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Light Propagation in Liquid Crystals with a Chiral Dopant
JUSTIN LAWSON, KARL SAUNDERS, LOGAN GANTNER, California Polytechnic State University — This project will investigate the design and feasibility of a novel liquid crystal sensor that could be used to detect the presence and amount of foreign biological and/or chemical airborne agents. Such a sensor would have the advantage of being very portable. As such could have particular value in detecting biological or chemical weapons in the field of military operations. It would also be of use in a rapid response to a chemical or biological terrorist attack. The device would operate on the basic principal that when certain types of molecules bind to a liquid crystal molecule, the conformation of the liquid crystal molecule changes. This would in turn lead to a change in the overall arrangement of the liquid crystal, which could be detected using polarized light. In the absence of a contaminant the average molecular direction (optical axis, $\hat{n}$) is constant throughout the liquid crystal. The dopant adds a chirality or twist so that $\hat{n}$ precesses as a function of depth. We first solve for the reflected and transmitted light off of the air-liquid crystal boundary in the simplified case where there is linear chirality or a spiral configuration which repeats itself over some fixed interval (or pitch). We then generalize for cases in which this repeat distance varies with crystal depth. Finally we will obtain an expression for the contaminated crystal configuration which should depend on time and a diffusion constant and examine how the light properties change with respect to intensity and duration of exposure to the contaminant.

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