About QS$^3$: Quantum Computing, Quantum Materials, Quantum Devices

The Quantum Leap: Leading the Next Quantum Revolution

Quantum Materials

Quantum devices

The QS³ is an annual summer school with the mission of training graduate students and postdocs in physics, chemistry, engineering, mathematics, materials science, computer science and related fields for the next "quantum revolution."

\[ |\text{Quantum Scientist}\rangle = C_1 |\text{Materials & Chemistry}\rangle + C_2 |\text{Engineering}\rangle + C_3 |\text{Physics}\rangle + C_4 |\text{Computer Science}\rangle \]

Theory, Experiment, Simulation, Algorithm, Application

Image Credit: L. Ye
Example of Quantum Leap: Computing

http://www.nobelprize.org/educational/physics/transistor/

Modern Classical Computers: Product of 20\textsuperscript{th} Century Quantum Leap
Example of Quantum Leap: Computing

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Modern Classical Computers: Product of 20th Century Quantum Leap
Example of Quantum Leap: Computing

Modern Classical Computers: Product of 20th Century Quantum Leap

Quantum Computation Product of 21st Century Quantum Leap

http://www.nobelprize.org/education/physics/translator/

MIT news / Vuletic
Modern Synthesis of Quantum Materials

Quantum Materials

- Electron
- Photon
- Cooper pair
- Spin
- Valley
- Exciton
- Magnon
- Zero modes

- Topological edge states
- Topological photonics
- Topological spintronics
- Majorana zero modes
- Topological superconductivity
- Topological quantum computing

Light-Matter States
- 2D materials
- Bulk Crystals
- Moiré Systems
- Oxides
- Thin films
- Electrochemical Materials
### School Outline

#### Week 1: July 18-22

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday 18</th>
<th>Tuesday 19</th>
<th>Wednesday 20</th>
<th>Thursday 21</th>
<th>Friday 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:40-9:00</td>
<td>Opening</td>
<td></td>
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<tr>
<td>9:00-10:00</td>
<td>Narang I</td>
<td>Narang II</td>
<td>Jin I</td>
<td>Jin II</td>
<td>Stemmer I</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
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<tr>
<td>10:30-11:30</td>
<td>Dean I</td>
<td>Dean II</td>
<td>Searles I</td>
<td>Searles II</td>
<td>Wilson I</td>
</tr>
<tr>
<td>11:30-13:30</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:30-15:00</td>
<td>Crystal Modeling A</td>
<td>Crystal Modeling B</td>
<td>Open Lab Visits (13:30 - 16:00)</td>
<td>Active Learning 1 (13:30 - 16:00)</td>
<td>Hands-on (13:30 - 16:00)</td>
</tr>
<tr>
<td>15:00-16:00</td>
<td>Introductions</td>
<td>Poster Talks 1</td>
<td></td>
<td>Group Photo</td>
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#### Week 2: July 25-29

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday 25</th>
<th>Tuesday 26</th>
<th>Wednesday 27</th>
<th>Thursday 28</th>
<th>Friday 29</th>
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<tbody>
<tr>
<td>9:00-10:00</td>
<td>Stemmer II</td>
<td>Mitrano I</td>
<td>Mitrano II</td>
<td>Faison II</td>
<td>Cano II</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>10:30-11:30</td>
<td>Wilson II</td>
<td>Karunadasa I</td>
<td>Karunadasa II</td>
<td>Cano I</td>
<td>School Summary</td>
</tr>
<tr>
<td>11:30-13:30</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:30-15:00</td>
<td>Hands-on (13:30-16:00)</td>
<td>Zheng</td>
<td>Faison I (13:30 - 14:30)</td>
<td>Active Learning 2</td>
<td></td>
</tr>
<tr>
<td>15:00-16:00</td>
<td>Poster Talks 2</td>
<td>Industry Panel (14:30-16:30)</td>
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#### Activities
- **21 lectures** (Elings Hall)
- **2 poster sessions** (with hors d’oeuvres)
- **1 visits** to faculty labs (see participating list)
- **2 facility tour/hands-on activities** (TBD)
  - **2 active learning sessions**
  - **1 panel discussion** (Industry)
- **1 picnic** at the Beach

• Hands-on activities (July 22 and 25, see schedule, grouping and meeting place on website)
• Poster sessions (July 19 and 26, outside Elings Hall)
• Group photo (July 21, after active learning)
Please Submit Designs for our School T-shirt

Fast Turnaround: Please submit art by end of Monday

Selected Designs will be shared for voting by lunch Tuesday

Please fill out Google form for shirt ASAP
Questions, Exchanges and Feedback

Ask questions throughout lectures and the entire school

- Active Learning Sessions (Thursday afternoons)
  Informal discussions
  Recap lecture points
  Go deeper in your thinking
  Stimulate connections between subjects

- Panel discussions on Wednesday July 27
  Submit questions to our (mostly) industry panelists before Tuesday night.

- Feedback and input for the future
  Fill out the questionnaire
Location: University of California, Santa Barbara

- Established 1944
- One of 9 UC campuses
- 24,000 students @ UCSB

Founded at Penn State in 1973
Research Centers and Facilities

UC SANTA BARBARA Quantum Foundry
DMR-1906325

UC SANTA BARBARA Kavli Institute for Theoretical Physics

UC SANTA BARBARA MRL Materials Research Laboratory

Local industry efforts: Microsoft + Google both in Goleta
(Some) Quantum Materials and Devices at UCSB

Ania Jayich: Quantum defects
Galan Moody: Nanophotonics
Stephen Wilson: Material synthesis Scattering
Dirk Bouwmeester: Optomechanics

Andrea Young: Van der Waals heterostructures
Chenhao Jin: Optics, TMDs
Susanne Stemmer: Oxide MBE TEM
Chris Palmstrom: MBE Heteroepitaxy
Where to go over the weekend

Old Mission

Stearn’s Wharf

Channel Islands National Park

Botanic Garden
Questions?

Organizers

Joe Checkelsky (MIT)
Natalia Drichko (JHU)
Liang Fu (MIT)
Kyle Shen (Cornell)
Stephen Wilson (UCSB)
Andrea Young (UCSB)
Jun Zhu (PSU)

Modern Synthesis of Quantum Materials

Program Details:

Summary Schedule

Detailed Schedule

Questions (including Reimbursements):

Kelsey Leonard Moore

cnsi-qf-admin@ucsb.edu
Software to Install


During coffee break, make sure you can connect to wifi
- Need this from 2pm for crystal modeling
- If there are any issues, ask organizer during coffee or lunch
Jen Cano
Cory Dean
Joe Falson
Chenhao Jin
Hema Karunadasa
Matteo Mitrano
Pri Narang
Thomas Searles
Susan Stemmer
Stephen Wilson
Kent Zheng