Non-local relativistic delta shell interactions

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The recent development of boundary triples theory allowed us to study self-adjointness of the Dirac operator perturbed by the singular potential $D_l^{\mathbb{A}} = D+\mathbb{A}\delta_\Sigma$, where $\mathbb{A}$ is arbitrary hermitian matrix and δ_Σ stands for the single-layer distribution supported on closed non-self-intersecting Lipchitz-smooth curve or surface Σ in $\mathbb{R}^n$, $n \in \{2,3\}$; cf. [1],[2]. It was proved that the operator $D_l^{\mathbb{A}}$ corresponds to a self-adjoint extension of a symmetric operator $D_0\varphi = D\varphi$, $\varphi \in H_0^1(\mathbb{R}^n \setminus \Sigma)$. Contrary to the general belief, by studying seemingly similar formal operator $D_{nl}^{\mathbb{A}} = D + \mathbb{A}|\delta_\Sigma\rangle\langle\delta_\Sigma|$ we will be able to define completely new self-adjoint extensions of the operator D_0. Let us mention that this is not the case in one dimension, where operators $D_l^{\mathbb{A}}$ and $D_{nl}^{\mathbb{A}}$ are one and the same. Finally, in case of C^2 curve resp. surface we will be able to construct regular approximations and prove the norm-resolvent convergence to the operator $D_{nl}^{\mathbb{A}}$ without renormalization.

References

[1] J. Behrndt, M. Holzmann, T. Ourmières-Bonafas, K. Pankrashkin, *Two-dimensional Dirac operators with singular interactions supported on closed curves.* Journal of Functional Analysis, vol. 279, 2020.

[2] J. Behrndt, M. Holzmann, C. Stelzer, G. Stenzel, *Boundary triples and Weyl functions for Dirac operators with singular interactions.* https://arxiv.org/abs/2211.05191, 2022.