Strong entanglement criterion based on momentum weak values

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Weak values have been used in recent years to explore various quantum features in novel ways. In this work we present a separate analysis of the real and imaginary parts of the weak value of the linear momentum operator, which are associated with the flow and the diffusive velocity, respectively. We then establish an entanglement criterion for a bipartite system, based on weak momentum correlations, which allows us to discern whether the entanglement is encoded in the amplitude and/or the phase of the wave function. Our results throw light on the physical role of the real and imaginary parts of the weak values, and serve to stress the relevance of the latter in the multi-particle scenario.