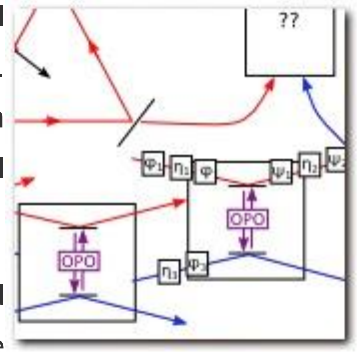
QUANTUM INFORMATION AND CONTROL



Quantum computers may seem a long way off, but conventional computers will probably become "quantum" in the next decade or two. Already, microprocessor circuits have become small enough for quantum effects to come into play, and as chips are scaled down, these effects will become more and more important.

Nanophotonics is a promising approach to scale up computing beyond the inherent limitations of silicon electronics. But in order to be competitive with silicon, photonic logic elements must operate in the quantum regime (tens of photons). In this regime, classical mechanics breaks down completely and the logic gates must be simulated as full quantum systems.

As the field of nanophotonics matures, people will move from building *individual devices* to building*circuits* – multiple photonic devices linked together. A quantum analog of "control theory" and "circuit theory" will be needed to confront the challenges of designing, simulating and controlling the behavior of these intrinsically quantum circuits.

Looking out to the more distant future, engineers will be interested in designing fully quantum computers. A coherent theory of quantum circuits will be even more important in this regime, from the lowest levels in the computer architecture (bits, gates, error correction) to the highest levels (processes and algorithms).

Find out more at the Mabuchi Lab Homepage »

Teaching

Teaching physics is a good way to learn physics – and even if you fully understand it, teaching is a good way to learn how other people think and learn. Plus, it teaches one good presentation and communication skills, which matter outside the classroom.

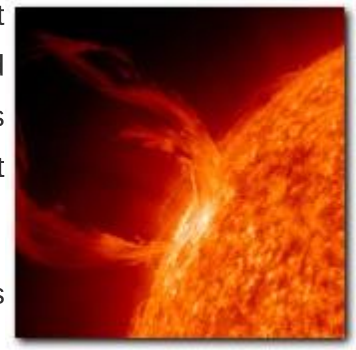
I was a teaching assistant for several physics courses, including:

- ♣ Ph 107 — Intermediate Physics Lab (David Goldhaber-Gordon, Rick Pam)
- ♣ Ph 46 — Heat & Light Lab (Ramendra Bahuguna, Giorgio Gratta, Chaya Nanavati)

- ♣ Ph 43 — Electromagnetism (I. Fisher, C. Nanavati)
- ♣ Ph 21 — Mechanics and Heat (Peter Michelson)

I have also tutored high-school students in the Bay Area in pre-calculus, calculus, physics, chemistry, and computer science. Location and time are flexible. Contact me for more information.

Past Stanford Research



At Stanford, physics students rarely start their thesis research their first quarter. Instead, they go through a series of "rotations" to get aquainted with different research groups or fields of physics. The rotation process can take as long as a year, and students tend to rotate with a different advisor each quarter.

During fall quarter, I rotated with the Bucksbaum Group, which does research into the atomic and molecular physics of ultrafast laser pulses. Professor Bucksbaum, who leads the group, is director of the PULSE Institute, a broader collaboration of ultrafast research groups. I was involved in studying a phenomenon called *High Harmonic Generation*, in which an extremely intense laser pulse excites a gaseous sample and emits a coherent pulse train of soft X-rays. These X-ray pulses are mere attoseconds long, short enough to probe the electronic motion in excited atoms.

During winter quarter, I rotated with with Phil Scherrer in Stanford's Solar Physics group. A technique called *helioseismology* allows us to map out the interior of the Sun by watching its surface oscillations. Current measurements show that the sound speed in the Sun's core is roughly a percent lower than models predict – a statistically significant difference. However, the models neglected dark matter, which accumulates inside the Sun and can self-annihilate to heat the solar interior. I am working on incorporating dark matter into the solar simulation models. A paper by Cumberbatch et al. has shown that the effect is not negligible, and is roughly large enough to explain the discrepancy.

Our helioseismology results were submitted to the proceedings of teh 61st Fujihara Seminar. See Hamerly & Kosovichev, arXiv:1110.1169.

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