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First radio evidence for ubiquitous magnetic reconnections and impulsive heating in the quiet solar corona

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It has been a long standing problem as to how the solar corona can maintain its million K temperature, while the photosphere, which is the lowest layer of the solar atmosphere, is only at a temperature of 5800 K. A very promising theory to explain this is the “nanoflare” hypothesis, which suggests that numerous flares of energies ~10^{24} ergs are always happening in the solar corona, and maintain its million K temperature. However, detecting these nanoflares directly is challenging with the current instrumentation as they are hypothesised to occur at very small spatial, temporal and energy scales. These nanoflares are expected to produce nonthermal electrons, which are expected to emit in the radio band. These nonthermal emissions are often brighter than their thermal counterparts and might be detectable with current radio instruments. Due to their importance multiple searches for these nonthermal emissions have been done, but thus far they have been limited to active regions. The quiet corona is also hot, and often comprises the bulk of the coronal region, so it is equally important to understand the physical processes which maintain this medium at MK temperatures. We describe the results from our effort to use the data from the Murchison Widefield Array (MWA) to search for impulsive radio emissions in the quiet solar corona. By pushing the detection threshold of nonthermal emission by about two orders of magnitude lower than previous studies, we have uncovered ubiquitous very impulsive nonthermal emissions from the quiet sun. We refer to these emissions as Weak Impulsive Narrowband Quiet Sun Emissions (WINQSEs). Using independent observations spanning very different solar conditions we show that WINQSEs are present throughout the quiet corona at all times. Their occurrence rate lies in the range of many hundreds to about a thousand per minute, implying that on average order 10 or so WINQSEs are present in every 0.5 s MWA image. Preliminary estimates suggest that WINQSEs have a bandwidth of ~2 MHz. Buoyed by their possible connection to the hypothesised “nanoflares”, we are pursuing several projects to characterise and understand them. These include developing machine learning algorithms to identify WINQSEs in radio images and characterise their morphologies; exploring the ability of the present generation EUV and X-ray instruments to estimate the energy corresponding to the brightest of WINQSEs; and attempting very high time resolution imaging to explore their temporal structure. In this talk, I will present the results from the past and ongoing projects about WINQSEs and argue that these might be a key step towards detecting “nanoflares” and the resolution of the coronal heating problem.