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An Exactly Solvable Model of Quantum Communications
GRAEME SMITH, JOHN SMOLIN, IBM Research — Information theory establishes the ultimate limits on performance for noisy communication systems. Accurate models of physical communication devices must include quantum effects, but these typically make the theory intractable. As a result, communication capacities are not known, even for transmission between two users connected by an electromagnetic waveguide with gaussian noise[6]. We present an exactly solvable model of communications with a fully quantum electromagnetic field. This gives explicit expressions for all point-to-point capacities of noisy quantum channels, with implications for quantum key distribution and fiber optical communications. We also develop a theory of quantum communication networks by solving some rudimentary networks for broadcasting and multiple access. We compare the predictions of our model with the orthodox gaussian model and in all cases find agreement to within a few bits. At high signal to noise ratios (SNRs) our simple model captures the relevant physics while remaining amenable to exact solution.

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