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Lessons from Group Theory for Physics Students and Physicists

You may not realize it from the outside but an undergraduate physics curriculum is composed of numerous interconnected topics that ``we'' have decided are necessary for a complete physics education. This process necessarily leaves some topics on the outside. Today I would like to talk about one of those topics, group theory. I will focus primarily on finite point symmetry groups as these tend to be closer to my own research interests. The primary question is as follows: if you know that the surroundings of a particular obey some symmetry laws what does this tell us about what functions are the most useful to describe say, electron density or vibrational modes? Is this done with fortuitous guesswork or is there a systematic way to do it?