

Institute of Physics of the ASCR, v.v.i.

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Referee report on the thesis

High mobility two-dimensional electron gas in CdTe quantum wells:

High magnetic field studies

by Jan Kunc

Thesis submitted by Jan Kunc was prepared during his “en co-tutelle” doctoral studies at the Charles university in Prague (since 2006) and at the Université de Grenoble (since 2007). The work is devoted to mostly experimental investigation of the magneto-optical and magneto-transport properties of the two-dimensional electron gas confined in n-doped rectangular CdMgTe/CdTe/CdMgTe and CdMgTe/CdMnTe/CdMgTe quantum wells. The employed experimental methods were magneto-photoluminescence, photoluminescence excitation, and measurements of the longitudinal and Hall resistance. The experimental work was carried out in the Grenoble High Magnetic Field Laboratory at temperatures as low as 90 mK and in broad range of magnetic fields up to 28 T.

The 137 pages of the thesis text are organized into 10 chapters, including preface, conclusions and references.

The chapters 2 to 5 (pages 7 to 31) review the theoretical background necessary for interpretation of experimental results described in subsequent chapters. This part includes the description of the electron motion in a periodic potential, the motion of confined carriers subject to magnetic fields, and even the self-consistent calculation of the electronic structure of quantum wells based on their crystal structure. Also the basic equations of magneto-transport and optical transition are presented and discussed. The basic characterization of samples are determined by Raman scattering and the far infrared spectra measurements.

The chapter 6 to 8 are the central part of the thesis, where the most important experiments and their results are described and discussed. The chapter 6 (pages 32 to 70) describes in detail the low-field and high-field magneto-transport measurements including the remarkable fractional quantum Hall effect. The chapter 7 (pages 71 to 113) presents the magneto-photoluminescence measurements. Based on these results and results obtained from magneto-transport, the candidate carefully discusses the spin gap enhancement, i.e. the magnetic field and temperature dependence of spin splitting of fully occupied Landau levels. The chapter 8 (pages 114 to 120) is devoted to the photoluminescence excitation, which is a complementary experimental technique to the photoluminescence measurement.

In the chapter 9 the main results are briefly summarised and the possible direction of the further research, resulting from the presented achievements, is discussed.

I appreciate the high scientific level of the presented work. During his work, the candidate Jan Kunc accumulated very large amount of new original experimental data. My opinion is that the material presented in any of the chapters 6, 7 or 8 could form the experimental basis of three different good thesis.

It is obvious that the candidate has developed a high degree of expertise in a variety of sophisticated experimental techniques during the work on the thesis. Moreover, he demonstrated very good knowledge of the present solid state physics, an ability to understand the recent

theoretical achievements, and a skill to use them for interpretation of experimental results. In this way he undoubtedly demonstrated his qualification to carry out the independent scientific research.

Many experimental results have been successfully interpreted and the interpretation supported by theoretical data modeling and numerical simulations. On the other hand, some problems remain unsolved and new questions appeared. In spite of it, the progress achieved by the candidate to my knowledge surpasses the standard level of Ph.D. thesis.

The manuscript is written very carefully and in a good English. Nevertheless, I have found a few typographical errors and unclear formulations. An example: it is difficult to understand why in Fig. 6.2 σ/σ_0 tends to 0.5 instead of 1.

Summarizing the above facts my conclusion is that the submitted thesis fulfils all requirements and therefore I recommend to award Jan Kunc the Ph.D. degree.

Prague, 7.1.2011



Ludvík Smrčka

NOTE A L'ATTENTION
DES RAPPORTEURS SUR LES TRAVAUX DES CANDIDATS AU DIPLOME DE
DOCTORAT DE L'UNIVERSITE de GRENOBLE

Il est demandé aux rapporteurs qui établissent les rapports préalables de bien vouloir compléter la grille d'évaluation suivante et de la joindre à leur rapport : (merci de respecter cette grille, sans ajouter d'autres items)

Nom du rapporteur :	Ludvík Smrčka			
Nom du doctorant :	Jan Kunc			
Niveau scientifique :	Satisfaisant	Bon	Très bon	Exceptionnel
	[]	[]	[x]	[]