Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

❑ posudek vedoucího X posudek oponenta
❑ bakalářské práce X diplomové práce

Autor/ka: Jan Priessnitz
Název práce: *Modeling and study of quasi-two-dimensional magnetic materials*
Studijní program a obor: Physics, Physics of Condensed Matter and Materials
Rok odevzdání: 2023

Jméno a tituly vedoucího/oponenta: Ing. Dominik Legut Ph.D.
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Odborná úroveň práce:
X vynikající ❑ velmi dobrá ❑ průměrná ❑ podprůměrná ❑ nevyhovující

Věcné chyby:
X téměř žádné ❑ vzhledem k rozsahu přiměřený počet ❑ méně podstatné četné ❑ závažné

Výsledky:
X originální ❑ původní i převzaté ❑ netriviální kompilace ❑ citované z literatury ❑ opsané

Rozsah práce:
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Celková úroveň práce:
X vynikající ❑ velmi dobrá ❑ průměrná ❑ podprůměrná ❑ nevyhovující

Slovní vyjádření, komentáře a připomínky vedoucího/oponenta:

Review of the Master thesis "*Modeling and study of quasi-two-dimensional magnetic materials*" by Jan Priessnitz, Charles Univerisity in Prague, Faculty of Mathematics and Physics, Department of condensed matter physics supervised by Dr. Pavel Baláž, Institute of Physics, Czech Academy of Sciences of the Czech Republic.

The thesis contains ca. 57 pages . Theoretical chapters amount to first 24 ones, second half is devoted to the own spin dynamical results first-principles calculations and measurements. The results deal with the magnetic phase transiton (FM vs. AFM) for the various exchange interactions (J) between nearest-neibhors on triangular lattice with varoius strenght of Dzyaloshinskii/Moriya interaction(DMI), magnetic field (H) and later even for temperature dependence.

Number of observables (magnetization, static spin structure factor, susceptibility tensor, heat capacity, hysteresis loop) are presented here that are relevant to describe the temperature dependent magnetic properties. This could serve for realistic description of the micromagnetic simulations of already real and dimensional magnetic materials.

One of the main outcomes is the simulated and analytically derived (physical understanding) of the magnetic phase diagrams for various J, DMI, H. This is then used for the determination of the temperature dependent properties and hysteresis loop and the identifying the linear relation between DMI energy barrier vs coercivity. Many results in this thesis are novel, not published before as this should be done on earliest convenience as the thesis is publicly available. In general this is the only small drawback of this research.

Questions and comments:

1. What will be the role of the damping parameter α on the magnetic phase transitions? Here is taken some average value of 0.05, but in reality there are materials, where it is one order larger or smaller.

2. In metallic systems, but not only, also in some insulating ones (systems with superexchange int.) the next nearest neighbors also play a significant role of J's. Is there any intentation to go beyond nearest-neibhors?

3. Why the model is not suitable for the $EuAl_{12}O_{19}$ compound? How far are the simulated and experimental data far from each other and what quantities were compared?

4. Is there any other system that was compared with experimental data by the student?

5. Why sometimes it is discussed about the experiment instead of simulation? (e.g. page 19th and others). This is interesting.....as other people in community call the these spin dynamics calculations as simulations in general.

Formal things (e.g. typos):

There are almost no typos in the thesis, which is very much appreciated that such large care was taken. Also I highlight that it is written in latex, etc.

p. 28 There is link to non-existing Figure 3.1.1. Author most likely means to refer to Figure 3.10.

Conclusion: This Master thesis is a well handled, bringing not only new reuslts and uderstanding of the strenght of DMI in the various magnetic field directions (M_x, M_z), and temperature in order to define the FM to AFM phase transition (1st and 2nd order), but also explains the decieve factors analytically. In addition, the author found and corrected the bug in the heat bath technique employed in the spin-dynamics code UppsASD as well as developed some other pre and post-processing tools in python. Therefore, I grade the work as "**Excellent**" and recommend **this work** for the Master thesis defense.

Práci
X doporučuji
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uznat jako diplomovou/bakalářskou.

Navrhuji hodnocení stupněm:
X výborně ❑ velmi dobře ❑ dobře ❑ neprospěl/a

In Ostrava, June 1st 2023

Ing. Dominik Legut, Ph.D.

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