Fisica nucleare teorica

Iniziativa specifica STRENGTH

Partecipanti:

G. Colò (PO Unimi)

X. Roca-Maza (RTD-B Unimi)

E. Vigezzi (Dir. Ric. INFN)

S. Shihang

(Postdoc/ENSAR2)

INFN Istituto Nazionale di Fisica Nucleare

In Memoriam: Pier Francesco Bortignon (1948–2018)

Pier Francesco Bortignon

On 27 August 2018, Pier Francesco Bortignon, a scientist able to set standards in his field of research, passed away. Standards, above all, of accuracy and of consistency.

He acquired the basis of those standards from the education he received at the Department of Physics of the University of Padova. But a major part came from his interaction with Aage Bohr and Ben Mottelson, starting during his first prolonged visit to The Niels Bohr Institute in 1972, when a similar, privileged relation with Gerry Brown developed.

Also as a result of these inspiring and most fruitful interactions, repeated through the years, Pier Francesco became a member of a unique school of physics, and made important contributions toward a quantitative description and understanding of nuclear structure. The simple and basic concepts and expressions he found to describe the dynamics of the shell model, the anharmonicities of multiphonon states, and the properties of giant resonances in both hot and cold nuclei, a subject in which Pier Francesco was a world leader, are here to stay. These results, derived within the framework of finite many-body physics, more precisely of nuclear field theory, have become standard references and are part of the toolkit of nuclear practitioners.

Research was an urge for Pier Francesco. But this did not make him forget that he was a member of a social community and of an academic world. He invested as much effort and dedication in taking care of institutional and university chores as he did in scientific investigation. And always in his unique, intellectually honest approach, which made him a widely respected figure among both colleagues and administrators.

He contributed in an important way to the reordering of didactics in the Department of Physics of the University of Milan, as chairman of the corresponding council. He also fostered the implementation of cutting edge research in the university at large, as a member of the large facilities committee. Regarding didactics, he blended his physical knowledge and his vast humanistic culture with his ever-present respect for the point of view and concern for the aspirations of others, a blend that made him an inspiring and beloved teacher.

It is an euphemism to state that we will miss him. With his passing away we have lost a reference point. Somebody we could recur to when confronted with subtle questions in our research, being confident that, if there was an answer, a correct physical answer, he would be able to help finding it. This was a result of his vast, encyclopedic knowledge and prodigious memory, but above all of his unique physical understanding of nuclear physics in particular and of the quantum mechanics of finite many-body systems in general.

Having collaborated with Pier Francesco since the beginning of the 1970s and having published our last joint paper in 2016, I recognize how privileged I have been to enjoy over a lifespan the light of a beautiful mind and the warmth of an equally beautiful spirit. Light and warmth that are to be found throughout his *opus* and thus in our present memory and future research.

Quoting the poet-rector of Salamanca:

> Ahora es cuando veo de mi vida
> la eterna juventud ...
> he vivido, he vivido, y aunque muera
> yo sé que viviré
>
> —M. de Unamuno, "Teresa"

R. A. Broglia
Department of Physics,
University of Milan
The Niels Bohr Institute,
University of Copenhagen

Iniziativa specifica in cui il gruppo è coinvolto: STRENGTH

Sedi consorziate: **NA, PD, PI, LNS, CT**

Proposal for an INFN Research Network (Iniziativa Specifica)

Section I:

Title:

Structure and Reactions of Nuclei: towards a global Theory

Acronym:

Strength

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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.**

- Il gruppo ha una posizione di **leader** in molti di questi studi, come testimoniato da **recenti articoli di rassegna**
- 15 articoli, 38 talks, 11 tesi (2017-2018)
- Ha numerose **collaborazioni** nazionali ed internazionali (> 10 Università e istituti di ricerca in Europa, Cina, Giappone, USA).

Tradizionale collaborazione con i gruppi sperimentali

G. Colò (50% Gamma)

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

IVth Topical Workshop on Modern Aspects in Nuclear Structure

The Many Facets of Nuclear Structure

BORMIO 19 - 25 February 2018

The Workshop is preceded on **February 19th** by a
Satellite Meeting focused on
"Working at the interface between Nuclear Structure and Reactions"
(Organizer - Gianluca.Colo@mi.infn.it) ** PROGRAM **

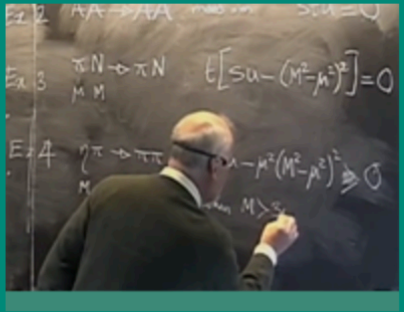
Comitato Organizzatore

Pietro Antonioli INFN-Bologna
Maria Benedetta Barbaro Università & INFN-Torino
Marco Contalbrigo INFN-Ferrara
Gianluca Colò Università & INFN-Milano
Alessandra Fantoni INFN-LNF
Vincenzo Greco Università di Catania & INFN-LNS
Gianluca Imbriani Università & INFN-Napoli
Marco Mazzocco Università & INFN-Padova
Vincenzo Patera Università & INFN-Roma
Giovanni Salmè INFN-Roma
Domenico Santonocito INFN-LNS
Emanuele Scifoni TIFPA-INFN
José Javier Valiente Dobón INFN-LNL
Michele Viviani INFN-Pisa

The Galileo Galilei Institute For Theoretical Physics

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

Arcetri, Firenze



Frontiers in Nuclear and Hadronic Physics 2019

25 February 2019 to 8 March 2019

Organizers

Francesco Becattini (University and INFN, Firenze)
Ignazio Bombaci (University and INFN, Pisa)
Angela Bonaccorso (INFN, Pisa)
Maria Colonna (INFN,LNS)
Marzia Nardi (INFN, Torino)
Giovanni Salmè (INFN, Roma)
Elena Santopinto (INFN, Genova)
Enrico Vigezzi (INFN, Milano)

Definizione di funzionali densità capaci di riprodurre sia le proprietà fondamentali (masse, raggi) dei nuclei nello stato fondamentale che le loro eccitazioni collettive (risonanze giganti).

Dinamica delle eccitazioni nucleari e dei meccanismi di reazione, per ottenere una riproduzione coerente e quantitativa delle sezioni d'urto misurate.

Teoria dei funzionali densita'
Teoria di campo nucleare
Eccitazioni collettive
Reazioni di trasferimento di nucleoni
Superfluidita' nucleare
Stelle di neutroni
Cattura elettronica, Risonanza di Gamow-Teller e decadimento beta
Violazione di parita' , e-N scattering

Skyrme Model

Hamiltonian[a]

Includes **central tensor terms (J^2 terms)** due to the coupling of tensor and spin and gradients terms and **two spin-orbit parameters** (same as SkO and some SkI forces)

$$\mathcal{H} = \mathcal{K} + \mathcal{H}_0 + \mathcal{H}_3 + \mathcal{H}_{\text{eff}} + \mathcal{H}_{\text{fin}} + \mathcal{H}_{\text{SO}} + \mathcal{H}_{\text{sg}} + \mathcal{H}_{\text{Coul}}$$

$$\mathcal{K} = \hbar^2 \tau / 2m$$

$$\mathcal{H}_0 = (1/4) t_0 [(2 + x_0)\rho^2 - (2x_0 + 1)(\rho_n^2 + \rho_p^2)]$$

$$\mathcal{H}_3 = (1/24) t_3 \rho^\alpha [(2 + x_3)\rho^2 - (2x_3 + 1)(\rho_n^2 + \rho_p^2)]$$

$$\mathcal{H}_{\text{eff}} = (1/8)[t_1(2 + x_1) + t_2(2 + x_2)]\tau\rho + (1/8)[t_2(2x_2 + 1) - t_1(2x_1 + 1)](\tau_n \rho_n + \tau_p \rho_p)$$

$$\mathcal{H}_{\text{fin}} = (1/32)[3t_1(2 + x_1) - t_2(2 + x_2)](\nabla\rho)^2 - (1/32)[3t_1(2x_1 + 1) + t_2(2x_2 + 1)][(\nabla\rho_n)^2 + (\nabla\rho_p)^2]$$

$$\mathcal{H}_{\text{SO}} = (1/2) W_0 \mathbf{J} \cdot \nabla\rho + (1/2) W_0' (\mathbf{J} \cdot_{\mathbf{n}} \nabla\rho_n + \mathbf{J_p} \cdot \nabla\rho_p)$$

$$\mathcal{H}_{\text{sg}} = -(1/16)(t_1 x_1 + t_2 x_2)\mathbf{J}^2 + (1/16)(t_1 - t_2)(\mathbf{J_n}^2 + \mathbf{J_p}^2)$$

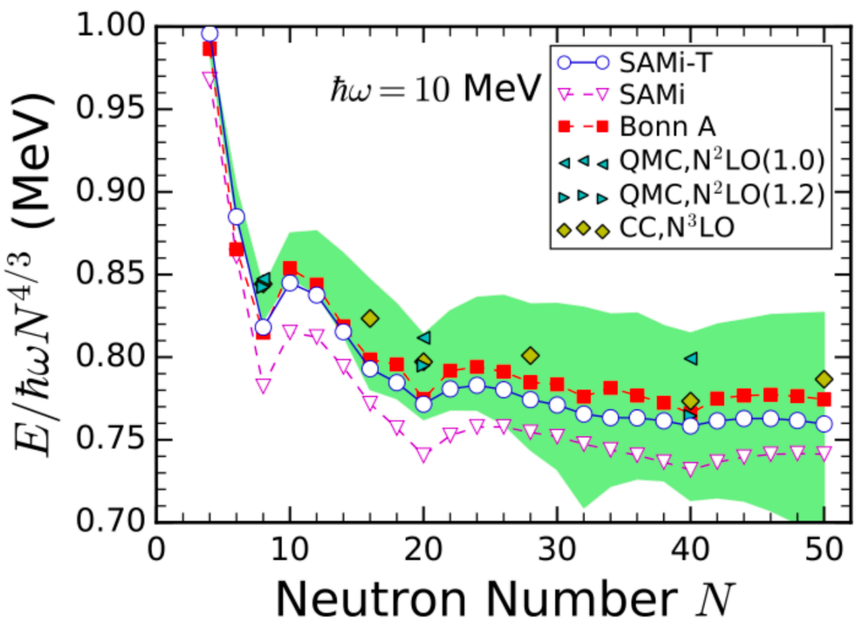
[a] E. Chabanat et al., Nucl. Phys. A **635**, 231 (1998); E. Chabanat *et al.*, ibid. **643**, 441 (1998)

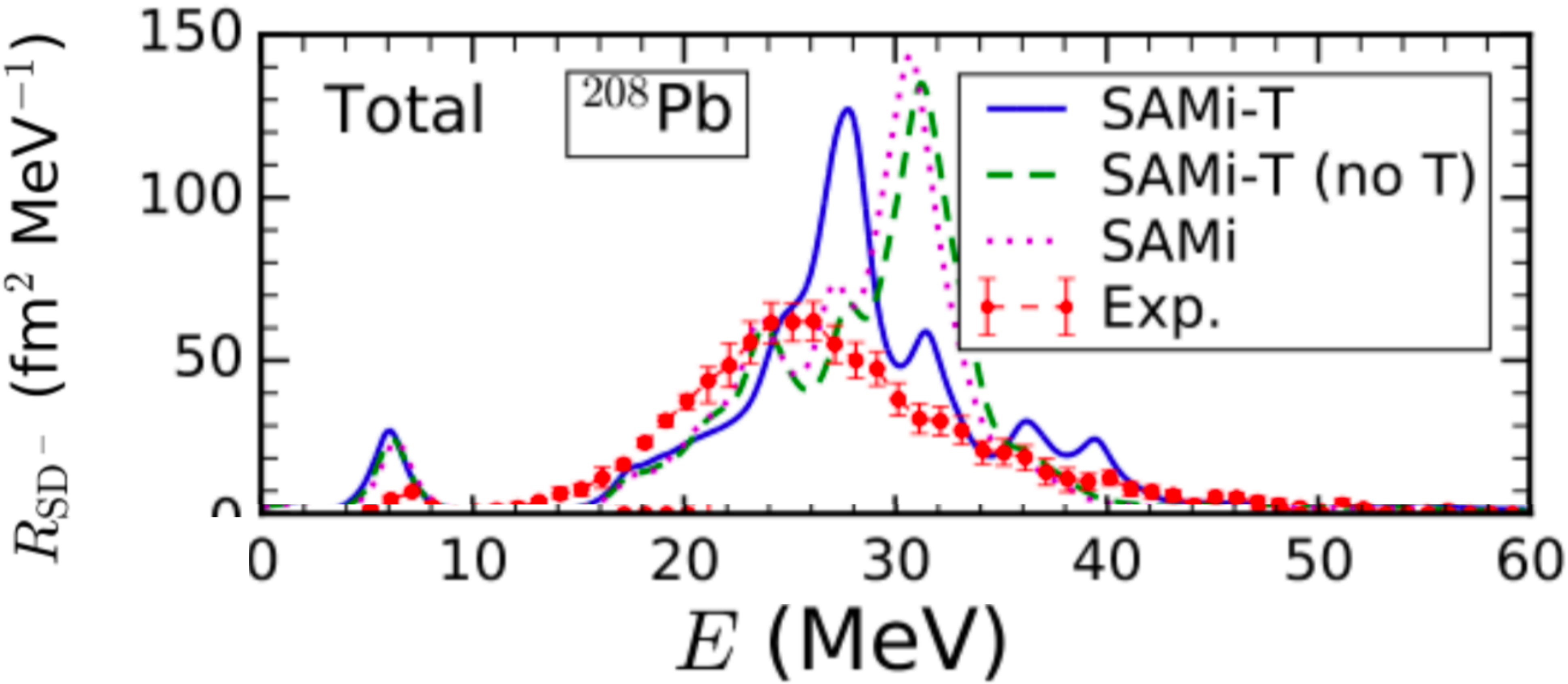
PHYSICAL REVIEW C **99**, 034322 (2019)

Skyrme functional with tensor terms from *ab initio* calculations of neutron-proton drops

Shihang Shen (申时行), Gianluca Colò,* and Xavier Roca-Maza

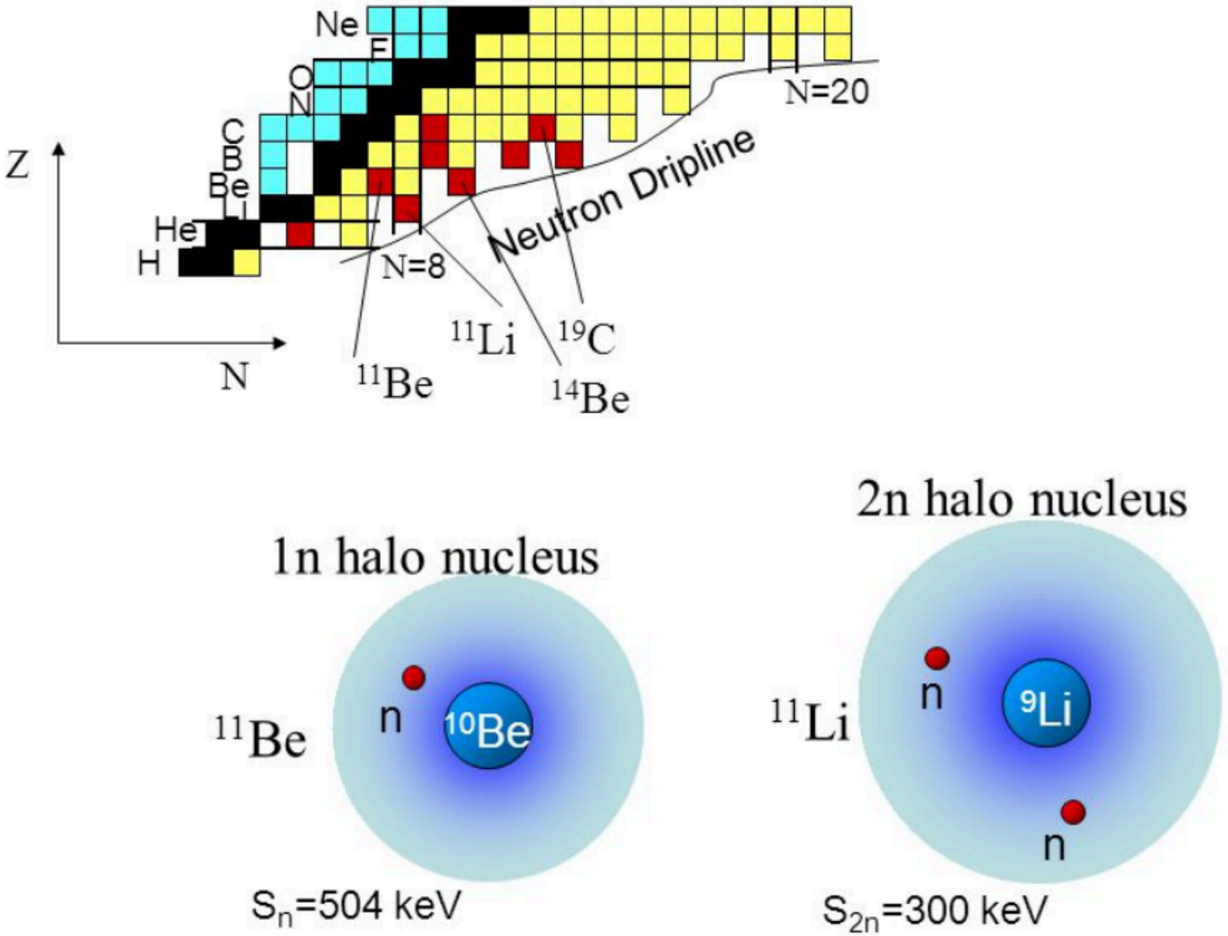
Alcuni parametri del nuovo funzionale densità SAMI-T (termini tensoriali) sono stati determinati dal confronto con *metadati* ottenuti con calcoli microscopici avanzati su gocce di neutroni e protoni. In questo modo si riescono a superare delle ambiguità che si presentano quando si fissano i parametri solo su proprietà empiriche.





El.	A	B (MeV)	B^{expt} (MeV)	r_c (fm)	r_c^{expt} (fm)
O	16	127.78(33)	127.62	2.774(4)	2.699
Ca	40	343.74(52)	342.05	3.477(3)	3.478
	48	415.32(50)	415.99	3.515(3)	3.477
Ni	56	468.73(1.06)	483.99	3.784(4)	
	68	591.27(56)	590.41	3.901(4)	
Zr	90	783.35(46)	783.89	4.263(3)	4.269
Sn	100	812.91(1.18)	824.79	4.480(5)	
	132	1100.80(54)	1102.85	4.714(4)	4.709
Pb	208	1637.81(67)	1636.43	5.479(5)	5.501

Neutron Halo Nuclei– Nuclei at the stability limit



T. Nakamura

Structure and Reactions of ^{11}Be: Many-Body Basis for Single-Neutron Halo

F. Barranco,[1] G. Potel,[2] R. A. Broglia,[3,4] and E. Vigezzi[5]