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# N = 4 supersymmetric Yang-Mills thermodynamics to order λˆ2

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We calculate the resummed perturbative free energy of N = 4 supersymmetric Yang-Mills in four spacetime dimensions $SYM_{4,4}$ through second order in the ' t Hooft coupling λ at finite temperature and zero chemical potential. Our final result is ultraviolet finite and all infrared divergences generated at three-loop level are canceled by summing over $SYM_{4,4}$ ring diagrams. Non-analytic terms at $\mathcal{O}(^{3/2})$ and $\mathcal{O}(^{2}log)$ are generated by dressing the $A_0$ and scalar propagators. The gauge-field Debye mass $m_D$ and the scalar thermal mass $M_D$ are determined from their corresponding finite-temperature self-energies. Based on this, we obtain the three-loop thermodynamic functions of $SYM_{4,4}$ to $\mathcal{O}(^{2})$.

## Summary

By comparing our final result with prior results obtained in the weak- and strong-coupling limits and construct a generalized Padé approximant that interpolates between the weak-coupling result and the large-$N_c$ strong-coupling result. Our results suggest that the $\mathcal{O}(^{2})$ weak-coupling result for the scaled entropy density is a quantitatively reliable approximation to the scaled entropy density for 0 ≤ λ ⊠ 2.

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