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Derivatives and fast evaluation of the Witten zeta function

We study analytic properties of the Witten zeta function $\mathcal{W}(r, s, t)$, which is also named after Mordell and Tornheim. In particular, we evaluate the function $\mathcal{W}(s, s, \tau s)$ ($\tau > 0$) at $s = 0$ and, as our main result, find the derivative of this function at $s = 0$, which turns out to be surprisingly simple. These results were first conjectured using high-precision calculations based on an identity due to Crandall that involves a free parameter and provides an analytic continuation. This identity was also the main tool in the eventual proofs of our results. Finally, we derive special values of a permutation sum and study an alternating analogue of $\mathcal{W}(r, s, t)$. (Joint work with Jon Borwein).