Informal Report on the Third Workshop on Computing $\sigma(dd \to \alpha\pi^0)$ and Charge Symmetry Breaking

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Here are some quick notes from the Third CSB Workshop that was held at IUCF on Aug. 24-25, 2002.

1. Ed Stephenson reported on the IUCF Cooler $d + d \to \alpha + \pi^0$ experiment. Data was taken at lab energies of both 228.5 MeV ($\eta_\pi = 0.1434$) and 231.8 MeV ($\eta_\pi = 0.209$). There is a clear signal for pions with the pion signal reconstructing to the pion mass at both energies while the background moves with phase space. We congratulate the experimentalists on this remarkable measurement.

2. For $d + d \to \alpha + \pi^0$, the Weinberg operator, that involves a large isospin-violating pion rescattering on a nucleon, gives zero if one uses the simplest s-wave d and α wave functions and omits both short-range correlations and entrance-channel distortions. [Thus the answer to our "Homework problem" is zero.] This is because the strong isospin dependence of this operator breaks up the isospin-zero states of both incoming deuterons and it is difficult to couple the resulting pair of $T = 1$ states back to the $T = 0$ α particle. Note, this Weinberg operator is very important for CSB for $n+p \to d+\pi^0$. Therefore $d + d \to \alpha + \pi^0$ and $n + p \to d + \pi^0$ measure very different things.

3. A. Nogga reported that while the matrix element of the Weinberg operator is not zero if one uses correlated α and d wave functions with p and d waves, the cross section is still small. [Note, there was a question of $(2\pi)^3$ in his phase space which appears to have been resolved at the meeting.]

4. Gardestig and Horowitz reported that isoscalar short-range meson exchange currents from sigma and omega exchange contribute coherently with one-body pion emission and greatly increase the cross section. This is directly analogous to threshold pion production in $p + p \to p + p + \pi^0$. An estimate of one-body plus just the sigma exchange, using simple s-wave wave functions and no distortions, yields around 5pb for the cross section at 228.5 MeV lab energy. Here the isospin violation comes from an isospin-violating pion nucleon coupling with a value determined from pi-eta mixing. Thus $d + d \to \alpha + \pi^0$ may be dominated by pi-eta mixing with a strong interaction enhancement from short-range meson exchange currents. The short-range MECs are large because all $4 \times 3 = 12$ nucleon pairs contribute coherently.

5. A second homework problem was prepared to calculate the $d + d \to \alpha + \pi^0$ cross section with just the one-body operator and the simplest wave functions. This checks that we all have the same normalizations and will be a benchmark for better two-body calculations. Furthermore it will allow A. Nogga to check the role of high momentum components in the α wave function.

6. A list of operators that could play a significant role in $d + d \to \alpha + \pi^0$ was prepared. This list includes operators involving Deltas which could be important for p-wave pion production. [Note, this list and the 2nd homework will be sent shortly.]

7. The next meeting of the CSB collaboration should be in March of 2003 either in Indiana or Tucson.