Gogny ou …

la Force vive

Par Michel Girod

Being the oldest in the group of theoretical physics today, I suggest presenting you a brief history of the years during which I had the chance and the pleasure to collaborate with Daniel Gogny.

It began in 1973.

At that time, I was a young physicist at CEA Limeil Center with my old friend, Jacques Dechargé.

One day, arrived a researcher . He seemed full of life, having with difficulty contained passion and what he tried to communicate with us.

He came from the IPN of Orsay , the laboratory of Professor Jean, Marcel Vénéroni, Dominique Vautherin, and he had made a new force.

This fellow was Gogny.

This force was his child.

After the realistic «soft core" force which he had elaborated with P.Pyres and R.de Tourreil (1970),

And laborious and rather disappointing second order calculations of G Matrix performed with Michel Maire,

Daniel Gogny convinced himself that the only possible "exit" was the "effective force" allowing mean field calculations of Hartree-Fock type. Such calculations were becoming accessible to the new generations of computers.

The Skyrme forces already existed but they were of zero range.

Gogny wants that his force can treat on the same footing the mean field and the pairing correlations in the framework of the Hartree-Fock-Bogoliubov (HFB) theory .

He also wants to be able to go beyond the mean field.

For that purpose, a finite range is necessary.

In that case however, the calculations are considerably time consuming and considering the still very modest power of computers, some people say to him that it is not "reasonable".

It is probably one of the reasons for his decision to create the D1 force …

For that purpose,

1. *He writes a HFB code in a spherical symmetry, the wave functions are developed on a harmonic oscillator's basis,*
2. *He conceives a cleaver program to fit the parameters which allows to generate forces having a priori good properties at the same time in infinite nuclear matter and nuclei.*

This force, here it is:

The force

$$V(|\vec{r}_1 - \vec{r}_2|) =$$

$$\sum_{j=1,2} e^{-\left\{\frac{(\vec{r}_1-\vec{r}_2)^2}{\mu_j^2}\right\}} \left(W_j + B_j P_\sigma - H_j P_\tau - M_j P_\sigma P_\tau\right)$$

$$+ t_0 (1 + x_0 P_\sigma)\ \delta(\vec{r}_1 - \vec{r}_2)\ \left[\rho\left(\frac{\vec{r}_1+\vec{r}_2}{2}\right)\right]^\alpha$$

$$+ i.W_{ls}\ \overleftarrow{\nabla}_{12}.\delta(\vec{r}_1 - \vec{r}_2) \times \vec{\nabla}_{12}.(\vec{\sigma}_1 + \vec{\sigma}_2)$$

$$+ \text{Coulomb}$$

The main characteristic of this force is to be of finite range,

- *a short range of 0.7fm*
- *a medium range of 1.2fm.*

It also has a term dependent on the density to the power 1/3 and of zero range.

With x_0=1, this term is useless in the pairing channel.

Trieste 75

1.

SELF-CONSISTENT PAIRING CALCULATIONS

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Centre d'Etudes de Bruyères-le-Châtel

B.P. n° 61

92120 MONTROUGE - France

This famous paper of Trieste 1975 explains the philosophy which inspired Daniel Gogny.

He describes the HFB method and the writing of a code in a spherical symmetry …

And also the method used to determine the parameters of the new force.

Philosophy (1)

INTRODUCTION

The search for a microscopical theory capable of reproducing global properties of nuclei has considerably progressed in the past few years. In particular, it now appears more and more clearly that the Hartree-Fock (H.F.) procedure using a convenient renormalized interaction is a reliable approach to study the bulk properties of nuclei such as nuclear masses, density distributions, deformation properties etc. .

To assign a place to the work presented here, let us briefly recall which are the different types of H.F. calculations with effective forces.

They can be divided into two groups according to the two different ways of defining the effective interaction.

In the first one [1,2,3], the effective interaction in finite nuclei is derived from a realistic two body nucleon-nucleon force. To this end, the framework of Brueckner's theory in the local density approximation is used. If a phenomenological correction is added to include higher-order corrections, H.F. calculations with such forces were able to reproduce, with a relatively good precision, binding energies, charge radii, and deformation properties [5].

J.W.Negele (1970)

P.K.Banerjee, D.W.L.Sprung (1970)

X.Campi, D.W.L.Sprung (1972)

J.Zofka, G.Ripka (1971)

...rization of the effec-
...all forces deduced
... the nuclear density.
...but one should mention
...rive their density-
...determined by fitting
...two finite nuclei. The
... Skyrme's type [8]

... the previous one,

...but satisfies the two following requirements :

i) We want an approach which gives a description of nuclear properties as accurate as possible.

ii) The interaction must be simple enough to permit systematic calculations and extension of the H.F. method.

Philosophy (2)

D.M.Brink, E.Boeker (1967)

A.B.Volkov (1965)

S.A.Moszkowski (1970)

A.Faessler (1974)

INTRODUCTION

The search for a microscopical theory capable of reproducing global properties of nuclei has considerably progressed in the past few years. In particular, it now appears more and more clearly that the Hartree-Fock (H.F.) procedure using a convenient renormalized interaction is a reliable approach to study the bulk properties of nuclei such as nuclear masses, density distributions, deformation proper

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For the second group, one chooses a direct parameterization of the effective force, including an essential and common feature to all forces deduced with the previous approach, namely a strong dependence on the nuclear density. (Here, we limit ourselves with density dependent forces, but one should mention that Brink and Boeker, and Volkov [4)] were the first to derive their density-independent force in that way). Then, the parameters are determined by fitting nuclear matter data and some global properties of one or two finite nuclei. The Moskowski's modified interaction [6,7)] and also that of Skyrme's type [8)] were derived along this line.

Such an approach is obviously less fundamental than the previous one, but satisfies the two following requirements :

i) We want an approach which gives a description of nuclear properties as accurate as possible.

ii) The interaction must be simple enough to permit systematic calculations and extension of the H.F. method.

D.Vautherin, D.M.Brink (1972)

Ambition

For our part, we have carried out extensive calculations with an effective density dependent force of finite range which was proposed two years ago at the Munich Conference [14]. Its derivation was based on a set of criteria which is more complete than those used in fitting the very short range interactions mentioned above. Thus, we have thought desirable to give some details about its derivation and not only results of calculations. In fact, this force was fitted with the ambitious purpose of treating pairing correlations in finite nuclei by employing the Hartree-Fock-Bogoliubov procedure (H.F.B.). As it will appear below, such a purpose requires one to determine separately some of the spin and isospin components of the force in contrast with other derivations where one does not mind about the behaviour of each one of these components. Specifying these components, is an essential difference between the two ways this force and the Skyrme forces were obtained. We shall come back to this question later on.

The parameters

The saturation properties of ^{16}O and ^{90}Zr calculated with the restricted H.F. procedure (see ref. 4) provided four linear equations in the combinations (Si + Gi) and (Si - Gi) where Si and Gi represent the quantities

$$S_i = 4W_i + 2(B_i - H_i) - M_i \quad , \quad G_i = W_i + 2(B_i - M_i) - 4M_i \quad , i = 1,2$$

The occurrence of the combinations Si ± Gi only is a consequence of the fact that we have expressed the saturation properties of the ^{90}Zr as if

always 300 MeV. We show in Fig.1 the

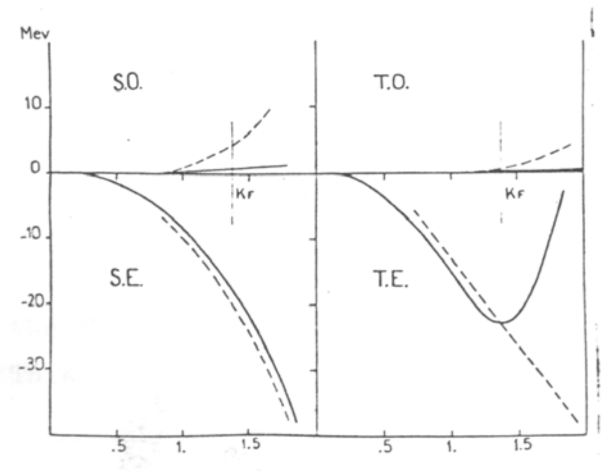

Fig. 1

Table 1

μ_1, μ_2	W	B	H	M MeV
0.7	-402.4	-100.	-496.2	-23.56
1.2	-21.30	-11.77	37.27	-68.81
$\alpha=1/3$ $x_0=1$ $W_{LS}=-115$MeV $t_0=1350$MeV.fm^6				

Table 2

E (MeV)	K_f (fm^{-1})	K (MeV)	a_τ (MeV)
-16.3	1.36	228	30.3
-16	1.35	150 K 200	30.
Nuclear matter properties of D1			

nuclear matter. Two more equations resulted from imposing some values to the pairing matrix elements

$$\langle (1s)^2 J=0 | V | (1s)^2 J=0 \rangle_{T=1} \quad , \quad \langle (2s)^2 J=0 | V | (2s)^2 J=0 \rangle_{T=1}$$

Indeed these last two matrix elements were varied until complete H.F.B. calculations of the tin isotopes satisfactorily reproduce the pairing effects.

The reference paper

PHYSICAL REVIEW C VOLUME 21, NUMBER 4 APRIL 1980

Hartree-Fock-Bogolyubov calculations with the $D1$ effective interaction on spherical nuclei

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(Received 3 August 1979)

A self-consistent approach allowing the introduction of pairing into a comprehensive study of the bulk as well as the structure properties of nuclei is presented. It is emphasized that the density-dependent effective force used in the calculations reported here does permit the extraction of the mean field and the pairing field in the framework of the Bogolyubov theory. First, a brief review of Hartree-Fock-Bogolyubov formalism with density-dependent interactions is presented. Then the derivation of the effective interaction is explained and some details concerning the nuclear matter properties are given. Finally, we report the studies on spherical nuclei with special reference to the pairing properties. In order to demonstrate the versatility of our approach a comprehensive study of various nuclear properties is given. In view of the abundance of results obtained with our approach we plan to report the results on the deformed nuclei in a future publication.

[NUCLEAR STRUCTURE Density-dependent Hartree-Fock-Bogolyubov (DDHFB) approximation applied to the calculations of the structure of spherical nuclei: binding energies, pairing correlations, density distributions, magnetic form factors, and quasiparticle spectra.]

Why the finite range?

A very long paragraph gives the justifications of his research which could have seemed too ambitious at that time.

C. Why the finite range?

In order to explain the motivations which led us to introduce a finite range in the course of construction of $D1$, we discuss some aspects which are related to the choice of the zero range effective interactions. Of course it is not our intention to discredit the excellent results obtained with the zero range effective interactions but rather to indicate the limitations in their applications.

If we believe that the effective force is something like a G matrix, the presence of finite range leaves no doubt and the first question is to understand its influence on the HF results. The density matrix expansion (DME) derived by Negele and Vautherin[30] is the convenient tool to study the role of the finite range. These authors have shown on the proton distribution the effect of truncating their expansion to the few terms corresponding to a Skyrme's force. They conclude that the exact DDHF and such DME calculations lead to shell model fluctuations which are significantly different.

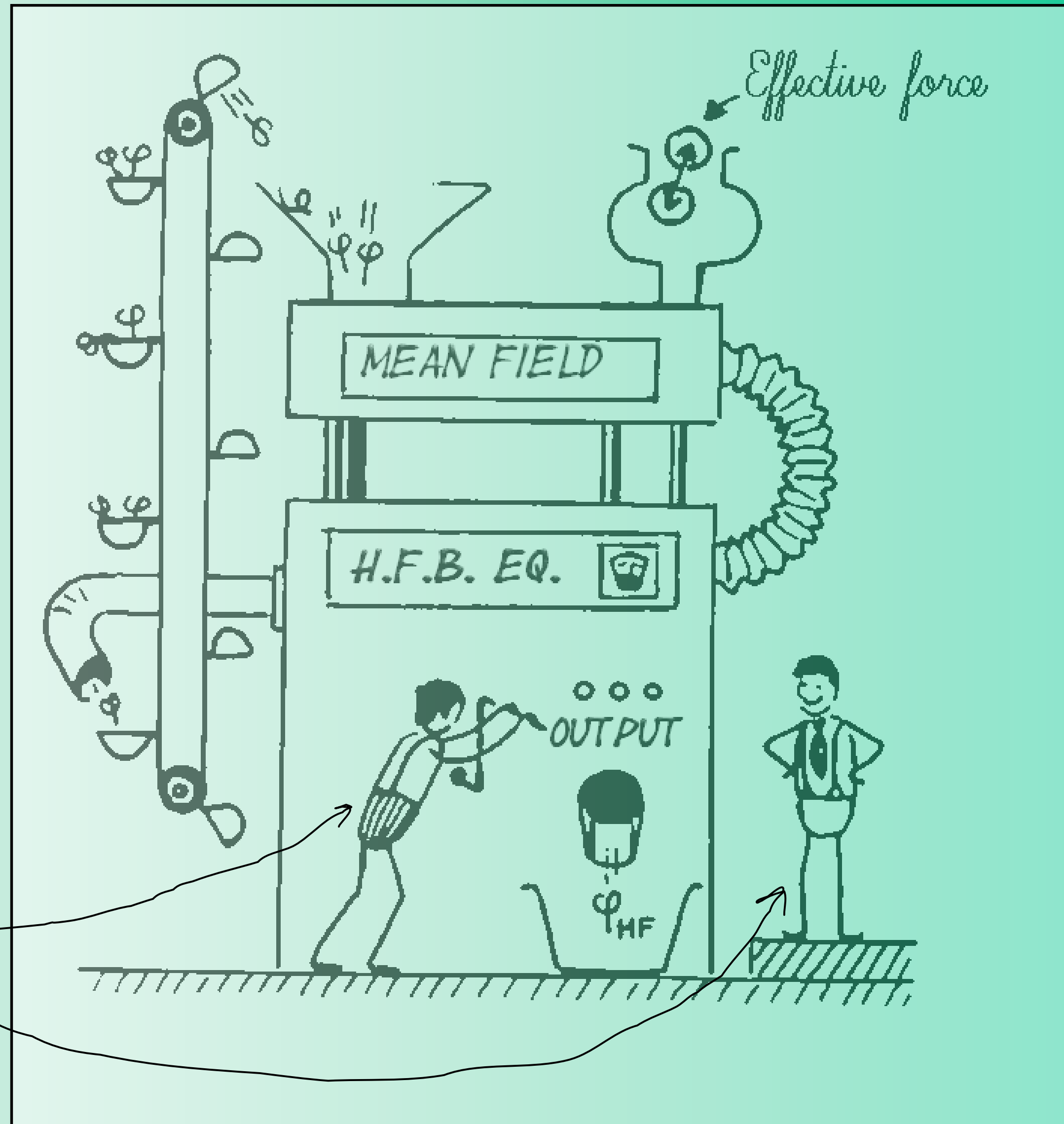
It is a consequence of the fact that the long range of the force smoothes the fluctuations of the HF field as compared to a short range interaction which takes into account the local variation in the HF density; an effect which is emphasized by the self-consistency. For the same reason one may wonder if the short range forces can

always simulate the long range or the intermediate range when studying the response of the nuclei to an external field as one does for instance to get the potential energy surfaces as function of deformation. Clearly this question is important if we try to understand the limitations of the HF theory itself.

The role of the finite range is still more crucial when one desires to extend the theory beyond the HF approximation. In reality the fact that pathologies may exist when putting the range of the interaction to zero is clearly seen when analyzing the Fourier transform of the zero range forces. In particular, one recognizes that their behavior with high relative momenta is completely unrealistic. For example, these forces contain terms constant or increasing quadratically in the relative momenta instead of vanishing rapidly as it is the case in the calculations with finite range forces. Such unrealistic feature is not too dramatic in the HF calculation because one only needs the low Fourier components in the relative momenta which never exceed $2k_F$, but as soon as one wants to go beyond HF the situation is quite different. Thus, in the case which interests us directly, i.e., in the HFB procedure, the particle-particle matrix elements enter in the calculations and in principle there is no restriction on the Fourier components interfering in this procedure. The difficulty we discuss here is well illustrated in the BCS approach to the pairing with a constant pairing force. As is well known, the corresponding gap equations must be solved in a restricted space, otherwise these equations would be divergent in the whole space. That is to say, the smearing of the Fermi surface due to the pairing is restricted arbitrarily over particle states close to the Fermi surface. In such an approach to the pairing it has been recognized that there is a crucial interdependence between the pairing force intensity and the one particle level density. We agree that it may be a reasonable way to take into account the essential features of pairing effects in some specific studies but we believe that the proper pairing theory constructed for the systematic use does not tolerate such *ad hoc* procedures. Clearly the finite range force allows us to avoid such *ad hoc* truncations since they will automatically result from the properties of the interaction itself. In our view this is the only way to define an approach to the pairing which is completely self-consistent and general enough. Finally, although we are not directly concerned here with the RPA calculations, let us mention another pathology when employing zero range force, namely that we get too much collectivity for the

states at high energy. This is easily understood by analyzing the RPA particle-hole Green's function which never tends to the free particle-hole Green's function as it should as the transfer $q \to \infty$. It is a consequence of the unrealistic behavior of particle-hole interaction at the high momentum transfer.

With this new D1 force, the "Hartree-Fock machine" imagined by Jacques Dechargé can start working.



Both persons can perfectly be identified …

Axial code

Long months were necessary to correct 36582 programming errors …

- phase errors ,
- errors of factor π or 2 π or $\pi/2$ or $\sqrt{\pi}$ …
- array overflows, etc , etc, etc…

You should not exceed
512K of memory to have a result during the day
800K for night runs,
1000K for the weekend.

… And especially to save computing time!

The method of separation of variables made miracles,
The genius of the programmers too …
We eventually reached 10s / iteration in basis 10 on the IBM 360-91 of Saclay, one of the fastest computers of the world (in 1975).
We had reached our objective.

The first paper

The first article published with the D1 force : HFB calculations in axial symmetry of the potential energy surfaces of 148, 150, 152 and 154 Samarium isotopes with respect of quadrupole moment.

Volume 55B, number 4 PHYSICS LETTERS 3 March 1975

SELF CONSISTENT CALCULATIONS AND QUADRUPOLE MOMENTS OF EVEN Sm ISOTOPES

J. DECHARGE, M. GIROD and D. GOGNY
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Table 1

Definition and values of the D1 interaction parameters. D1 interaction:

$$V = \sum_{i=1,2} \exp(-|\bar{r}_1-\bar{r}_2|^2/\mu_i^2)(W_{\mu_i}+B_{\mu_i}P_\sigma - H_{\mu_i}P_\tau - M_{\mu_i}P_\sigma P_\tau)$$
$$+ iW_{LS}(\bar{\sigma}_1+\bar{\sigma}_2)\cdot \overleftarrow{\nabla}_{12} \times \delta(\bar{r}_1-\bar{r}_2)\overrightarrow{\nabla}_{12}$$
$$+ t_3(1+x_0P_\sigma)\cdot\delta(\bar{r}_1-\bar{r}_2)\rho^\alpha((\bar{r}_1+\bar{r}_2)/2).$$

$\overrightarrow{\nabla}_{12}$ and $\overleftarrow{\nabla}_{12}$ are the operators $(\overrightarrow{\nabla}_1-\overrightarrow{\nabla}_2)/2i$ acting respectively on the right and on the left. $P_\sigma = (1+\bar{\sigma}_1\cdot\bar{\sigma}_2)/2$, $P_\tau = (1+\bar{\tau}_1\cdot\bar{\tau}_2)/2$.

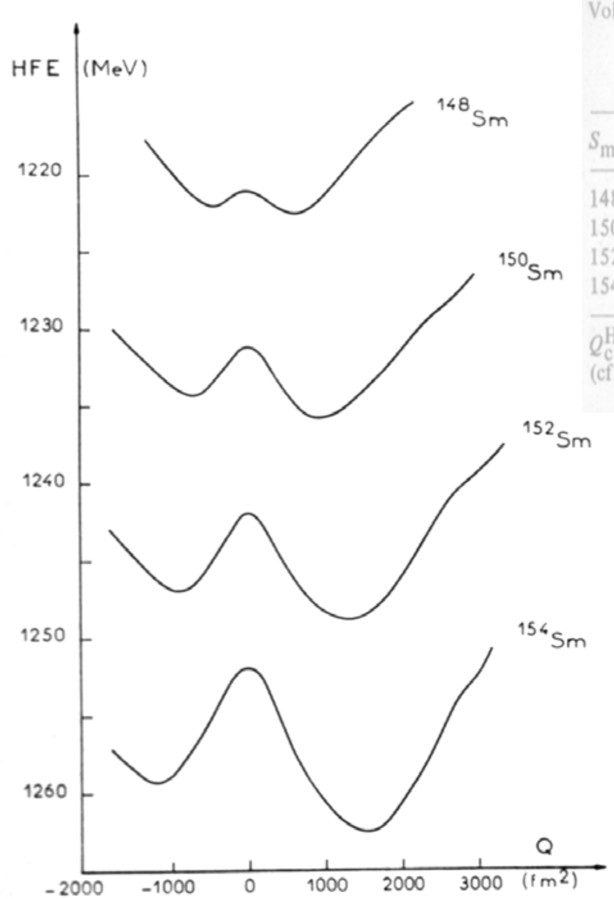

Fig. 1. Total energy curves as a function of the mass quadrupole moment Q obtained for ^{148}Sm, ^{150}Sm, ^{152}Sm and ^{154}Sm.

Volume 55B, number 4 PHYSICS LETTERS 3 March 1975

Table 2

S_m	B^{HF} (MeV)	B^{EXP} (MeV) [14]	Q_c^{HF} (fm^2)	Q_c^{EXP} (fm^2)	$E_{pro}-E_{obl}$	$E_{sph}-E_{pro}$
148	1222.5	1225.4	228		−0.6	+ 1.4
150	1235.8	1239.3	383	367 [15]	−1.2	+ 4.5
152	1249.0	1253.1	572	590 ± 40 [10]	−1.9	+ 7.2
154	1262.6	1266.9	660	660 ± 40 [10]	−3.1	+10.5

Q_c^{HF} H-F charge quadrupole moment; B^{HF} H-F binding energy; $E_{pro}-E_{obl}$ energy difference between prolate and oblate minima (cf. fig. 1); $E_{sph}-E_{pro}$ spherical barrier on the prolate side (cf. fig. 1).

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[1] D. Vautherin and D.M. Brink, Phys. Rev. C5 (1972) 626.
[2] D. Gogny, Proc. Int. Conf. on Nuclear physics, Munich (1973).
[3] D.M. Brink and Boeker, Nucl. Phys. A91 (1967) 1.
[4] C. Titin Schneider and P. Quentin, Phys. Lett. 49B (1974).
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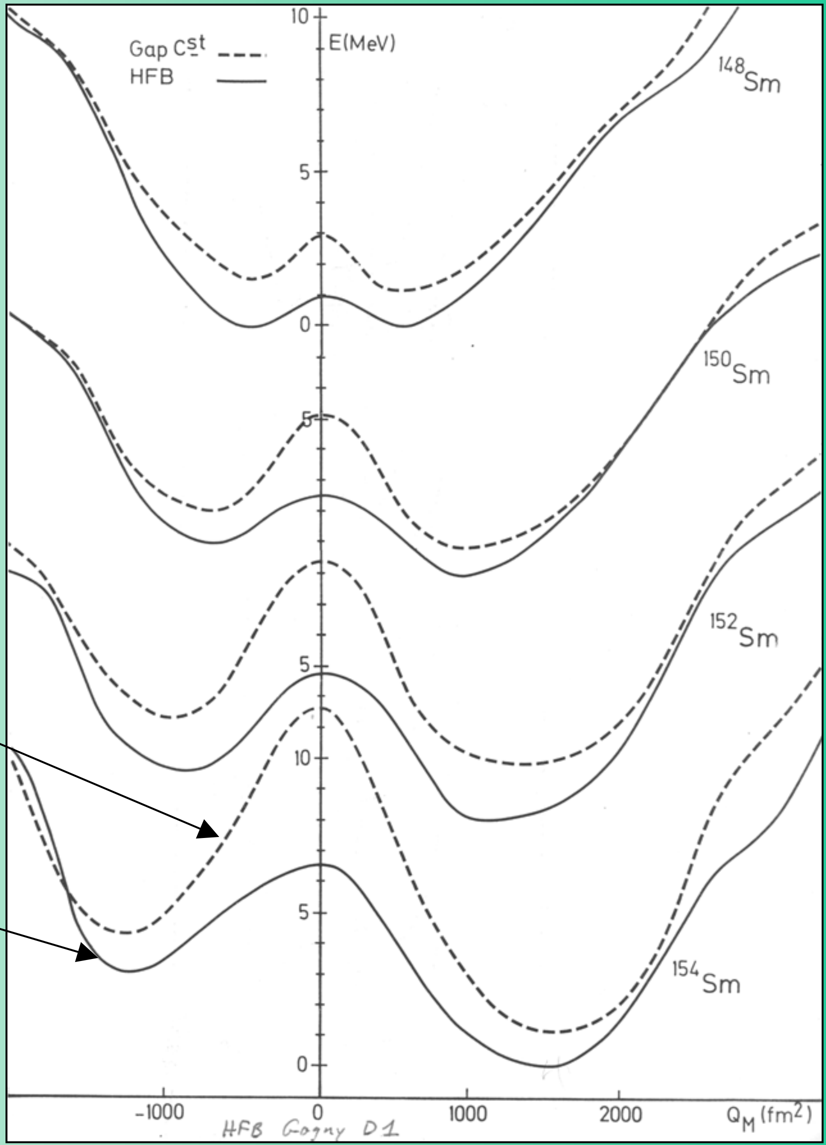
[6] D. Gogny, to be published in Nucl. Phys.
[7] H. Flocard and P. Quentin, Phys. Lett. 46B (1973) 304.
[8] U. Mosel and W. Greiner, Z. Physik 217 (1968) 256.
[9] K. Kumar and M. Baranger, Nucl. Phys. A110 (1968) 529.

These curves illustrate the effect of pairing correlations on the potential energy surfaces according to methods :

1 - «constant gap» approximation

2 - full HFB



Collective modes - GCM

From 1976,
we go beyond the mean field by calculating the charge density convoluted by a collective wave function of generator coordinate type in axial symmetry.
The experimental charge density is from ALS (Saclay).

It is the beginning of a fruitful collaboration with Bernard Frois and his group at Saclay.

Volume 64B, number 1 PHYSICS LETTERS 30 August 1976

SELF CONSISTENT CALCULATION OF THE CHARGE DENSITY OF ^{58}Ni INCLUDING A DYNAMICAL CORRECTION

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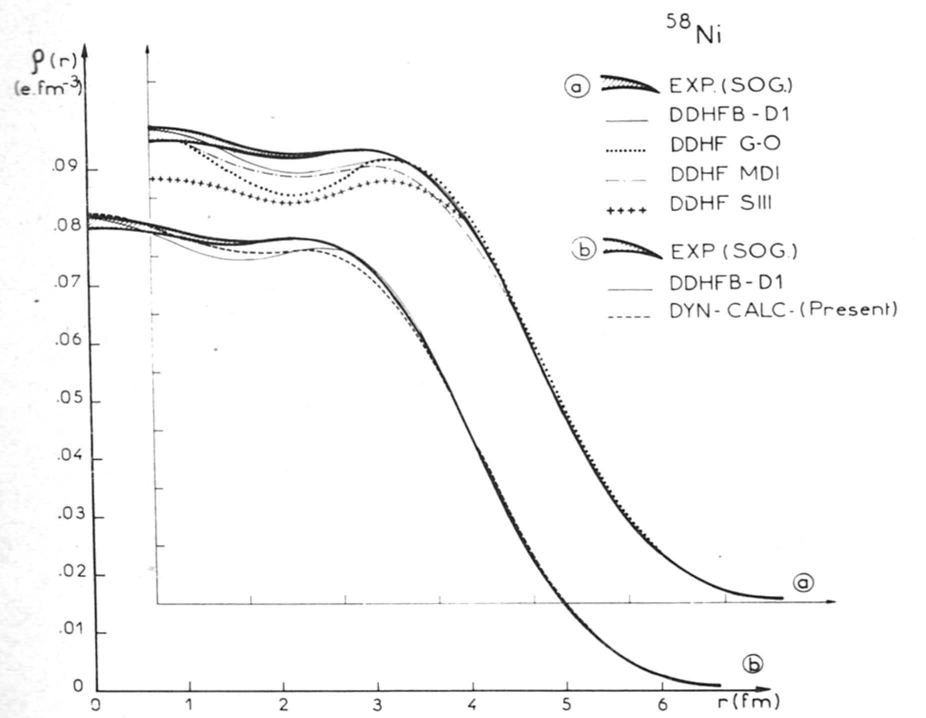
Service de Physique Nucléaire, Centre d'Etudes de Bruyères-le-Châtel, B.P. no. 61, 92120 Montrouge, France

Volume 64B, number 1 PHYSICS



Collective modes - RPA

From 1976 also, RPA calculations give a harvest of good results.
In association with J.P.Blaizot and B.Grammaticos, the calculation of the monopole resonances in RPA with various forces allows for the first time to give a value of the nuclear compressibility:

K_∞=210±30 MeV

1.D.2
Nuclear Physics **A265** (1976) 315—336; © *North-Holland Publishing Co., Amsterdam*

NUCLEAR COMPRESSIBILITY AND MONOPOLE RESONANCES

J. P. BLAIZOT, D. GOGNY † and B. GRAMMATICOS
Service de Physique Théorique, Centre d'Etudes Nucléaires de Saclay, BP no. 2, 91190 Gif-sur-Yvette, France

Received 12 February 1976

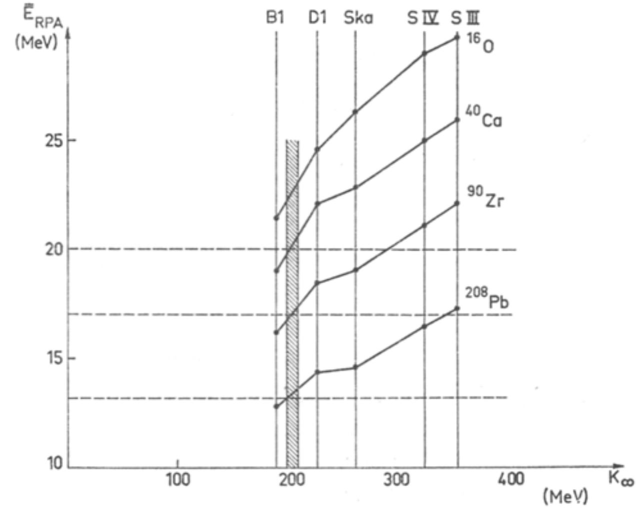


Fig. 5. The energy of the monopole resonance ($\bar{E}_{RPA}$) is plotted as a function of K_∞. The horizontal dotted line corresponds to the results of ref. [25]).

Collective modes - RPA

Here in 1977, a collaboration with Radovan Padjen on the study of the collective modes in nuclear matter, the calculation of the Landau parameters and the forward scattering amplitude sum rule.

Paper presented at the National Soviet Conference on Neutron Physics
(KIEV, April 18-22, 1977)

THE COLLECTIVE MODES IN NUCLEAR MATTER

D. GOGNY, R. PADJEN

1.C

Nuclear Physics **A293** (1977) 365 – 378; © *North-Holland Publishing Co., Amsterdam*

THE PROPAGATION AND DAMPING
OF THE COLLECTIVE MODES IN NUCLEAR MATTER

D. GOGNY and R. PADJEN

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Abstract: In this work we study the properties of the collective modes in nuclear matter in the four available longitudinal channels. For the calculations we selected four different effective interactions. The particularly successful one was the finite-range interaction with density-dependent part D1. No instabilities appeared in any channel and the Landau parameters deduced from it reproduce satisfactorily some previous microscopic calculations with the Reid soft-core potential *G*-matrix. The forward scattering amplitude sum rule, satisfied to a very good accuracy with D1, is discussed in some detail.

Collective modes - RPA

In 1981-1982, with J.Dechargé, collaboration with B.Grammaticos and Léo Sips on the RPA response function to the operator $j_J(qr)$ as a function of the momentum transfer q.

Volume 98B, number 4 PHYSICS LETTERS 15 January 1981

FULLY SELF-CONSISTENT DESCRIPTION OF HIGH SPIN MAGNETIC STATES IN ^{208}Pb

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Received 23 September 1980

VOLUME 49, NUMBER 14 PHYSICAL REVIEW LETTERS 4 OCTOBER 1982

High-Frequency Part of Giant Resonances

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F-

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[b]Permanent address: R. Bošković Institute, P. O. Box 1016, 41001 Zagreb, Yugoslavia.

[1]*Giant Multipole Resonances*, edited by F. E. Bertrand, Nuclear Science Research Conference Series Vol. 1 (Harwood, Chur, 1980).

Collective modes - RPA

Continuation of the collaboration with B.Frois et al. : Study of the charge density and the transition densities of various collective states of ^{208}Pb compared with the recent experimental results of the ALS.

(Los Alamos 1980)

MATTER DISTRIBUTIONS COMPARED WITH ELECTRON SCATTERING RESULTS

by

D. Gogny

With the collaboration of J. Dechargé

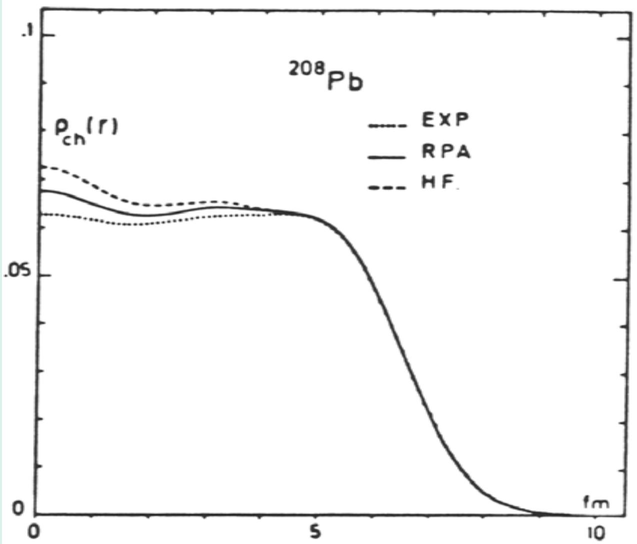


Fig. 5.
The charge distribution of ^{208}Pb
----- D.D.H.F.B.
—— RPA
...... Empirical

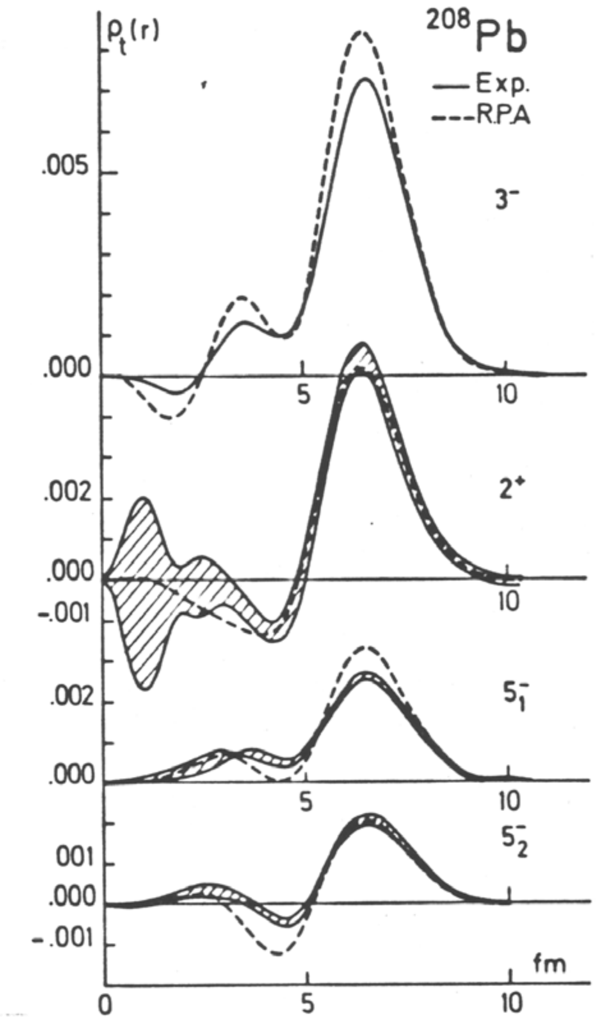
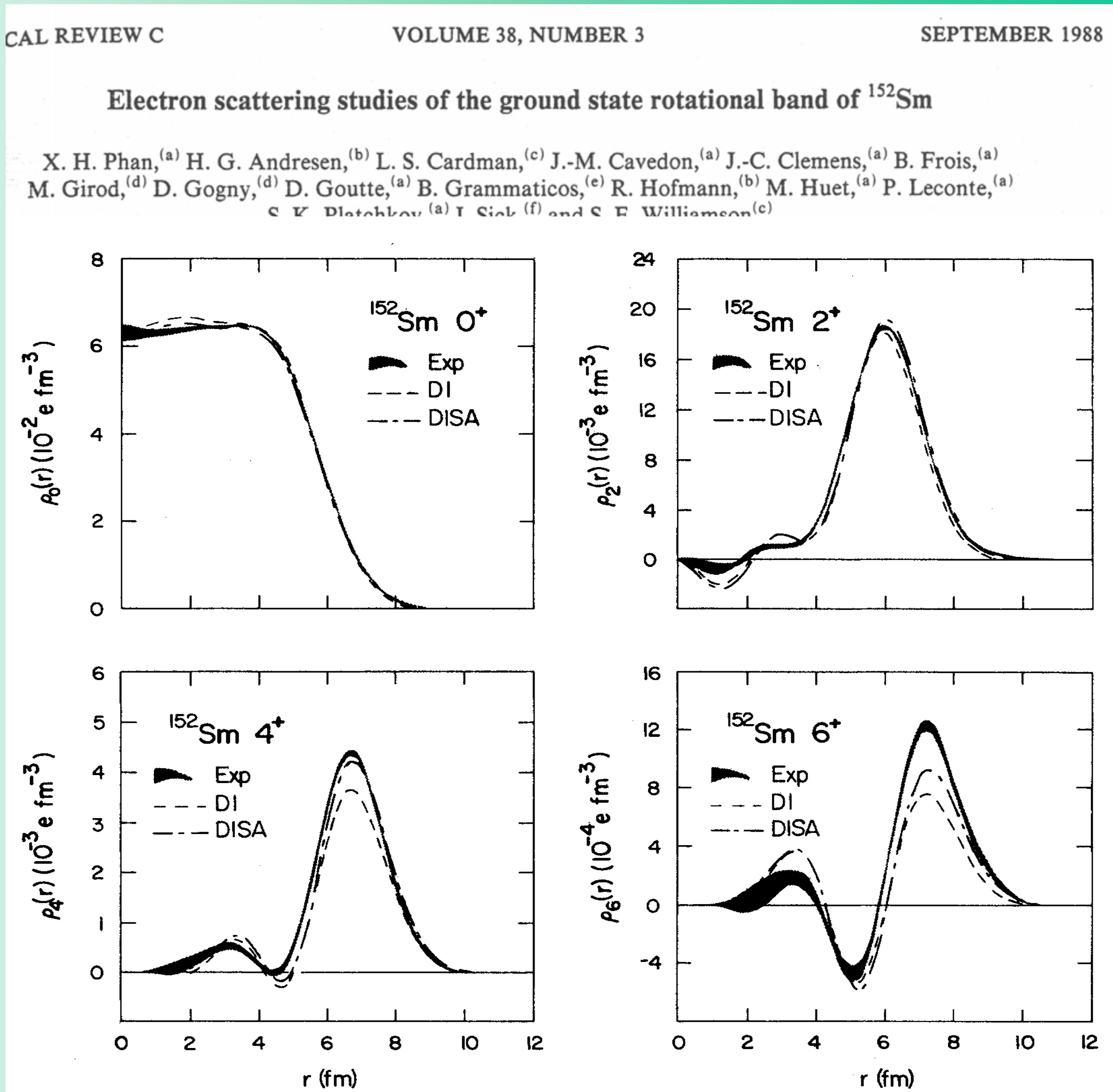


Fig. 3.
The transition densities for the first low lying excited states compared with the data from Saclay (3^-) and M.I.T. (2^+, $5^-{}_{1,2}$).

Collective modes - GCM

Highlight of the collaboration with the experimentalists of ALS:
Study of the charge and transition densities of a deformed nucleus ^{152}*Sm using a 5D Bohr Hamiltonian.*

What is the D1SA force ...?

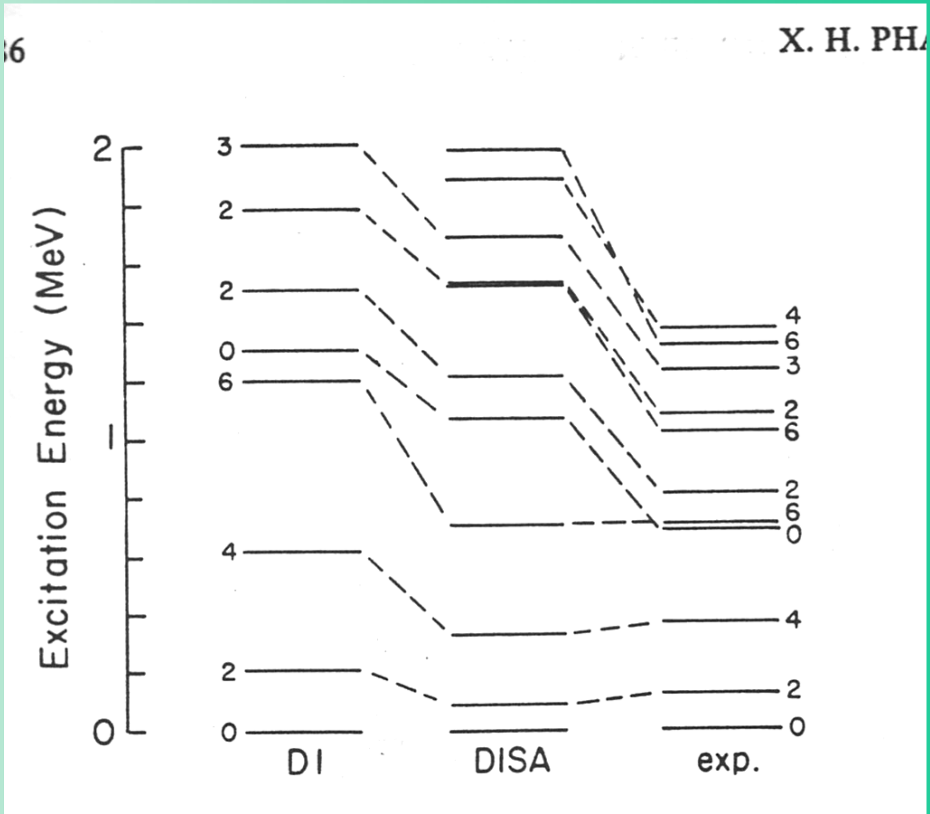

CAL REVIEW C VOLUME 38, NUMBER 3 SEPTEMBER 1988

Electron scattering studies of the ground state rotational band of ^{152}Sm

X. H. Phan,[a] H. G. Andresen,[b] L. S. Cardman,[c] J.-M. Cavedon,[a] J.-C. Clemens,[a] B. Frois,[a] M. Girod,[d] D. Gogny,[d] D. Goutte,[a] B. Grammaticos,[e] R. Hofmann,[b] M. Huet,[a] P. Leconte,[a]

Pairing adjustment

It seems that the pairing correlations are too strong with the D1 force.
The D1SA (or D1A) force fits the odd-even mass differences in tin isotopes.
As a consequence, the collective masses and moments of inertia are getting much stronger , which contributes to compress the rotational and vibrational spectra.



5D Bohr Hamiltonian

Nuclear fission

In 1981, le « compte-rendu à l'Académie des Sciences de Paris » with J.F.Berger.

C. R. Acad. Sc. Paris, t. 293 (26 octobre 1981) Série II — 485

PHYSIQUE NUCLÉAIRE. — *Description microscopique de la fission nucléaire.* Note (*) de **Jean-François Berger, Michel Girod** et **Daniel Gogny,** présentée par Robert Dautray.

Partant d'une description complètement microscopique du noyau, nous tentons d'interpréter la fission du noyau ^{240}Pu en termes de coordonnées collectives considérées comme variables dynamiques. Nous insistons en particulier sur le mécanisme de la scission.

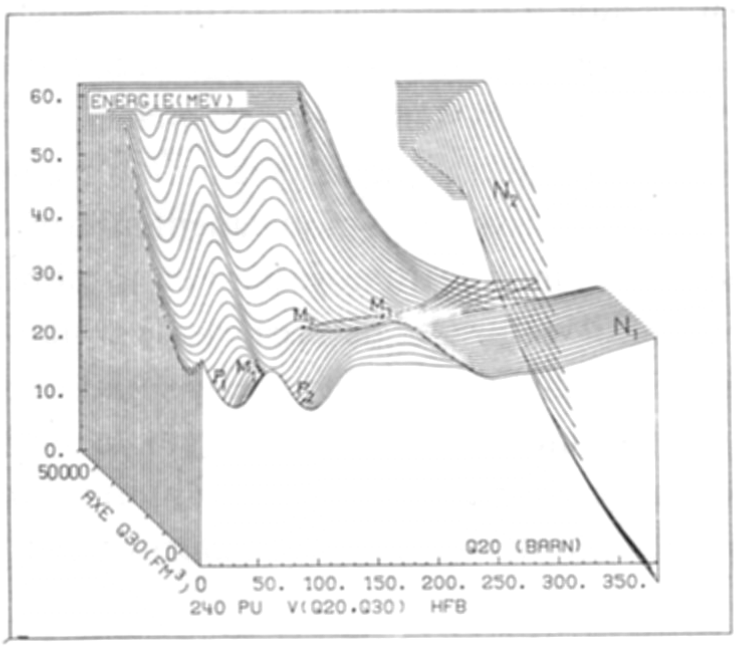


Fig. 1

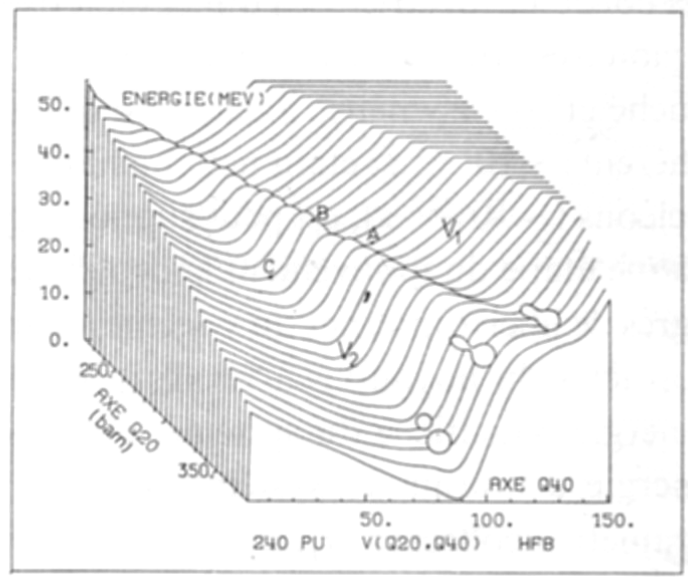


Fig. 2

Nuclear fission

Conférence Internationale sur "Les Approches Théoriques des Mécanismes de Reaction entre Ions Lourds" - Paris 14-18 Mai 1984

MICROSCOPIC ANALYSIS OF COLLECTIVE DYNAMICS IN LOW ENERGY FISSION

(Invited paper)

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Nuclear Physics **A502** (1989) 85c-104c
North Holland, Amsterdam

85c

CONSTRAINED HARTREE-FOCK AND BEYOND

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NORTH-HOLLAND PHYSICS PUBLISHING

Time-dependent quantum collective dy[...]
to nuclear fission

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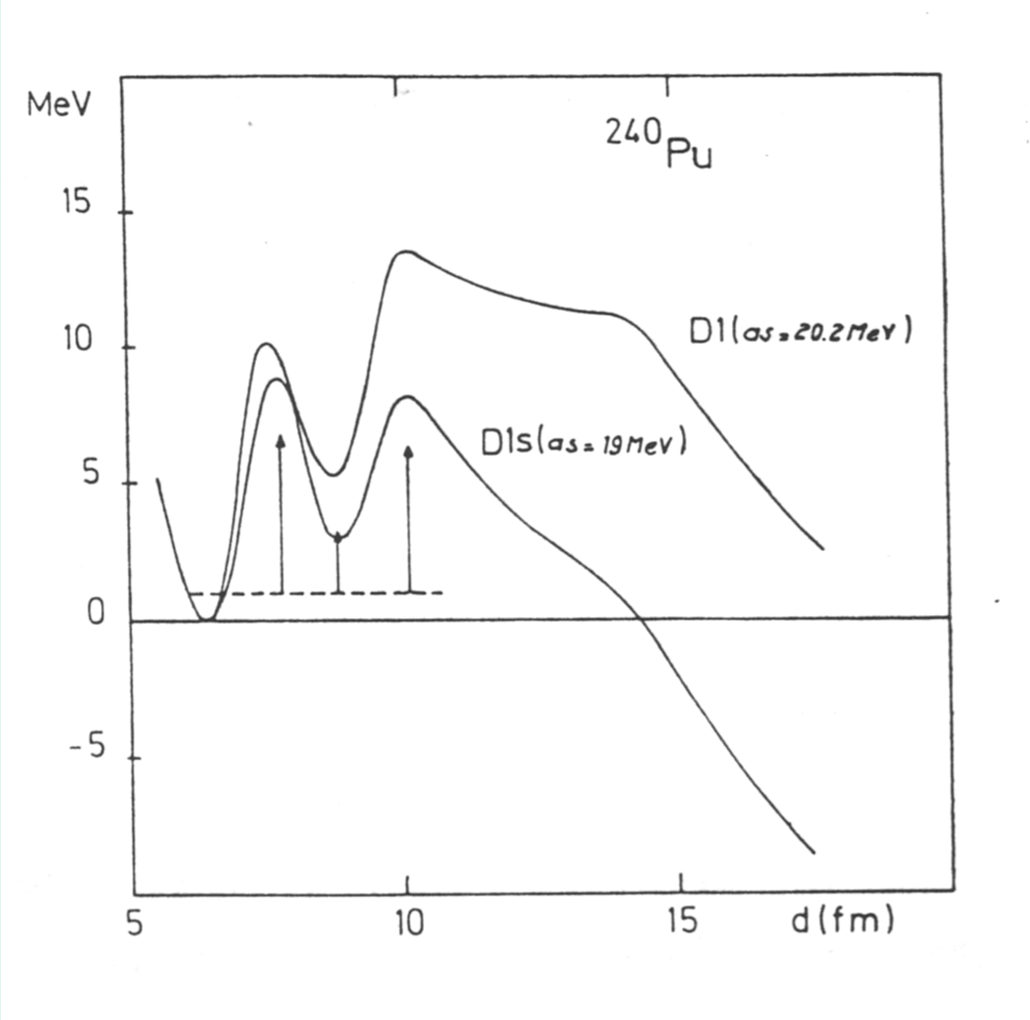
Received 22 February 1990

D1S

An improvement of the D1 force, the D1S force, with "S" as surface:
The coefficient of surface of D1 was too strong, 20.2 MeV.

With D1S, a_s=19 MeV.

The effect on the heights of fission barriers is spectacular.



Shape Isomerism

VOLUME 62, NUMBER 21 PHYSICAL REVIEW LETTERS 22 MAY 1989

Hartree-Fock-Bogoliubov Predictions for Shape Isomerism in Nonfissile Even-Even Nuclei

M. Girod, J. P. Delaroche, D. Gogny, and J. F. Berger

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(Received 28 December 1988)

Secondary minima in the potential-energy surfaces of even-even nuclei are searched for through non-axial Hartree-Fock-Bogoliubov calculations based on a finite-range, density-dependent effective force. This study covering the mass region $64 < A < 208$ is intended to select nonfissile nuclei which would develop shape isomers. Results are presented for nuclei which seem to be the most interesting candidates for experimental investigations.

PACS numbers: 21.60.Jz, 21.10.Re

Shape isomer - GCM

PHYSICAL REVIEW C VOLUME 45, NUMBER 4 APRIL 1992

Limits on the lifetime of the shape isomer of ^{238}U

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(Received 9 September 1991)

In 1991, with J.F. Berger, collaboration with M.Weiss and C.Chinn on the lifetime of the shape isomer of ^{238}U.

And in 1992 with Q.Haider.

Microscopic approach to the generator coordinate method with pairing correlations and density-dependent forces

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Received 21 October 1991, in final form 21 January 1992

So ends the history of the «rich hours" which we shared with Daniel Gogny within the group of theoretical nuclear physics of Bruyères-le-Châtel.

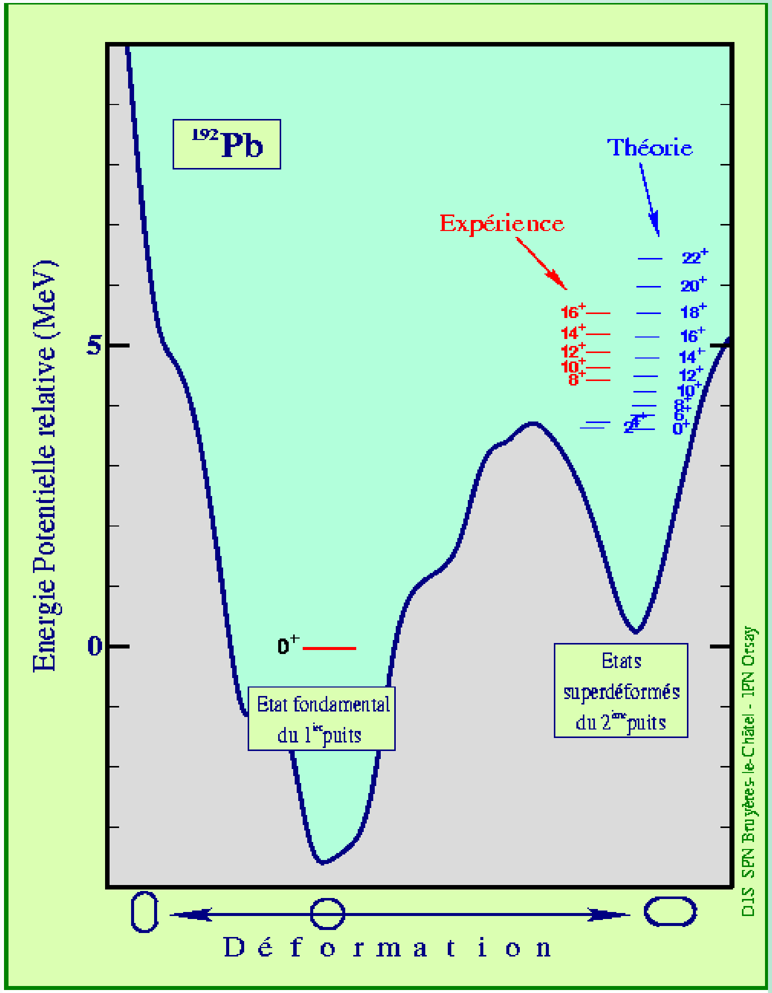
The homesickness is not absent in this statement. We were 30 years younger …

But it is especially the enjoyment and the pride to have lived this beautiful adventure that has to stay in your memories.

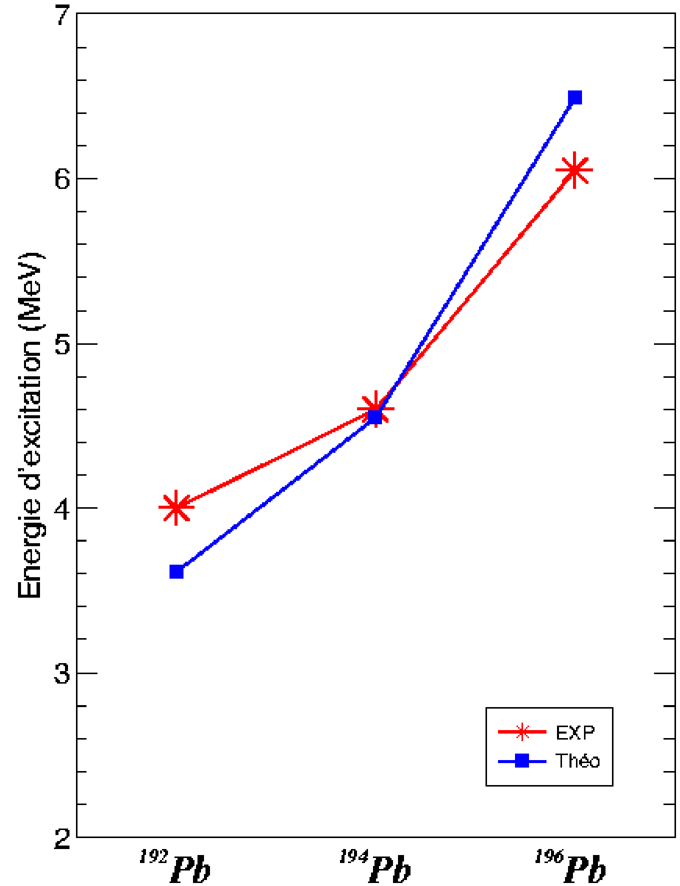
However, this adventure is still alive.

To conclude, I would like to show you some outstanding results illustrating the predictive character of the mean field approach with Gogny force.

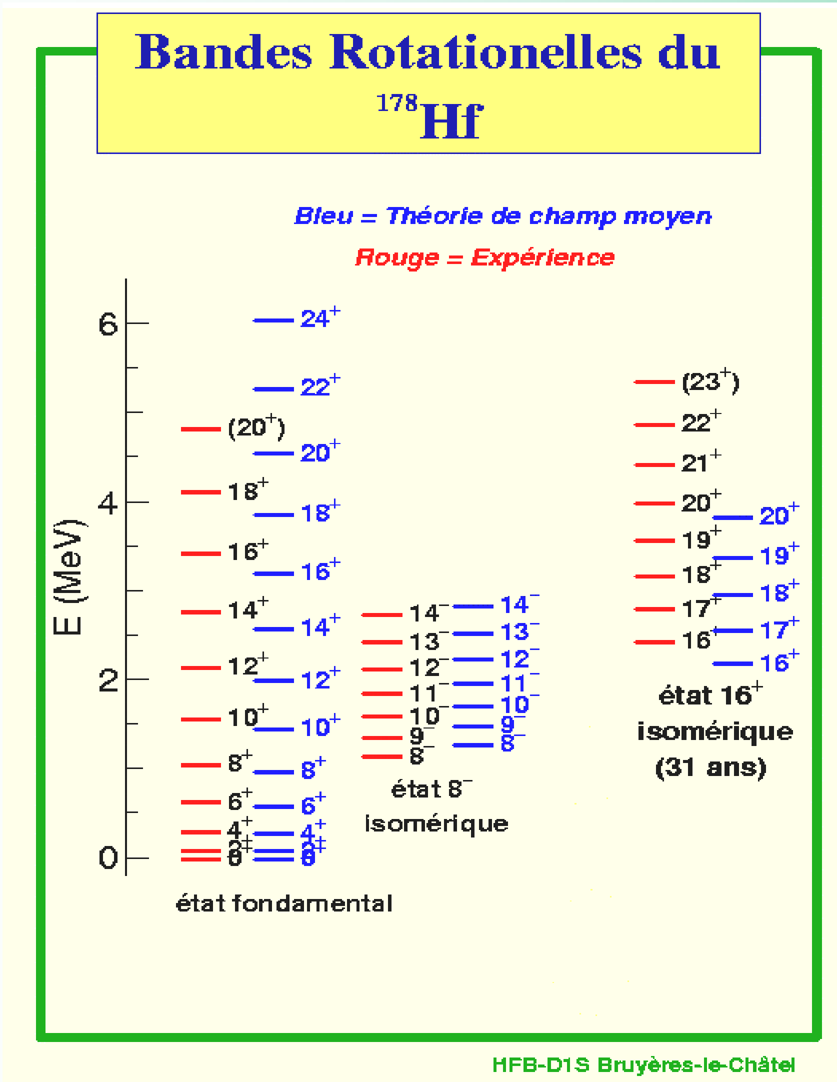
Shape isomer - GCM

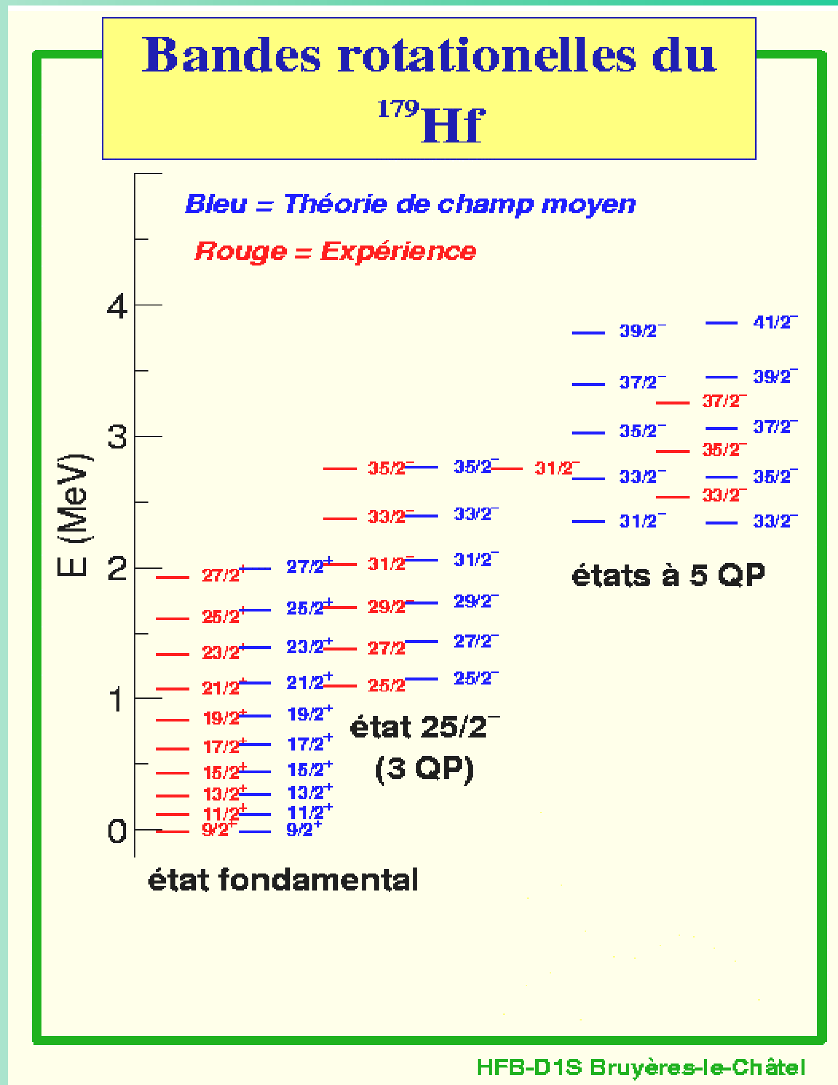


First 0+ SD energies compared to the experimental ones

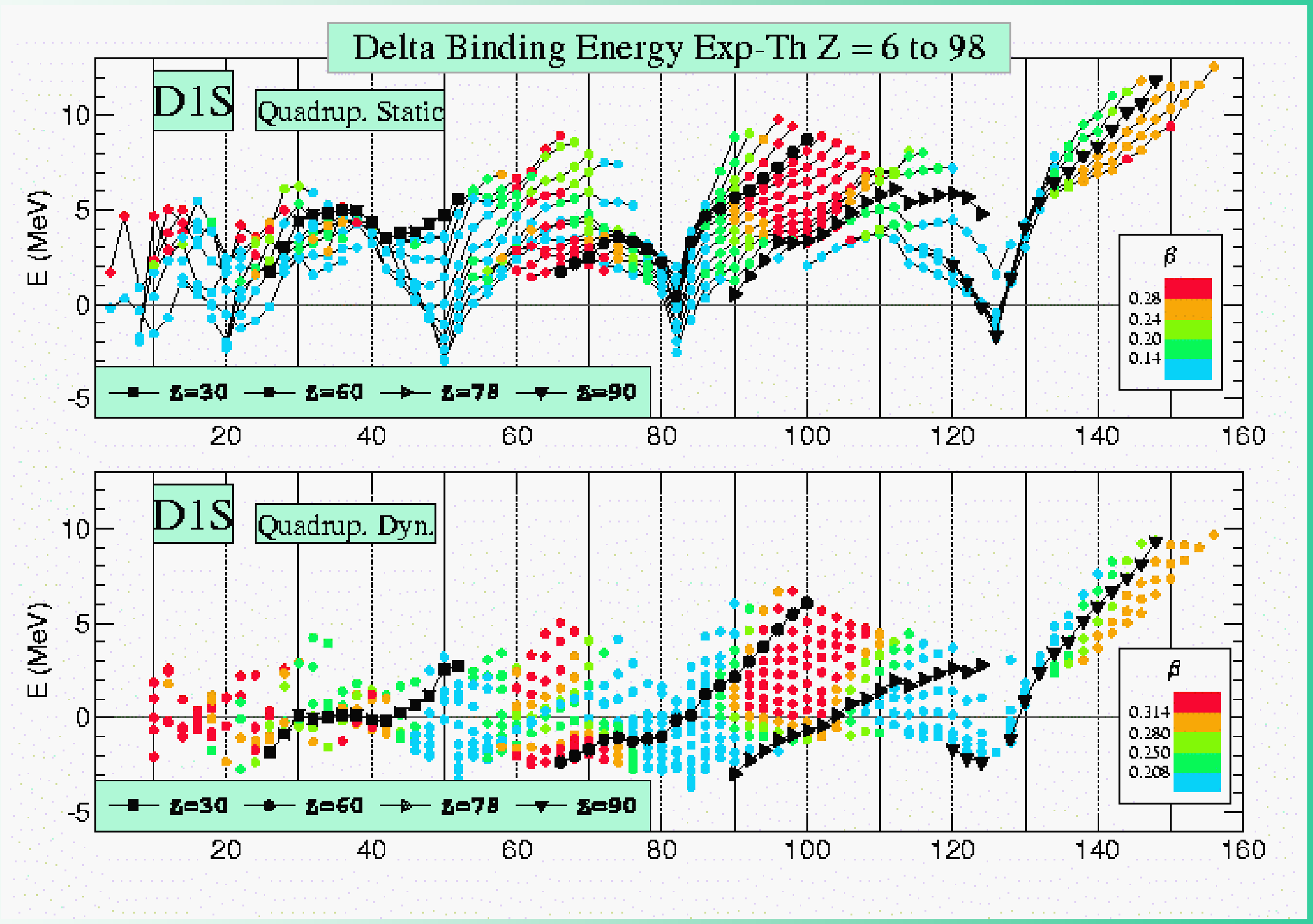


Shape isomer - Cranking HFB





Extensive HFB +GCM-GOA calculations



Extensive HFB +GCM-GOA calculations