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Entanglement Entropy of U(1) Quantum Spin Liquids MICHAEL PRETKO, T SENTHIL, Massachusetts Institute of Technology — We investigate the entanglement structure of the ground state of a (3+1)-dimensional U(1) quantum spin liquid, described by the deconfined phase of a compact U(1) gauge theory. The excitations of the system are a gapless photon and gapped electric/magnetic charges. The elements of the entanglement spectrum can be grouped according to the electric flux between the two regions, leading to an interpretation in terms of particles living on the boundary. The entanglement spectrum is given additional structure due to the presence of the gapless photon. Making use of the Bisognano-Wichmann theorem and a local thermal approximation, these two contributions are recast in terms of boundary and bulk contributions, respectively. Both pieces give rise to universal subleading logarithms in the entanglement entropy, as opposed to the subleading constant in gapped topologically ordered systems. The photon term arises from the low-energy conformal field theory and is essentially local in character. The particle term arises due to the constraint of closed electric loops and is shown to be the natural generalization of topological entanglement entropy to the U(1) spin liquid. This contribution to the entanglement entropy can be isolated by means of a special geometric construction.

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