

International Summer School on
Computational Methods for Quantum Materials
EXAMPLE Exam (Not supposed to know)

Friday, May 31, 2024

1 Superconductivity

Question 1

which of the following statement is **incorrect**?

- a there are many different families of materials where antiferromagnetism and superconductivity appear nearby in the phase diagram.
- b in the high-temperature superconductors, the origin of the pseudogap is hotly debated.
- c charge order was recently discovered in the high-temperature superconductors.
- d superconductivity can be understood in all these materials from bcs theory and cooper pairs.
- e some of the methods discussed in this school have been applied to study unusual superconductivity in some of these materials.

2 ABINIT

Question 2

Which of the following is **wrong**?

- a The number of plane-waves is not a continuous function of the cut-off energy.
- b The number of plane-waves is not a continuous function of the lattice parameter.
- c When working at constant cut-off energy without smearing, the energy curve as a function of the lattice parameter is ragged.
- d The number of plane-waves varies linearly with the cut-off energy.
- e Using a non-zero smearing of the cut-off energy (variable ecutsm in ABINIT), the total energy curve as a function of cut-off energy can be smoothed.

3 TRIQS

Question 3

Which of the following statements about TRIQS is **wrong**?

- a Matplotlib tools for plots are available in TRIQS
- b Once the Green function's in Matsubara frequencies is known, it takes just one line of code to find the density.
- c TRIQS cannot perform sums over Matsubara frequencies without being given an explicit additional information on the high frequency behaviour of the Green function.
- d The Matsubara Green's function whose spectral weight is the semi-circular density of states does not need to be read from a file in HDF5 to be initialized.
- e Pade approximants can be used in TRIQS to perform analytic continuation.

4 General many-body theory

Question 4

Which of the following statements is **wrong** for the fermionic Matsubara Green's function?

- a Its Fourier representation involves only odd multiples of πT .
- b In imaginary time it is periodic.
- c It can be analytically continued to obtain information relevant for photoemission experiments.
- d A time-ordered product comes in its definition.
- e It has a formal expression in Grassmann functional integrals.