Title:	On ‘Orbital’ and ‘Spin’ Angular Momentum of Light in Classical and Quantum Theories – A General Framework
Authors:	Arvind (/jspui/browse?type=author&value=Arvind)
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Abstract:	We develop a general framework to analyze two much discussed questions concerning (a) ‘orbital’ and ‘spin’ angular momentum carried by light and (b) the paraxial approximation of the free Maxwell system both in the classical as well as quantum domains. After formulating the classical free Maxwell system in the transverse gauge in terms of complex analytical signals we derive expressions for the constants of motion (COM) associated with its Poincaré symmetry. In particular, we show that the COM corresponding to the total angular momentum J naturally splits into an ‘orbital’ part L and a ‘spin’ part S each of which is a COM in its own right. We then discuss quantization of the free Maxwell system and construct the operators generating the Poincaré group and analyze their algebraic properties and find that while the quantum counterparts urn:x-wiley:00158208:media:prop201800040:prop201800040-math-0001 and urn:x-wiley:00158208:media:prop201800040:prop201800040-math-0002 of L and S go over into bona fide observables, they fail to satisfy the angular momentum algebra making their interpretation as ‘orbital’ and ‘spin’ operators untenable at the quantum level. On the other hand urn:x-wiley:00158208:media:prop201800040:prop201800040-math-0003 does satisfy the angular momentum algebra and together with urn:x-wiley:00158208:media:prop201800040:prop201800040-math-0004 generates the group E(3). We then present an analysis of single photon states, paraxial quantization both in the scalar as well as vector cases, and single photon states in the paraxial regime. All along a close connection is maintained with the Hilbert space urn:x-wiley:00158208:media:prop201800040:prop201800040-math-0005 that naturally arises in the classical context.
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