

Ab Initio Study of Low-Energy Antiproton-Nucleus Systems

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I was born in Tehran, Iran.

Education:

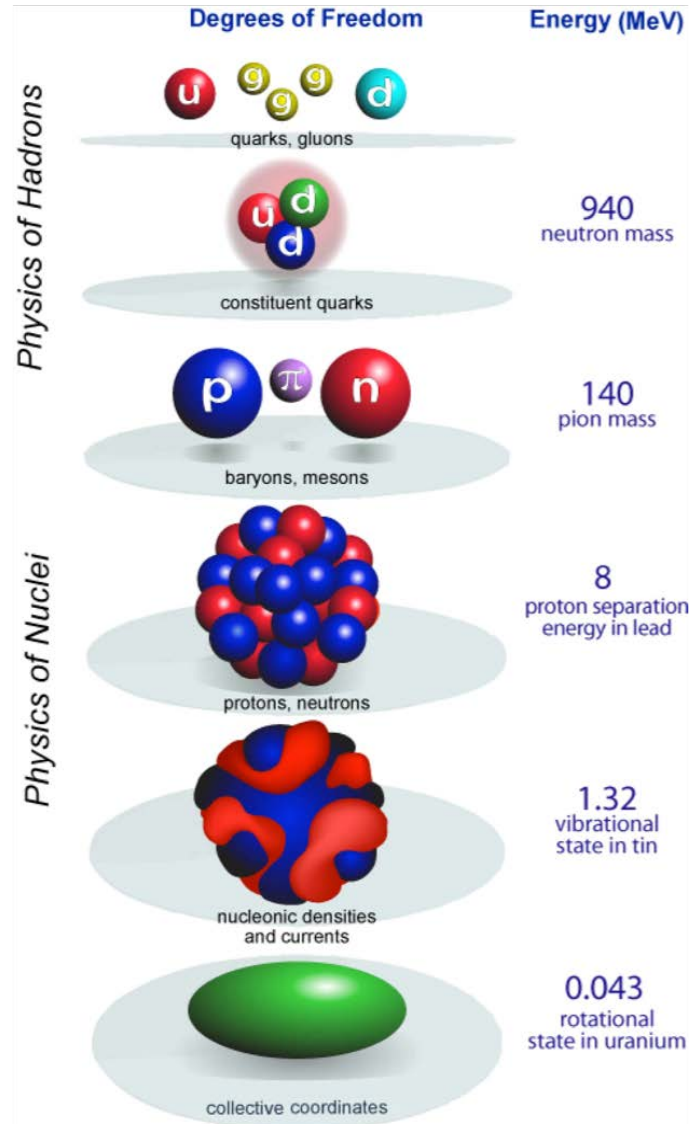
- ❖ University of Tehran (MSc in Nuclear Physics)
- ❖ Azad University (BSc in Nuclear Physics)

Master's Thesis: Proton Radiative Capture by Deuteron
(Pionless EFT)

Research Interests:

- ❖ Few-body Strongly-Interacting Systems
- ❖ *Ab initio* Methods in Nuclear Physics
- ❖ Effective Field Theories





Thesis Directors:

Dr. Guillaume Hupin
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Ab initio Nuclear Reactions Theory Team Members:

Dr. Lorenzo Contessi
Osama Yaghi (PhD student)
Alireza Dehghani (PhD student)

Collaborators (Antiprotonic Research):

Dr. Jaume Carbonell (IJCLab)
Prof. Slamowir Wycech (NCNR, Poland)

Ab initio expansion methods for nuclear structure:

- Direct calculation of the A-body system (all nucleons are active)
- Only input: 2- and 3-nucleons, e.g. Chiral-EFT interactions.

Applicability:

$2 \leq A \leq 16$: Full spectroscopy on structure properties

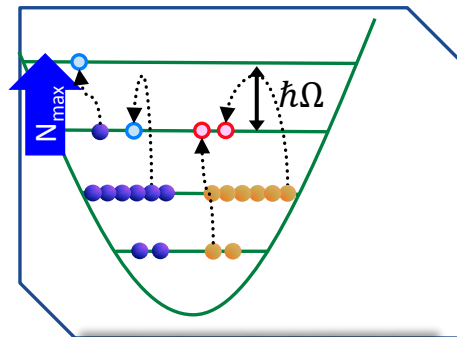
$2 \leq A \leq 10$: Elastic Channel $E > 0$

$2 \leq A \leq 6$: Threebody Dynamics

$$\Psi_{NCSM}^{(A)} = |A\lambda J^\pi T\rangle = \sum_{\alpha} c_{\alpha} |A\alpha j_z^{\pi} t_z\rangle$$

Mixing coefficients(unknown)

A-body harmonic oscillator states



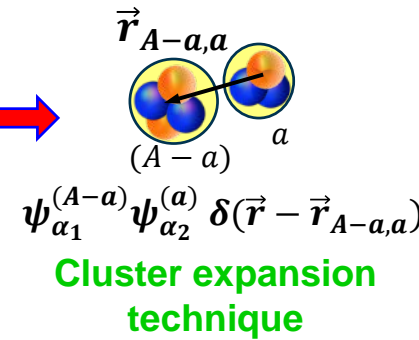
No-Core Shell Model (NCSM)

$$\Psi_{RGM}^{(A)} = \sum_v \int d\vec{r} g_v(\vec{r}) \hat{A}_v |\Phi_{v\vec{r}}^{(A-a,a)}\rangle$$

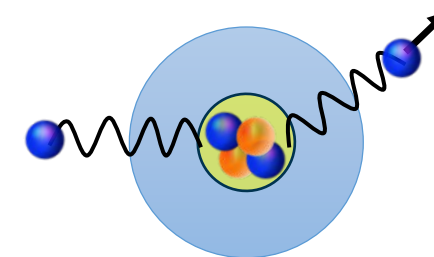
Relative wave function (unknown)

Antisymmetrizer

Channel basis



Cluster expansion technique



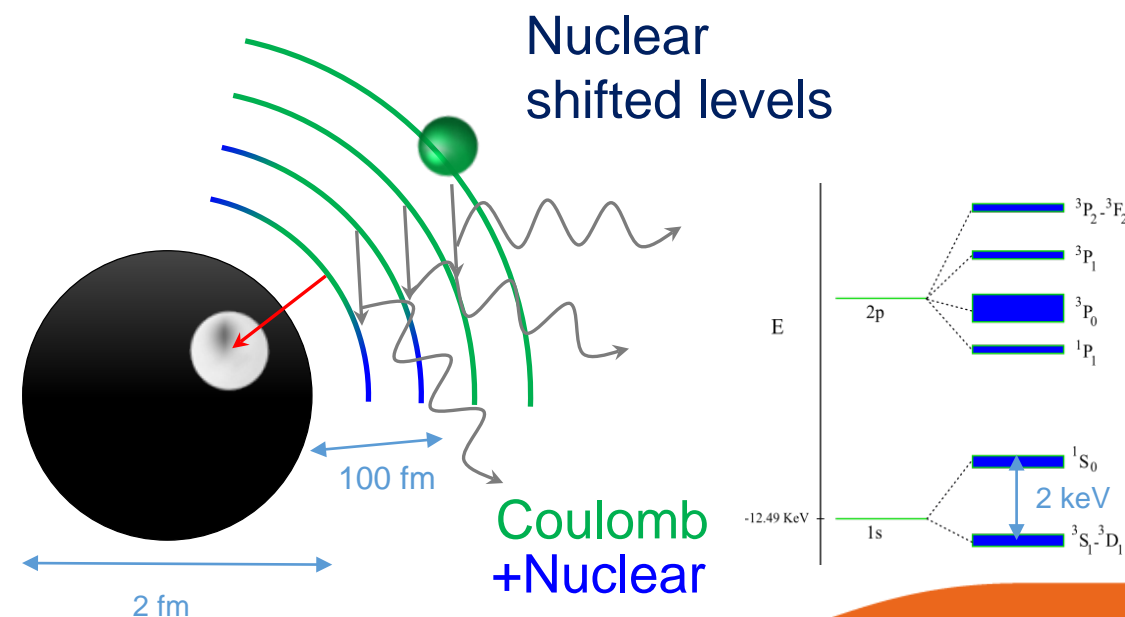
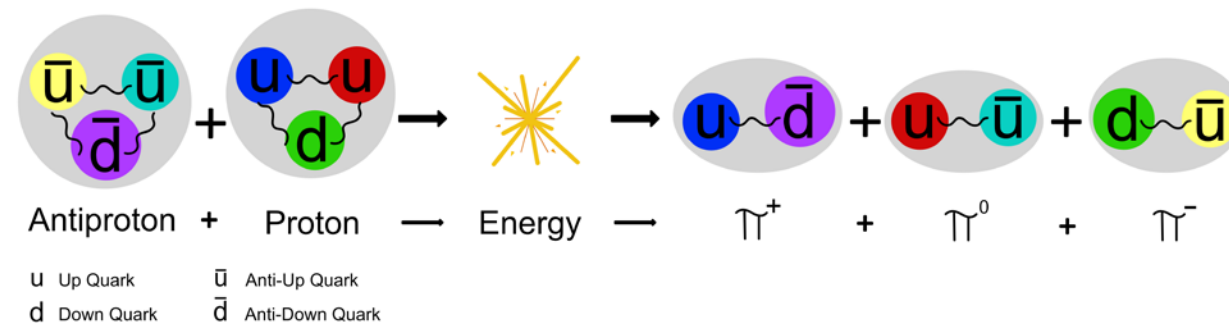
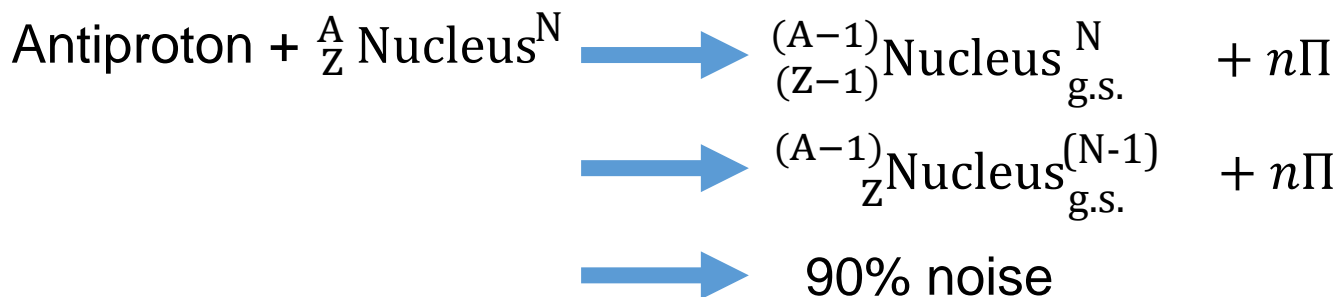
NCSM/RGM

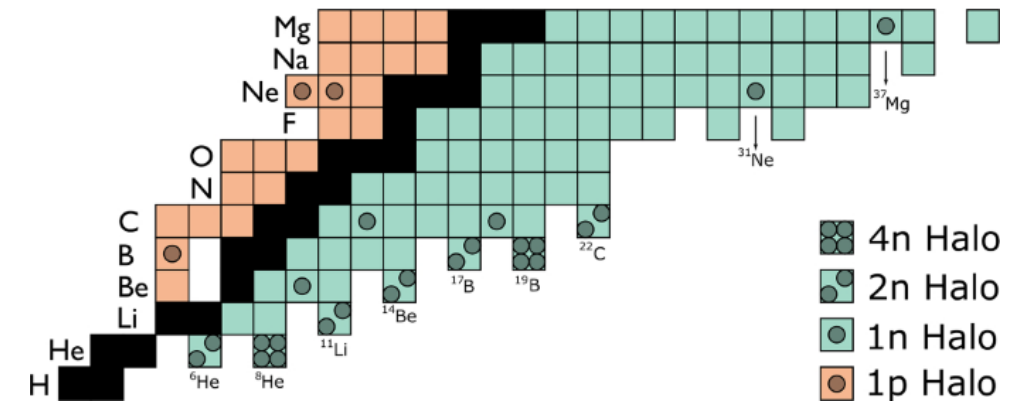
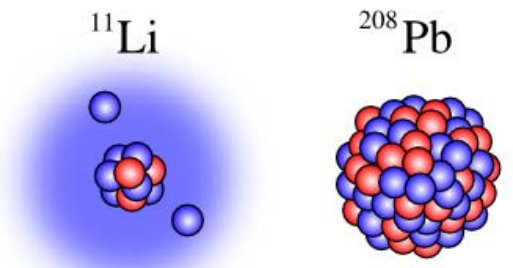
Nucleon-Antinucleon Interaction:

- Long Range: Mesons, $G\text{-parity} = C \exp(I_2\pi)$

Meson	T	C	G
π	1	+	-
η	0	+	+

- Short range (**Annihilation**): When the antiproton touches the surface of the nucleus it is immediately annihilated



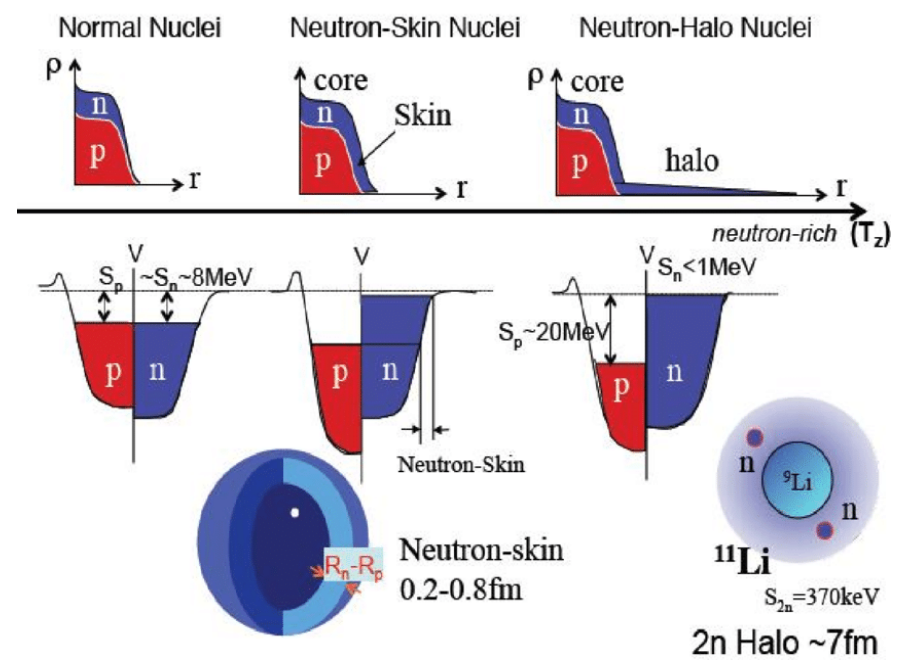


anti**P**roton **U**nstable Matter **A**nnihilation: **PUMA**

Aim: Using antiprotons as a probe for nuclear surface structure

What is measured?

neutron-to-proton annihilation ratio (which can be related to N/Z at the surface)



Thank you for your attention!