University of Trieste

Graduate Program in Physics
Lectures on ADVANCED SPECTROSCOPY OF SOLIDS
Prof. FULVIO PARMIGIANI

SCOPE OF THE LECTURES

The scope of these lectures is help the students of our graduate program to build a bridge between the theory (quantum) of condensed matter and the most advanced spectroscopies nowadays available. The matter is extremely vast and complex and probably the barriers to understand these concepts are high. Hence, it is wise to not try to hop them in a single leap.
The lectures are thought for graduate students in experimental condensed matter, having in mind the necessity of providing these students with a clear and possibly simple theoretical back-ground. It is my conviction that this approach is always source and aliment for novelties and creativity.

Although, there are experimental techniques other than those based on light-matter interaction, such as cyclotron resonance, de Haas-van Alphen effect, galvanometric effects, positron annihilation spectroscopy, Compton scattering, etc., the optical spectroscopies, including photoelectric emission, are those that cover, with high accuracy, a much wider range of energy scales, while involving linear and non-linear interactions that can be derived from time-dependent perturbation theory.

With these lectures I will avoid being generic but deep on specific problems. That will probably leave out some important arguments and questions, although I hope the concepts introduced will provide the basic tools (and curiosity) for extending the studies to topics not discussed in the present lecture series.

The lectures are organized in three sections. Each section consists of 32 hours of frontal teaching. I will try keeping the sections self-consistent, although they will be delivered in different semesters.

Finally, I assume a background typical of master studies in condensed matter, as they are organized in the European Universities.

The first set of lectures is devoted to the optical spectroscopies of free electrons, heavy electrons and Kondo systems, along with some relevant collective phenomena.

FIRST SET OF LECTURES
(Key words have capital initials)

1- Maxwell's equations and the Dielectric Function
- 1.1 - Maxwell's microscopic and macroscopic equations
- 1.2 - Formal solution of Maxwell's equations
- 1.3 - Interaction of the light with a medium
- 1.4 - Fourier analysis of the Maxwell's equations
- 1.5 - The Dielectric Tensor.

2- Absorption and Dispersion
- 2.1 - The Drude model for Metals
- 2.2 - Quantum theory of Absorption and Dispersion
- 2.3 - Oscillator Strengths and Sum-Rules

2.4 - The Absorption coefficient, Optical Conductivity and Dielectric Function.

3 - Electrons in Metals

3.1 - Classical theory of free-electrons Metals
3.2 - The classical and anomalous skin effects.
3.3 - The optical properties of the Fermi Surface.
3.4 - Volume and Surface Plasmons
3.5 - Energy Loss spectra.

4 - Heavy fermions and Kondo systems

4.1 - Boson systems and Second Quantization
4.2 - Quantum Statistics at finite temperatures
4.3 - Magnetic Moment and Spin
4.4 - The Kondo effect
4.5 - The Heavy Fermions
4.6 - Extended Drude model and optical spectra.

Lectures Calendar
Meeting Room FERMI BLDG.

2014

December	**day**	**hours**	**December**	**day**	**hours**
1- Monday	15	14-16	6- Monday	20	14-16
2 - Tuesday	16	9-11			
3 - Wednesday	17	9-11			
4 - Thursday	18	9-11			
5 - Friday	19	9-11			

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2015

January	**day**	**hours**	**January**	**day**	**hours**
7 - Wednesday	7	9-11	13 - Monday	19	14-16
8 - Thursday	8	9-11	14-Wednesday	21	9-11
9 - Friday	9	9-11	15 - Friday	23	9-11
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10- Monday	12	14-16	16- Monday	26	14-16
11-Wednesady	14	9-11			
12- Friday	16	9-11			