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Light-cones and quantum caustics in quenched spin chains

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If a single spin in a spin chain is suddenly flipped, the information regarding the disturbance propagates outwards at a maximum speed given by the Lieb-Robinson bound. This results in a light-cone-like structure in the space-time dependence of correlation functions which has been observed in experiments with cold atoms and ions. In this talk I will show that these "light cones'' are examples of quantum caustics. These are discrete matter-wave versions of the caustics known in optics such as rainbows and the bright lines on the bottom of swimming pools. Caustics are classified by catastrophe theory which endows light cones with certain characteristic features: 1) structural stability; 2) discretized Airy and hyperbolic umbilic functional forms for, respectively, the wave- and correlation functions near the cone edges; 3) existence of a lattice of vortex-antivortex pairs inside the light cone. The vortices are sensitive to the quantum phase transition exhibited in spin chain models and their rate of production is determined by the dynamical critical exponent.

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