Defintions

The dimensionless **partial wave amplitude** for the reaction $\nu \to \mu$ with the channel indices ν, $\mu = \pi N$, ηN, $K\Lambda$, $K\Sigma$ is denoted by $\tau_{\mu\nu}$. Its definition is identical to the one of, e.g., the GWU/SAID group for πN [1]. We give $\tau_{\mu\nu}$ in the JLS basis, where J is the total angular momentum, L is the orbital angular momentum and S denotes the total spin of the system.

τ is related to the T-matrix of the Jülich model (Eq. (1) in Eur. Phys. J. A49 (2013) 44) via a phasefactor:

$$\tau_{\mu\nu}^{JLS} = -\pi\sqrt{\rho_\mu \rho_\nu}\, T_{\mu\nu}^{JLS} \tag{1}$$

with

$$\rho_\mu = \frac{k_\mu}{z}\, E(k_\mu)\, \omega(k_\mu). \tag{2}$$

Here, z denotes the total c.m. energy while E and ω are the energies of the baryon and meson, respectively. k_ν is the initial onshell-, k_μ the final onshell-momentum in the center-of-mass.

To calculate observables, we express the spin-scattering matrix M in terms of the non-spin-flip and spin-flip amplitudes g and h as

$$M = g(k,\theta) + h(k,\theta)\, \vec{\sigma}\cdot\hat{n}\ , \tag{3}$$

where θ is the scattering angle, $\vec{\sigma}$ is the Pauli-spin vector and $\hat{n} = \frac{\vec{k}_\nu \times \vec{k}_\mu}{|\vec{k}_\nu \times \vec{k}_\mu|}$.

The **differential cross section** can be written as

$$\frac{d\sigma}{d\Omega} = \frac{k_\mu}{k_\nu}(|g|^2 + |h|^2). \tag{4}$$

For the final state **polarization** P_μ with an unpolarized target we have

$$\vec{P}_\mu = \frac{2\mathrm{Re}(gh^*)}{|g|^2 + |h|^2}\hat{n}\ . \tag{5}$$

The explicit form of the non-spin-flip and spin-flip amplitudes g and h in terms of the partial wave amplitude τ in the JLS basis is

$$\begin{aligned} g &= \frac{1}{2\sqrt{k_\mu k_\nu}} \sum_J (2J+1) d^J_{\frac{1}{2}\frac{1}{2}}(\theta) \left[\tau^{J(J-\frac{1}{2})\frac{1}{2}} + \tau^{J(J+\frac{1}{2})\frac{1}{2}}\right] \cos\frac{\theta}{2} \\ &+ \frac{1}{2\sqrt{k_\mu k_\nu}} \sum_J (2J+1) d^J_{-\frac{1}{2}\frac{1}{2}}(\theta) \left[\tau^{J(J-\frac{1}{2})\frac{1}{2}} - \tau^{J(J+\frac{1}{2})\frac{1}{2}}\right] \sin\frac{\theta}{2} \end{aligned} \tag{6}$$

$$
\begin{aligned}
h &= \frac{-i}{2\sqrt{k_\mu k_\nu}} \sum_J (2J+1) d^J_{\frac{1}{2}\frac{1}{2}}(\theta) \left[\tau^{J(J-\frac{1}{2})\frac{1}{2}} + \tau^{J(J+\frac{1}{2})\frac{1}{2}}\right] \sin\frac{\theta}{2} \\
&+ \frac{i}{2\sqrt{k_\mu k_\nu}} \sum_J (2J+1) d^J_{-\frac{1}{2}\frac{1}{2}}(\theta) \left[\tau^{J(J-\frac{1}{2})\frac{1}{2}} - \tau^{J(J+\frac{1}{2})\frac{1}{2}}\right] \cos\frac{\theta}{2}, \qquad (7)
\end{aligned}
$$

where the upper index of τ denotes the corresponding JLS and $d^J_{\lambda'\lambda}(\theta)$ are the Wigner (small) d-functions with helicity $\lambda, \lambda' = \pm\frac{1}{2}$. We apply the convention of Brink and Satchler

$$
\begin{aligned}
d^J_{m'm}(\theta) &= \sum_s (-1)^s \frac{[(J+m')!(J-m')!(J+m)!(J-m)!]^{\frac{1}{2}}}{(J+m'-s)!(J-m-s)!s!(s+m-m')!} \\
&\times \left(\cos\frac{\theta}{2}\right)^{2J+m'-m-2s} \left(\sin\frac{\theta}{2}\right)^{2s+m-m'}, \qquad (8)
\end{aligned}
$$

where $m = -J, -J+1, ..., J$.

Threshold energies

To calculate the partial wave amplitude $\tau_{\mu\nu}$ in the different channels ν, μ we use the following threshold energies:

	πN	ηN	$K\Lambda$	$K\Sigma$
E_{thr} [MeV]	1076.96	1486.38	1611.42	1688.32

Note that in the τ files of this website we do not quote $\tau_{\mu\nu}$ but

$$
\Theta\left(z - \max(E^\mu_{\text{thr}}, E^\nu_{\text{thr}})\right) \cdot \tau_{\mu\nu} \qquad (9)
$$

with the stepfunction Θ so that the entries in the tables vanish for scattering energies z below the higher threshold of the channels μ and ν.

References

[1] R. A. Arndt, W. J. Briscoe, I. I. Strakovsky and R. L. Workman, Phys. Rev. C **74**, 045205 (2006).