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A General Three-Body Interaction with the GPT-Potential

A general three-body interaction could be generated by the two-body linear and nonlinear interactions which could appear in the very short and in the long range regions, although the three-body Faddeev equation is written in terms of a two-body linear interaction.
However, in the very short range, many meson or multi quark/gluon exchanges may take place which are taken into account by a "three-body short range force: $V_{\rm 3BSF}$". In the long range region, the linear three-body Faddeev equation can not be exactly described by a two-body long range potential.
In this context, we could employ a general three-body interaction $V_{\rm 3BF}$ by using the *general particle transfer* (GPT) potential $V_\alpha(\mathbf{r}_{\beta\gamma};n)$ [1], i.e.,
$\left[V_{\rm 3BF}\right]_{\alpha\beta} \equiv \left[b_{\alpha\beta} + \left\{1/V_\alpha(\mathbf{r}_{\beta\gamma};n) + 1/V_\beta(\mathbf{r}_{\gamma\alpha};n)\right\}\right]^{-1}$
$= V_\alpha(\mathbf{r}_{\beta\gamma};n)V_\beta(\mathbf{r}_{\gamma\alpha};n)/calV$
and
$calV = b_{\alpha\beta}V_\alpha(\mathbf{r}_{\beta\gamma};n)V_\beta(\mathbf{r}_{\gamma\alpha};n) + V_\alpha(\mathbf{r}_{\beta\gamma};n) + V_\beta(\mathbf{r}_{\gamma\alpha};n) \equiv (E - H_0)$,
with the three-body kinetic energy H_0 and the total energy E, respectively.
$b_{\alpha\beta}$ denotes a parameter which represents a border between the linear and the nonlinear interactions.
We obtain
$\left[V_{\rm 3BF}\right]_{\alpha\beta}$
$= V_\alpha(\mathbf{r}_{\beta\gamma};n)V_\beta(\mathbf{r}_{\gamma\alpha};n)/(E - H_0 + i\epsilon)$.
This formula is a generalized Alt-Grassberger-Sandhas (AGS) Born term which includes both the three-body short range force (3BSF), and the three-body long range force (3BLF).

[1] Shinsho Oryu, ~~~~J. Phys. Commun. {\bf 6} 015009 (2022).

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