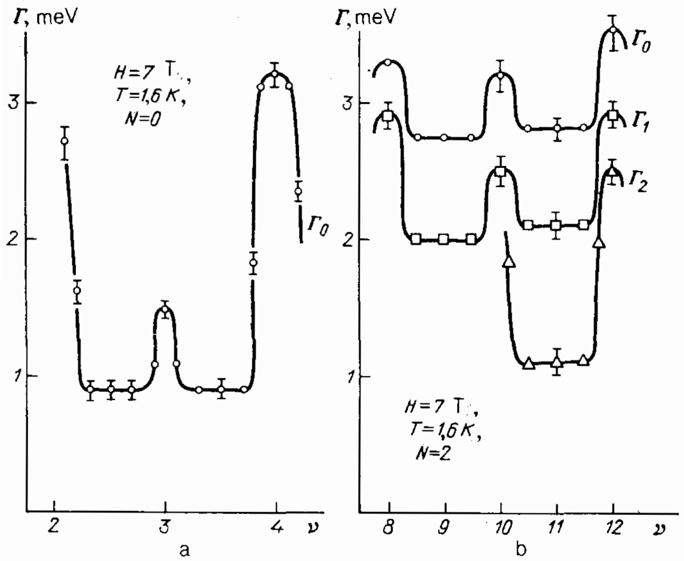

FIG. 2. The width of the Landau levels γ as a function of the filling factor ν ($\nu = n_s h/eB$) at $H = 7$ T, $T = 1.6$ K, $W = 10^{-3}$ W/cm² for various Landau levels N.

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,

$$\bar{I} > I_0. \qquad (1)$$

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

$$N(\rho) = 1 + B_I(\rho), \qquad (2)$$

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

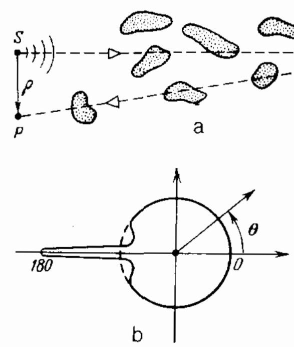

FIG. 1

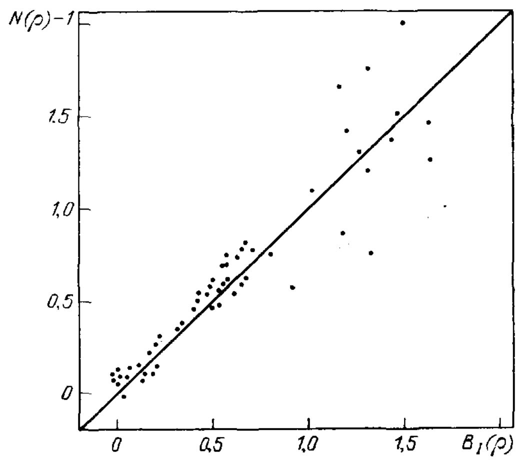

FIG. 2

medium (for sound waves). The enhancement will occur given any extended scatterer with a sufficiently broad scattering indicatrix. For example, Ref. 2 used a sheet of typing paper for the scatterer.

In the case of light focusing in the atmosphere the backscattering enhancement factor N can exceed unity severalfold. In Fig. 2 we plot experimental data obtained by Kashkarov for laser radiation in the atmosphere over paths of 650 and 1300 m.[3]

The backscattering enhancement effect will occur with any type of wave. It is observed in the sonar probing of the atmosphere and the ocean, in radio wave scattering in the ionosphere, cosmic, and laboratory plasma, in seismoacoustic probing, in electron scattering from complex molecules, and so forth. Reviews of published studies are available in Refs. 4 and 5.

Similar and even more pronounced enhancement effects can take place in scattering from bodies situated behind a random phase screen[1] or near a rough interface between two media. This last phenomenon was predicted in Ref. 6 and then experimentally confirmed by laser probing of the ocean (see the report of A. A. Apresyan and D. V. Vlasov below). Related to the discussed phenomena are the long-range correlation effects and partial wave front reversal in randomly inhomogenous media, discussed below by A. N. Malakhov, A. V. Polovinkin, and A. I. Saichev.

Finally, the enhancement phenomenon is also related to the multichannel coherence effects that can occur when waves are scattered from an ensemble of scatterers.

[1] A. G. Vinogradov, Yu. A. Kravtsov, and V. I. Tatarskiĭ, Izv. Vyssh. Uchebn. Zaved., Ser. Radiofiz. **16**, 1064 (1973) [Radiophys. Quantum Electron. **16**, 818 (1973)].
[2] A. S. Gurvich and S. S. Kashkarov, Izv. Vyssh. Uchebn. Zaved., Ser. Radiofiz. **20**, 794 (1977) [Radiophys. Ouantum Electron. **20**, (1977)].
[3] S. S. Kashkarov, Izv. Vyssh. Uchebn. Zaved., Ser. Radiofiz. **26**, 44 (1983) [Radiophys. Quantum Electron. 26 (1983)].
[4] Yu. A. Kravtsov and A. I. Saichev, Usp. Fiz. Nauk **137**, 501 (1982) [Sov. Phys. Usp. **25**, 494 (1982)].
[5] Yu. A. Kravtsov and A. I. Saichev, J. Opt. Soc. Am. Ser. A **2**, 2100 (1985).
[6] V. U. Zavorotnyĭ and V. I. Tatarskiĭ, Dokl. Akad. Nauk SSSR **265**, 608 (1982) [Sov. Phys. Dokl. **27**, 566 (1982)].

A. N. Malakhov, A. V. Polovinkin, and A. I. Salchev. *Partial wave front reversal in a randomly inhomogeneous medium.* In the case of backscattering or reflection in an inhomogeneous medium there may exist a multitude of coherence channels through which different components of a wave travel in opposite directions. Their mutual coherence leads to specific effects which do not occur when waves propagate and scatter predominantly in one direction. Such effects are at their most obvious in the case of reflected waves which pass twice through the same inhomogeneities in the medium, as in the case of optical waves reflected by a turbulent atmosphere. One notable effect is that of partial reversal: the field of the reflected wave contains a component whose wave front is partially reversed with respect to the wave front of the incident wave.

Let us clarify the mechanism of partial reversal in the simplest case of a wave emitted in an inhomogeneous medium by two mutually coherent point sources located at $\mathbf{R}_1$ and $\mathbf{R}_2$. The wave is reflected by a point reflector at $\mathbf{R}_0$ (Fig. 1). The complex amplitude of the reflected wave's field at an arbitrary point $\mathbf{R}$ is

$$v(\mathbf{R}) = fg(\mathbf{R}, \mathbf{R}_0)\,[u_1 g(\mathbf{R}_1, \mathbf{R}_0) + u_2 g(\mathbf{R}_2, \mathbf{R})];$$

where u_1 and u_2 are the complex amplitudes of the source waves, f is the reflection coefficient, and $g(\mathbf{R}', \mathbf{R}'')$ is the Green's function for the wave. The coherence channel illustrated in Fig. 1 results in the reflected wave having mutually coherent components in the vicinity of both sources

$$v_0(\mathbf{R}_1) = fu_2 g(\mathbf{R}_1, \mathbf{R}_0)\, g(\mathbf{R}_2, \mathbf{R}_0),$$
$$v_0(\mathbf{R}_2) = fu_1 g(\mathbf{R}_2, \mathbf{R}_0)\, g(\mathbf{R}_1, \mathbf{R}_0),$$

the phases of which are reversed with respect to those of the source waves. Indeed, let the initial source wave phases be S_1 and S_2. By reciprocity, when these waves travel via the same coherence channel in opposite directions they acquire the same phase factor S_{12}. Thus

$$v_0(\mathbf{R}_1) \sim \exp[j(S_2 + S_{12})],\quad v_0(\mathbf{R}_2) \sim \exp[j(S_1 + S_{12})].$$

Since $S_2 + S_{12} = -S_1 + S$, $S_1 + S_{12} = -S_2 + S$ then, up to an overall phase factor $S = S_1 + S_2 + S_{12}$ the phases of the reflected wave's coherent components at $\mathbf{R}_1$ and $\mathbf{R}_2$ are $-S_1$ and $-S_2$ respectively, i.e., reversed with respect to the initial source phases.

If the medium contains many coherence channels then many field components with reversed phases combine into a

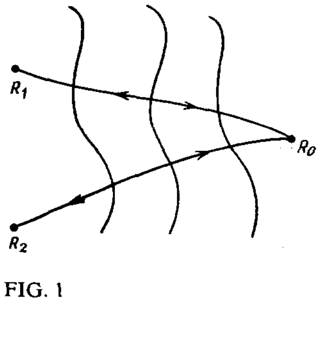

FIG. 1