Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy v Praze

☐ posudek vedoucího ☒ posudek oponenta
☐ bakalářské práce ☒ diplomové práce

Autor: Štěpán Uxa
Název práce: Magnetooptical Properties of Semiconductor Quantum Structures
Studijní program a obor: Physics, Optics and Optoelectronics
Rok odevzdání: 2009

Jméno a tituly vedoucího/oponenta: Mgr. Nataliya Goncharuk, PhD.
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Odborná úroveň práce:
☒ vynikající ☐ velmi dobrá ☐ průměrná ☐ podprůměrná ☐ nevyhovující

Věcné chyby:
☒ téměř žádné ☐ vzhledem k rozsahu přiměřený počet ☐ méně podstatné četné ☐ závažné

Výsledky:
☐ originální ☒ původní i převzaté ☐ netriviální kompilace ☐ citované z literatury ☐ opsané

Rozsah práce:
☒ veliký ☐ standardní ☐ dostatečný ☐ nedostatečný

Grafická, jazyková a formální úroveň:
☐ vynikající ☒ velmi dobrá ☐ průměrná ☐ podprůměrná ☐ nevyhovující

Tiskové chyby:
☐ téměř žádné ☒ vzhledem k rozsahu a tématu přiměřený počet ☐ četné

Celková úroveň práce:
☒ vynikající ☐ velmi dobrá ☐ průměrná ☐ podprůměrná ☐ nevyhovující

Slovní vyjádření, komentáře a připomínky vedoucího/oponenta:

The master thesis of Mr. Uxa reports on results obtained within research carried out in the Institute of Physics of the Charles University, Faculty of Mathematics and Physics. The aim of the project is theoretical investigation of optical properties of excitons in the GaAs/AlGaAs double quantum well system subject to external electric and magnetic fields. The subject is very interesting. This is still an active research area, both from theoretical and experimental viewpoint. The solid piece of work presented in the thesis of Mr. Uxa gives a valuable contribution to the field.

The core of the thesis lies in Chapters 3 and 4. While the most important results are presented in Chapter 4, Chapter 3 is devoted to systematic presentation of the theoretical methods and approaches used for calculations. The excitonic hamiltonian was constructed with taking into account light/heavy holes, the effect of valence-subband mixing, the Coulomb interaction and the double quantum well confinement for electrons and holes. The right choice of the tight-binding basis allowed the separation of the parallel and perpendicular motion with respect to the double quantum well plane. To simplify the numerical simulations the author chose the parabolic approximation for the Coulomb potential. This substitution introduced the basis composed of the Hermite-Gauss functions with one/two unknown parameters according to the expansion of in-plane components of the wave function. The exciton radius related parameter/parameters were determined by the one/two-dimensional variational method. The advantages and shortages of the variational method and applicability of the chosen basis were extensively described in the text. To improve precision of numerical calculations the basis was extended up to 9th order.

In Chapter 4, the influence of the electric field in the structure growth direction and/or the magnetic field of different orientations (in-plane and perpendicular) on the excitonic energy dispersions, shift of energy levels, absorption and photoluminescence spectra, charge density of the excitonic ground state are discussed. The excitons of different types are classified and identified.

The results obtained for bases of various extensions are compared. The results are qualitatively the same, however, quantitatively they differ, especially for higher energies and/or stronger fields. This was the reason why calculations of optical spectra were performed in the largest possible basis that the program allowed.

The thesis is well written and logically structured, it includes all important details necessary for understanding the text and contains a generally well-chosen list of references. The terminology of the thesis is correct and appropriate. The discussion of the problem is consistent and conceivable. The basic theory is supported by new results and calculations which are conveniently linked to the educational introduction. The calculations can be followed in detail. The figures are of a good quality. Furthermore, the CD-ROM with Fortran program codes for calculations of energy dependencies, optical spectra (absorption and photoluminescence), charge density distribution and other helpful executable applications is attached to the thesis, together with their detailed explanation in the appendices. Providing the theoretical and numerical machinery in a usable and understandable form may be one of the main benefits of the present work as it enables their subsequent use for studying experimental data in future.

I think that author of the thesis is creative personality capable of independent scientific activity. With respect to the new and interesting results presented in his work, I assess the thesis „excellent". I recommend the thesis to be accepted and award to Mr. Uxa the Master degree.

Případné otázky při obhajobě a náměty do diskuze:

1. Explain the physical meaning of the effect of the Kramer's degeneracy in double quantum wells in the presence of an external electric field.

2. How do you think taking into account of the Zeeman effect is important when interpreting double quantum wells in perpendicular magnetic fields?

Práci
☒ doporučuji
☐ nedoporučuji
uznat jako diplomovou/bakalářskou.

Navrhuji hodnocení stupněm:
☒ výborně ☐ velmi dobře ☐ dobře ☐ neprospěl/a

Místo, datum a podpis vedoucího/oponenta: Prague, 9.9.2009, Goncharuk Nataliya A.