

Ammonia asymmetry

OSCAR A. RONDON

INPP-U. of Virginia

Number of counts from all target components for helicity L :

$$L = \Phi(N_{15}\sigma_{15}^L + N_p\sigma_p^L + N_{He}\sigma_{He} + N_{Al}\sigma_{Al})$$

$$\begin{aligned}\sigma_{He}^L &= \sigma_{He}^R = \sigma_{He} \\ \sigma_{p(A)}^{L(R)} &= \sigma_{p(A)}(1 \pm A_p^A P_A P_b) \\ \sigma_{15}^{L(R)} &= 8\sigma_n^{15} + 6\sigma_p^{15} + \sigma_{p(15)}^{L(R)}\end{aligned}$$

Symbols: $15 = {}^{15}\text{N}$; $p = {}^1\text{H}$; $L(R) = +(-)$; $p(N)$ = proton in N ; Φ = flux factor;
 $P_{A,p}$ = Nuclear, proton target polarization; P_b = beam polarization; A_p = Asymmetry.

$$\begin{aligned}L(R) &= \Phi[N_{15}(8\sigma_n^{15} + 6\sigma_p^{15} + \sigma_{p(15)}(1 \pm A_p^{15} P_{15} P_b)) \\ &\quad + N_p\sigma_p(1 \pm A_p P_p P_b) + N_{He}\sigma_{He} + N_{Al}\sigma_{Al}]\end{aligned}$$

$$N_p = 3N_{15}$$

The L-R counts difference simplifies to:

$$\begin{aligned}L-R &= 2\Phi P_b N_p \left(\frac{1}{3} \sigma_{p(15)} A_N^{15} P_{15} + \sigma_p A_p P_p \right) \\ A_N^{15} &= -\frac{1}{3} A_p\end{aligned}$$

After factoring $\sigma_p A_p$ out

$$L-R = 2\Phi P_b N_p \sigma_p A_p \left[\frac{-1}{3} \frac{1}{3} \frac{\sigma_{p(15)}}{\sigma_p} P_{15} + P_p \right]$$

During a given run, the polarization changes were small, so:

$$P_{15} = \alpha P_p$$

$$L-R = 2\Phi P_b P_p N_p \sigma_p A_p \left[\frac{-1}{9} \alpha \frac{\sigma_{p(15)}}{\sigma_p} + 1 \right]$$

The sum of counts is:

$$L+R = 2\Phi (N_{15}\sigma_{15} + N_p\sigma_p + N_{He}\sigma_{He} + N_{Al}\sigma_{Al})$$

$$L+R = 2\Phi \sigma_p N_p \left[\frac{1}{3} \frac{\sigma_{15}}{\sigma_p} + 1 + \sum \frac{N_A \sigma_A}{N_p \sigma_p} \right]$$

The raw asymmetry and the dilution factor then are:

$$\epsilon = \frac{L-R}{L+R} = f P_b P_p A_p \left[1 - \frac{1}{9} \alpha \frac{\sigma_{p(15)}}{\sigma_p} \right]$$

$$f = \left[\frac{1}{3} \frac{\sigma_{15}}{\sigma_p} + 1 + \sum \frac{N_A \sigma_A}{N_p \sigma_p} \right]^{-1}$$

and the corrected proton asymmetry in $^{15}\text{NH}_3$ is:

$$A_p = \frac{1}{1 - \frac{1}{9} \alpha \frac{\sigma_{p(15)}}{\sigma_p}} \left[\frac{\epsilon}{f P_b P_p} \right]$$

If the liquid He in the cell and outside the cell are represented by N'_{He} and N_{He} , and the fraction of ammonia in the cell is p_f :

$$f = \left[\frac{1}{3} \frac{\sigma_{15}}{\sigma_p} + 1 + \left(\frac{1}{p_f} - 1 \right) \frac{N'_{\text{He}} \sigma_{\text{He}}}{N_p \sigma_p} + \frac{1}{p_f} \sum \frac{N_A \sigma_A}{N_p \sigma_p} \right]^{-1}$$