Pramāṇa – J. Phys., Vol. 35, No. 5, November 1990, pp. C516–C517. © Printed in India.

Rebuttal to B K Shivamoggi's comments

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It appears that the author of these comments (*Pramana – J. Phys.*, this issue) has misunderstood our paper. We have discussed Hamiltonian systems with indefinite kinetic energy. The author does not seem to differentiate between indefinite and non-positive definite kinetic energy. We would like to point out the subtle difference between indefinite and non-positive definite. Systems with indefinite metric do give rise to indefinite kinetic energy. In quantum electrodynamics the semi-positive definiteness is imposed upon the definite metric space by projection on gauge-conditioned physical spaces. The existence of non-trivial complex solutions, of Yang-Mills theory, are well known; these are indeed essential to describe the complicated vacua for the theory.

According to the author, all cases of separable potentials, are trivial; we find it very hard to accept this. In any case, we had explicitly pointed out (cf. sec. 2, p. 500) that the reduction of Hamiltonian systems with kinetic energy indefinite and *quadratic* in velocity, to classical dynamical systems with positive definite kinetic energy is possible only for separable potentials but this restriction of separable potential may not be essential in case of systems with kinetic energy containing terms of order higher than quadratic in velocity. We had clearly illustrated the possibility of transforming a system with separable potential and indefinite kinetic energy to an equivalent system with positive definite energy. Hence the argument based on unbounded spectral character is meaningless.

The author is further confusing the issue by unnecessarily bringing into picture the dissipative systems which are distinctly different in character; for an illustrative example see Buti (1990) and Hada *et al* (1990).

We have not claimed that our discussion is restricted to harmonic potentials. In fact the two examples, namely the amplitude modulated nonlinear Langmuir waves and nonlinear electromagnetic waves in plasmas, deal with potentials which are by no means harmonic potentials. We have also not claimed that the complexification has relevance only to harmonic systems.

Complexification of nonlinear field theoretical systems (e.g., systems governed by kdV, $MkdV$, Sine Gordon) give rise to rich variety of new solutions with interesting topological properties very different from the one corresponding to real solutions (Buti *et al* 1986).

As regards the applications, we have given the examples of nonlinear Langmuir waves and nonlinear electromagnetic waves; these waves have been observed in many space and astrophysical plasmas.

The purpose of our paper was to point out the possibility of existence of new complex solutions, even for the systems with indefinite kinetic energy.

References

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