Large parameter asymptotics for hypergeometric and Legendre functions

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Abstract: Surprisingly, apart from some special cases, simple asymptotic expansions for the associated Legendre functions $P_\nu^\mu(z)$ and $Q_\nu^\mu(z)$ for large degree ν or large order μ are not available in the literature. In this presentation we will fill this gap by deriving several simple (inverse) factorial expansions for these functions and provide sharp and realistic bounds on their error terms. In the cases that ν is an integer or 2μ is an odd integer, many of these new expansions terminate and provide finite representations in terms of simple functions. Most of these representations appear to be new.

It is well known that the hypergeometric series can be regarded as a large-c asymptotic expansion for the hypergeometric function $F(a, b; c; z)$. We will also present computable bounds for the remainder term of this expansion. To our best knowledge, no such estimates have been given in the literature.