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DISCUSSION

Reply to Comment on "Theory of a Two-Dimensional Rotating Wigner Cluster" (JETP Letters 115, 608 (2022))

Mahmood M. Mahmoodian[a, b], *, Mehrdad M. Mahmoodian[a, b], **, and M. V. Entin[a], ***

[a] *Rzhanov Institute of Semiconductor Physics, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 630090 Russia*

[b] *Novosibirsk State University, Novosibirsk, 630090 Russia*

**e-mail: mahmood@isp.nsc.ru*

***e-mail: m.makhmudian1@g.nsu.ru*

****e-mail: entin@isp.nsc.ru*

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We agree that the $\omega_c/2$ result for the rigid cluster follows from fundamental formulas. However, a crucially important assumption in our case was the proportionality of the mechanical moment of inertia to the moment of the force of the vortex field; i.e., the contribution of each electron to the moment of force is proportional to the square of the distance from the center. For example, universality is not applicable to the same cluster in the field of a solenoid with a finite radius. At the same time, a point solenoid (see [1]) satisfies the condition of universality (but expressed in terms of the magnetic field flux) because its magnetic field vanishes in the exterior.

Next, concerning the behavior of the soft cluster in an alternating magnetic field, there are various scenarios of motion of a complex system of electrons in an external potential and an alternating magnetic field. We suggested [2] that the magnetic field is switched on quite rapidly, $\omega_c\tau \ll 1$. Another variant corresponding to the adiabatic limit $\omega_c\tau \gg 1$ is illustrated in Fig. 1. In this case, the azimuthal motion of electrons is first induced by the vortex field. Then, cyclotron orbits are formed and drift under the action of the vortex electric field toward the center of the cluster. After the establishment of the magnetic field, the vortex field disappears, whereas the field of the potential well remains; consequently, the azimuthal drift of electrons begins. We emphasize that the cluster in the drift approximation is contracted, holding its structure.

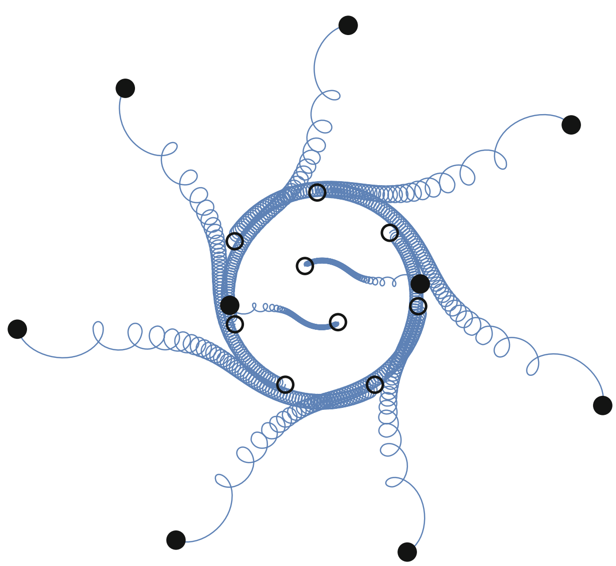

Fig. 1. (Color online) Two-dimensional Wigner cluster with nine electrons in the magnetic field $B(t) = B_0(\mathrm{th}((t - t_0)/c_0) + 1)$ at $B_0 = 50$, $t_0 = 1$, and $c_0 = 1$. The filled and empty circles are the initial and final positions of electrons and lines are their trajectories.

We do not agree that the magnetic field cannot be switched on rapidly. This is likely possible if a superconducting plate screening the external magnetic field or a superconducting ring with a trapped flux is placed above the two-dimensional Wigner cluster. If the superconductor is rapidly transferred to a normal state by, e.g., pulsed laser heating, the magnetic field acting on electrons varies from zero to a finite value in the former case and from a finite value to zero in the latter. Since a laser pulse can be very short, the variation time of the magnetic field can reach the inverse conductivity of the normal sample, i.e., $\leq 10^{-14}$ s for lead. This very low value certainly cannot be achieved in practice because the heating of the sample is a fairly inertial process. Assuming a heating time of 10^{-10} s and a field of 0.01 T, we obtain $\omega_c\tau = 0.16$, which corresponds to the nonadiabatic case.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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