Comment on "Reduced System Dynamics from the *N*-Body Schrödinger Equation"

In his Letter [1], Muriel presents a time-dependent wave function for one particle "in the company of $N-1$ other particles." Starting from the N-particle wave function $\psi_N(r_1, r_2, \ldots, r_N)$, the one-particle wave function is derived by the projection $\psi_1 = P\psi_N$ which, in detailed form, reads

$$\psi_1(r_1; t) = (1/\Omega^{N-1}) \times \int \psi_N(r_1, r_2, \ldots, r_N; t)\, dr_2\, dr_3 \ldots dr_N .$$

Assuming the standard N-body Schrödinger equation for ψ_N, the time-dependent solution of the "reduced" one-particle wave function can formally be written as

$$\psi_1(t) = P \exp(-itH)\psi_N(0) ,$$

with the N-body Hamiltonian H. The Letter calls the dynamics of ψ_1 "reduced dynamics" of the distinguished particle.

Here I will not discuss the Letter's main goal, that is, giving the above solution $\psi_1(t)$ a more instructive form. I should, however, question whether the Letter's reduced dynamics has enough to do with the usual concept of reduced dynamics. Obviously, the projection P projects the N-body quantum state onto the subspace where each body except for the distinguished one is in *zero-momentum eigenstate*. Consequently, the reduced dynamics of the Letter offers *conditional* predictions for the distinguished particle while, unfortunately, the conditions concern the *other* $N-1$ bodies. Calculating the "reduced one-body wave function" $\psi_1(r_1, t)$ for $t > 0$, one can predict the expectation value of a Hermitian observable $A_1(r_1, r_1')$ of the distinguished body in the form

$$\frac{\int \overline{\psi}_1(r_1; t) A_1(r_1, r_1') \psi_1(r_1'; t)\, dr_1\, dr_1'}{\int \overline{\psi}_1(r_1; t)\psi_1(r_1; t)\, dr_1}$$

provided the $N-1$ *accompanying bodies are simultaneously found in zero-momentum eigenstates*. In such a way, the set of theoretical predictions which Muriel's reduced dynamics is capable of offering becomes extremely restrictive.

One-body reduced dynamics, as it is commonly understood, is capable of predicting the expectation values of one-body observables A_1 *without further tests on the accompanying bodies*. Consequently, Muriel's proposal does not serve as true reduced dynamics and numerous theoretical implications, claimed in the Letter, are not likely to be relevant for the standard issue.

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Lajos Diósi*
KFKI Research Institute for Particle and Nuclear Physics
H-1525 Budapest 114, POB 49, Hungary

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*Electronic address: diosi@rmki.kfki.hu

[1] A. Muriel, Phys. Rev. Lett. **75**, 2255 (1995).

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