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Comment

On "Maxwell's equations and vorticity: A note on the viscosity of magnetic fluids"

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I was very surprised to find in Ref. [1] a lot of expressions such as: "Shliomis ignores – and his results contradict – the Maxwell equations" or "Shliomis does not distinguish the magnetic fields: He identifies $\boldsymbol{H}$ in Eq. (1) with $\boldsymbol{H}_0$ in Eq. (3)".

This unwarranted attack is directed against my paper [2], which has played an important role in the development of ferrohydrodynamics (see, e.g., the monograph by Rosensweig [3]). The main peculiarity of ferrofluids – a specific relation between magnetic and rotational mechanical degrees of freedom of the magnetic particles – was first discovered in the paper. This concept has allowed us to derive the now conventional complete set of hydrodynamic equations [2], which includes the equation of fluid motion, the equation for magnetization of a moving ferrofluid, and, certainly, the Maxwell equations. Later on the system of equations was refined on the basis of the Fokker–Planck equation for colloidal particles of ferromagnet and applied to an analysis of the wide range of dynamic processes in magnetic fluids: from a dispersion of the magnetic susceptibility to the magnetoviscous effect (see the book [3], the reviews [4–8] and references therein). Nevertheless Shliomis' formula [2] for an additional (rotational) viscosity of ferrofluid in a stationary magnetic field is used up to now. It is corroborated by numerous experimental data, first obtained a quarter of a century ago [9]. Recently it was predicted theoretically [10] and discovered experimentally [11] the so-called 'negative viscosity' effect: the rotational viscosity of ferrofluid can become *negative* in an alternating magnetic field. This unexpected result has induced a new rush of interest in the physics and hydrodynamics of magnetic fluids [12].

In Ref. [2] I really "do not distinguish the magnetic fields" $\boldsymbol{H}$ and $\boldsymbol{H}_0$ (see above), because it is the same *internal* magnetic field, i.e. the field in the ferrofluid. All ferrohydrodynamic equations including the Maxwell ones contain only this field. Of course, one must distinguish it from the *external* field (that which is present in the absence of the fluid). Then one must account for a demagnetization factor. However, this is a point well known to those skilled in the art. All people remember it and always make the necessary correction in experimental data.

McTague, whose data [9] I have used in Ref. [2], has accounted for a demagnetization factor of his round capillary as well.

A few words about the 'new experiment' proposed in Ref. [1] for testing the field dependence of viscosity. This experiment was done a number of years ago (see Ref. [13] and references therein) with help of an original vibrational viscometer; the results of the experiment agree well with the theory [2].

Thus, not a single point in Ref. [1] can be reputed to be a research contribution.

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