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On V P Bykov's article "Fractional charge: a new trend in electronics"

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V P Bykov's article, in my opinion, calls for brief commentary. The point is that it deals with two fundamentally different types of physical situations.

The first is the real existence of objects with fractional electric charges, caused by collective effects. Examples are the fractional charge that shows up in the fractional quantum Hall effect considered in the article under discussion, as well as the fractional charge at the 'kink', which was predicted by Jackiw and Rebbi [1] and experimentally realized on polyacetylene molecules (see the review Ref. [2] and references cited therein).

The second situation is in fact an example of entangled states in quantum mechanics. This is precisely the situation that occurs in the system considered by H Maris and in the system of two protons and an electron dealt with at the end of Bykov's article. In these cases, each individual charge measurement would yield an integer value, while the *probability* that the charge is discovered in one spatial domain or another is fractional. In the simple example of quantum mechanics with two spatially separated potential wells, the symmetric electron wave function has the form

$$\psi(x) = \frac{1}{\sqrt{2}} \left[\psi_1(x) + \psi_2(x)\right],$$

where ψ_1 and ψ_2 are confined to the first and second well, respectively. Charge measurements in the first well would yield 0 and 1 values with 1/2 probability each, and therefore one cannot say that the charge is really fractional (although the quantum-mechanical average describing the result of averaging over many measurements is equal to 1/2).

At the formal level, the difference between the first and second situations consists in the fact that the dispersion of charge as a quantum-mechanical observable is zero in the first case ('kink', Hall effect), but is nonzero and comparable to the average value in the second case (bubbles in liquid helium, two protons and an electron) [3].

References

1. Jackiw R, Rebbi C *Phys. Rev. D* **13** 3398 (1976)
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