APHY 650/PHYS 650: Theory of Solids I (Fall 2015)

Location and time: Tuesdays 3:30pm-5:30pm in Becton 508
Web page: See APHY 650 at classesv2.yale.edu
Instructor: Sohrab Ismail-Beigi, sohrab.ismail-beigi@yale.edu, 432-2107
office: Becton 307, email for a meeting or drop by with questions

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A graduate level introduction with focus on advanced & specialized topics. Knowledge of advanced quantum mechanics (Sakurai level) and solid state physics (*Kittel* and *Ashcroft-Mermin* level) is assumed. This course covers the same material normally taught in 856a Theory of Solids I.

The weekly seminar meeting time is for discussion and answering questions, so you should do the reading, study the problem set, and prepare your questions before the meeting. There are weekly problem sets due on Fridays by noon to Sohrab into his mailbox (2nd floor of Becton next to elevators). The course grade is based entirely on the problem sets. Most problem sets are analytical, but some are numerical involving basic matlab/octave (or equivalent) programming that comes with a simple tutorial.

The first seminar meeting is Tuesday September 8th. The first problem set is due Friday September 11th and is already on line. Please sign up on classesv2 ASAP so as to receive emails, readings, and the problem set on time. Readings, problem sets, and solutions will be placed online on "Resources" in classesv2. There will a be a total of 11 problem sets for this course.

Makeups and last class meeting: due to conference travel, class is canceled on Tuesday October 6 and December 1. I may have to move class on Tue Nov 10 to Nov 11 due to travel (but this is not yet decided). The last class meeting is planned to be on Tue Dec 15 during reading period. We will discuss potential makeup times during the first meeting.

Topics covered are:

- Introduction — response functions, elementary excitations, models, approximations.
- Symmetries — translational: Blochs theorem, Brillouin zones; rotational: space & point groups; dispersion relations; k-point sampling: sums & integrals.
- Representations of groups — theorems, examples, applications to crystals.
- Wannier functions — effectives theories, locality, density matrices, O(N) methods.
- Phonons — quantization, symmetries, models, anharmonicity.
- Electronic structure — Density Functional Theory and applications; band structure methods: cellular, APW/KKR, OPW, pseudopotentials, LCAO, wavelets, etc.; modern computational methods for electronic structure.
- Many-body interactions (time permitting) — electron gas, Sommerfeld model, Hartree & Hartree-Fock approximations, correlation, the dielectric function & properties, plasmons.

Useful texts:

My PDF lecture notes (will be distributed during the term).
M. P. Marder, Condensed Matter Physics, Wiley (2000).
C. Kittel, Introduction to Solid State Physics, Wiley (1996).
N. W. Ashcroft & N. D. Mermin, Solid State Physics, Saunders (1976).
W. A. Harrison, Solid State Theory, Dover (1980).
W. A. Harrison Electronic Structure & the Properties of Solids, Dover (1989).
O. Madelung, Introduction to Solid State Theory, Springer-Verlag (1996).
J. M. Ziman, Principles of the Theory of Solids, Cambridge U. Press (1979).
D. Pines, Elementary Excitations in Solids, Perseus (1963).