

# VILLUM FONDEN



## QUSCOPE Annual Report 2018

### Details

Programme: Villum Foundation Centre of Excellence  
 Grant number: VKR023372  
 Project title: QUSCOPE, Quantum Scale Optical Processes  
 Name: Klaus Mølmer  
 University/institution: Aarhus University  
 Department/section: Physics and Astronomy  
 ORCID:  
 Grant received in year: 2014

### People

Name	Position	Number of months employed (e.g. 12 months)	Funded by VILLUM FONDEN (%)	Nationality (e.g. American)	Gender (M/F)
Klaus Mølmer	Professor	12	0	Danish	M
Lars Bojer Madsen	Professor	12	0	Danish	M
Thomas Garm Pedersen	Professor	12	0	Danish	M
Mahmoud Abu-samha	Guest Professor	2½	100	Palestinian, Jordanian	M
Chuan Yu	Postdoc	10	100	Chinese	M
Yuan Zhang	Postdoc	9	100	Chinese	M
Felix Motzoi	Postdoc	2	100	Canadian	M
Sudip Sasmal	Postdoc	5	100	Indian	M
Albert Benseny Cases	Postdoc	9	100	Spanish	M
Alireza Taghizadeh	Postdoc	12	100	Iranian	M
Fábio Hipólito	Postdoc	12	100	Portuguese	M
Eliska Greplova	Research Assistant	1	100	Czech	F
Jinglei Zhang	Research Assistant	3	100	Italian	F
Jinglei Zhang	PhD Student	3½	100	Italian	F
Jørgen Johansen Rørstad	PhD Student	11	100	Norwegian	M
Philip Blocher	PhD Student	12	100	Danish	M
Alexander Kiilerich	PhD Student	10,5	100	Danish	M
Kenneth Hansen	PhD Student	8,5	100	Danish	M
Enok Johannes Haahr	PhD Student	12	100	Danish	M
Farzad Bonabi	PhD Student	½	100	Iranian	M
Jonas Have	PhD Student	12	100	Danish	M
Hossein Irvani	Guest PhD Student	2	100	Iranian	
Grete Flarup	Administration	12	25	Danish	F
Niels Carl Hansen	Systems administrator	12	25	Danish	M

## Educational activities

Please list educational activities that the above-mentioned 'People' have contributed to, including PhD courses, courses at master and bachelor levels. Also list summer schools and courses given abroad. Please state ECTS points (if possible) and length of the course (in hours).

Title of activity	ECTS	Length of course
Atomic Molecular and Optical Physics II	10	1 semester
Ultrafast Science	5	1 semester
Generel Mekanik og Termodynamik	5	1 semester
Linear Algebra	5	1 semester
Project for master students: Funktionelle nanostrukturer - NFM2	10	13 weeks ~50 hours
Project for master students: Fysikkens anvendelser: Teoreti - FYS7-projekt	10	13 weeks ~50 hours
Supervisor for a group of 4th semester physics students	10	~50 hours
Supervisor for a group of 4th semester nano students	10	~40 hours
Didactical issues in Physics" for 7th semester physics students	5	168 (12 lectures * 14 hours pr lecture, including preparation)
Optical properties of Silicon	10	~60h
Electronic and optical properties of nanoribbons	10	~60h
Quantum Engineering II	10	1 semester
Mekanik og Termodynamik	10	1 semester
Quantum Mechanics (Teaching Assistant)	10	1 semester 66/187
Atomic and Molecular Physics (Teaching Assistant)	5	1 semester 28/70

Please list the number of Master Graduates and Bachelor Graduates supervised.

Number of Master Graduates	Number of Bachelor Graduates
3	2

## Project

### 1) Project abstract (VILLUM Young Investigators only) in English

### 2) Project status

In 2018, QUSCOPE has seen the successful completion of a number of PhD projects supervised under the Villum Center grant. The students have been deeply engaged in the fulfilment of our research plan in the past 3-4 years, and we are happy to see almost all of them continue in academic research positions around the world. During 2018, the group of postdocs employed by QUSCOPE has been decreasing in size, and some postdocs have been gradually transferred to other research grants. Throughout the project, we supplemented the QUSCOPE Center grant with separate funding by participating in international collaborations. The Center grant gave us critical mass and made us attractive partners in highly ambitious and stimulating projects.

We are grateful for the extension until end of 2019 of the period in which we may spend the funding from the Villum Foundation. This enables us to attract new grants and enter new projects at full speed and with minimal loss of competences in our groups.

The research follows the themes of our original proposal. While direct collaboration of the three research groups has been limited, two groups have published a joint article in Nature, Scientific Reports, and discussions among the partners have led to transfer of ideas and methods and have inspired some of our most innovative research, while being eventually carried out within the separate teams.

As anticipated in our report from 2017, the partial transfer of budget from 2018 to 2019 and the accompanying reduction in postdoc person months has had only moderate influence on our scientific output. We have thus published 41 articles, (including 2 in the Nature family, 4 in Physical Review Letters, and 6 in Physical Review B) – three of our articles received special editorial mentioning.

Main QUSCOPE contributions in 2018 include: analyses of superradiant lasing with record low phase noise; collective emission into optical and plasmonic radiation modes; non-linear optical and spin-optical effects in graphene; extension of theory of high-harmonic generation in gases towards discovery of entirely new optical phenomena in solids; new optical schemes for quantum computing and communication between spatially separate qubits; exciton dynamics in monolayer materials; a fully developed theoretical framework for attosecond photoionization.

Please consult <http://phys.au.dk/forskning/forskningsomraader/quscope/> for a complete overview of center publications, staff and activities.

2018 also brought new and exciting outreach activities, including large audience public talks, conferences with musicians; a publication in a Musicology journal, and a presentation to initialize collaboration with the School of Ballet, The Royal Theatre. (See our special Outreach page on the QUSCOPE website for more information).

### **3) Challenges in 2018**

All research groups in QUSCOPE try to keep a high level of activity while the funding from the Center grant is gradually expiring. We face the same challenges as all our colleagues to acquire funding for our continued research, and, in particular, to attract long term funding that allows recruitment of PhD students.

### **4) Planned project activities in 2019**

The research plans for 2019 largely constitute finishing of projects with outgoing postdocs, consolidation of activities with external partners developed over the project period, and leveraging of the QUSCOPE efforts by transfer of staff and know-how to projects continued with new funding.

While further recruitment is now only possible through new grants, the new students and postdocs joining the research groups will still be incorporated in and contribute to the activities of the QUSCOPE Center of Excellence until the end of 2019.

### **Contact at VILLUM FONDEN**

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