Iniziativa Specifica: Few-Body Systems

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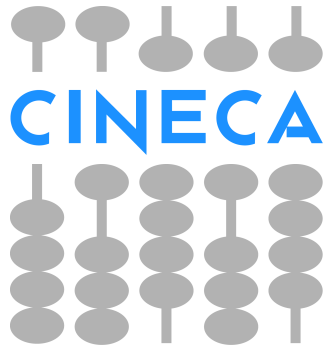


Scientific cases

- Structure and dynamics of few-nucleon systems
- Test of nuclear interaction derived from chiral effective field theory (low energy theory of QCD)
- Study of reactions of astrophysical interest
- Study of fundamental symmetries (parity & time reversal)
- Electroweak reactions (form factors, beta decays,. . .)
- Hypernuclei

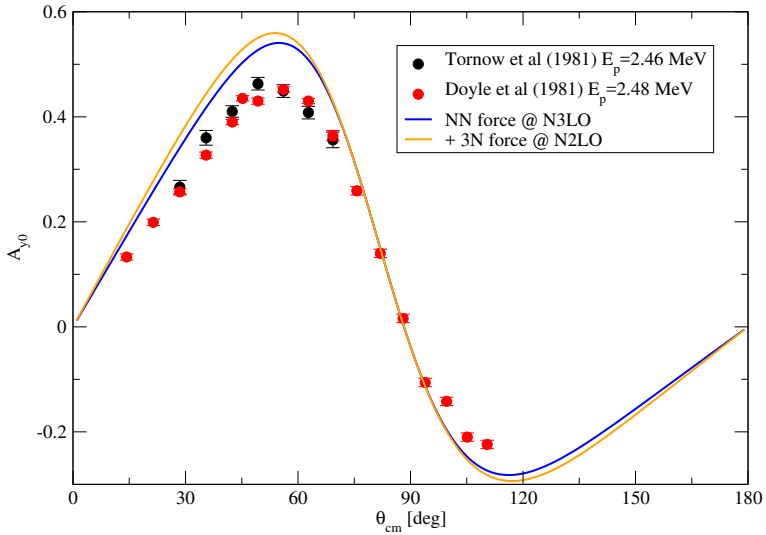
Pisa: MV, J. Dohet-Eraly (Post-doc), A. Gnech (Dott.)

Trento: G. Orlandini, W. Leidemann, F. Ferrari-Ruffino (Dott.), S. Deflorean (Dott.)

From nuclei . . .

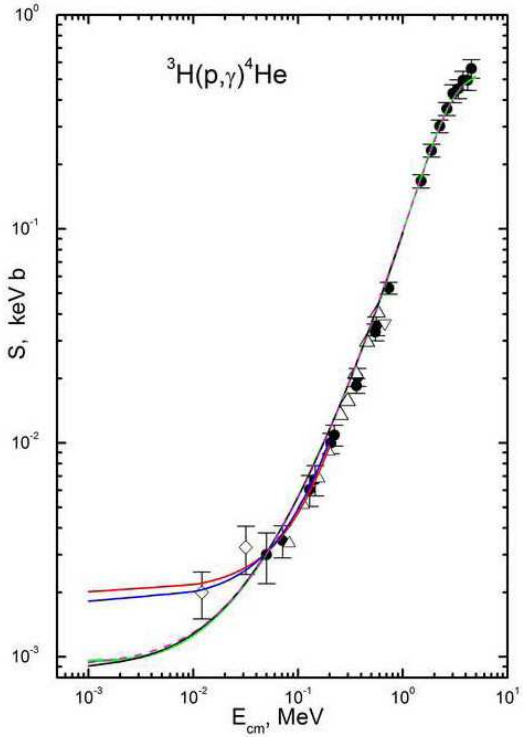
Test of nuclear interactions in few-nucleon reactions

Charge-exchange $p + {}^3\mathrm{H} \to n + {}^3\mathrm{He}$



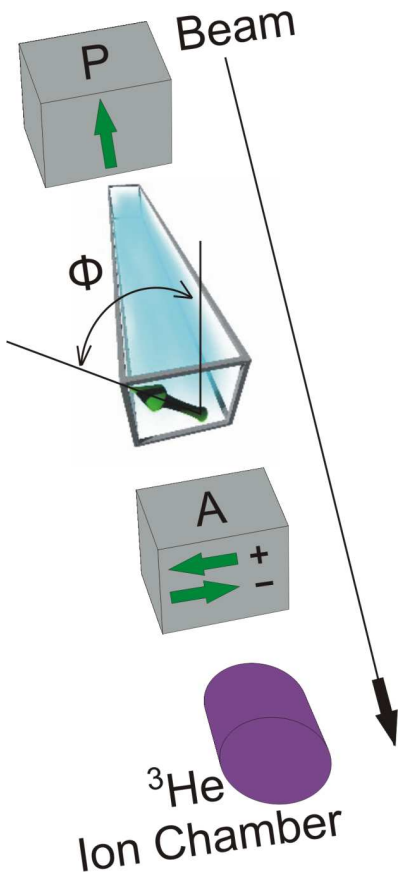
NN, 3N, γ-N, weak-N interactions derived using chiral perturbation theory

Calculation of astrophysical factor of reactions of astrophysical interest

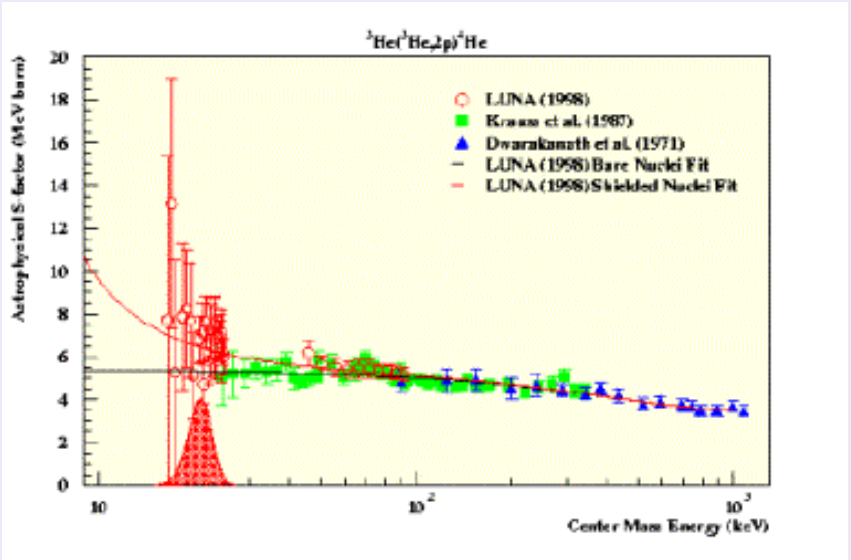


In progress $d + d \to {}^4\mathrm{He} + \gamma$, $p + {}^3\mathrm{H}$, $n + {}^3\mathrm{He}$

Study of fundamental symmetries
Neutron spin rotation due to parity-violation at ORNL & NIST
Electric dipole moment of light nuclei (time-reversal violation)



- Numerical method: expansion of the wave function over a basis
- 2014-2016: developed codes for $A = 4$
- 2017-2019: application for $A = 5$, 6
- LUNA (LNGS) experimental program
  - $^3\mathrm{He} + {}^3\mathrm{He} \rightarrow {}^4\mathrm{He} + p + p$
  - $^4\mathrm{He} + d \rightarrow {}^6Li + \gamma$

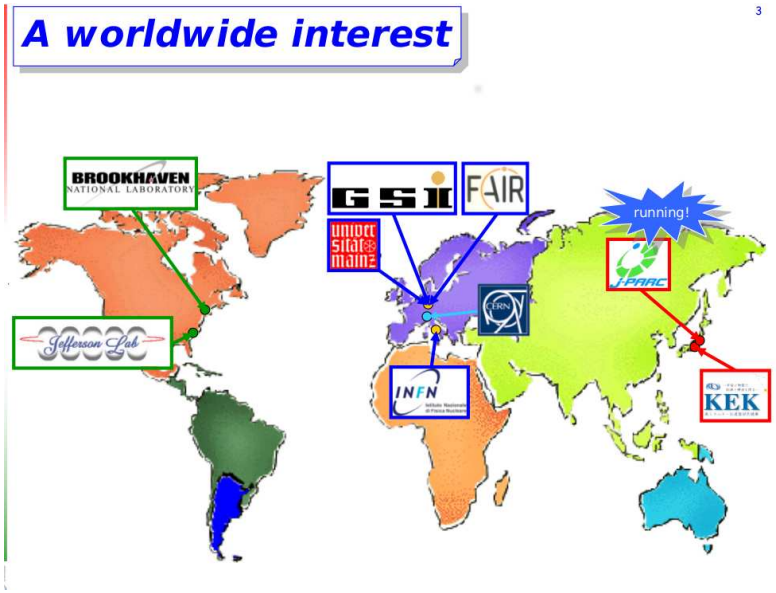


- $\sim$ a factor 100 $\Rightarrow$ 25M core-hours

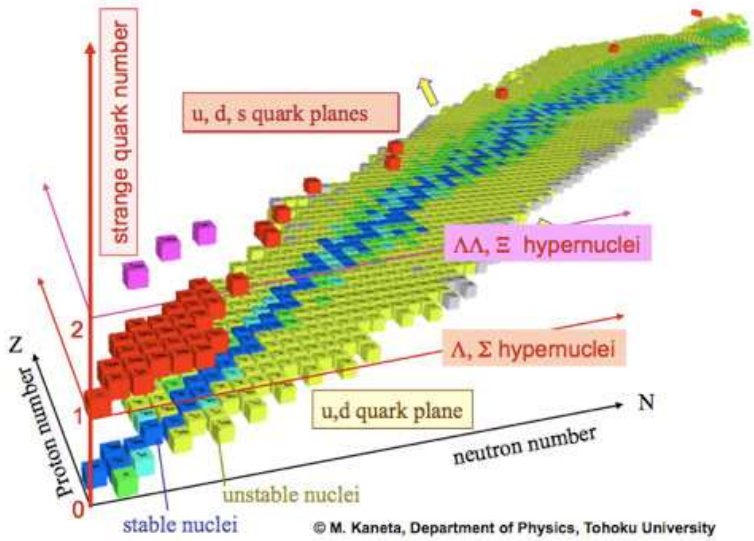
. . . to hypernuclei

Hyperon-nucleon interaction still in its infancy!

single Λ hypernucleus | double Λ hypernucleus



Interest: hypernuclei → neutron stars



- 2016: developed codes for $A = 3, 4$ hypernuclei
- 2017-2019: extension to $A = 5, 6$ hypernuclei
- $\Rightarrow$ 10M core-hours

Details

Past....

- Fermi: 4M core-hours MPI Monte-Carlo code $\vec{e} + {}^3\mathrm{He} \rightarrow p + d$
- Galileo (2016): 250,000 core-hours OpenMP code for $A = 4$ scattering
- Marconi/A1 (2016): 70,000 core-hours mainly dedicated to the hypernuclei calculations

2017

- Galileo (2017): 250,000 core-hours (125,000 stdh)
- Marconi/A1 (2017): 200,000 core-hours (50,000 stdh)
- Marconi/A2 (2017): 1,000,000 core-hours (125,000 stdh)

These resources are the only available to our groups!