Abstract
We provide a careful analysis of the proper significance of Riahi’s comment in light of our paper (2009 J. Phys. A: Math. Theor. 42 165302). We point out a fundamental difference between the quantum–classical correspondence scheme considered in our paper and that used in Riahi’s comment.

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In order to assess the comment by Riahi [1] in the context of our work, let us recall the relevant essential essence of our paper [2], where the quantum and the classical evolutions are compared by starting from a given initial ensemble that has the specified position and momentum distributions that are fixed by the relevant preparation procedure for the ensemble, with the quantum evolution governed by the Schrödinger equation and the classical evolution considered in terms of the phase space dynamics using Liouville’s equation. The central contention of Riahi’s comment concerns the use of the initial phase space distribution in our classical calculation, which is taken to be the product of the position and the momentum distributions. To understand the basis of this choice, we note that, given the phenomenologically specified position and the momentum distributions, although the phase space distribution function of the initial ensemble is not uniquely fixed, an important point to reckon with is that, within the framework of classical mechanics, the initial positions and momenta (that determine the classical time evolution of all the observable dynamical variables) are mutually independent variables. Hence, it is logically consistent to write, as the simplest possible choice, the initial phase space distribution evolving under classical dynamics to be a product of the given position and the momentum distributions.
On the other hand, Riahi in her comment, for computing the classical evolution, considers the initial phase space distribution function to be the Wigner function that is evaluated using the given initial wavefunction. It is, therefore, not surprising that the nonvanishing covariance denoting the correlation of position and momentum implied by the initial wavefunction holds good in terms of the Wigner function as well. Here, it is important to stress the difference between the scheme for studying the quantum–classical correspondence adopted by Riahi in her comment as compared to that used in our paper. The key point is that while in our scheme, for the purely classical calculation, the initial phase space distribution function is essentially fixed by using the phenomenological inputs in terms of the position and the momentum distributions in a way entirely consistent within the framework of classical mechanics (as explained in the preceding para), Riahi’s procedure uses the input from quantum mechanics in terms of the initial wavefunction itself for fixing the initial phase distribution function (through computing the corresponding Wigner function) that is used for the classical calculation. We may remark here that for the purpose of studying the macroscopic range of validity of quantum mechanics by examining in any given example the extent to which the quantum mechanical results agree with the corresponding results derived purely from classical mechanics, it is desirable not to use any quantum mechanical input in fixing the initial condition for the classical calculation.

The motivation underlying the Wigner function approach is crucially different because it is aimed at studying the extent to which the quantum mechanical results can be reproduced in terms of classical phase space dynamics based on the initial phase space distribution function which is calculated from the initial wavefunction according to some given prescription. If one considers essentially from this point of view, Riahi’s comment is interesting in the sense of extending the applicability of the Wigner function approach for the evaluation of the mean arrival time. We think that this clarification is necessary for the purpose of considering the comment made by Riahi from a proper perspective in the light of our paper.

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References

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[2] Home D, Pan A K and Banerjee A 2009 Quantitative probing of the quantum–classical transition for the arrival time distribution J. Phys. A: Math. Theor. 42 165302