Statement of teaching interests

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For me, teaching is an important component of an academic career. As a physicist I am motivated not only by the "pleasure of finding things out," but also explaining them to others. I receive great intellectual pleasure from explaining physical concepts and seeing students understand them. I feel that it is essential to keep students involved in the subject, and convey to them not just the information but the concepts and thought processes that make up physics. In this document I will begin by presenting what physics education means to me, next I will describe my teaching philosophy, finally I will suggest some upper level courses that I would like to teach.

What physics education means to me

To answer the question of how should one teach physics, it is important to first ask what exactly is physics education? When I just started learning about quantum mechanics, prof. Bersuker told us the famous quote of Einstein, that *Education is what remains after one has forgotten what one has learned in school*. This quote summarizes both what education is and is not. Many people outside of physics feel that physics education is about memorizing formulas, but this is certainly not the case. Especially in the information age, any competent student can either look up or re-derive the formulas of our science, so education is not really about that. What is important, is having students learn and internalize the methods and concepts of physics. As highlighted by the infamous "Force Concepts Inventory," many students go through physics classes and learn quite well how to manipulate formulas without ever grasping the concepts behind those formulas[1]. Being able to understand the basic concepts like forces and fields, how they are related to the real world, and how they square with the students perception of the world are the essentials of the undergraduate education.

Teaching philosophy

As a postdoctoral fellow at Harvard and Caltech I had the opportunity to give several lectures on various topics in condensed mater physics. My curiosity about teaching also got me the more formal position of being a teaching fellow, which involved helping prof. Demler run his class on condensed matter physics and its applications to electronic devices. I chose to participate in teaching because I have always been curious about what it is like, whether I would enjoy it, and if my students would understand what I was talking about. Although my experience is very limited, I really did enjoy the opportunities that I got, and hopefully "my students" learned something about quantum mechanics, BCS theory, quantum dots, and phase transitions in two dimensions.

My teaching philosophy is that it is essential to keep students interested and involved, as the point of education is for students to understand the material. One of the key tools is getting more feedback from the students and adjusting accordingly. In my limited experience, I have found that it beneficial to actively encourage students to keep asking questions during the lectures as well as asking them questions myself. One useful strategy that I would like to try, especially in introductory classes, is the interactive teaching method as advocated by prof. Mazur, at Harvard. The point of the method is to take a break from lecturing every so often and get students to discuss conceptual questions and work out model problems in small groups. The effect of this is two fold (1) there is instant feedback on what the students do not understand and (2) discussion with peers helps to transfer the knowledge from students that have already grasp it to those students that are not quite there yet. Surprisingly, this approach has been made to work even in relatively large classes at Harvard.

Advising philosophy

In my career as postdoc, I have worked with graduate students, both at Harvard (M. Babadi) and Caltech (S. Iyer). Indeed, it has been a pleasure to work with graduate students, to teach them a about physics, and to co-author papers together. In addition to graduate students, I had two opportunities to co-advise undergraduate students.

At Harvard, prof. Eugene Demler asked me to help advise Eric Vernier, who was visiting us for a semester abroad before he started graduate studies at ENS in Paris. The collaboration grew to include prof. Martin Zwierlein at MIT, and proved quite fruitful. At the end of the semester, we published a nice article in Physical Review B, describing Eric's results on bound states of magnetic impurities in ultracold Fermi gases.

While at Caltech, I had the opportunity to participate in Summer Undergraduate Research Fellowship. Over the summer, Doron Bergman (a fellow postdoc), prof. Gil Refael, and I co-advised our undergraduate Sam Goldberg. The goal of our summer research program was to understand phase-slips in topological superconductor, and their implications for the use of topological superconductors for quantum computing. We have now largely achieved this goal, and Sam is working on writing a paper.

Advanced courses

I feel reasonably comfortable in teaching any of the standard introductory courses. In addition, it would be a great pleasure to teach a specialized courses on topics that are close to my research interests for advanced undergraduate and graduate students.

Many-body physics in ultracold atoms

One possible topic would be a course on many-body physics in the context of ultracold atom experiments. In this course I would like to start with the basic concepts of atomic physics that are relevant for ultracold atom experiments like optical trapping and Feshbach resonances. Next, it would be great to discuss topics like Bose-Einstein condensation and the BEC-BCS crossover to introduce the ideas of strong coupling and reinforce the meaning of Feshbach resonance, and experimental probes like time of flight. Moving on, it would be good to introduce the concept of optical lattices which would allow for discussion of one and two dimensional systems, and the Hubbard model. Finally, it would be great to conclude by discussing disorder in the context of ultracold atoms in connection to Anderson localization as well as my own research.

Topics in superconductivity

Another possible topic would be a course on superconductivity that would begin with classical superconductors and progress to high temperature superconductors and iron pnictides. The goal would be to start by covering basic topics that are usually not covered in detail by condensed matter classes including: (1) basic properties of superconductors like the Meissner effect and the isotope effect; (2) the London and Pippard theories of electrodynamics in superconductors; (3) Cooper instability and the BCS theory; (4) Bogoliubov-de Gennes and Andreev equations; (5) Josephson effect; and (6) dirty superconductors. Next, would be a move towards more modern topics including (1) Berezinskii-Kosterlitz-Thouless theory; (2) dissipation in one and two dimensional superconductors (3) unconventional superconductivity; (4) high temperature superconductors; (5) iron-pnictide superconductors.

Concluding remarks

In summary, I am enthusiastic about teaching as well as research. I am looking forward to helping to educate the next generation of physicists and teaching non-physicists to think physically. Finally, I would like to add that teaching people about physics should continue outside of the university, and therefore I am quite interested in participating in outreach to the general public.

[1]D. Hestenes, M. Wells, and G. Swackhamer, The Physics Teacher **30**, 141 (1992).