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Angle and angular momentum – new twist for an old pair

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Reaching ultimate performance of quantum technologies requires the use of detection at quantum limits and access to all resources of the underlying physical system. We establish a full quantum analogy between the pair of angular momentum and exponential angular variable, and the structure of canonically conjugate position and momentum. This includes the notion of optimal simultaneous measurement of the angular momentum and angular variable, the identification of Einstein-Podolsky-Rosen-like variables and states, and finally a phase-space representation of quantum states. Our construction is based on close interconnection of the three concepts and may serve as a template for the treatment of other observables. This theory also provides a new testbed for implementation of quantum technologies combining discrete and continuous quantum variables.

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