Review of: "Correlating exciton coherence length, localization, and its optical lineshape"

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Potential competing interests: No potential competing interests to declare.

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Title: Correlating exciton coherence length, localization, and its optical lineshape

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In this study, the researchers propose a new method to understand the local environment of a system by analyzing the lineshapes of spectroscopic transitions.

They specifically focus on the connection between the lineshape of a molecular exciton and lattice vibrations at finite temperatures. The approach involves a continuous model that incorporates thermal effects as fluctuations around the zero-temperature localized soliton state. The model considers two parameters: the exciton band-width (J) and the exciton reorganization energy (μ). By utilizing this model, the researchers aim to bridge the gap between the strongly localized limit, where the exciton homogeneous line width remains unaffected by temperature, and the molecular aggregate limit, where the line width increases linearly with temperature.

The idea of associating the lineshape of a molecular exciton to finite-temperature lattice vibrations is an interesting idea. However, my main problem with this manuscript is that it is very unclear to me. I cannot understand the connection between the different equations in the text. For example, the authors have written that they derived equation 1 using two-dimensional free exciton model, but they did not explain how they did it. They have not given any explanation about the physics involved in Hamiltonian 2. They have claimed that if they treat the local energy fluctuations as a time dependent perturbation, then the exciton energy levels acquire a fluctuation given by first-order perturbation theory, can be deduced as Eqs. 5 and 6. But, it is absolutely not clear how this result can be achieved. Also, Hamiltonian 13 and deriving the non-linear Schrödinger equation equation 15 for this Hamiltonian are ambiguous and incomprehensible. It seems that this Hamiltonian does not follow the conservation laws. In addition, the relationship between the performed calculations and the correlating exciton coherence length, localization, and optical lineshape of the considered system is not well explained.

Also, there are relatively many editing errors in the text and formulas.

In summary, in my opinion, the article should be rewritten in such a way that the reader who is familiar with the subject can build the bridges between the different parts of the manuscript.