

Present Status of Four–Nucleon Scattering Calculations

A.C.Fonseca

CFNUL, Univ. of Lisbon

This review covers the work of three groups:

a) Grenoble: J.Carbonell and R.Lazauskas

Yakubovsky Equations in Coordinate Space (allows Coulomb)

Only Local Interactions AV14, AV18, Nijmegen + Urbana 3N force

Exact 3 variable eq. after partial wave decomposition

b) Pisa : M.Viviani, A.Kievsky

Variational Hyperspherical (allows Coulomb)

Only Local Interactions AV18 + Urbana 3N force

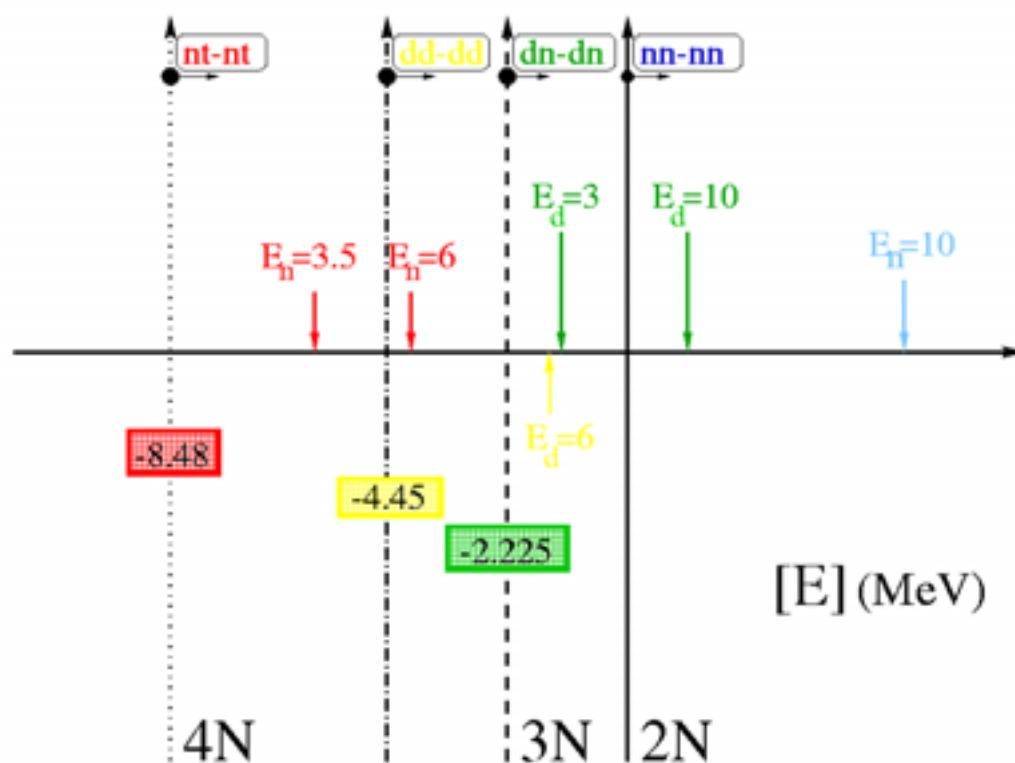
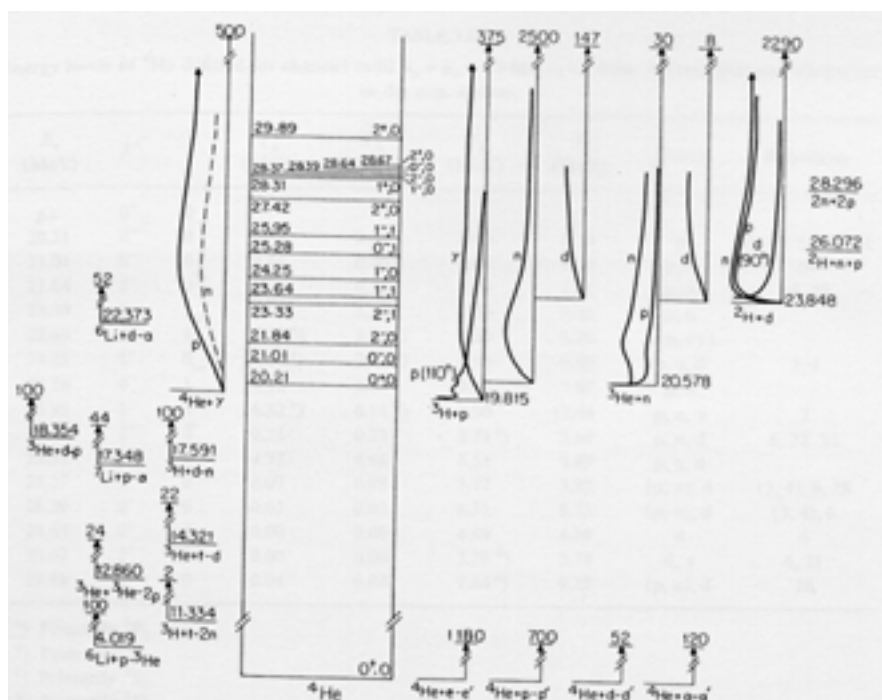
Exact in a variational sense but has had complicated convergence problems

c) Lisbon : A.C.Fonseca

Alt,Grassberger, and Shandas Equations in Momentum Space (no Coulomb)

All interactions, no 3N forces

Rank one representation of the NN interaction



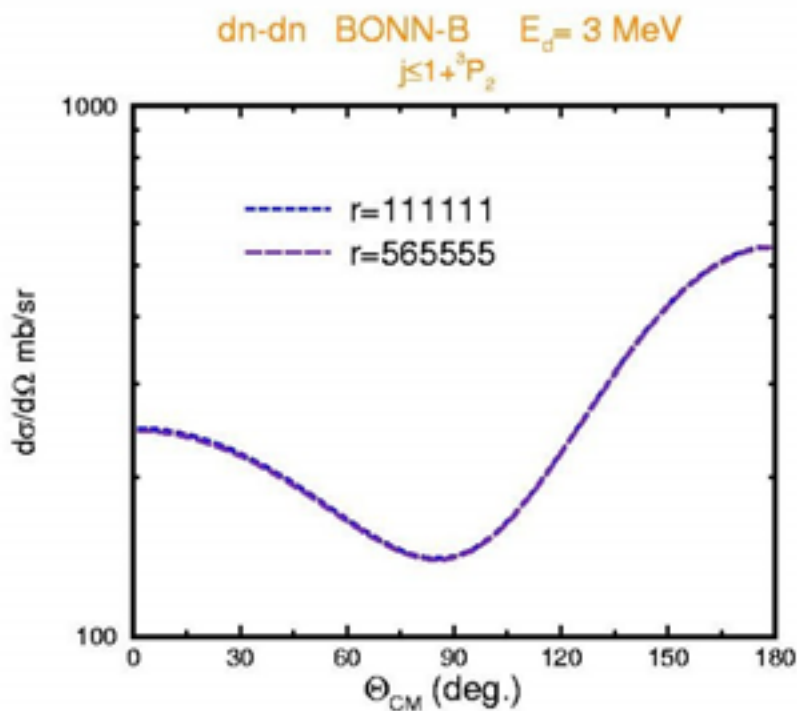
4N A.G.S. Equations Solved Using Finite Rank Representation for 2N and 3N t-Matrix

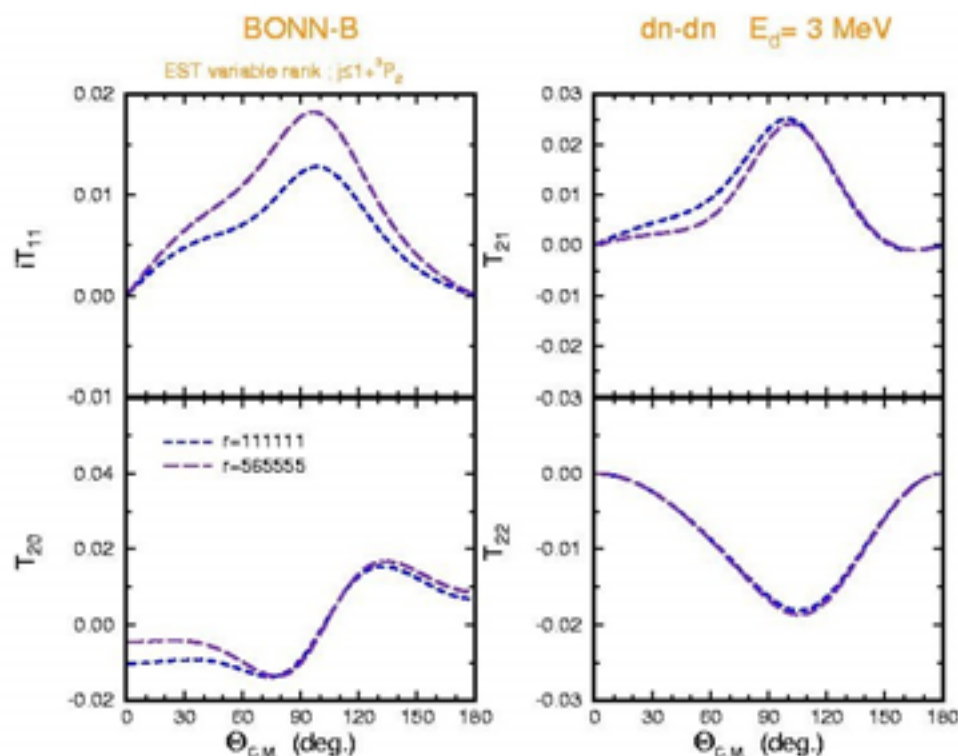
2N t-matrix : Ernest, Shakin, and Taylor (EST) rank one only
Sole Approximation

3N t-matrix : Energy Dependent Pole Expansion (EDPE) high rank
(6-8)

Convergence of 4N observables with rank is checked

2N+2N t-matrix : Exact Convolution of pairs Green's functions

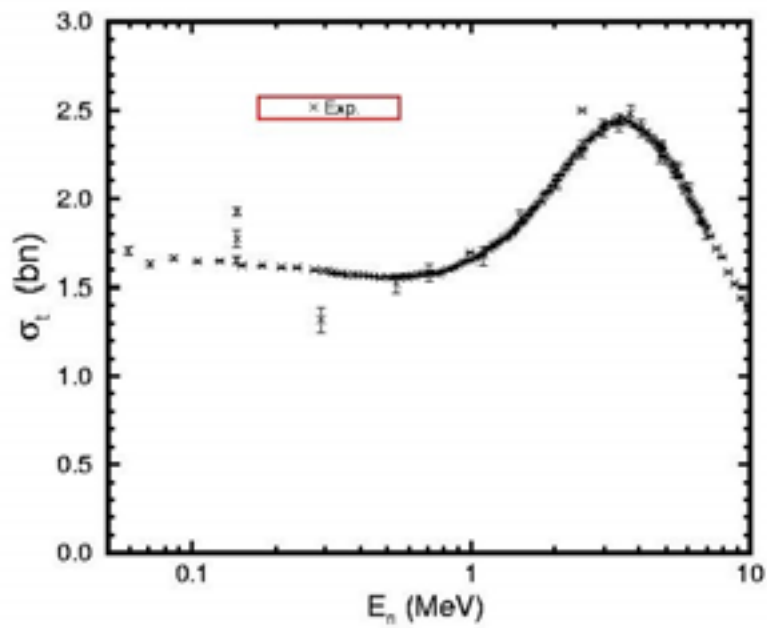




Isospin I=1

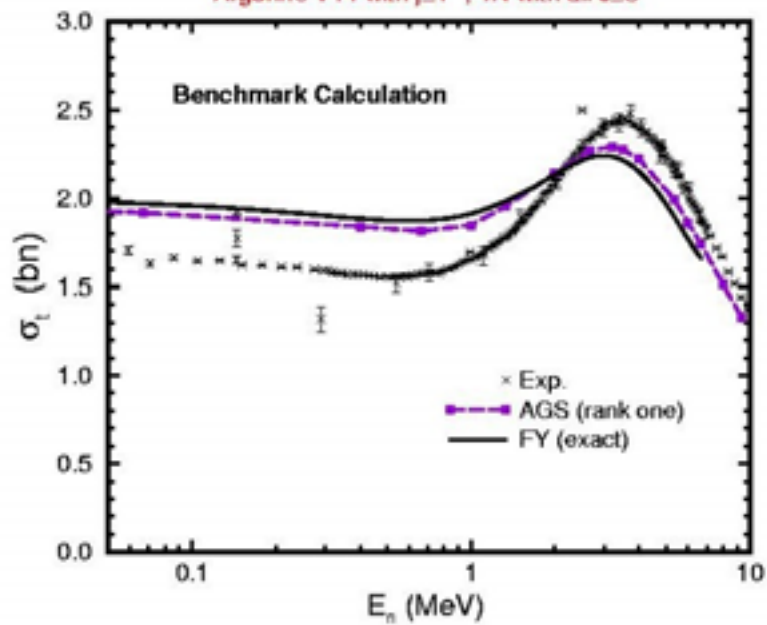


Total Cross Section for $n+{}^3\text{H}$



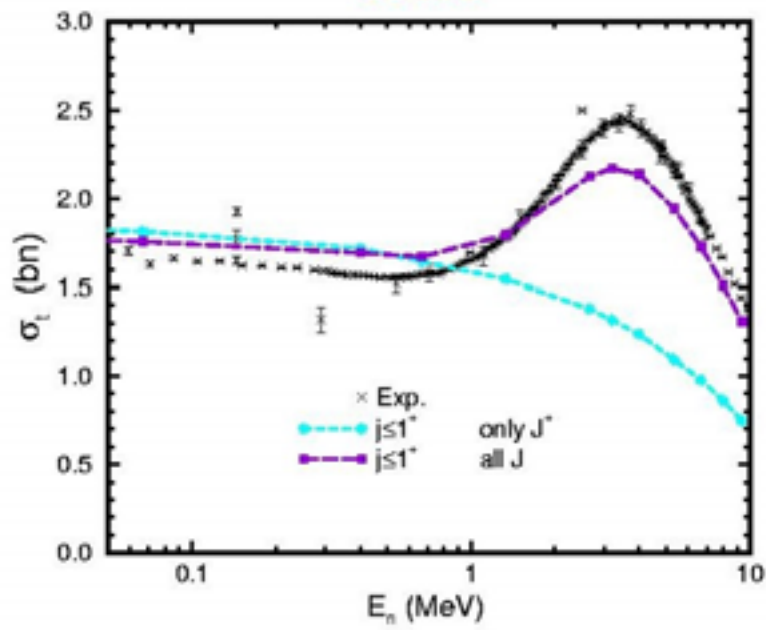
Total Cross Section for $n+{}^3\text{H}$

Argonne V14 with $j \leq 1^+$; 4N with all $J \leq 3$



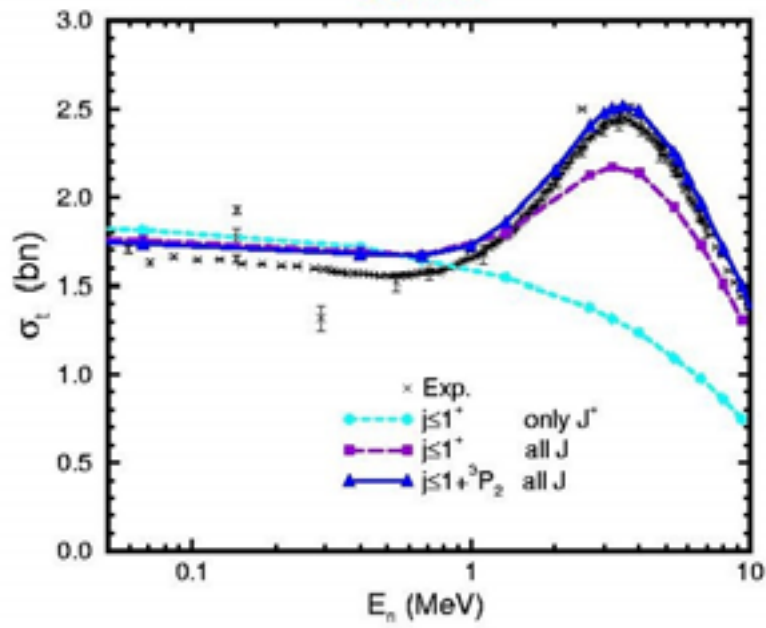
Total Cross Section for $n+{}^3\text{H}$

BONN-B

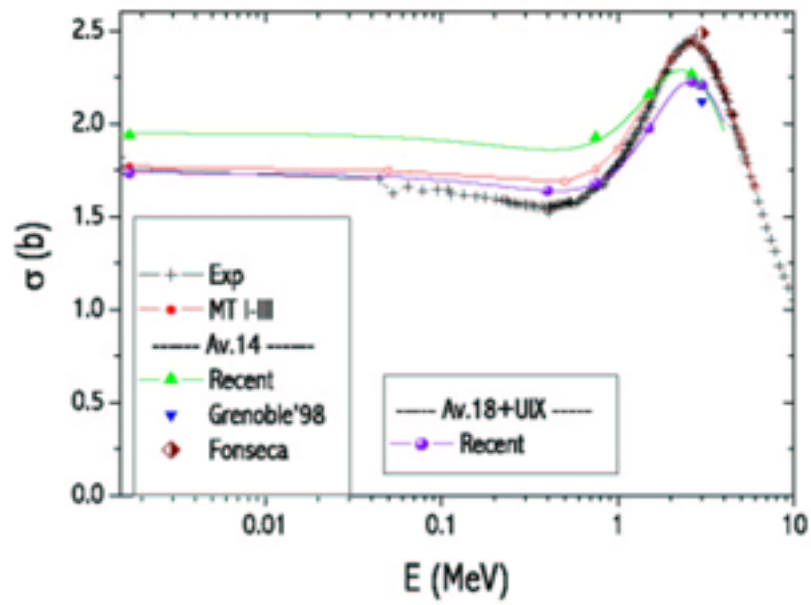
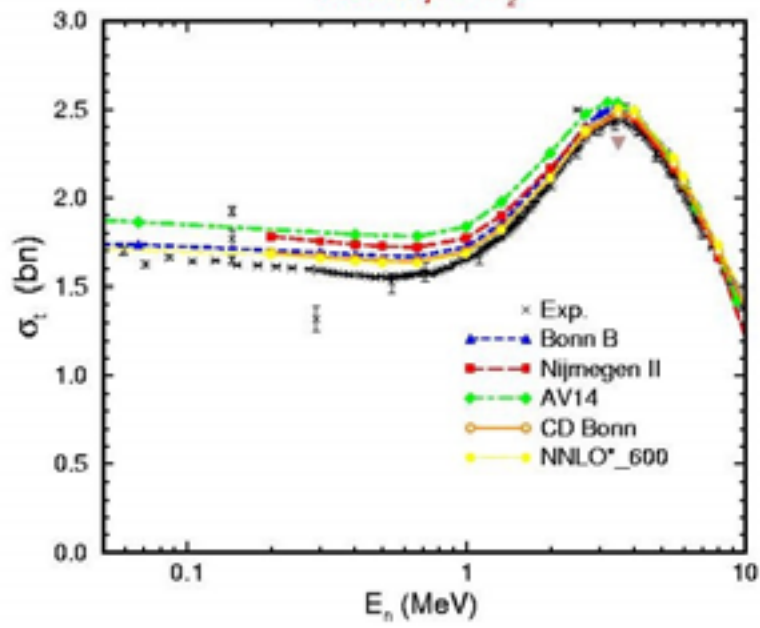


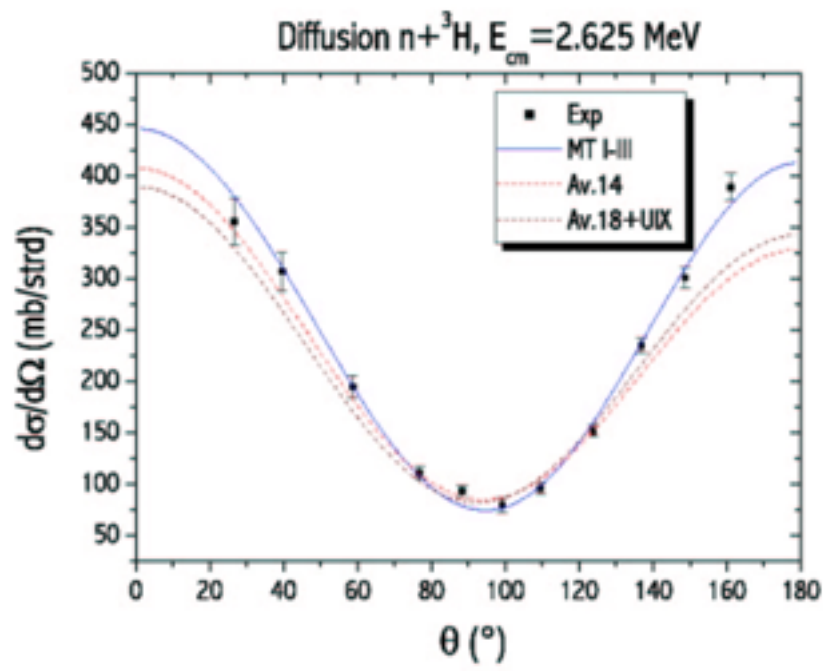
Total Cross Section for $n+{}^3\text{H}$

BONN-B

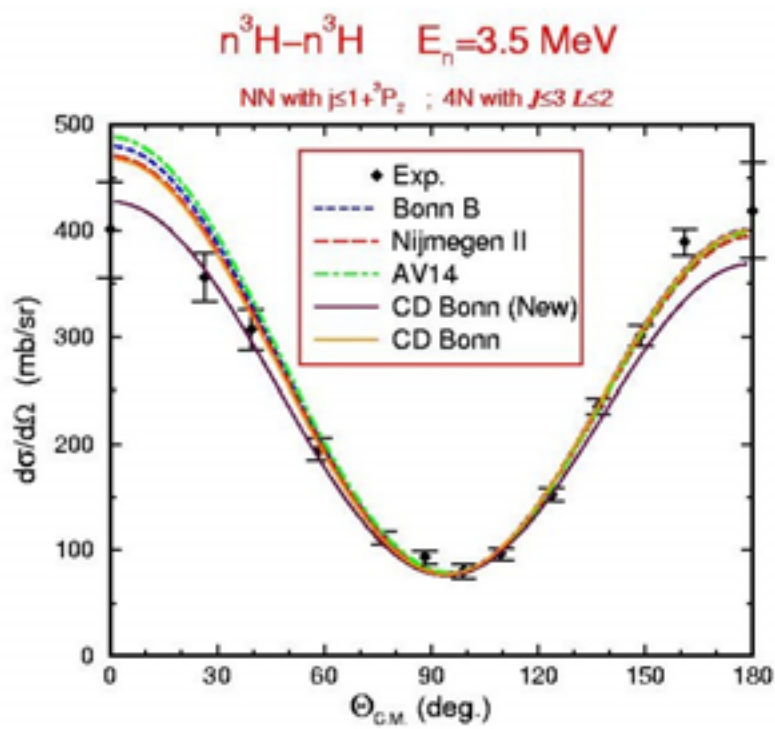


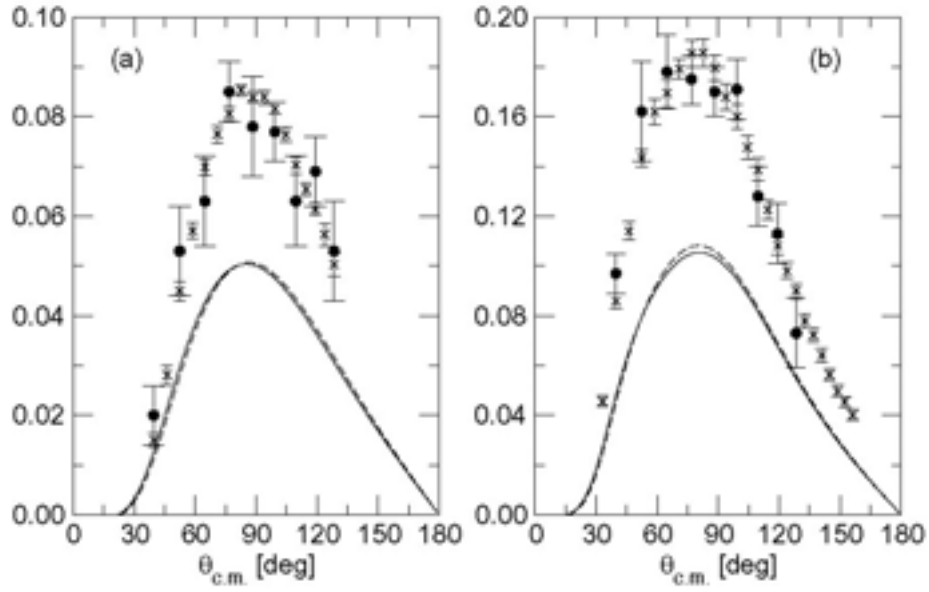
Total Cross Section for $n+{}^3\text{H}$ NN with $j \leq 1+{}^3\text{P}_2$



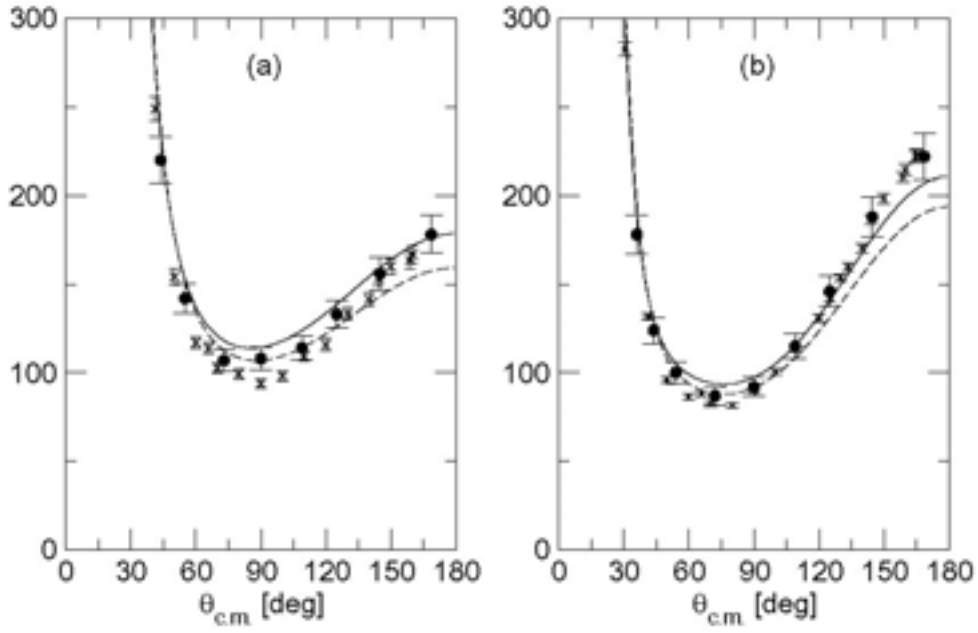


J. Carbonell et al.





M. Viviani et al.; $E_p = 1.2$ MeV (a) and $E_p = 1.69$ MeV (b)



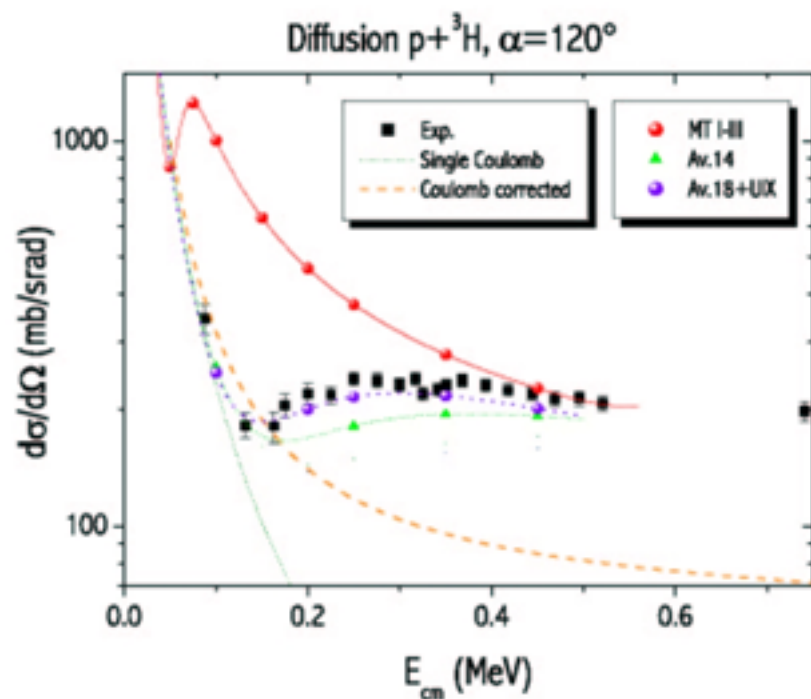
M. Viviani et al.; $E_p = 1.2$ MeV (a) and $E_p = 1.69$ MeV (b)

Isospin I=0,1

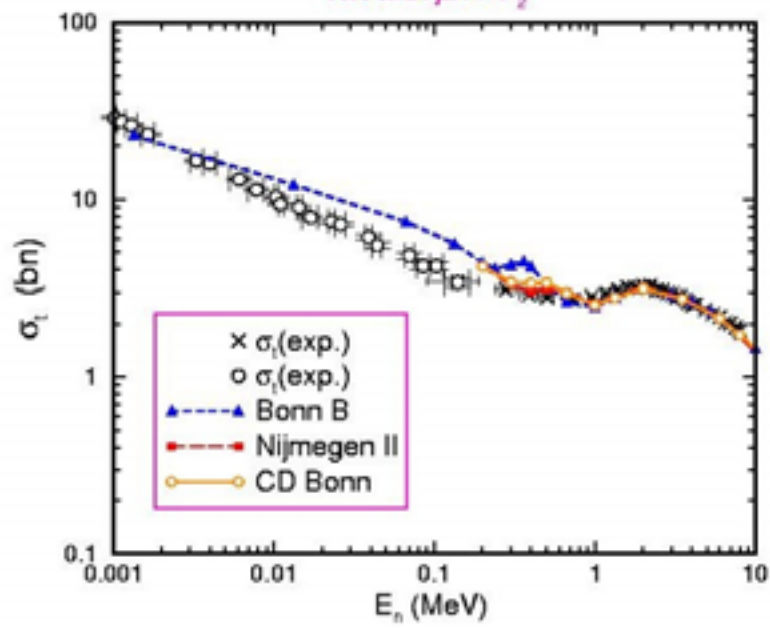
$n + {}^3\text{He} \rightarrow n + {}^3\text{He}$

$p + {}^3\text{H} \rightarrow p + {}^3\text{H}$

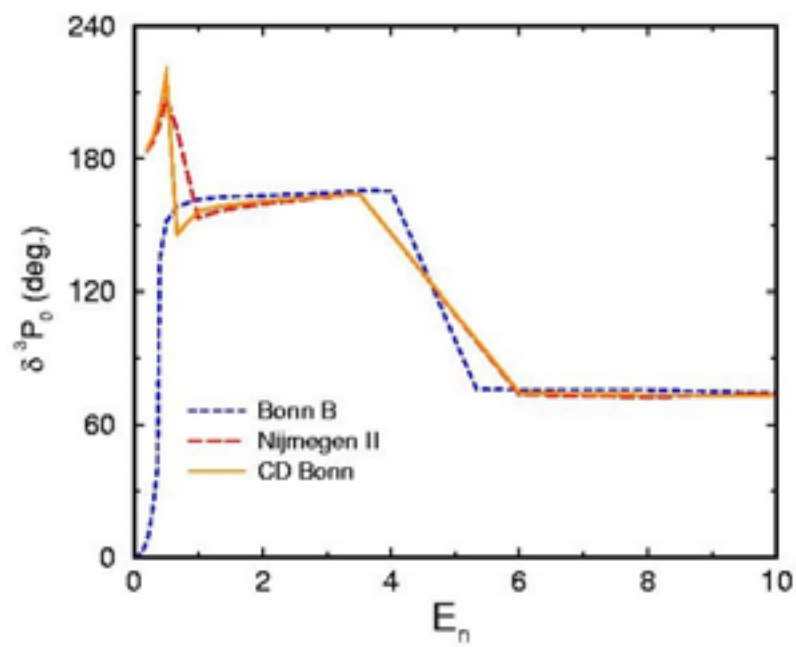
$p + {}^3\text{H} \rightarrow n + {}^3\text{He}$

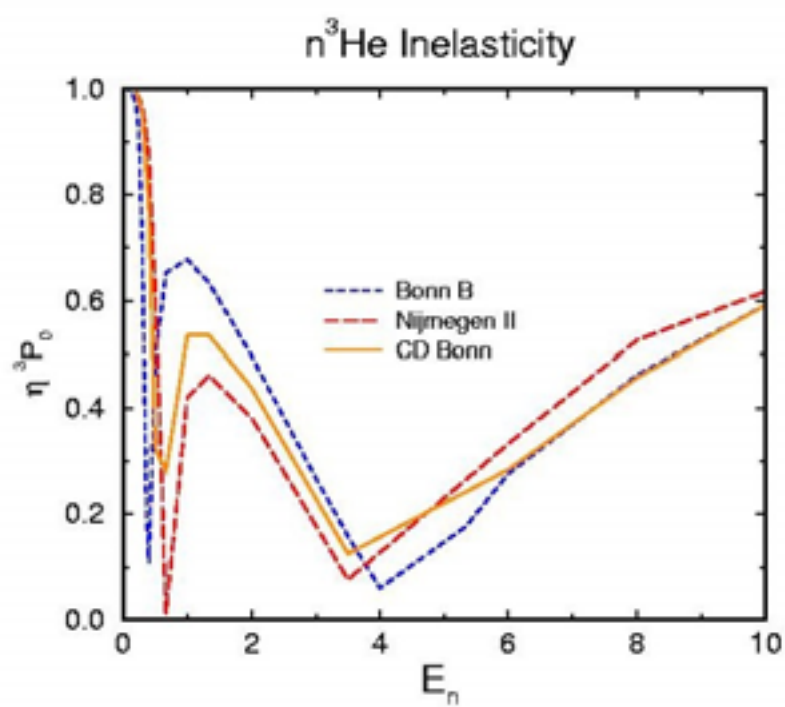
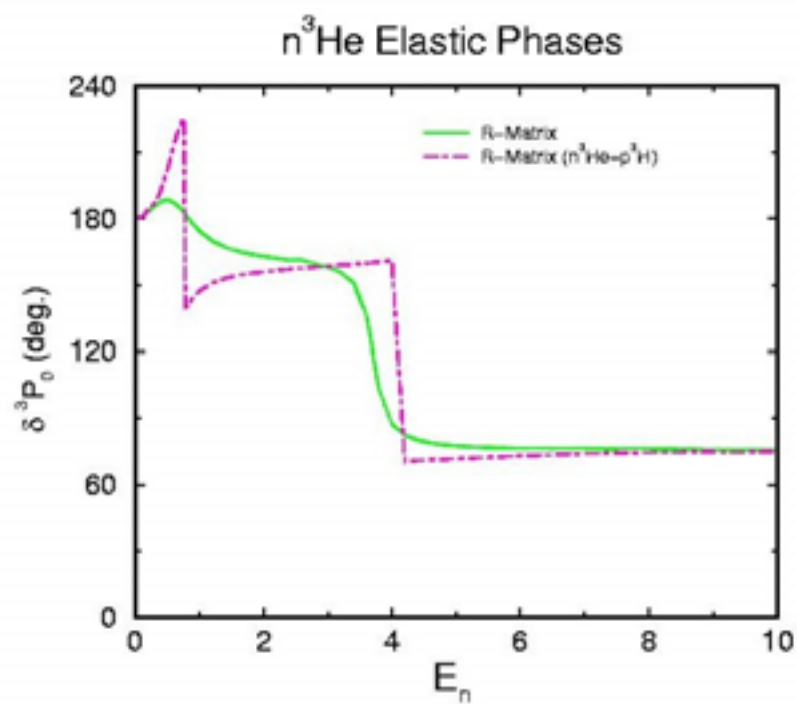


Total Cross Section for $n+{}^3\text{He}$ NN with $j \leq 1+{}^3P_2$

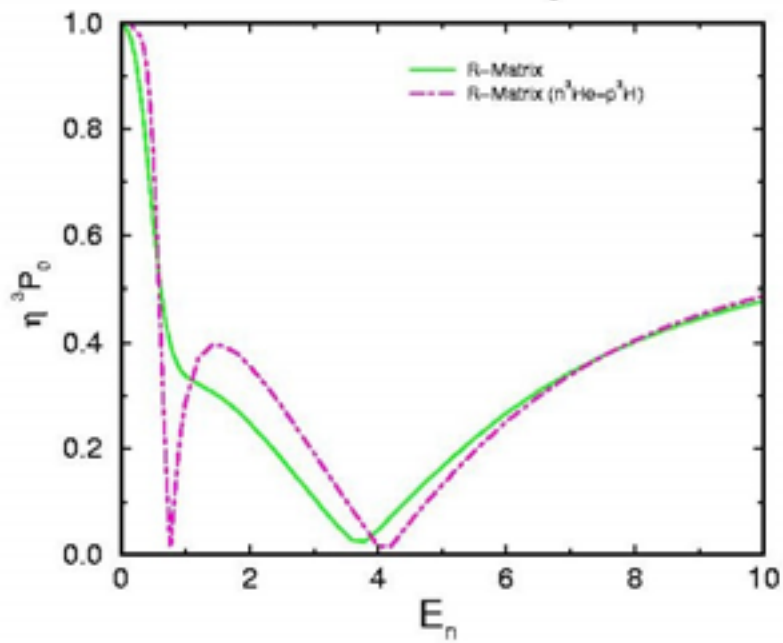


$n+{}^3\text{He}$ Elastic Phases



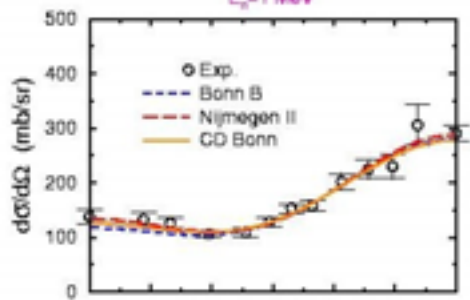


$n^3\text{He}$ Inelasticity



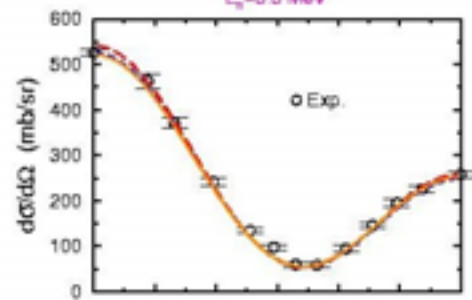
$n^3\text{He}-n^3\text{He}$

$E_n = 1$ MeV

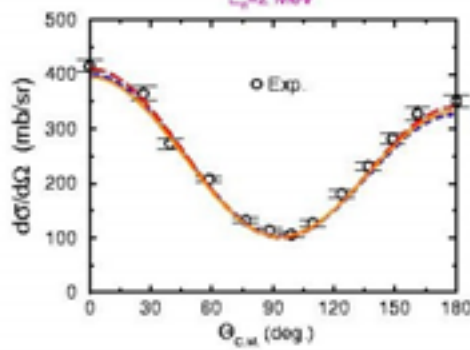


NN with $j \leq 1 + ^3P_2$

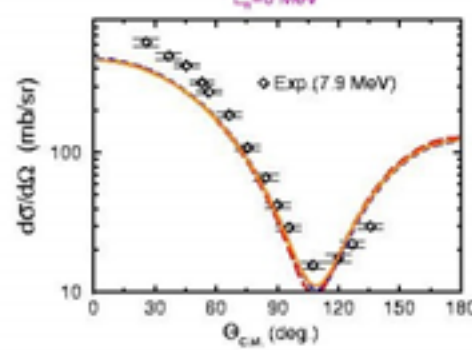
$E_n = 3.5$ MeV

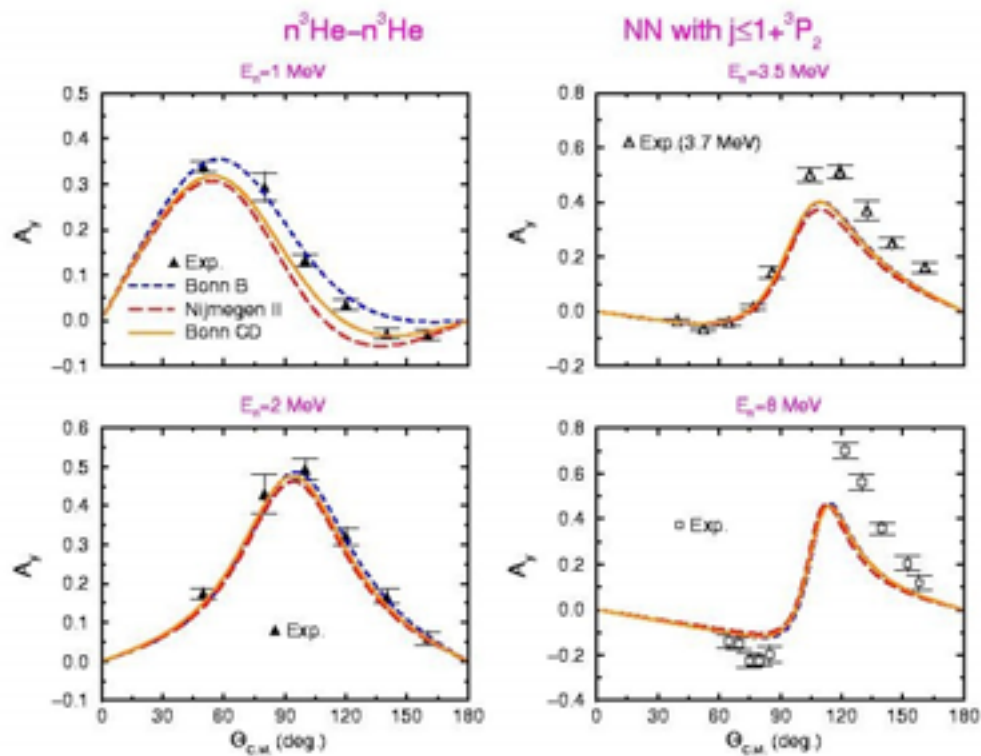


$E_n = 2$ MeV



$E_n = 8$ MeV

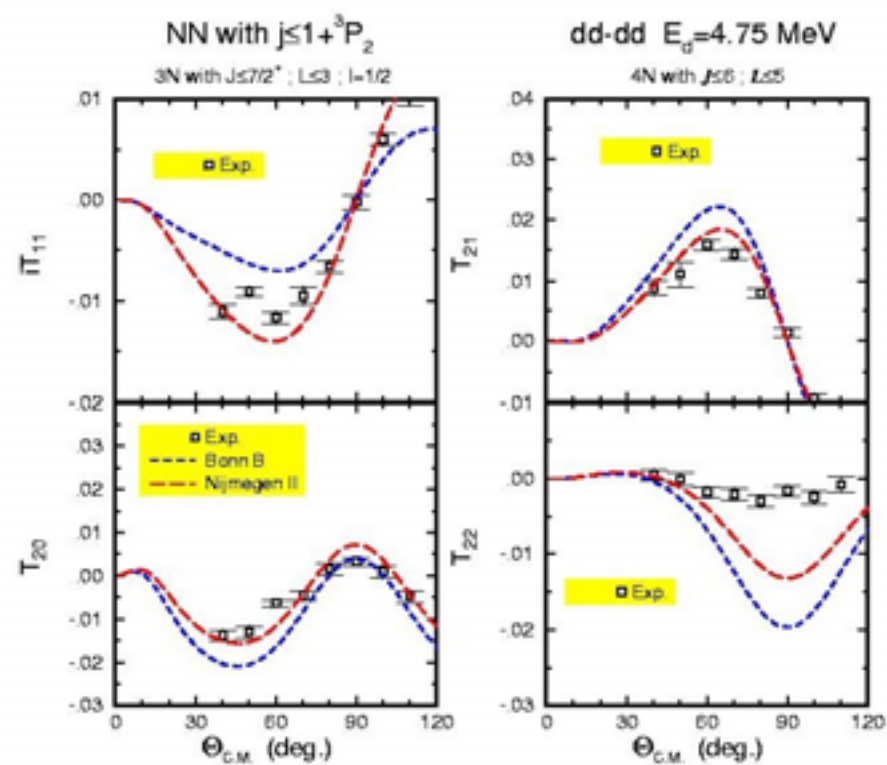
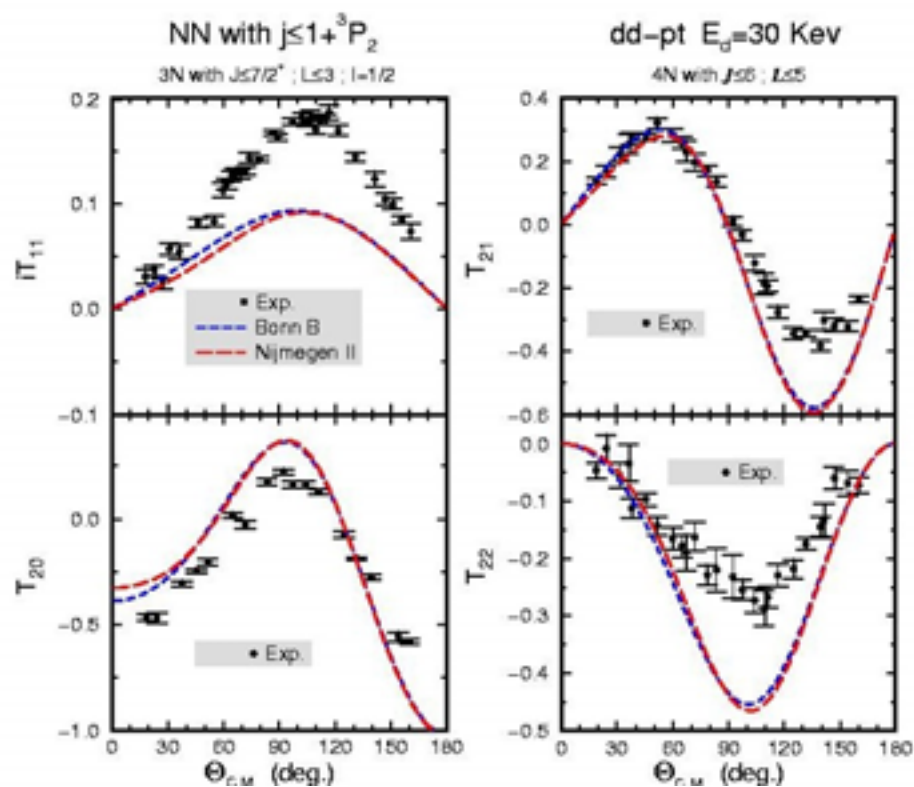




Isospin $I=0$

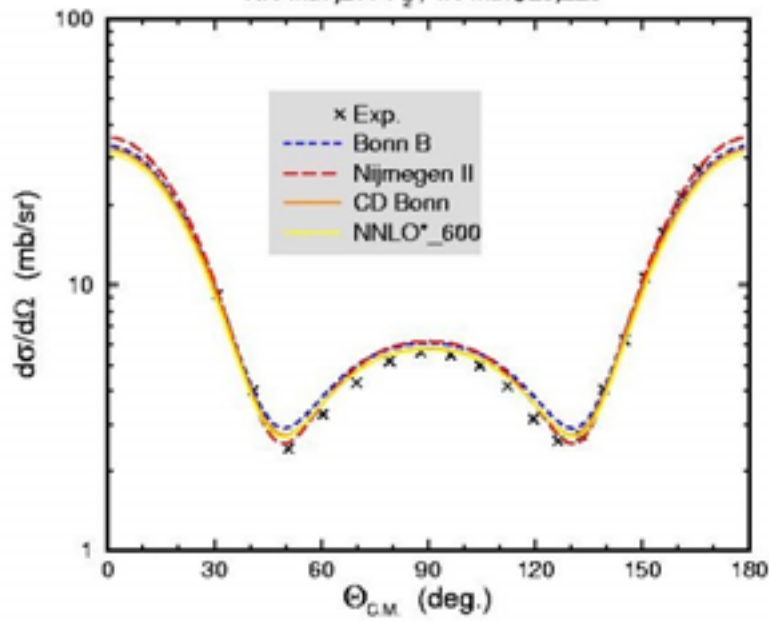
$d+d \rightarrow d+d$

$d+d \rightarrow p+{}^3\text{H}$



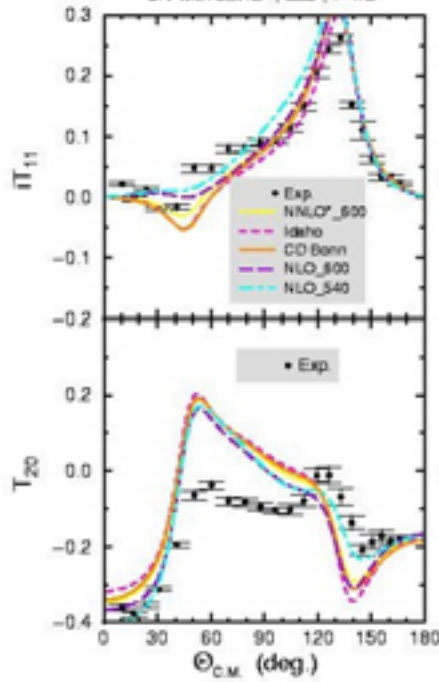
DD-PT $E_d=6.1\text{MeV}$

NN with $j \leq 1 + ^3P_2$; 4N with $J \leq 6, L \leq 5$



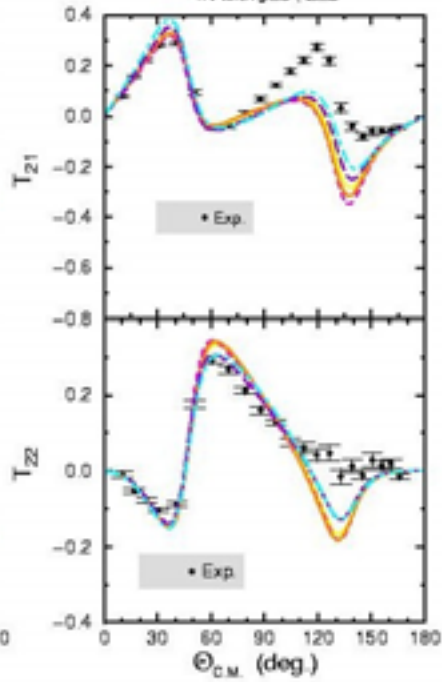
NN partial waves $j \leq 1 + ^3P_2$

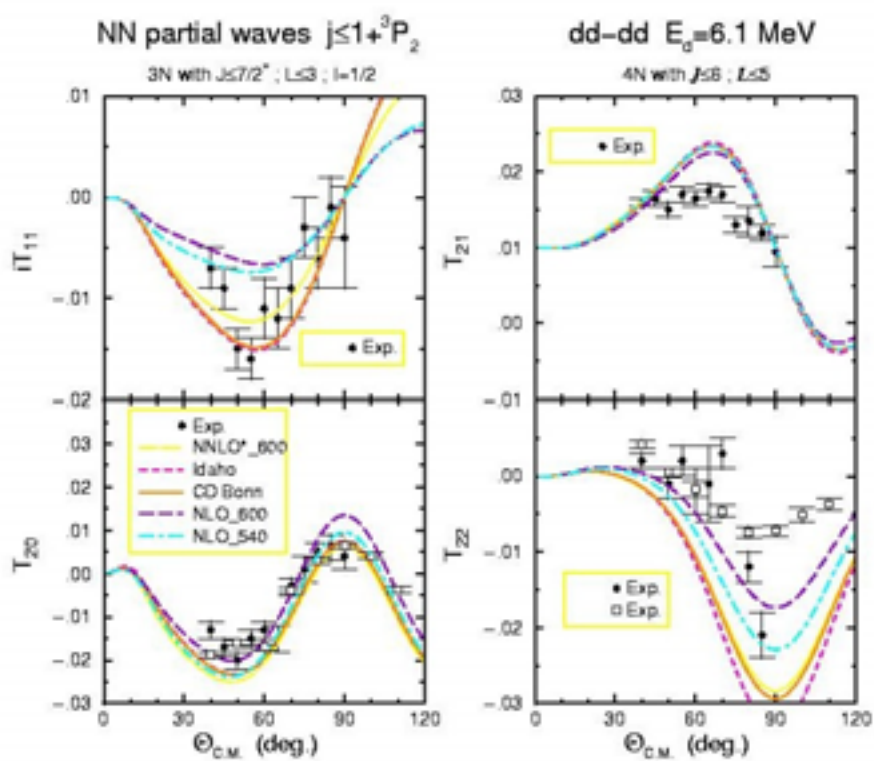
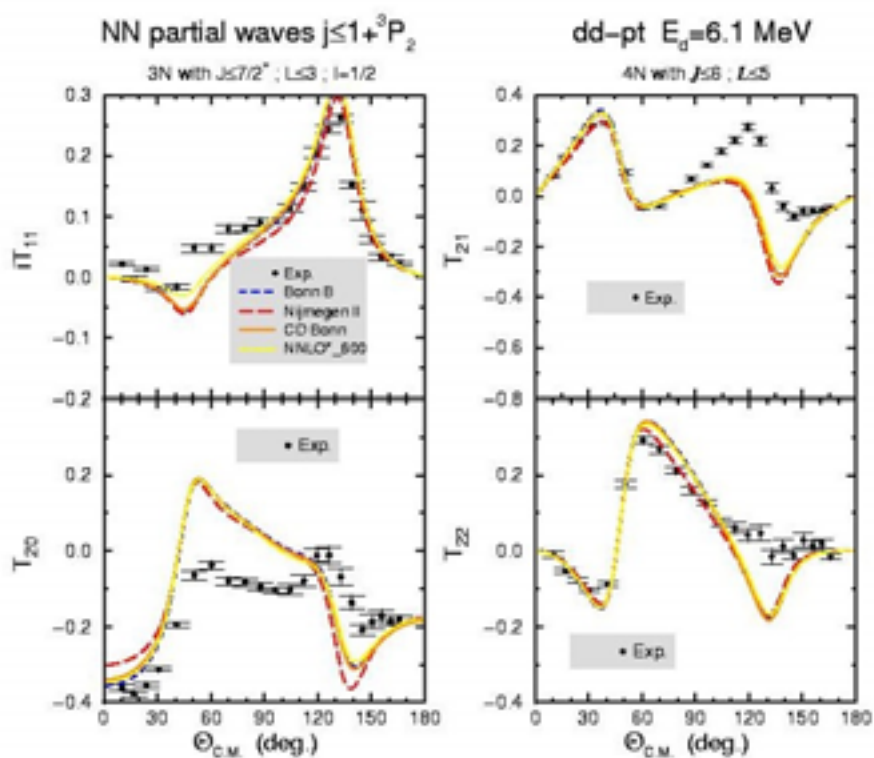
3N with $J \leq 7/2^+$; $L \leq 3$; $l = 1/2$



dd-pt $E_d=6.1\text{ MeV}$

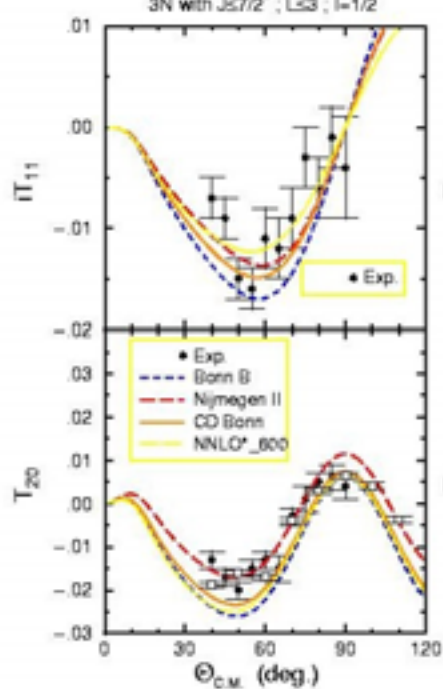
4N with $J \leq 6$; $L \leq 5$





NN partial waves $j \leq 1 + {}^3P_2$

3N with $j \leq 7/2^+$; $L \leq 3$; $I = 1/2$



dd-dd $E_d = 6.1$ MeV

4N with $j \leq 8$; $L \leq 5$

