Localization landscape theory – An introduction and overview.

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Our understanding of semiconductor devices builds on a good description of the eigenstates and eigenenergies of a Hamilton operator (solution to the Schrödinger equation):

$$H(x)\psi_i(x) = E_i\psi_i(x) \quad .$$

In semiconductor systems with random alloy fluctuations (such as alloys of aluminium nitride and gallium nitride), the Hamilton operator includes a random potential. This disordered energy landscape can lead to localized eigenstates near the minima of the potential [1]. Scaling up the problem to large system sizes is a numerical challenge, and in recent years, approximations to the Schrödinger equation have been explored. One such approximation is the so called "*localization landscape theory*" (LLT) [2]. Instead of an eigenvalue problem, the solution is found to the linear problem

$$H(x)u(x) = 1 \quad .$$

The solution, $u(x)$, can be used in a number of ways to approximation the solutions to the eigenvalue problem (for both E_i and $\psi_i(x)$) for localized states. In this seminar a selection of results on the origin and applications of LLT will be presented, as well as an outlook on future development.

References

[1] R. Finn and S. Schulz, "Impact of random alloy fluctuations on the electronic and optical properties of (Al,Ga)N quantum wells: Insights from tight-binding calculations," *The Journal of Chemical Physics*, vol. 157, p. 244705, 12 2022.

[2] M. Filoche and S. Mayboroda, "Universal mechanism for anderson and weak localization," *Proceedings of the National Academy of Sciences*, vol. 109, no. 37, pp. 14761–14766, 2012.