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Functional equations related to indeterminate moment problems

For $\beta \in \mathbb{R}$, $p > 0$, and $0 < q < 1$ fixed, we characterize the integrable functions on $(0, \infty)$ satisfying the functional equation $f(qx) = q^{\beta-1/2}(x + pq^{-1/2})f(x)$, and show that they are solutions to the generalized Stieltjes–Wigert moment problem.