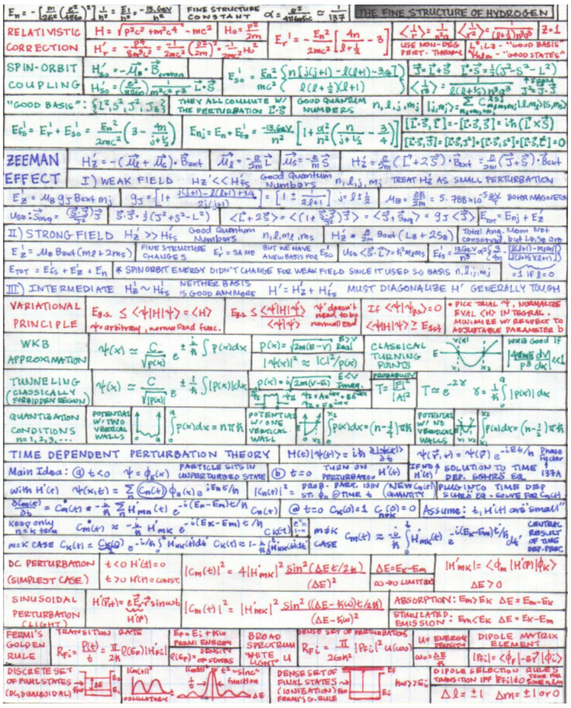
# Quantum Mechanics : Applications to Astrophysics

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## Contact

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## Objectives

During this lecture the students should acquire or activate the following skills: computation rigor, autonomy , work in group , synthesis, pedagogy.

The aim of this lecture is twofold.

First to insure that the Master students will be able to justify in their CV that they have followed this fundamental topic for an astrophysicist career.

Second to give them the theoretical tool to interpret, model and analyze spectroscopic data from astrophysics objects.

## Main progression steps

First part of the lecture (january to march):

the students will have to work by themselves or in group for the resolution of the exercise in the online PDF document. They will have to review their previous knowledge or reach the first level (QM fundamentals) using external sources of their choice and in contacting the supervisor.

Traditional lectures will be given for the second part of the lecture concerning perturbations methods and their applications.

Second part of the lecture (in june):

students will have to prepare and present a lecture on topic linking QM and astrophysics chosen in a list of proposed subjects. The goal is not to make an oral presentation but to make the exercise consisting in preparing and presenting a lecture to a master level class.

## Evaluation

The evaluation will be composed by a written exam and a lecture presentation (oral + documents if necessary).

The written exam will consist of 4 parts : two questions on exercises that are proposed in the online PDF and that have to be searched (any exercise in the PDF doc can be considered),
one exercise on a part of the classical lecture done by the supervisor (demonstration or application),
one exercise using the acquired knowledge but not treated in the PDF or lecture.

A second grade will be obtained after a 30 minute presentation by the student about a chosen lecture among the proposed topics. Pedagogy , mastering of the subject , synthesis will be appreciated from a provided grid of evaluation

The final grade will be the mean of these two examinations

## Example of Bibliography

Pradhan and Nhar : Atomic Astrophysics and Spectroscopy (2011 Cambridge University Press)
Tennyson: Astronomical Spectroscopy (2005 Imperial College Press)
Mc Quarrie : Quantum Chemistry (2007 University Science Books)
Levine : Quantum Chemistry (2009 Pearson Education)
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## Contents

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chapter 1: Do you remember those happy days ? : Review of QM postulates, math and applications

chapter 2: H like atoms : Schrodinger equation in spherical coordinates

chapter 3: Perturbation Theories and Applications

1. Independent Time Perturbations
2. Dependant Time Perturbations
3. Variational Methods
4. Fine Structure of H-like atoms
5. Ground level of He

chapter 4: Matter-Radiation Interaction

1. Maxwell Equation
2. Charged particles and radiations
3. Rayleigh Shrodinger Perturbation

4. Einstein Coefficients
5. Line Intensity and Lifetime of an Excited State *Selection Rules in the dipole Approximation*

## chapter 5: QM and Astrophysics

Among this list (which can change) make a presentation similar to a lecture given to a master level class

1. Zeeman and Starck Effect
2. Scattering and cross section
3. e- ion collision
4. Fine Structure of H-like atoms
5. Photoionization
6. e- ion recombination
7. Multi wavelength emission spectra
8. Stellar properties an spectra
9. Gaseous nebulae and H II regions
10. AGN and Quasars
11. Cosmology