magnons and excitons in monolayer CrI₃ from many-body perturbation theory*, Phys Rev Lett **127**, 166402 (2021)
- T. Olsen, *Magnetic anisotropy and exchange interactions of two-dimensional FePS₃, NiPS₃, and MnPS₃ from first principles calculations*, J. Phys. D, **54**, 314001 (2021)
- T. Rauch, T. Olsen, D. Vanderbilt, I. Souza, *Mirror Chern numbers in the hybrid Wannier representation*, Phys Rev B **103**, 195103 (2021)
- Z. Z. Qiu, M. Holwill, T. Olsen, P. Lyu, J. Li, H. Y. Fang, H. M. Yang, M. Kashchenko, K. S. Novoselov, J. Lu, *Visualizing atomic structure and magnetism of 2D magnetic insulators via tunneling through graphene*, Nature Comm **12**, 70 (2021)

DTU, Chemistry (2)

- H. Chen, L. Voigt, M. Kubus, D. Mihrin, S. Mossin, R. W. Larse, S. Kegnæs, S. Piligkos, K. S. Pedersen, *Magnetic Archimedean tessellations in metal-organic frameworks*, J. Am. Chem. Soc. **143**, 14041 (2021) [With KU-Chemistry](#)
- L. Voigt, R. W. Larsen, M. Kubus, K. S. Pedersen, *Zero-valent metals in metal-organic frameworks fac-M(CO)₃(pyrazine)_{3/2}*, Chemical Communications **57**, 3861 (2021)

AAU, SDU, and RUC had no Q-MAT related publications in 2021.

B.2 Publications related to Q-MAT topics, 2022

AU Chemistry (5)

- * J. Thomas-Hunt, A. Povlsen, H. Vijayan, C. G. Knudsen, F. H. Gjørup, M. Christensen, *Alignment of strontium hexaferrite, by cold compaction of anisotropic non-magnetically interacting crystallites*, Dalton Trans., 51, 3884 - 3893 (2022)
- * H. Vijayan, A. Povlsen, J. Thomas-Hunt, M. Mørch, M. Christensen, *Exploiting different morphologies of non-ferromagnetic interacting precursors for preparation of hexaferrite magnets*, J. Alloys Compd., 915, 165333 (2022)
- O. T. L. Traistaru, P. Shyam, M. Christensen, and S. P. Madsen, *Optimizing the energy product of exchange-coupled soft/hard Zn_{0.2}Fe_{2.8}O₄/SrFe₁₂O₁₉ magnets*, J. Appl. Phys. **132**, 163904 (2022)
- K. Henry, J. Voldum Ahlburg, H. L. Andersen, C. Granados-Miralles, M. Stingaciu, M. Saura-Múzquiz, M. Christensen, *In-depth investigations of size and occupancies in cobalt ferrite nanoparticles by joint Rietveld refinements of X-ray and neutron powder diffraction data*, J. Appl. Cryst., **55**, 1336-1350 (2022)
- P. Shyam, M. Mørch, A. Z. Eikeland, J. Ahlburg, A. Mamakhel, M. Saura-Múzquiz and M. Christensen, *Combined characterization approaches to investigate magnetostructural effects in exchange-spring ferrite nanocomposite magnets*, Mater. Chem. Front., **6**, 2422-2437 (2022)

KU, NBI (9)

- * C. N. Breiø, P. J. Hirschfeld, and B. M. Andersen, *Supercurrents and spontaneous time-reversal symmetry breaking by nonmagnetic disorder in unconventional superconductors*. Phys. Rev. B **105**, 014504

- * U. B. Hansen, O. F. Syljuåsen, J. Jensen, T. K. Schäffer, C. R. Andersen, J. A. Rodriguez-Rivera, N. B. Christensen, and K. Lefmann, *Magnetic Bloch Oscillations and domain wall dynamics in a near-Ising ferromagnetic chain*, Nature Communications 13, 2547 (Published 10 May 2022) [With DTU-Physics](#)
- Andreas Kreisel, Yundi Quan, P. J. Hirschfeld, *Spin triplet superconductivity driven by finite momentum spin fluctuations*, Phys. Rev. B 105, 104507 (2022)
- Chaofei Liu, Andreas Kreisel, Shan Zhong, Yu Li, Brian M. Andersen, P. J. Hirschfeld, Jian Wang, *Orbital-Selective High-Temperature Cooper Pairing Developed in the Two-Dimensional Limit*, Nano Lett. 22, 3245, (2022)
- Andreas Kreisel, P. J. Hirschfeld, Brian M. Andersen, *Theory of spin-excitation anisotropy in the nematic phase of FeSe obtained from RIXS measurements*, Frontiers in Physics 10, 859424 (2022)
- Andreas Kreisel, Brian M. Andersen, Astrid T. Rømer, Ilya M. Eremin, Frank Lechermann, *Superconducting Instabilities in Strongly-Correlated Infinite-Layer Nickelates*, Phys. Rev. Lett. 129, 077002 (2022)
- Astrid T. Rømer, T. A. Maier, Andreas Kreisel, P. J. Hirschfeld, Brian M. Andersen, *Leading superconducting instabilities in three-dimensional models for Sr₂RuO₄*, Phys. Rev. Research 4, 033011
- Mercè Roig, Astrid T. Rømer, Andreas Kreisel, P. J. Hirschfeld, Brian M. Andersen, *Superconductivity in multiorbital systems with repulsive interactions: Hund's pairing vs. spin-fluctuation pairing*, Phys. Rev. B 106, L100501 (2022)
- Yu Li, Dingyu Shen, Andreas Kreisel, Cheng Chen, Tianheng Wei, Xiaotong Xu, Jian Wang, *Anisotropic gap structure and sign reversal symmetry in monolayer Fe(Se,Te)*, Nano Lett. 2022,

KU, Chemistry (7)

- Prakash, O.; Lindh, L.; Kaul, N.; Rosemann, N. W.; Losada, I. B.; Johnson, C.; Chábera, P.; Ilic, A.; Schwarz, J.; Gupta, A. K.; Uhlig, J.; Ericsson, T.; Häggström, L.; Huang, P.; Bendix, J.; Strand, D.; Yartsev, A.; Lomoth, R.; Persson, P.; Wärnmark, K.: *Photophysical Integrity of the Iron(III) Scorpionate Framework in Iron(III)–NHC Complexes with Long-Lived 2LMCT Excited States*. Inorganic Chemistry 2022, 61, 17515-17526.
- Tasić, M.; Ivković, J.; Carlström, G.; Melcher, M.; Bollella, P.; Bendix, J.; Gorton, L.; Persson, P.; Uhlig, J.; Strand, D.: *Electro-mechanically switchable hydrocarbons based on [8] annulenes*. Nature Communications 2022, 13, 860.
- Bonde, N. A.; Appel, M.; Ollivier, J.; Weihe, H.; Bendix, J.: *Unequal sensitivities of energy levels in a high-symmetry Ho³⁺ complex towards lattice distortions*. Chemical Communications 2022, 58, 7431-7434.
- Buch, C. D.; Kundu, K.; Marbey, J. J.; van Tol, J.; Weihe, H.; Hill, S.; Piligkos, S.: *Spin–Lattice Relaxation Decoherence Suppression in Vanishing Orbital Angular Momentum Qubits*. Journal of the American Chemical Society 2022, 144, 17597-17603.
- Kragoskow, J. G. C.; Marbey, J.; Buch, C. D.; Nehrkorn, J.; Ozerov, M.; Piligkos, S.; Hill, S.; Chilton, N. F.: *Analysis of vibronic coupling in a 4f molecular magnet with FIRMS*. Nature Communications 2022, 13, 825.
- Wilson, L. R. B.; Coletta, M.; Evangelisiti, M.; Piligkos, S.; Dalgarno, S. J.; Brechin, E. K.: *The coordination chemistry of p-tert-butylcalix[4]arene with paramagnetic transition and lanthanide metal ions: an Edinburgh Perspective*. Dalton Transactions 2022, 51, 4213-4226.
- N. P. L. Magnard, A. S. Anker, O. Aalling-Frederiksen, A. Kirsch, K.M.Ø. Jensen. *Characterisation of intergrowth in metal oxide materials using structure-mining: the case of γ-MnO₂*. Dalton Trans. 2022, 51, 17150

DTU Physics (7)

- T. Skovhus, T. Olsen, H. M. Rønnow. *Influence of static correlation on the magnon dynamics of an itinerant ferromagnet with competing exchange interactions: First-principles study of MnBi*. Physical Review Materials 6, 054402 (2022)
- T. Skovhus, T. Olsen. *Magnons in antiferromagnetic bcc Cr and Cr₂O₃ from time-dependent density functional theory*. Physical Review B 106, 085131 (2022)
- A.B. Kademane, C. Bhandari, D. Paudyal, S. Cottrell, P. Das, Y. Liu, Y. Yiu, C. M. N. Kumar, K. Siemensmeyer, A. Hoser, D. L. Quintero-Castro, D. Vaknin, R. Toft-Petersen, *Magnetization reversal driven by electron localization-delocalization crossover in the inverse spinel Co₂VO₄*, Physical Review B **105**, 094408 (2022).
- Q. Wang, K. v. Arx, D. G. Mazzone, S. Mustafi, M. Horio, J. Küspert, J. Choi, D. Bucher, H. Wo, J. Zhao, W. Zhang, T. C. Asmara, Y. Sassa, M. Månsson, N. B. Christensen, M. Janoschek, T. Kurosawa, N. Momono, M. Oda, M. H. Fischer, T. Schmitt, J. Chang, *Uniaxial pressure induced stripe order rotation in La_{1.88}Sr_{0.12}CuO₄*, Nat. Commun. **13**, 1795 (2022).
- J. Choi, Q. Wang, S. Jöhr, N. B. Christensen, J. Küspert, D. Bucher, D. Biscette, M. H. Fischer, M. Hücker, T. Kurosawa, N. Momono, M. Oda, O. Ivashko, M. v. Zimmermann, M. Janoschek, J. Chang, *Unveiling Unequivocal Charge Stripe Order in a Prototypical Cuprate Superconductor*, Physical Review Letters **128**, 207002 (2022).
- R. Frison, J. Küspert, Q. Wang, M. v. Zimmermann, M. Meven, D. Bucher, J. Larsen, Ch. Niedermayer, M. Janoschek, T. Kurosawa, N. Momono, M. Oda, N. B. Christensen, J. Chang, *Crystal symmetry of stripe ordered La_{1.88}Sr_{0.12}CuO₄*, Phys. Rev. B **105**, 224113 (2022).
- G. Simutis, J. Küspert, Q. Wang, J. Choi, D. Bucher, M. Boehm, F. Bourdarot, M. Bertelsen, C. N. Wang, T. Kurosawa, N. Momono, M. Oda, M. Månsson, Y. Sassa, M. Janoschek, N. B. Christensen, J. Chang, D. G. Mazzone, *Single-domain stripe order in a high-temperature superconductor*, Commun. Phys. 5, 296 (2022)

AAU, DTU Chemistry, SDU, and RUC had no Q-MAT related publications in 2022.

C. Patents related to Q-MAT topics.

Mogens Christensen and Harikrishnan Vijayan Pillai, *Enhanced magnetic properties through alignment of non-magnetic constituents*, EU no. 20201547.5 (2021)

Mogens Christensen, Anna Zink, Eikeland and Harikrishnan Vijayan Pillai, *Enhanced magnetic properties through hard-hard magnets*, (Jun. 2022)

D.1 Student degrees 2021

Ph.D. degrees

AU

Jennifer Hölscher, *Understanding the Relationship Between Synthesis, Structure and Properties of Magnetic Nanoparticles*, Mar. 2021

KU NBI (with SDU)

Sofie Janas, *Neutron spectroscopy studies of geometrically frustrated antiferromagnets*, Mar. 2021

KU NBI

Jacob Lass, *Neutron scattering and data treatment of CAMEA-like back-ends*, Jan. 2021

Ana-Elena Tutuenu, *Magnetic structure, and dynamics of cuprate superconductors studied by neutron scattering*, Jan 2021

DTU, Physics

Wenjie Wan, *Spectroscopy Study of Low-dimensional Quantum Magnets*, Dec. 2021.

SDU

Anders Bruhn Arndal Andersen, *The Atomic Level Structure of Layered Double Hydroxides*, Sept. 2021

M.Sc. degrees

AU

Cecilie Grønvaldt Knudsen, *Alignment of W-type hexaferrite by compaction of anisotropic non-magnetic crystallites*, June 2021

KU, NBI (with SDU)

Mathilde Borup Sørensen, *2D Quasi-Elastic Magnetic Scattering in Deuterium Jarosite*, Dec. 2021

Rasmus Tang Christensen, *Studies of the magnetic properties of Al(OH)₃-based layered double hydroxides*, Jan. 2021

Sidse Lærke Lolk, *Frustrated magnetism in Cr-jarosite*, Dec. 2020

KU, NBI (with ESS)

Morten Lunn Haubro, *Neutron scattering studies of spin-ice material Ho₂Ti₂O₇ under uniaxial pressure*, Dec. 2020

KU, NBI

Kris Marco Hoffmann, *RExact simulations of Azurite*, Nov. 2021

Jonas Hyatt, *Experimental AC susceptometry*, Nov. 2021

Estrid Buhl Naver, *Simulations of anisotropy effects of classical spin dynamics in frustrated magnets at finite temperatures*, June 2021

B.Sc. degrees

KU, NBI

Thomas Sahl Christensen, *High temperature superconductors in cryogenic environment*, Sept. 2021

Camilla Holm Sørensen, *Underdoped LSCO with Zn and Mn impurities*, June 2021

D.2 Student degrees 2022

Ph.D. degrees

AU

Frederik Holm Gjørup, *Understanding the Compaction of Nanopowders Through Neutron and X-ray diffraction*, Aug. 2022

Anna Zink Eikeland, *Tailoring the properties of ferrite nanoparticles*, June 2022

KU NBI (with ESS)

Lise Ørdu Sandberg, *Tuning magnetic frustration in titanates by applied pressure* (co-supervisor: Pascale Deen, ESS), June 2022

KU, Chemistry

Niels Andreas Bonde, *Dynamics of Crystalline Paramagnets*, Oct. 2022.

M.Sc. degrees

AU

Jens Plum Frandsen, *Synthesis and properties of W-type hexaferrite*, Dec. 2022.

Jacob Svane, *Development and investigation of novel solid salt matrix synthesis of SrFe₁₂O₁₉*, June 2022.

KU, NBI

Chrystalla Knekna, *Band structure of Mn₃Ge*, Dec. 2022

Timo Vinke, *Classical spin simulations with ClassiC*, June 2022

Cedric Qvistgaard, *Electron doped superconductors*, June 2022

Irene Sanlorenzo, *Superconductivity in LaPt₂Si₂*, April 2022

DTU Physics

Lise Grüner Hanson **XX, XX** 2022

B.Sc. degrees

AAU

Hamilton Delaney Miller, Magnus Stegenborg Hegelund and Thomas Steinfeldt Nielsen, *An STM study of Cobalt Oxides on Au (111)*, June 2022

KU NBI with ESS

Ian Bendix McKenzie, *Spin waves in frustrated GAG in a field*, June 2022

Simon K. K. Ørgaard and Frederik A. S. Philipsen, *Spin simulations on GAG*, June 2022

Timmy Sode Anker *Frustrated magnetism in ortho-niobates*, June 2022

KU NBI with DTU Physics

Thomas Bukholt Hansen and Peter Jacob Stensgaard Bech, *Neutron studies of frustrated h-YMnO₃*, June 2022

DTU Physics with ESS

Nicolai Lindaa Amin, Joakim Hoff-Møller, Ida Skøt Støvring, *Simulation of the ESS spectrometer BIFROST*, June 2022