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Aspects of non-equilibrium Physics

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1 Introduction and Motivation

Non-equilibrium systems can be - open, closed and quenched (changing parameters of the Hamiltonian suddenly so that the system as a whole is out of equilibrium). They arise in classical (integrable models) as well as quantum systems.

(question by Junaid on nonlinear Schrodinger equation, and a long detour about that. Manas writes the Schrodinger equation with a $|\psi|^2$ potential, and discusses a few methods of discretization of this equation. The essence of the discussion was that the nonlinear schrodinger equation can be reduced (in something called the reductive perturbation expansion) to a minimal model of the KdV equation. $u_t = -\partial_x(\alpha u^2 + \beta u_{xx})$). The solution to $\beta = 0$ case is $u(x, t) = U_0(x - u(x, t)t)$ So if we start out with lets say a Lorentzian profile, the u^2 term will cause the profile to curve to the right and steepen. But the derivative term will now convert the steepening to oscillations.)

Classical non-equilibrium systems can be classifield as :-

- Integrable Models
- Non-integrable Models
- Classical Field Theoretic systems

Quantum non-equilibrium systems :-

- Quantum Lattice Models (Incommensurate Models)- $H = \sum_i (a_i^\dagger a_{i+1} + \text{h.c.}) \sum_i (a_i^\dagger a_i)$. Lets say one starts with $\omega_i = \lambda \cos(2\pi b i)$, $b = 4/3$. The model basically repeats itself after every three steps in i , ie. $i \rightarrow i + 3$. Under this conditions this system is called a ballistic system. But if $b = \frac{\sqrt{5}-1}{2}$, this model never repeats itself. Such models are called incommensurate models. For $\lambda < 1$, these systems behave ballistic, but when $\lambda > 1$, the system is localized. The current goes down. When $\lambda = 1$, it's called the critical condition. Just by a model where there are no real interactions, we see a lot of different phases with respect to the parameter λ .

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