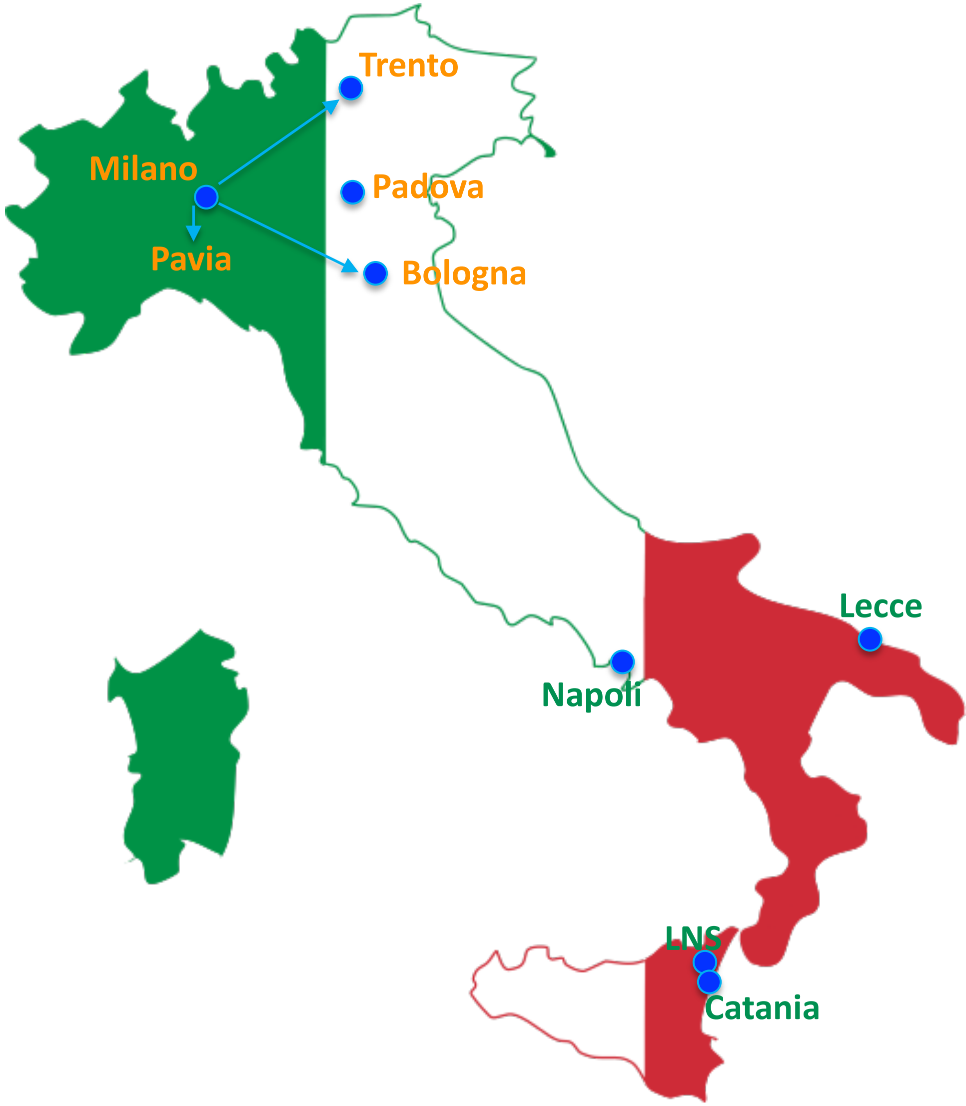
Iniziativa specifica MONSTRE

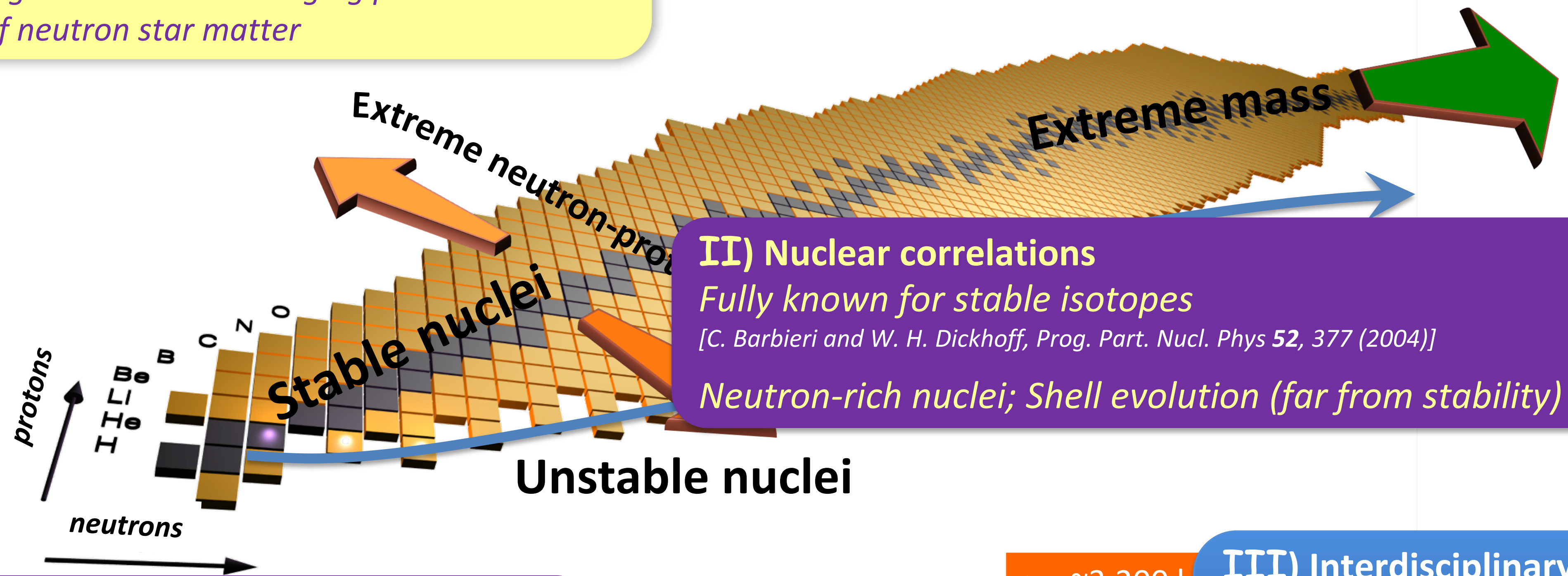


Sezioni partecipanti: MI, TN, PD, BO, NA, LE, CA, LNS

Current Status of low-energy nuclear physics

Composite system of interacting fermions
Binding and limits of stability
Coexistence of individual and collective behaviors
Self-organization and emerging phenomena
EOS of neutron star matter

Experimental programs
RIKEN, FAIR, FRIB, ISAC…



II) Nuclear correlations
Fully known for stable isotopes
[C. Barbieri and W. H. Dickhoff, Prog. Part. Nucl. Phys ***52****, 377 (2004)]*
Neutron-rich nuclei; Shell evolution (far from stability)

I) Understanding the nuclear force
QCD-derived; 3-nucleon forces (3NFs)
First principle (ab-initio) predictions

- ~3,200 k
- ~7,000 p
- Correlati
  in full fo

Nature **473**, 25

III) Interdisciplinary character
Astrophysics
Tests of the standard model
Other fermionic systems:
ultracold gasses; molecules;

MONSTRE a Milano

G. Colò
Nuclear Density Functional Theory
Nuclear response
and collective modes of excitation

E. Vigezzi
(Ab initio) Many-body approaches
Transfer reactions
Halo nuclei
Properties of neutron star matter

X. Roca-Maza
Nuclear Density Functional Theory
Nuclear response
Electron scattering

C. Barbieri
Ab Initio nuclear theory
Many-body methods

F. Marino (PhD candidate),
First principle derivation
Of nuclear DFT

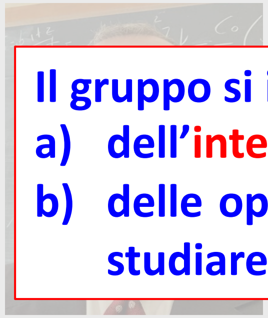
A. Scalesi (PhD candidate),
Nuclear forces from Effective
Field Theory

Moving to
CEA France

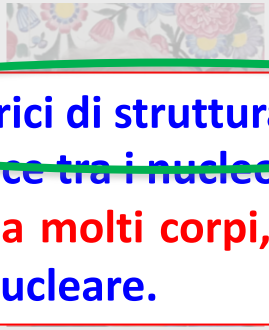
...plus several undergraduates.

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

MONSTRE a Milano



G. Colò



E. Vigezzi

Nuclear Density Functional Theory

...ody approaches

Il gruppo si interessa principalmente di problemi teorici di struttura nucleare:

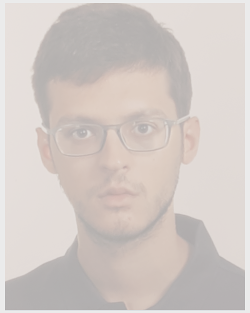
a) dell'interazione forte che agisce in maniera efficace tra i nucleoni;

b) delle opportune tecniche per sistemi fermionici a molti corpi, che consentono di studiare e comprendere la ricca fenomenologia nucleare.

...uclear theory

...y methods

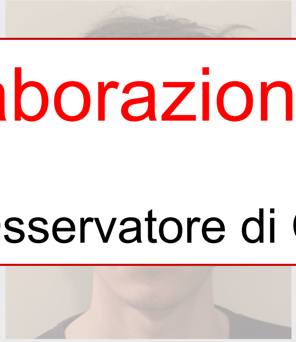
- Il gruppo ha una posizione di **leader** in molti di questi studi, come testimoniato da **recenti articoli di rassegna**
- ~30 articoli, ~10 tesi (2020-2021)
- Ha numerose **collaborazioni** nazionali ed internazionali (> 10 Università e istituti di ricerca in Europa, Cina, Giappone, USA).



F. Ma...

First ...

Of nu...



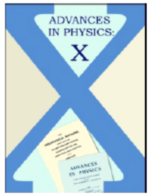
Tradizionale collaborazione con i gruppi sperimentali

G. Colò (50% Gamma)

E. Vigezzi (50% Gamma;Osservatore di Comm. IV in Comm. III)

...plus several undergraduates.

Pubblicazioni e lavori di rassegna



Taylor & Francis

Advances in Physics: X

ISSN: (Print) 2374-6149 (Online) Journal homepage: https://www.tandfonline.com/loi/tapx20

Nuclear density functional theory

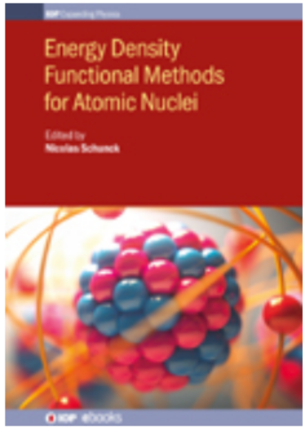
G. Colò

To cite this article: G. Colò (2020) Nuclear density functional theory, Advances in Physics: X, 5:1, 1740061, DOI: 10.1080/23746149.2020.1740061

To link to this article: https://doi.org/10.1080/23746149.2020.1740061

frontiers Research Topics

Topical review on Frontiers (2001)



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journal homepage: www.elsevier.com/locate/ppnp

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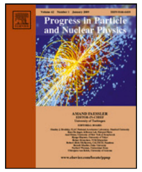


Review

Quenching of single-particle strength from direct reactions with stable and rare-isotope beams

Check for updates

T. Aumann [a,b], C. Barbieri [c,d,e], D. Bazin [f,g], C.A. Bertulani [h], A. Bonaccorso [i], W.H. Dickhoff [j], A. Gade [f,g], M. Gómez-Ramos [a,k], B.P. Kay [l], A.M. Moro [k,m], T. Nakamura [n], A. Obertelli [a,*], K. Ogata [o,p], S. Paschalis [q], T. Uesaka [r]

[a] Technische Universität Darmstadt, Fachbereich Physik, Institut für

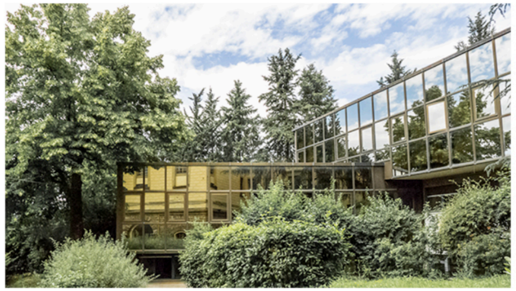
Fattori spettroscopici e limiti de modello a shell per nuclei esotici ed instabili

Formazione di giovani ricercatori

The Galileo Galilei Institute For Theoretical Physics

Centro Nazionale di Studi Avanzati dell'Istituto Nazionale di Fisica Nucleare

Arcetri, Firenze



Home > Schools > School

Event at Galileo Galilei Institute

School

Frontiers in Nuclear and Hadronic Physics 2021

Online Event

Mar 01, 2021 - Mar 12, 2021

FNHP2021
FRONTIERS IN NUCLEAR AND HADRONIC PHYSICS

School at the Galileo Galilei Institute for Theoretical Physics
Florence, March 1 - March 12, 2021

HOME PRACTICAL INFO PARTICIPANTS LECTURES SCHEDULE NEWS APPLY

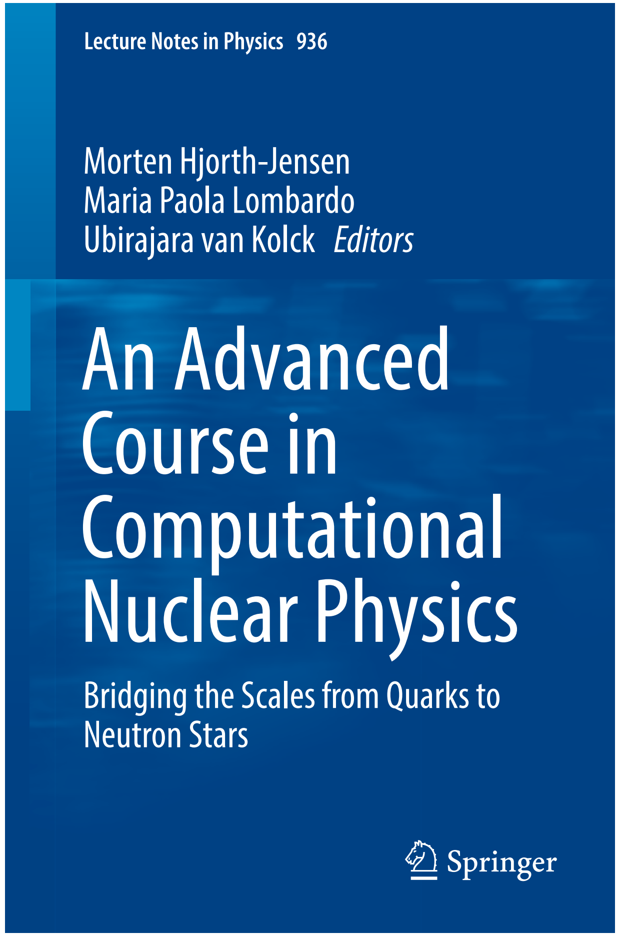
LECTURERS

GIANLUCA COLO' (Milano Univ.):	*Density functional theory methods for nuclear physics*
ALESSANDRO DRAGO (Ferrara Univ.):	*Dense nuclear matter in neutron stars*
ANTONIO MORO (Sevilla Univp;	*Modelling nuclear reactions probing the structure of exotic nuclei*
FRANCESCO PEDERIVA (Trento Univ):	*New computational approaches to nuclear physics*
ROBERT ROTH (Darmstadt Univ.):	*Ab initio calculations of nuclear structure*

ORGANIZERS

Francesco Becattini (Firenze Univ. & INFN)
Angela Bonaccorso (INFN Pisa)
Vincenzo Greco (Catania Univ. & INFN)
Elena Santopinto (INFN Genova)
Ignazio Bombaci (Pisa Univ. & INFN)
Maria Colonna (INFN LNS)
Giovanni Salmè (INFN Roma)
Enrico Vigezzi (INFN Milano)

Self-consistent Green's function formalism
and methods for Nuclear Physics

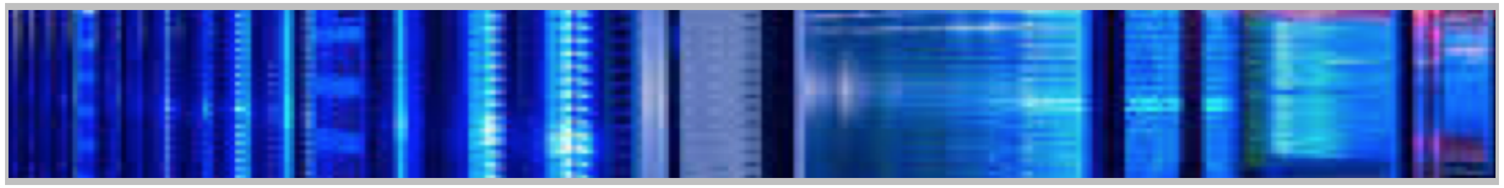


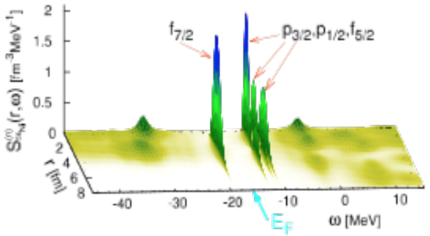
CB and A. Carbone,
chapter 11 of
Lecture Notes in Physics 936 (2017)

http://personal.ph.surrey.ac.uk/~cb0023/bcdor/

https://github.com/craolus/BoccaDorata-public

Computational Many-Body Physics





Download

Documentation

Welcome

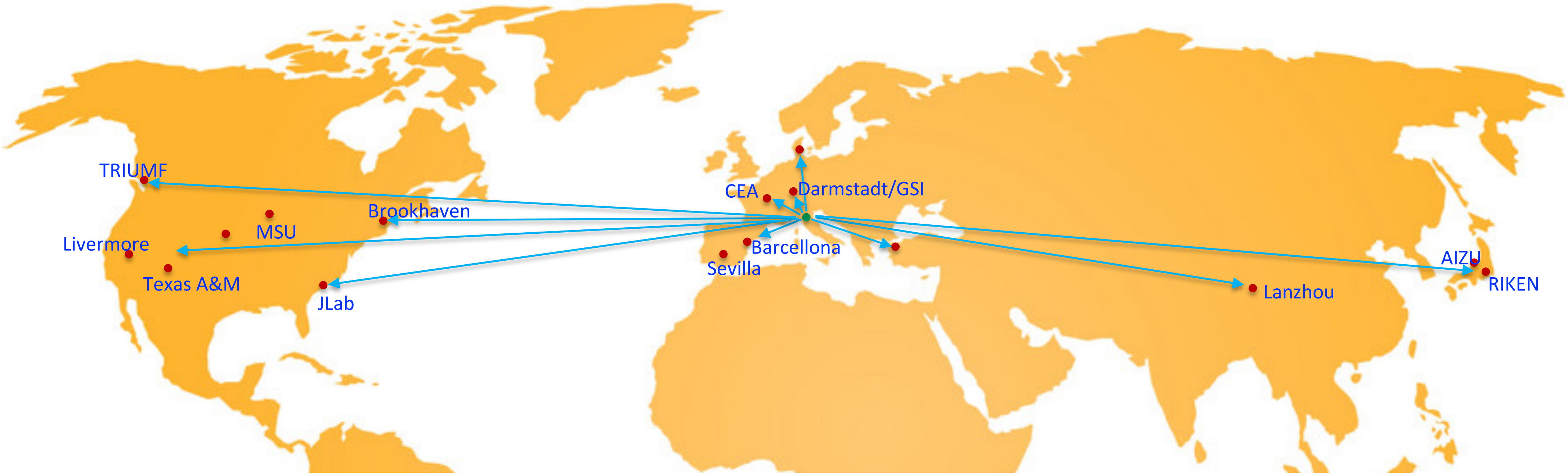
From here you can download a public version of my self-consistent Green's function (SCGF) code for nuclear physics. This is a code in J-coupled scheme that allows the calculation of the single particle propagators (a.k.a. one-body Green's functions) and other many-body properties of spherical nuclei.

This version allows to:
- Perform Hartree-Fock calculations.
- Calculate the the correlation energy at second order in perturbation theory (MBPT2).
- Solve the Dyson equation for propagators (self consistently) up to second order in the self-energy.
- Solve coupled cluster CCD (doubles only!) equations.

When using this code you are kindly invited to follow the creative commons license agreement, as detailed at the weblinks below. In particular, we kindly ask you to refer to the publications that led the development of this software.

Relevant references (which can also help in using this code) are:
Prog. Part. Nucl. Phys. 52, p. 377 (2004),
Phys. Rev. A76, 052503 (2007),
Phys. Rev. C79, 064313 (2009),
Phys. Rev. C89, 024323 (2014)

Collaborazioni



A. Arthuis, TU Darmstadt, Germany
F. Barranco, Sevilla University, Spain
C. Bertulani, Texas A&M, USA
R. A. Broglia, Niels Bohr Institute, Copenhagen, Denmark
L. G. Cao, Beijing Normal University, China
M. Centelles, X. Vinas, Barcelona University, Spain
U. Garg, Notre Dame University, USA
H. Z. Liang, T. Naito, RIKEN, Japan

A. Idini, Lund University, Sweden
A. Lovato, Argonnec Natl'Lab, USA
N. Rocco, Fermilab, USA
P. Navratil, M. Drissi, TRIUMF, Canada
Y. Niu, Lanzhou University, China
A. Obertelli, A. Auman, TU Darmstadt, Germany
A. Pastore, University of York, UK
G. Potel, Livermore Natl'Lab, USA
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M. Vorabbi, Brookhaven, USA
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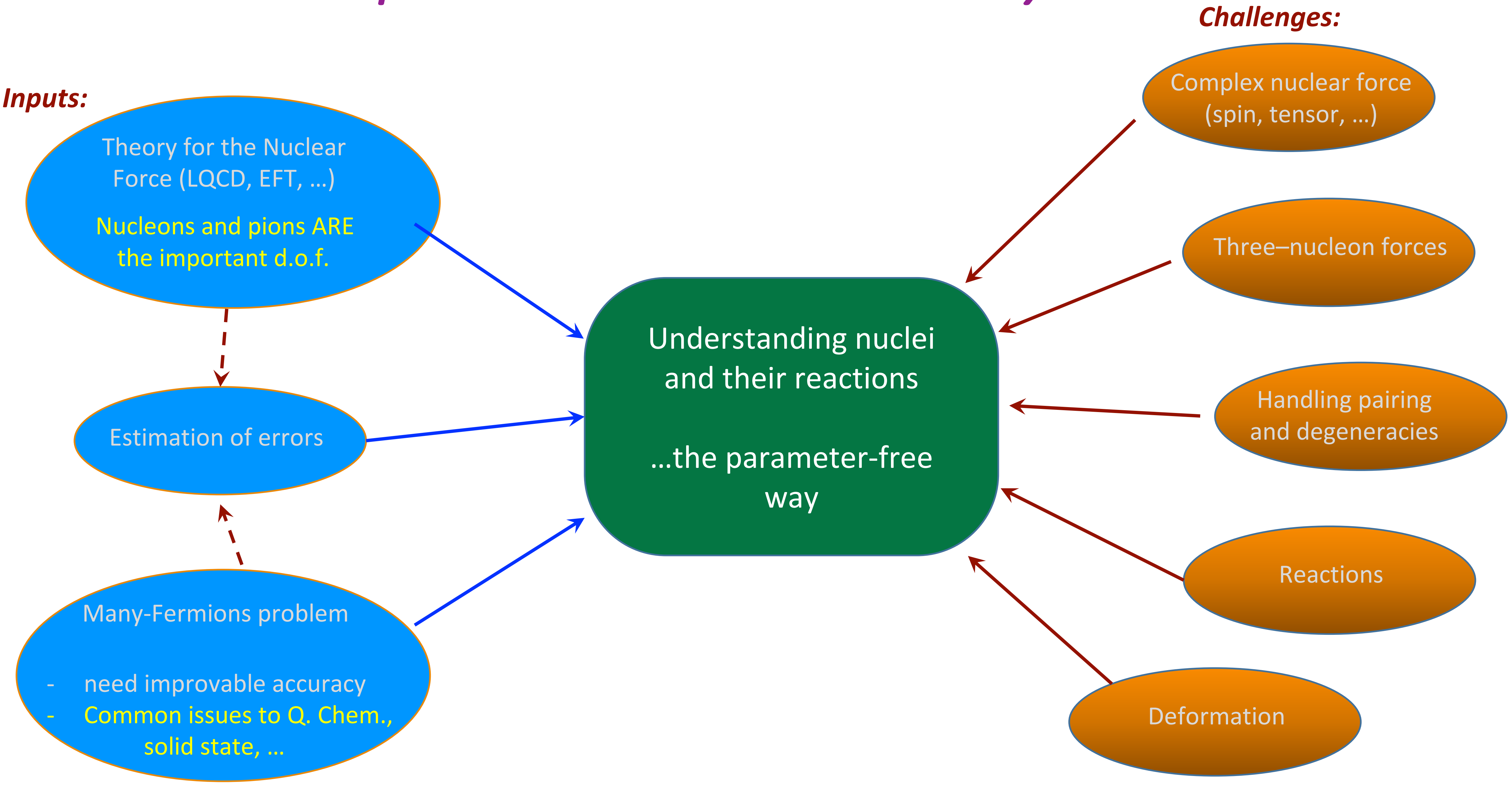
A. Roggero, F. Pederiva, Trento, Italy
C. giusti, Pavia, Italy
P. Finelli, Bologna, Italy
O. Benhar, Rome Italy and Virginia Tech USA

The ab initio problem in Nuclear Physics



Nuclear Density Functional Theory

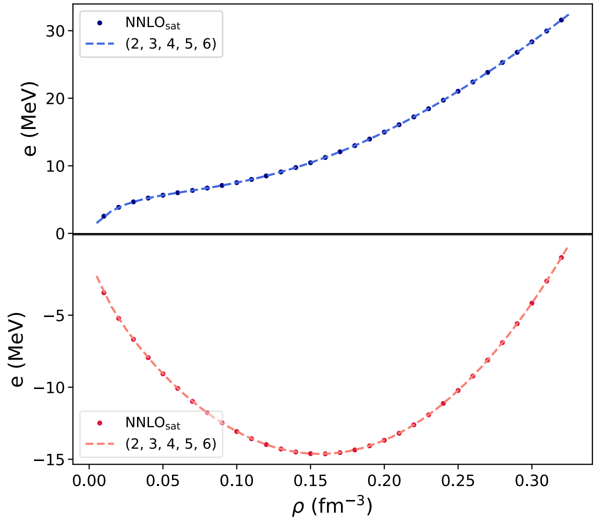
Nuclear energy density functionals grounded in ab initio calculations

F. Marino,[1,2,*] C. Barbieri,[1,2] G. Colò,[1,2] A. Carbone,[3]
A. Lovato,[4,5] F. Pederiva,[6,5] X. Roca-Maza,[1,2] and E. Vigezzi[2]
[1] *Dipartimento di Fisica "Aldo Pontremoli", Università degli Studi di Milano, 20133 Milano, Italy*
[2] *INFN, Sezione di Milano, 20133 Milano, Italy*
[3] *INFN-CNAF, Viale Carlo Berti Pichat 6/2, 40127 Bologna, Italy*

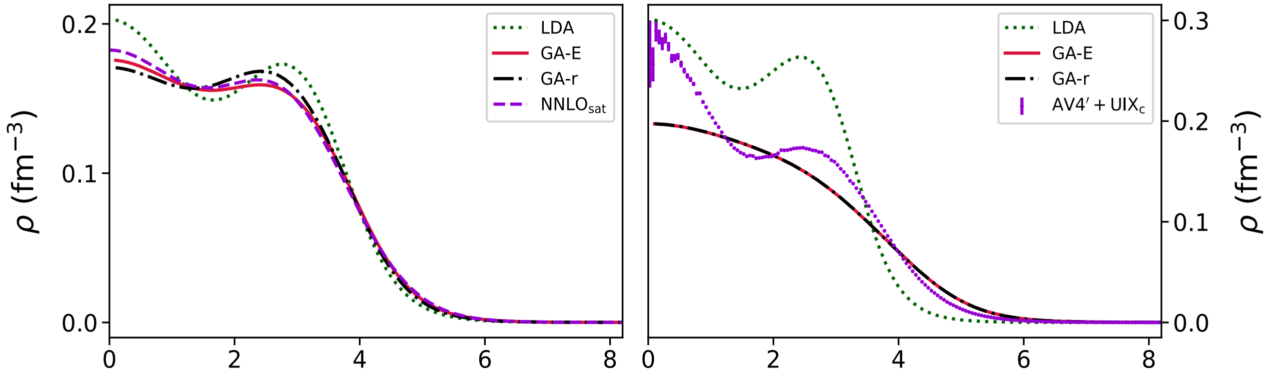
DFT is in principle exact – but the energy density functional (EDF) is not known

For nuclear physics this is even more demanding: need to link the EDF to theories rooted in QCD!

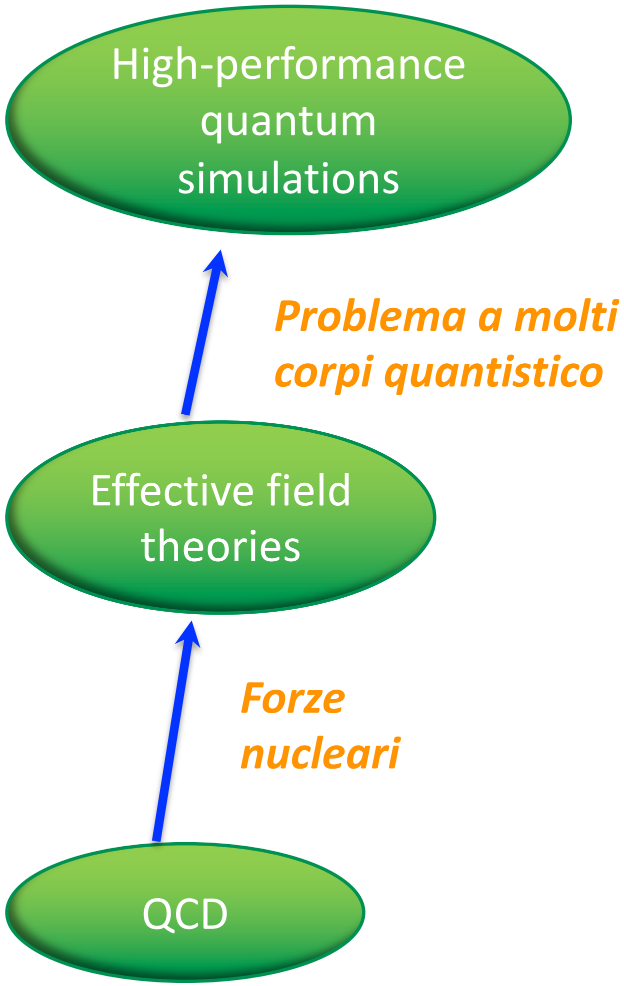
Machine-learn DFT functional
on the nuclar equation of state



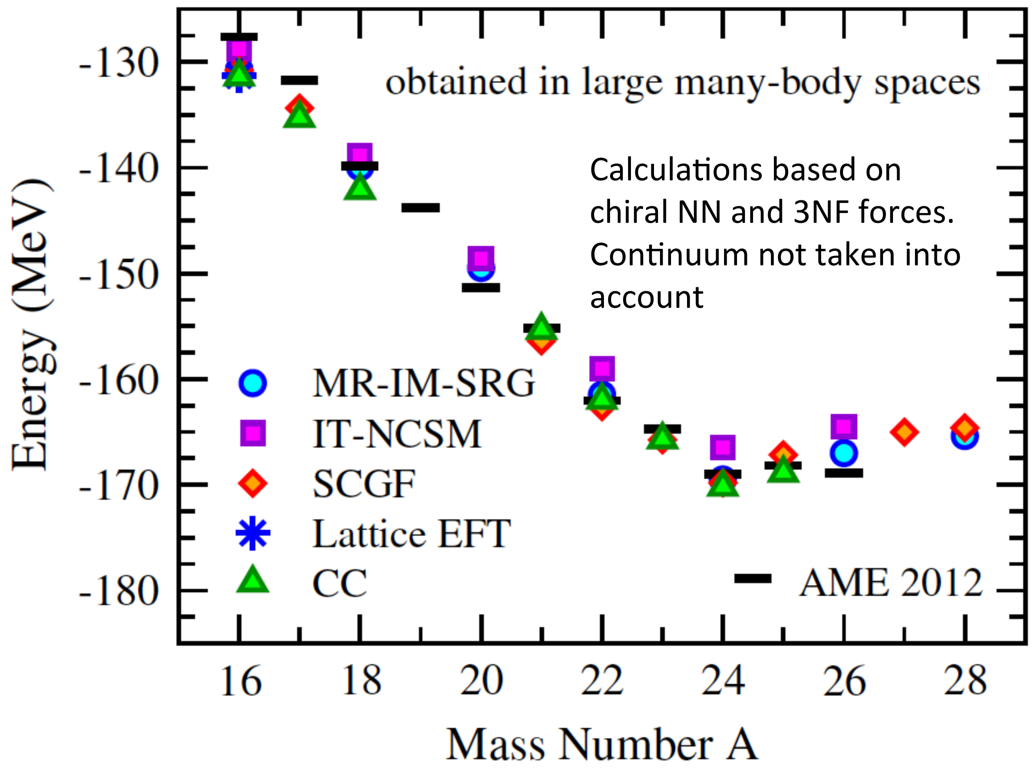
Benchmark in finite systems



Simulazioni ab initio di nuclei complessi



First success of chital-EFT interactions on oxygen isotopes….



Hebeler, Holt, Menendez, Schwenk, Ann. Rev. Nucl. Part. Sci. in press (2015)

Densità di carica in nuclei pesanti e instabili

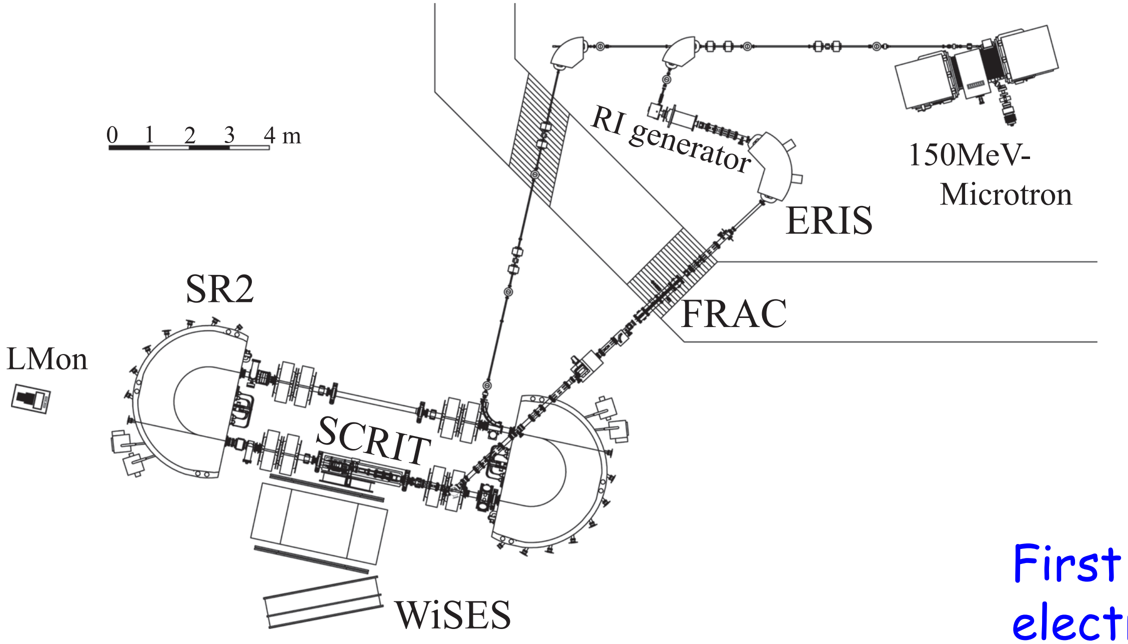


FIG. 1. Overview of the SCRIT electron scattering facility.

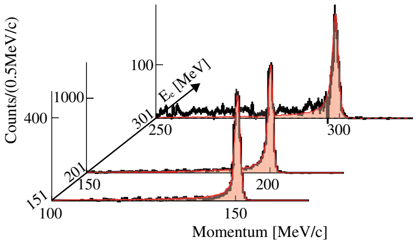
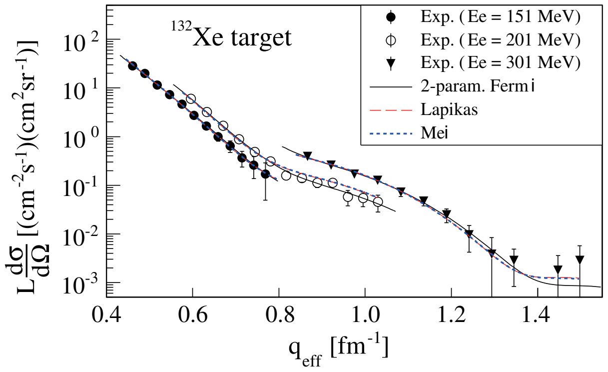


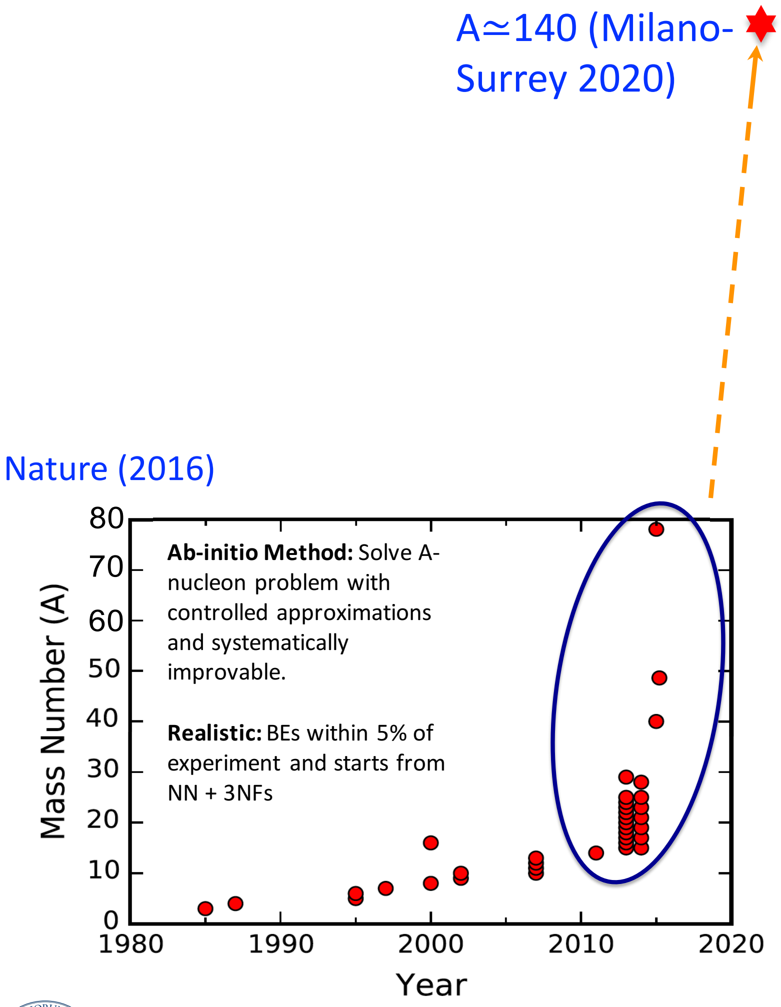
FIG. 3. Reconstructed momentum spectra of ^{132}Xe target after background subtraction. Red shaded lines are the simulated radiation tails following the elastic peaks.



First ever measurement of charge radii through electron scattering with and ion trap setting that *can be used on radioactive isotopes* !!

K. Tsukada *et al.*, Phy rev Lett **118**, 262501 (2017)

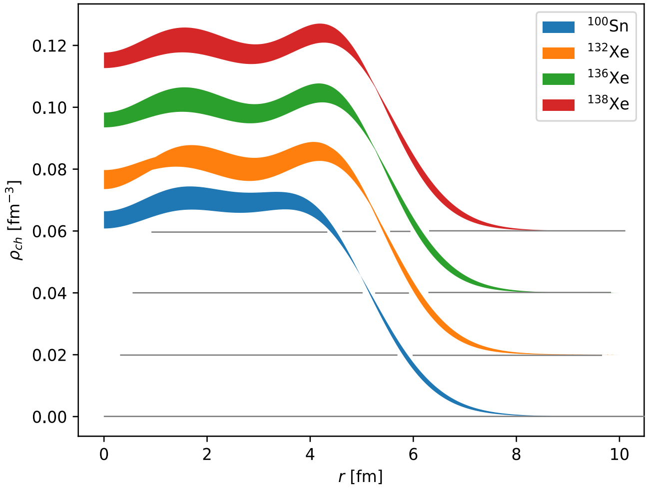
Densità di carica in nuclei pesanti e instabili

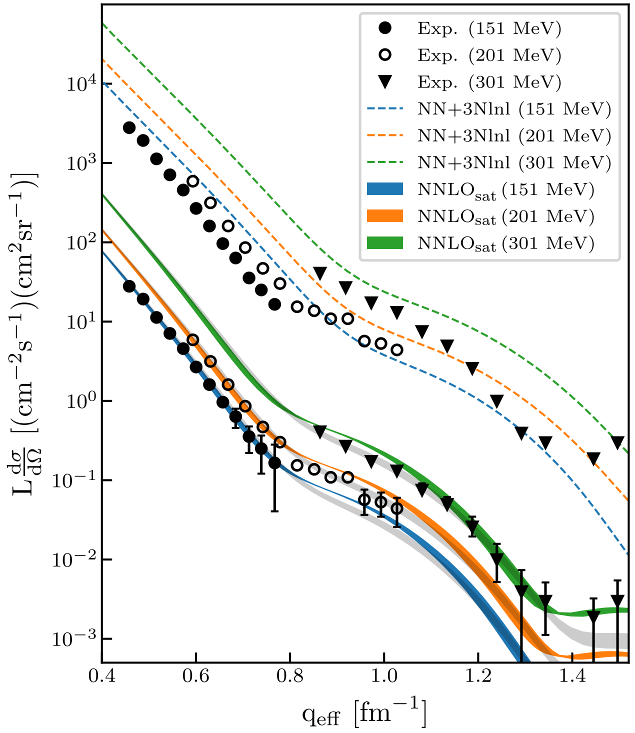


PHYSICAL REVIEW LETTERS **125,** 182501 (2020)

Ab Initio Computation of Charge Densities for Sn and Xe Isotopes

P. Arthuis,[1,*] C. Barbieri,[1,2,3,†] M. Vorabbi,[4,‡] and P. Finelli[5,§]
[1]Department of Physics, University of Surrey, Guildford GU2 7XH, United Kingdom
[2]Dipartimento di Fisica, Università degli Studi di Milano, Via Celoria 16, I-20133 Milano, Italy
[3]INFN, Sezione di Milano, Via Celoria 16, I-20133 Milano, Italy
[4]National Nuclear Data Center, Bldg. 817, Brookhaven National Laboratory, Upton, New York 11973-5000, USA
[5]Dipartimento di Fisica e Astronomia, Università degli Studi di Bologna and INFN,
Sezione di Bologna, Via Irnerio 46, I-40126 Bologna, Italy





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MONSTRE a Milano

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…ody approaches

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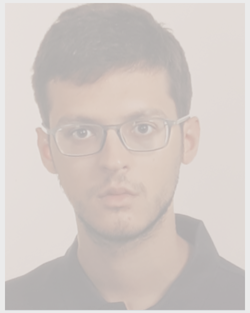
…uclear theory
…y methods



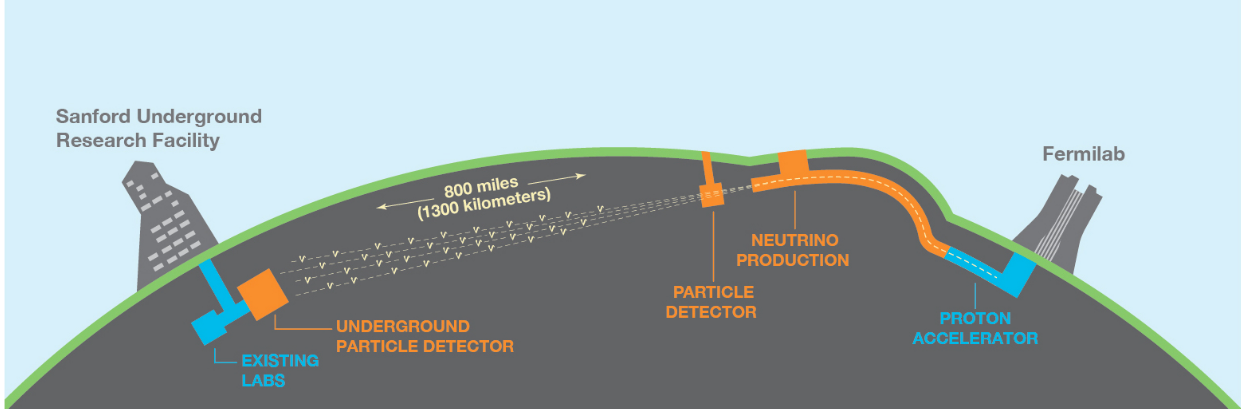
F. Mo…
First …
Of nu…

Tradizionale collaborazione con i gruppi sperimentali

G. Colò (50% Gamma)
E. Vigezzi (50% Gamma;Osservatore di Comm. IV in Comm. III)

…plus several undergraduates.

Neutrino Oscillations – next generation experiments



DUNE experiment will measure long base line neutrino oscillations to:

- Resolve neutrino mass hierarchy
- Search for CP violation in weak interaction
- Search for other physics beyond SM

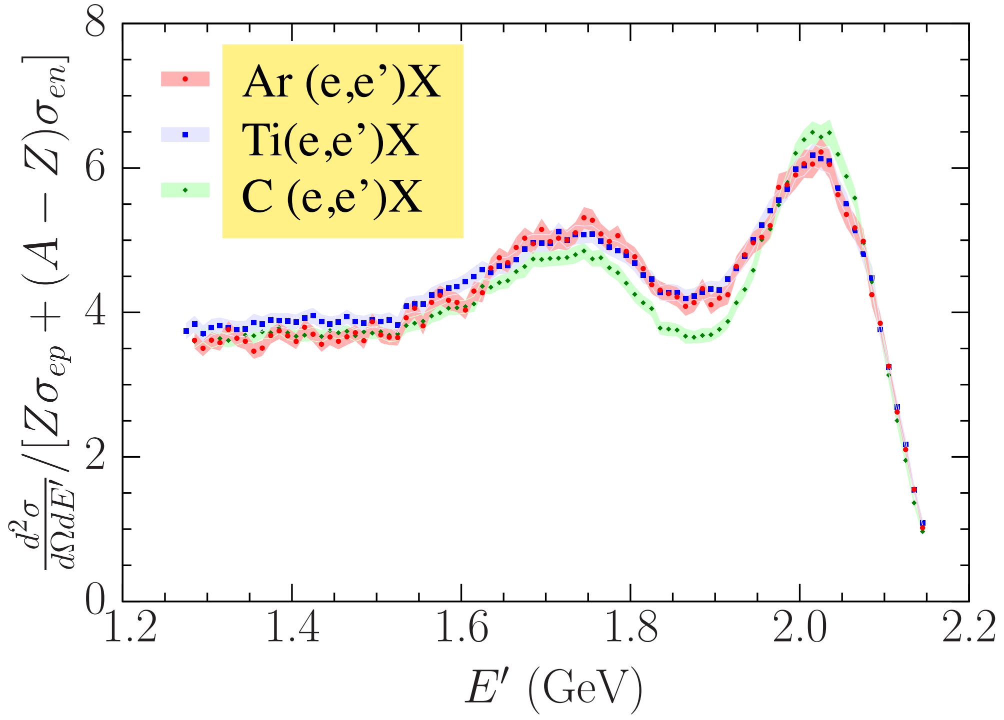
Liquid Argon projection chamber is being used. It will require one order of magnitude (20% → 2%) improvement in theoretical prediction for ν-^{40}Ar cross sections to achieve proper event reconstruction.

➔ **Need good knowledge of ^{40}Ar spectral functions and consistent structure-scattering theories.**

Spectral function for ^{40}Ar and Ti

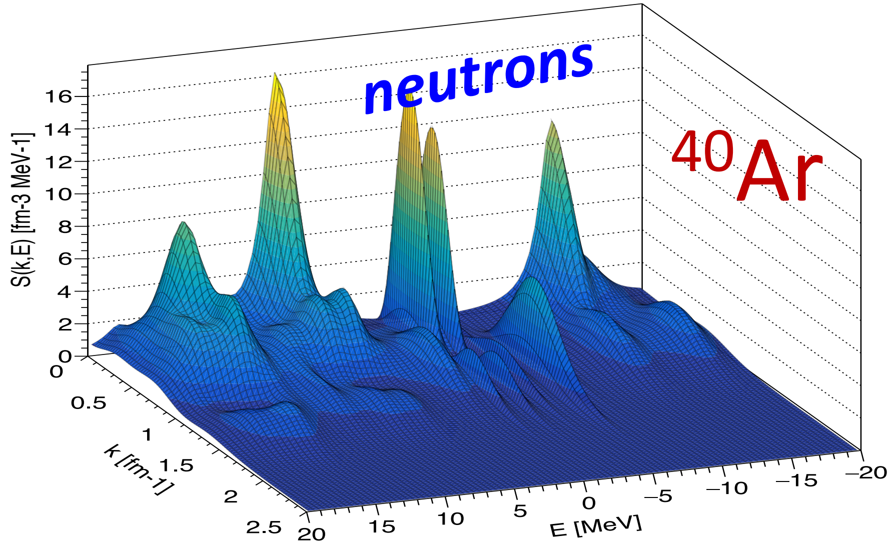
Jlab experiment E12-14-012 (Hall A)

Phys. Rev. C 98, 014617 (2018); arXiv:1810.10575



^{40}Ar(e,e'p) and Ti(e,e'p) data being analyzed

CB, N. Rocco, V. Somà,
PhysRevC 100, 062501(R) (2019)



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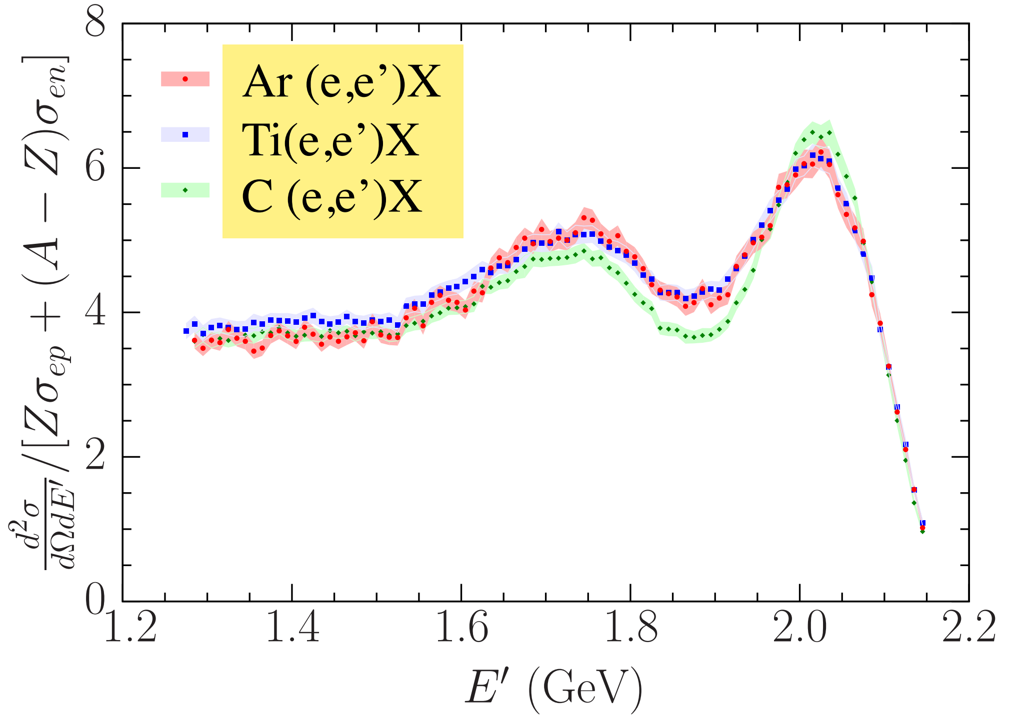
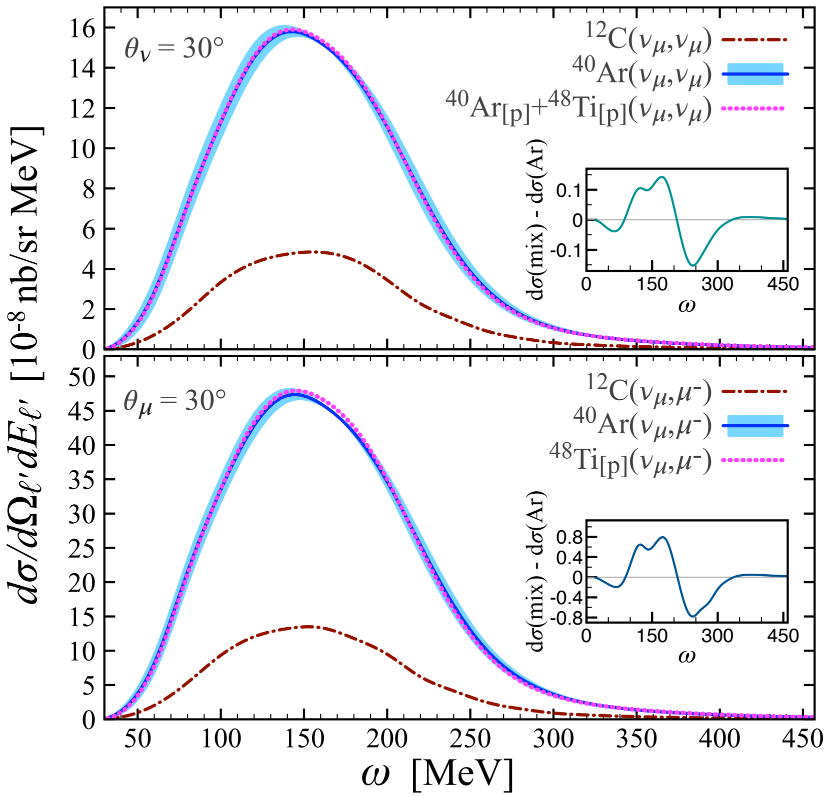


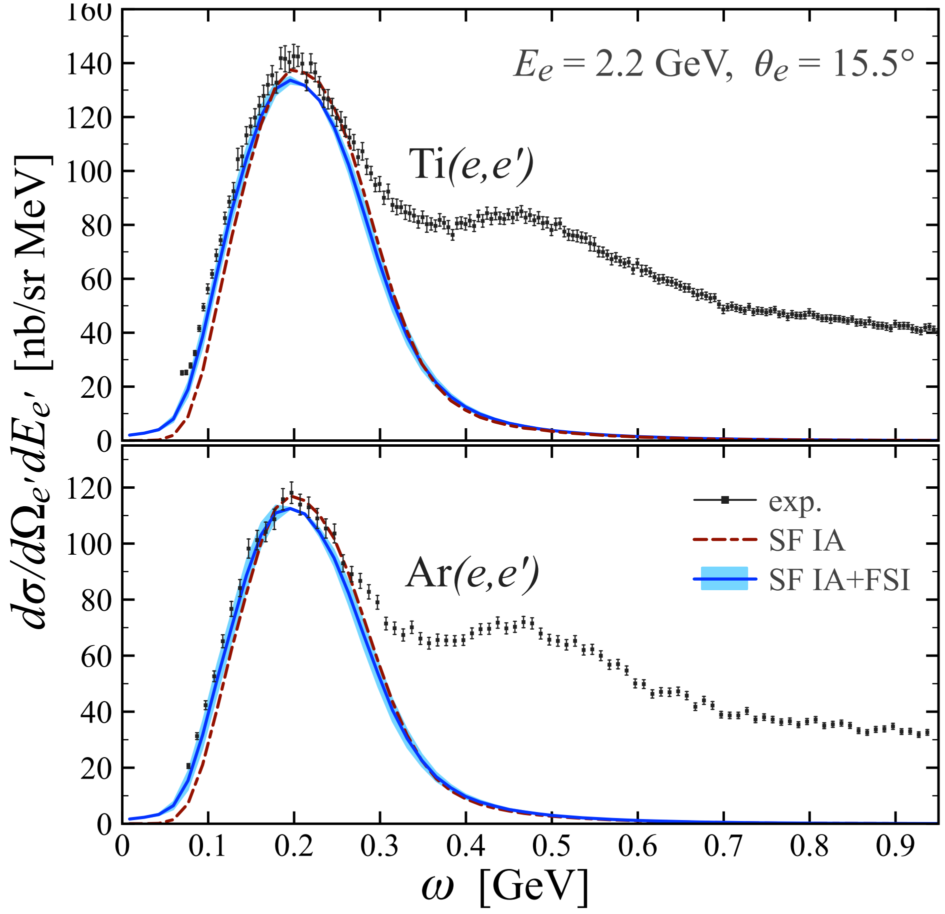


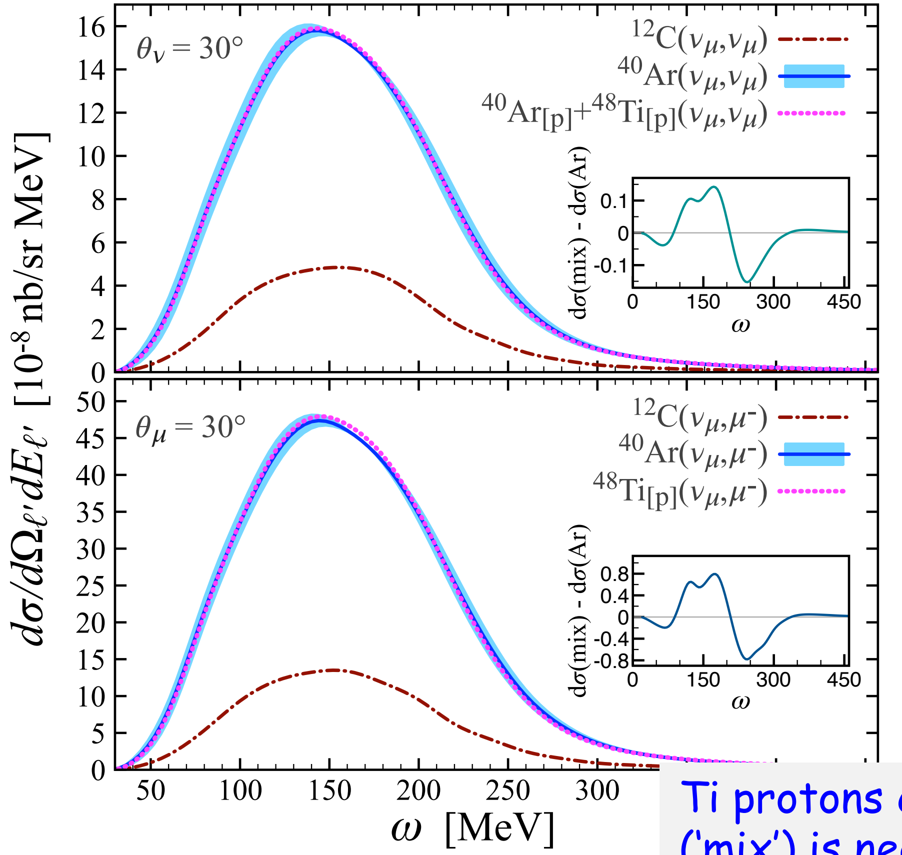
^{40}Ar(e,e'p) and Ti(e,e'p) data being analyzed

Electron and ν scattering on ^{40}Ar and Ti

Jlab experiment E12-14-012 (Hall A)

[Phys. Rev. C 98, 014617 (2018)]





Ti protons contribution ('mix') is nearly identical to neutrons in ^{40}Ar.

^{40}Ar(e,e'p) and Ti(e,e'p) data being analyzed

CB, N. Rocco, V. Somà, arXiv:1907.01122 – PhysRevC in print

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