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One mathematical problem in non-relativistic quantum field theories

We will consider a QFT of single scalar field $\phi(t, \vec{x})$ in d spatial dimensions. We will work with polynomial shift transformations of the field and we will solve the task to find Lagrangian terms, which are invariant - up to total derivative - under these polynomial shift transformations. We will develop graphical representation and we prove that a superposition of an exact P_E-invariant with the superposition of Q minimal loopless 1-invariants results in a P-invariant, provided $P_E + 2Q \geq P$. We prove that the above result captures all P-invariants. Our result should deepen our knowledge about the study of naturalness in non-relativistic QFT's of the Lifshitz type.