

Several models of the mechanical response of tilted lipid bilayers have been presented in the biophysics literature on an ad hoc basis. Here, following an idea due to Helfrich, we systematically derive a model via asymptotic analysis of three-dimensional liquid crystal theory in which bilayer thickness plays the role of the small parameter. The resulting model is a special case of Cosserat shell theory that features independent director fields, one for each of the two leaves comprising the bilayer. The model provides a local correction, in the vicinity of embedded transmembrane structures, to the classical Canham/Helfrich model in which lipid tilt is suppressed.