I. V. Kukushkin and V. B. Timofeev. *Density of states of two-dimensional electrons in a quantizing transverse magnetic field.* The question of the density of electron states in a random defect potential lies at the heart of the discussion about the energy spectra of two-dimensional (2D) systems in a transverse magnetic field.[1] This problem is particularly important because we seek a microscopic description of magnetotransport in two-dimensional space charge layers when the filling of quantum states by electrons (filling factor) varies over a wide range. In order to construct a microscopic theory we require sufficiently complete information about disorder present in the system or, more precisely, about the random potential (its amplitude and extent) produced by scattering centers. Equally important is the change in electronic screening of random potential fluctuations as the filling factor changes. A certain class of problems can be addressed experimentally via spectroscopic methods which sample the energy distribution of the single-electron density of states $D(E)$. The method is based on the changes in luminescence spectra produced by radiative recombination of 2D-electrons with photoexcited holes in silicon metal-insulator-semiconductor structures (p-Si (001)-MIS structures).[2] This method, which is fully described in Ref. 3, permits us to observe how the energy distribution of the density of states (DS) varies with the filling of Landau levels by electrons, as well as with the amplitude and extent of the long-period fluctuations of the random potential, magnetic field, and electron mobility.

Figure 1 illustrates how, in the absence of a magnetic field, the luminescence spectrum of 2D-electrons is a step function of energy (spectrum 2) in accordance with constant DS at $H = 0$. The spectrum acquires structure in a transverse magnetic field due to Landau quantization (spectrum 3). The energy values corresponding to the bottom of dimensional quantization band E_0 and the Fermi energy E_F at a given 2D-electron concentration are determined by the familiar Landau fan diagram (see the upper section of Fig. 1). The two-dimensional nature of the electron system being investigated is established by the appropriate shift in the quantization scale $\hbar\omega_c$ as the sample is tilted in a uniform magnetic field (spectrum 4).

It was found that the luminescence linewidth, which reflects the width of DS peaks in the Landau levels, oscillates depending on the filing of quantum states by electrons (the filling factor).[4] In systems with more than one Landau level oscillations are observed when the filling factor of the uppermost occupied level changes (Fig. 2). When the filling factor is one-half, the width Γ of the DS peak is minimal Γ_{min} and depends on the magnetic field H and the electron mobility μ as $\Gamma_{min} \propto (H/\mu)^{1/2}$ in accordance with the short-range random scatterer theory (see Ref. 1). When the filling factor of the Landau level is unity, the DS peak is broadest: Γ_{max} is determined by the amplitude of iarge-scale random potential fluctuations. At unity filling factor the density of states in the energy gaps is no longer exponentially small because of long-period fluctuations. The oscillatory behavior of DS at the Landau levels as a function of filling factor and the temperature dependence of the width of the levels are adequately described by the nonlinear screening of the random potential due to charged impurities.[5]

The luminescence technique makes it possible to study the structure of the Landau levels, i.e., to determine the spin and intervalley spiitting and carefully measure how the oscillations of these splittings, which are due to electron-electron interactions, change with filling factor.[6] Finally, the method described can be successfully applied to measure the

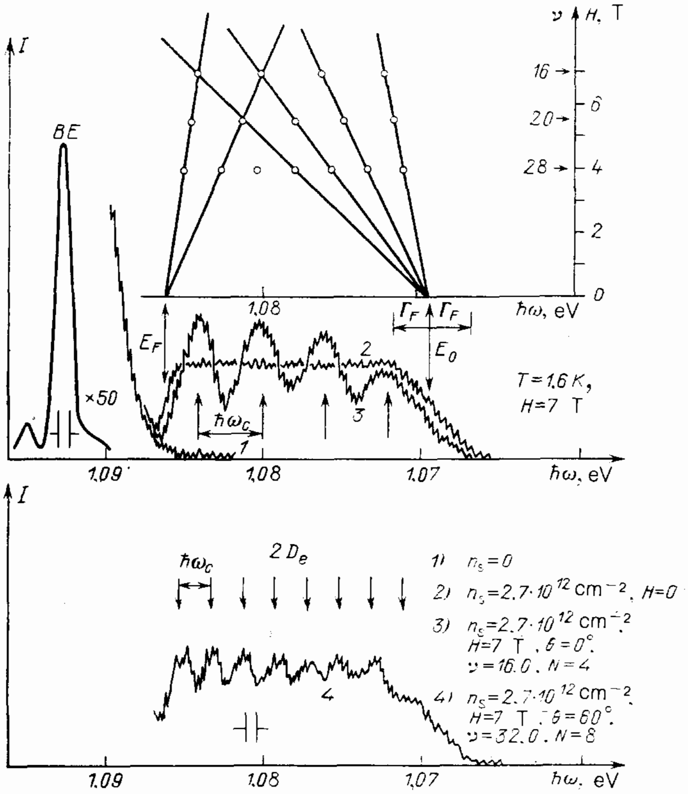

FIG. 1. Radiative recombination spectrum of 2D-electrons with photoexcited holes (2D$_e$ lines) measured at pumping level $W = 10^{-3}$ W/cm^2, $T = 1.6$ K, 2D-electron concentration $n_S = 2.7\cdot 10^{12}$ cm^{-2} and magnetic field $H = 0$ (spectrum 2), $H = 7$ T and perpendicular to the 2D-layer (spectrum 3), and $H = 7$ T tilted 60° from the normal to the 2D-layer (spectrum 4). Spectrum 1 is obtained at $n_S = 0$. The BE line corresponds to exciton emission from the bulk, with excitons localized at boron atoms. In the upper part of the figure we plot the Landau level fan diagram which determines the bottom of the dimensional quantization band E_0 and the Fermi energy E_F in the $H \to 0$ limit.

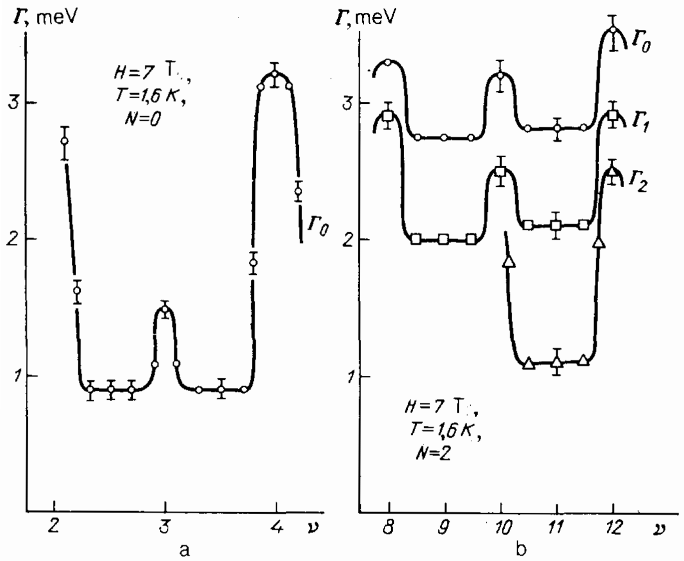

FIG. 2. The width of the Landau levels γ as a function of the filling factor ν ($\nu = n_s h/eB$) at $H = 7$ T, $T = 1.6$ K, $W = 10^{-3}$ W/cm^2 for various Landau levels N.

Coulomb gaps in the spectrum of incompressible Fermi liquids that are present in the fractional quantum Hall effect.[7]

[1] T. Ando, A. B. Fowler, and F. Stern, Rev. Mod. Phys. **54**, 437 (1982).
[2] I. V. Kukushkin and V. B. Timofeev, Pis'ma Zh. Eksp. Teor. Fiz. **40**, 413 (1984) [JETP Lett. **40**, 1231 (1984)].
[3] I. V. Kukushkin and V. B. Timofeev, Zh. Eksp. Teor. Fiz. **92**, 258 (1987) [Sov. Phys. JETP **65**, 146 (1987)].
[4] I. V. Kukushkin and V. B. Timofeev, Pis'ma Zh. Eksp. Teor. Fiz. **43**, 387 (1986) [JETP Lett. **43**, 499 (1986)].
[5] B. I. Shklovskiĭ and A. L. Efros, Pis'ma Zh. Eksp. Teor. Fiz. **44**, 520 (1986) [JETP Lett. **44**, 669 (1986)].
[6] I. V. Kukushkin, Pis'ma Zh. Eksp. Teor. Fiz. **45**, 222 (1987) [JETP Lett. **45**, 276 (1987)].
[7] I. V. Kukushkin and V. B. Timofeev, Pis'ma Zh. Eksp. Teor. Fiz. **44**, 179 (1986) [JETP Lett. **44**, 228 (1986)].

A. G. Vinogradov, A. S. Gurvich, S. S. Kashkarov, Yu. A. Kravtsov, and V. I. Tatarskiĭ. *The backscattering enhancement effect.* To date, all known effects of random inhomogeneities on propagating waves have been deleterious in some way: beam broadening, loss of coherence, decrease in mean field intensity, and so forth. Relatively recently, however, Vinogradov and co-workers predicted the backscattering enhancement effect, which always increases the mean intensity of the wave.[1] The effect was experimentally observed soon thereafter.[2] Although the effect has been known for some 15 years, it continues to attract scientific attention because of its constantly discovered new manifestations and numerous new applications.

The main point of the effect is as follows. Let a point source S irradiate a point scatterer T, which is immersed in a randomly inhomogenous medium, and let us choose the observation point P displaced a distance ρ from the source S (Fig. 1, a). Let $\bar{I}(\rho)$ be the average (over the ensemble of random inhomogeneity realizations) scattered field intensity at observation point P and let I_0 be the field intensity in the absence of inhomogeneities. It turns out that in the case of backscattering ($\rho = 0$), i.e., when the observation point P coincides with source S,

$$\bar{I} > I_0. \tag{1}$$

This inequality, established in Ref. 1, indicates that with the switching-on of inhomogeneities the mean backscattered intensity is unexpectedly enhanced. This backscattering intensity enhancement is due to the double passage of the wave through the same inhomogeneities in the medium.[1]

The magnitude of the effect is conveniently characterized by the enhancement coefficient $N(\rho) = \bar{I}(\rho)/I_0$. In Ref. 1 it is shown that

$$N(\rho) = 1 + B_I(\rho), \tag{2}$$

where $B_I(\rho) = \langle\tilde{I}(0)\tilde{I}(\rho)\rangle/(I_0)^2$ is the correlation function of relative intensity fluctuations $\tilde{I}/I_0$ due to the single passage of the wave over the paths connecting the scatterer to the receiver and the scatterer to the source. Because of energy conservation the enhancement N in the case of "exact" backscattering ($\rho = 0$) must be counterbalanced by some decrease in N when the wave is "nearly" backscattered. As a result the backscattering indicatrix has a characteristic maximum at $\theta = 180°$ and minima at angles close to 180° (Fig. 1, b). The dashed line in Fig. 1, b represents the circular indicatrix of small particle scattering in a homogenous

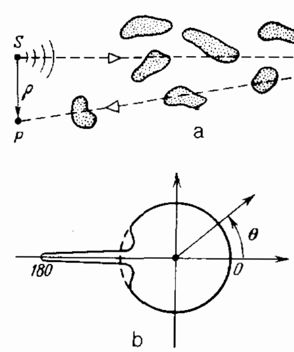

FIG. 1