Physics 8164: info regarding term paper or PowerPoint presentation

GENERAL REMARKS AND IMPORTANT DEADLINES

For your term paper (or PowerPoint presentation) there are a variety of topics to choose from. Details are given below. Alternatively, you may propose a topic of your own, but in this case you need to check with Prof. Umar to make sure that the topic is appropriate for this course. I expect about 20 typed pages (including figures, equations, and references) for the term paper or, alternatively, a 25-minute PowerPoint presentation (+5 minute discussion).

You are required to turn in a **one-page abstract, including references** of your term paper or presentation to Prof. Umar no later than **Monday, November 11, 2019**. You may send me an e-mail with the abstract attached as PDF file. In the e-mail, please state whether you prefer to write a paper or give a presentation. After you have turned in your abstract I will provide feedback to each of you.

The **term paper is due on the last day of class** (Monday, Decemeber 4, 2019), and the PowerPoint **presentations will be scheduled during the last week of class** or during the exam period.

LIST OF SUGGESTED TOPICS

Atomic physics

The following paper describes electron localization in atoms and molecules, based on the pair correlation function for fermions:

A. D. Becke and K. E. Edgecombe, J. Chem. Phys., Vol. 92. No.9 (1990), p. 5397-5403

This book by Vanderbilt professor emeritus Charlotte Froese Fischer describes the multi-configuration Hartree-Fock (MCHF) approach for atoms:

Charlotte Froese Fischer, Tomas Brage, and Per Jönsson, "Computational atomic structure: an MCHF approach", Institute of Physics Publ. (1997)

The following papers describe Time-dependent Hartree-Fock (TDHF) calculations of atoms:

a) Multi-electron atom in strong time-dependent laser field, K.C. Kulander, Phys. Rev. A36 (1987) 2726

b) Atomic collision of He + He, K.C. Kulander et al., Phys. Rev. A25 (1982) 2968

Condensed-matter physics, molecular physics, quantum chemistry

Review article (2015) on the history of density functional theory and recent develpments in condensed matter physics and chemistry:

R.O. Jones, Reviews of Modern Physics, Vol. 87, July-September 2015, p. 897-923 (you can download this paper from the "Lectures" section, Chapter 7 of our Website).

check for recent papers by VU condensed-matter theorists (Professors Pantelides and Varga, and their research groups) for static and time-dependent density functional calculations.

Nobel Lecture on superconductivity and superfluidity:

Vitaly L. Ginzburg, Reviews of Modern Physics, Vol. 76, No. 3 (2004), p. 981-998

Nuclear physics: HF, TDHF, and beyond

Detailed review article of time-dependent nuclear mean field theory, from collective vibrations to heavy-ion collisions. Choose any sub-topic you like:

C. Simenel, Eur. Phys. J. A **48**, 152 (2012).

Detailed review article of static nuclear mean field theories and approaches beyond; choose any sub-topic you like:

M. Bender, P.-H. Heenen, and P.-G. Reinhard, Reviews of Modern Physics, Vol. 75, No.1 (2003), pages 121-180

Computational techniques in many-body physics

The following textbook contains numerous projects in Computational Nanoscience:

Kalman Varga and Joseph A. Driscoll, "Computational Nanoscience: Applications for Molecules, Clusters, and Solids", Cambridge Univ. Press 2011

The following article describes the Basis-Spline Collocation method for solving static and time-dependent many-body problems on a 1-D, 2-D, and 3-D lattice:

A.S. Umar, J. Wu, M.R. Strayer and C. Bottcher, Journal of Computational Physics, Vol. 93, No. 2 (1991), p. 426-448

The following article compares various techniques (finite differences, Fourier representation with FFT, Basis Splines) for mean-field problems:

V. Blum, G. Lauritsch, J.A. Maruhn, and P.-G. Reinhard, Journal of Computational Physics, Vol. 100, No. 2 (1992), p. 364-376

Many-body theory at finite temperature: Green's function approach

Reference: Fetter and Walecka, "Quantum Theory of Many-Particle Systems", pages 227 -236 and 241-243.