Modelling of noise in Brillouin-based storage and retrieval

Oscar A. Nieves[a], Matthew D. Arnold[a], Mikolaj K. Schmidt[b], Michael J. Steel[b], and Christopher G. Poulton[a]

[a] *School of Mathematical and Physical Sciences, University of Technology Sydney*

[b]*MQ Photonics Research Centre, School of Mathematical and Physical Sciences, Macquarie University*

Simulated Brillouin Scattering (SBS) is an important coherent interaction between optical and acoustic waves in nanophotonic waveguides [1]. Recent work has applied this effect to the coherent transfer of information from the optical to the acoustic domain – such "acoustic memory" was first demonstrated in fibre [3] and has recently been shown in integrated nanophotonic circuits [2]. A significant challenge in these experiments is accounting for the effects of thermal noise, which arise from the bath of acoustic phonons surrounding the waveguide and which can degrade the stored information. Here, we discuss models for thermal noise in Brillouin scattering, and focus in particular on the effects of such noise on the storage of information acoustically [3]. We numerically and analytically investigate how thermal noise affects the Brillouin-mediated signal both in the steady state – in which the optical and acoustic pulses can be considered to be very long – and for the shorter pulses that are of interest in acoustic storage experiments. We give approximate formulas that can be used to estimate the magnitude of Brillouin noise, and present a numerical model that can be used to compute the noise effects in integrated platforms. We examine the particular case of amplitude and phase storage using SBS, and find that phase storage leads to reduced degradation of coherent information (Fig. 1).

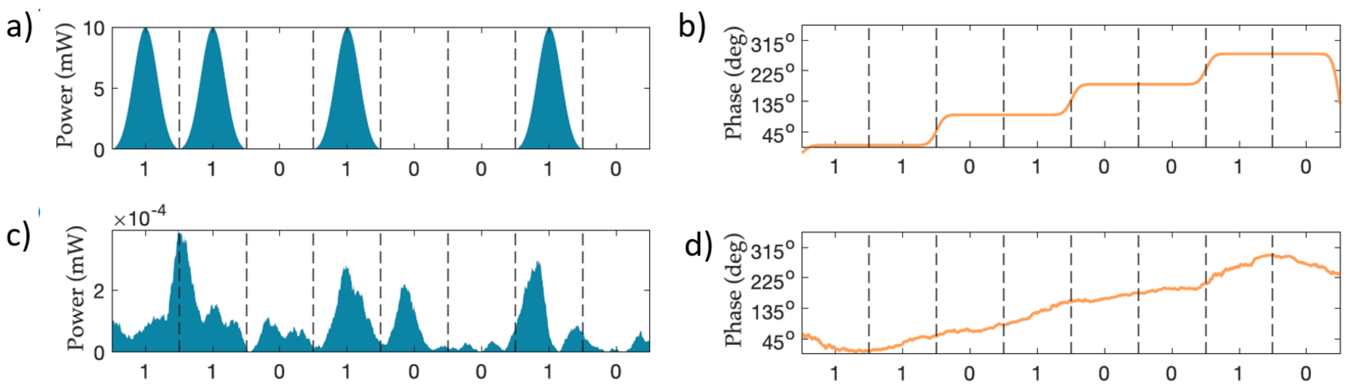

Fig. 1: Modelling the coherent storage of a pulse sequence using SBS in the presence of thermal noise. Amplitude storage storage shows degradation of the signal from the input (a) to the output (c); Phase storage is more robust, showing stronger preservation of the input phase information (b) in the read-out signal (d).

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