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Interference Mitigation in Wireless Communications assisted by Reconfigurable Intelligent Surfaces

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Future wireless network architectures aim to achieve unprecedented signal coverage and data-rates via dynamic modulation of the propagation medium. A practical way to achieve this stands on the reconfigurable intelligent surface (RIS) technology, which uses pixelated reflective meta-surfaces with individually tuneable unit cells. Besides improving signal coverage and reducing not spots, the RIS reduces signal variability, which is underpinned by impaired electromagnetic (EM) wave propagation. Wireless communications in complex occur via multiple propagation paths that are best characterised by a statistical channel model. Therefore, antenna arrays and RIS devices are excited by a stochastic EM field, i.e., instantaneous variability at a specific point in space is hard-to-predict. Inherently, channel Hardening (CH) occurs in Multiple-Input Multiple-Output (MIMO) systems where the wireless signal is spatially averaged through a large antenna array, thus reducing EM field fluctuations. As a practical consequence, the receive array perceives a dramatic reduction of the multi-path fading. However, the randomness is still present in the EM waves impinging onto the array, but the impact of signal fluctuations on the communication link is weaker at receiver. While CH was observed in real-life propagation channel, both supporting idealised and non-idealised multi-path fading statistics, an interesting research question has configured over the last year within the wireless communication community, which asks whether CH can be achieved in RIS-assisted SISO wireless propagation channels. Some effort has been devoted to address this question from both system level and EM perspectives.

In this work, we optimise a RIS-assisted digital link operating within an electromagnetic reverberation chamber (RC), which is a controlled laboratory environments used to emulate dynamic multi-path fading. The digital link includes two software defined radios that control both transmit and receive arrays. We show the onset of CH for optimal RIS configurations, which is due to the law of large numbers. Inherently, predictions based on a statistical channel model provides channel hardening bounds that are verified by RC measurements involving 2x2 MIMO wireless systems assisted by scalable sub-6 GHz RIS prototypes. Results are of interest for reducing the computational complexity carried by channel state information algorithms in mobile wireless networks, and to develop accurate protection technologies in directed energy scenarios.