Physics & Astronomy Colloquium – Fall 2018

Tuesday, Oct 30th at 3:30 pm in SC 234

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Identifying variation in physics students' ways of understanding quantization of energy, the photon concept and light quanta interference: Implications for instructional design and development

A detailed investigation of student conceptions of quantum phenomena is needed, both to characterize student understanding of quantum concepts and to inform how we might teach quantum mechanics (QM). In this vein, in-depth semi-structured interviews were conducted with 35 students who majored in physics and received university-level QM instructions. Interview protocols were used and based on three quantum contexts: the quantization of energy in explaining the blackbody radiation, the photon concept in explaining the photoelectric effect, and light quanta in explaining the gradual formation of an interference pattern in the cases of low-intensity light beam. By applying a developmental phenomenographic analysis of the interview responses, three description categories (i.e., general patterns behind the conceptual understandings used in explaining each quantum contexts) were identified. These categories of descriptions revealed that most students' thinking regarding foundational concepts in QM ranged from naïve and deficient descriptions based on classical ontologies to simple hybrid and/or mixed models of classical and quantum conceptions. Regarding learning QM, the study found that the perspective of naïve and classical ontologies in explaining quantum phenomena influenced students' responses; they made incorrect generalizations and/or inappropriate links to the concepts learned in classical physics; and patterns of incorrect notions of QM are analogous to those that were documented. Besides, the study confirmed that students' conceptual difficulties with QM are real and stable. Results from this study were applied to develop multiple representations based interaction and research-based interactive quantum learning tutorials to improve students' understanding of quantum mechanics.

Refreshments at 3:00 pm in SC 103