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Nucleon relativistic weak-neutral axial-vector four-current distributions

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Relativistic full weak-neutral axial-vector four-current distributions inside a general spin-$\frac{1}{2}$ system are systematically studied for the first time. We show in particular that the slope of the axial form factor $G_A(Q^2)$ in the forward limit – conventionally denoted as R_A^2 in the literature – does not represent the three-dimensional mean-square axial radius in the Breit frame, but corresponds instead to a contribution to the mean-square spin radius. We derive explicit expressions for the latter in different frames and find in general additional contributions that depend on both the nucleon mass and the forward values of the axial-vector form factors $G_A(0)$ and $G_P(0)$. This provides an additional key motivation for on-going lattice QCD calculations and future experimental measurements of the induced pseudoscalar form factor $G_P(Q^2)$.

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