Pauli operator and Aharonov-Casher theorem for measure valued magnetic fields

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We define the two dimensional Pauli operator and identify its core for magnetic fields that are regular Borel measures. The magnetic field is generated by a scalar potential hence we bypass the usual $\mathbf{A} \in L^2_{loc}$ condition on the vector potential which does not allow to consider such singular fields. We extend the Aharonov-Casher theorem for magnetic fields that are measures with finite total variation and we present a counterexample in case of infinite total variation. One of the key technical tools is a weighted L^2 estimate on a singular integral operator.