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Perspectives of quantum computing with magnons

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Finding new ways for fast and efficient processing and transfer of data is one of the most challenging tasks nowadays. One of the most challenging directions in this area is quantum computing, which is up to now dominated by superconducting circuits. Although such circuits are assumed to be well scalable, creating large quantum networks of multiple quantum bits is still a major problem. Thus, it is very important to look for other physical systems, which might become companions or even replacements for the current superconducting computing elements. Another challenge is to connect these systems to conventional superconducting circuits. One of the possible solutions might come from the investigation of magnetic systems and quasiparticles associated with the elementary disturbance of magnetic order – magnons. Large tunability, relatively long lifetimes of excitations, intrinsic nonlinearities, excellent ability to connect to other physical systems and easy creation of macroscopic quantum states like magnon Bose-Einstein Condensate (BEC) – these are some of the main features, which might be used for the advancement of quantum computing. In this talk, I will summarize the main achievements in the field of quantum magnonics. Firstly, the creation and manipulation of magnon BECs will be discussed. Secondly, the coherent coupling of magnon states to superconducting circuits will be reviewed. And finally, I will present a recently developed heralded single magnon source concept. Reported here works were funded in part by ERC within the AdG “Supercurrents of Magnon Condensates for Advanced Magnonics”, Alexander von Humboldt Foundation, and UCCS Office of Research CRCW Seed Grant.