Editor's Appendix:
New Developments Regarding Electron Correlation Effects in $Hg_{0.8}Cd_{0.2}Te$

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With 1 Figure

Since the publication of the data shown in Fig. 2.16, a great deal more experimental data has become available and this has resulted in profound changes in the interpretation of the results. The breaks in the log ($\sigma_\perp$) vs log (B) plots in Fig. 2.16 are no longer regarded as indicating a transition related to Wigner condensation of the electrons or charge density waves. It was shown that these breaks depend on the current passed through the sample [A.1]. Recently it has been suggested that the breaks are due to a surface layer which provides a shunt resistance [A.2]. Extensive measurements as a function of temperature and magnetic field have revealed that the conductivity is thermally activated. This was first shown for the low field range [A.1] and later extended to magnetic fields up to 35 T [A.3]. It is possible to give a consistent interpretation of these results by assuming "magnetic freeze-out" of conduction electrons which occurs when in a strong magnetic field the distance between the conduction band and the impurity levels becomes of the order kT. This analysis is based on both the Hall effect and the magnetoresistance; the carrier density in the conduction band is determined from the σ_{xy} component of the conductivity tensor which is related to the measured quantities $\varrho_\perp$ (transversal magnetoresistance) and $\varrho_H = R_H B$ (Hall resistivity; R_H = Hall constant, B = magnetic induction) by [A.4]

$$\sigma_{xy} = \varrho_H/(\varrho_H^2 + \varrho_\perp^2). \tag{A.1}$$

In the high field limit $\omega_c\tau \gg 1$, the charge carrier density is then given by

$$n = |\sigma_{xy}| B/e. \tag{A.2}$$

The activation energies determined from σ_{zz}, n and $\sigma_{xx} = \varrho_\perp/(\varrho_\perp^2 + \varrho_H^2)$ are given in Table A.1 (see also Fig. A.1). The consistency of the analysis is strengthened by finding the same values for the activation energy from both σ_{xy} and $\sigma_{zz} = 1/\varrho_\parallel$ ($\varrho_\parallel$: longitudinal magnetoresistance).

While experimental data obtained at Leuven/Nijmegen and Köln are in complete agreement, at Köln a different interpretation is given to these and some additional results. The idea of an electron correlation effect is maintained by interpreting the magnetotransport data as if the effect were caused by changes in the mobility rather than the carrier concentration. The thermally activated conductivity is interpreted as resulting from a transition of the electron gas to a viscous liquid [A.5]. Several arguments are given against magnetic freeze-out: it

Table A.1. The activation energies of thermally activated conduction in $Hg_{0.8}Cd_{0.2}Te$ at different magnetic fields as determined in Fig. A.1

B	Activation energy		
[T]	from σ_{zz} [meV]	from $\sigma_{xy}B/e$ [meV]	from σ_{xx} [meV]
4	0.33	0.40	
6	0.50	0.51	0.28
8	0.68	0.75	0.39
10	0.82	0.85	0.48
12	0.94	1.05	0.53
14	1.03	1.14	0.56
	±0.05	±0.1	±0.1

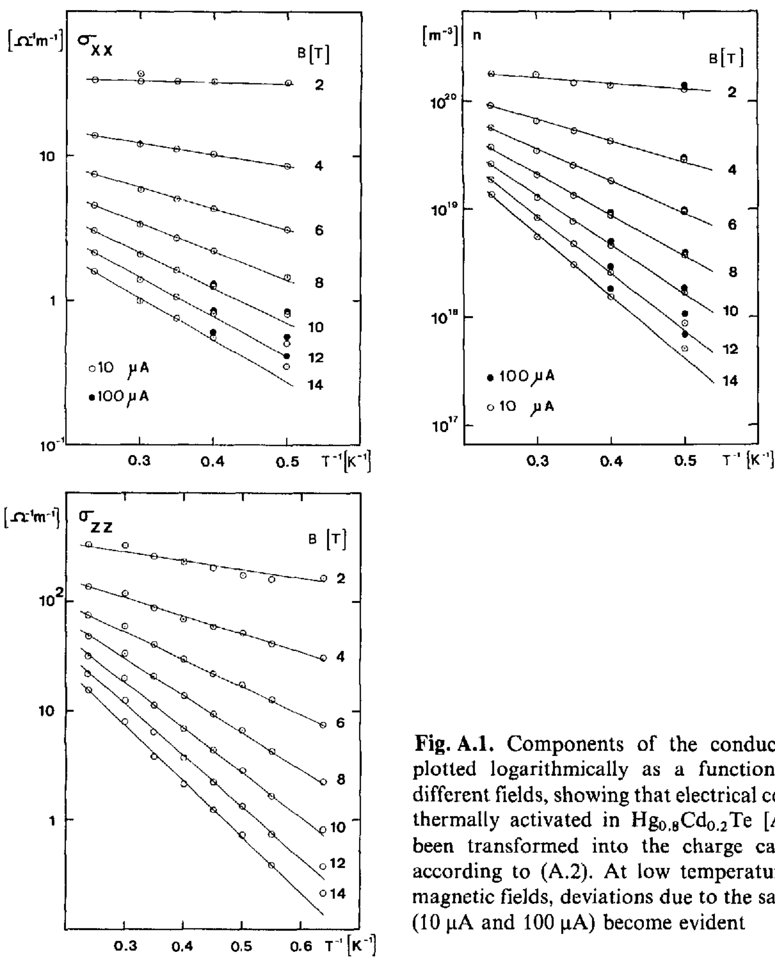

Fig. A.1. Components of the conductivity tensor plotted logarithmically as a function of $1/T$ for different fields, showing that electrical conductivity is thermally activated in $Hg_{0.8}Cd_{0.2}Te$ [A.3]. σ_{xy} has been transformed into the charge carrier density according to (A.2). At low temperatures and high magnetic fields, deviations due to the sample current (10 μA and 100 μA) become evident is pointed out that earlier experiments in zero magnetic field have not revealed any impurity levels (i. e. no ionized impurity scattering) to which freeze-out could occur. A complete survey of earlier work on HgCdTe and other narrow gap semiconductors is given in [A.6]. The transient response of electrical current to an applied voltage step does not show – within the range of magnetic field, temperature and applied electric field of these experiments – the typical delay depending on the applied voltage as is seen in InSb and which is indicative of impact ionization. In the voltage-current characteristics, a negative resistance and instabilities due to avalanche formation have been seen in InSb but not yet in HgCdTe. Finally, measurements of the differential photoconductivity and the specific heat have been carried out in strong magnetic fields and the results are reported to support the assumption of a thermally activated mobility and electron correlation effects [A.7].

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