# Higgs modes and triviality in quantum spin dimers in the vicinity of the quantum critical point

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We study the longitudinal spin fluctuations (Higgs mode) in 3D quantum dimer systems in the vicinity of the quantum phase transition (QPT) quantum dimer $\rightarrow$ quantum antiferromagnet. As an example we consider $TlCuCl_3$, where this QPT is driven by pressure. The critical dynamics is described in the framework of $\Phi^4$ model. The renormalization group analysis applied to the lattice $\Phi^4$ model shows that the quartic coupling constant $g$ diverges (Landau pole) at a finite momentum scale, i.e., the continuum limit of this model is free (trivial). The presence of the Landau pole generates an upper bound (triviality bound) on the mass of the Higgs mode.

We have found that in the case of $TlCuCl_3$ the Landau pole develops at the underlying lattice (reciprocal) scale, i.e., this system should be described within the strong coupling limit of $\Phi^4$ model or, equivalently, quantum non-linear $\sigma$-model (QNL$\sigma$M). Applying $1/N$ expansion method to the QNL$\sigma$M the dynamical spin susceptibilities of $TlCuCl_3$ have been computed and the pressure dependence of the longitudinal magnon gap and its full width at half maximum have been extracted. The Néel temperature, staggered magnetization, and the gap in the dimerized phase have been calculated. A good agreement with experiments has been obtained.