Symplectic No-Core Shell Model

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The symplectic no-core shell model (SpNCSM) is described. The theory is applied to a study of the structure of ^{12}C and ^{16}O. Results from a full $6\hbar\omega$ NCSM calculation for low-lying states in these nuclei using a realistic nucleon-nucleon interaction are found to project at approximately the 90% level onto a few of the leading 0p-0h and 2p-2h symplectic representations [1]. The results are nearly independent of the oscillator strength parameter and whether bare or renormalized effective interactions are used in the analysis. As shown in the Figure, the SpNCSM model space is typically only a very small fraction (under 1%) of the NCSM space, and grows slowly with increasing $\hbar\omega$.

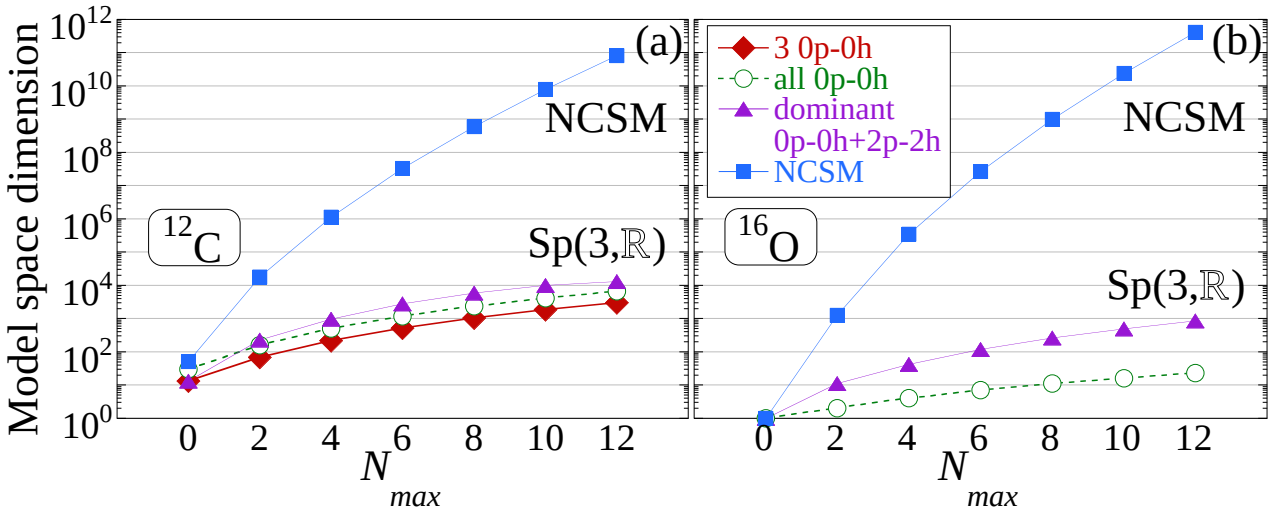

Figure: Comparison of SpNCSM and NCSM model space dimensionalities as a function of $\hbar\omega$.

What remains to be done to render the SpNCSM a stand alone theory will be discussed. The comparisons with NCSM results suggest either the effective nucleon-nucleon interation posesses a heretofore unappreciated symmetry, namely Sp(3,R) and the complementary (spin-isospin) super-multiplet symmetry, or the nuclear many-body system acts as a filter that allows the symplectic symmetry to propagate in a coherent way into the many-body dynamics while tending to dampen out symplectic symmetry breaking terms. Also, since the SpNCSM is a multi-$\hbar\omega$ generaliztion of the Elliott SU(3) model, the results obtained to date reaffirm the relevance of SU(3) to atomic nuclei.

References

[1]Tomáš Dytrych, Kristina D. Sviratcheva, Chairul Bahri, Jerry P. Draayer, and James P. Vary, Phys. Rev. Lett. **98** (2007) 162503.