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Entanglement in timelike region and sum rule

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We usually investigate the entanglement between different spacelike regions. From the perspective of quantum field theory, it is natural to generalize the concept of spacelike entanglement to timelike entanglement. This can be achieved through the analytical continuation of correlation functions of twist operators. In this approach, we have unified the concepts of timelike and spacelike entanglement. Moreover, we also discovered that the timelike entanglement entropy has an interesting sum rule that connects with the spacelike entanglement entropy. This sum rule holds true for many examples, both in two-dimensional and higher-dimensional conformal field theories (CFTs). We will also discuss the possibility of generalizing timelike entanglement to other entanglement measures, such as negativity. Timelike entanglement appears to be connected with complex geometry and the complex Ryu-Takayanagi surface.

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