

COLLOQUIUM IN MEMORY OF ORIOL BOHIGAS ORSAY MARCH 13 (2014) WANDERING FROM NUCLEI TO CHAOS

FROM INDIVIDUAL LEVELS TO STATISTICAL STUDIES

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1- INTRODUCTION

In 2013 I have lost two of my oldest and best friends ,NICOLE VINH MAU and ORIOL BOHIGAS. We were in 1956 ,NICOLE and I, both students at the INSTITUT DU RADIUM in PARIS.I met ORIOL when he joined the group of theoreticians of IPN in 1964.We worked together from 1966 to 1972.

From our collaboration I have selected the following 3 articles which, I believe, played a role in the vision of nuclear structure ORIOL had in mind when he began working on random matrices.

(1) R.ARVIEU,O.BOHIGAS and C.QUESNE Nucl.Phys. A143 (1970) 577.Analysis of the properties of the odd-mass single closed shell nuclei with a surface delta interaction.

(2) O.BOHIGAS,C.QUESNE and R.ARVIEU Phys Lett.26B (1968) 562. Generalized seniority breaking of two body interaction.

(3) H.NISSIMOV,R.ARVIEU and O.BOHIGAS Nucl.Phys.A190(1972) 514.Extension of the spectral distribution method to many quasi particle subspaces.

2-ORIOLE'S FIRST WORK

This work was a short note done under the supervision of PIERRETTE BENOIST GEUTAL and was proposed by N.VINH MAU:

(4)O. BOHIGAS Journal de Physique 27C1 (1966)39. Niveaux de trous et de particules de ^{15}O et de ^{17}O

In this work he showed that there was a fair amount of admixture of particle-hole states in the states of these odd isotopes that were usually considered as pure single particle. There was in addition a sensible energy shift.

3-SPECTROSCOPY OF ODD SINGLE CLOSED SHELL NUCLEI

In reference (1) the problem was similar to the previous one but the technique used was more ambitious. In the simplest theory there was a set of states in the single closed shell nuclei that were described as pure one quasi particle states. The interaction with three quasi particle states was thus introduced which required big matrix diagonalization. In Fig(1) the results of the model was compared to an exact diagonalization with three particles or three holes outside closed shell. In Fig(2) the results of the model are compared to experiment for a series of odd isotopes of Pb. There was a fair agreement with experiment, that was usual in this kind of calculation but clearly some of the experimental levels could be interpreted as having a three quasi particle structure. The strength of the interaction had been fixed to fit the 2 quasi particle states of even nuclei.

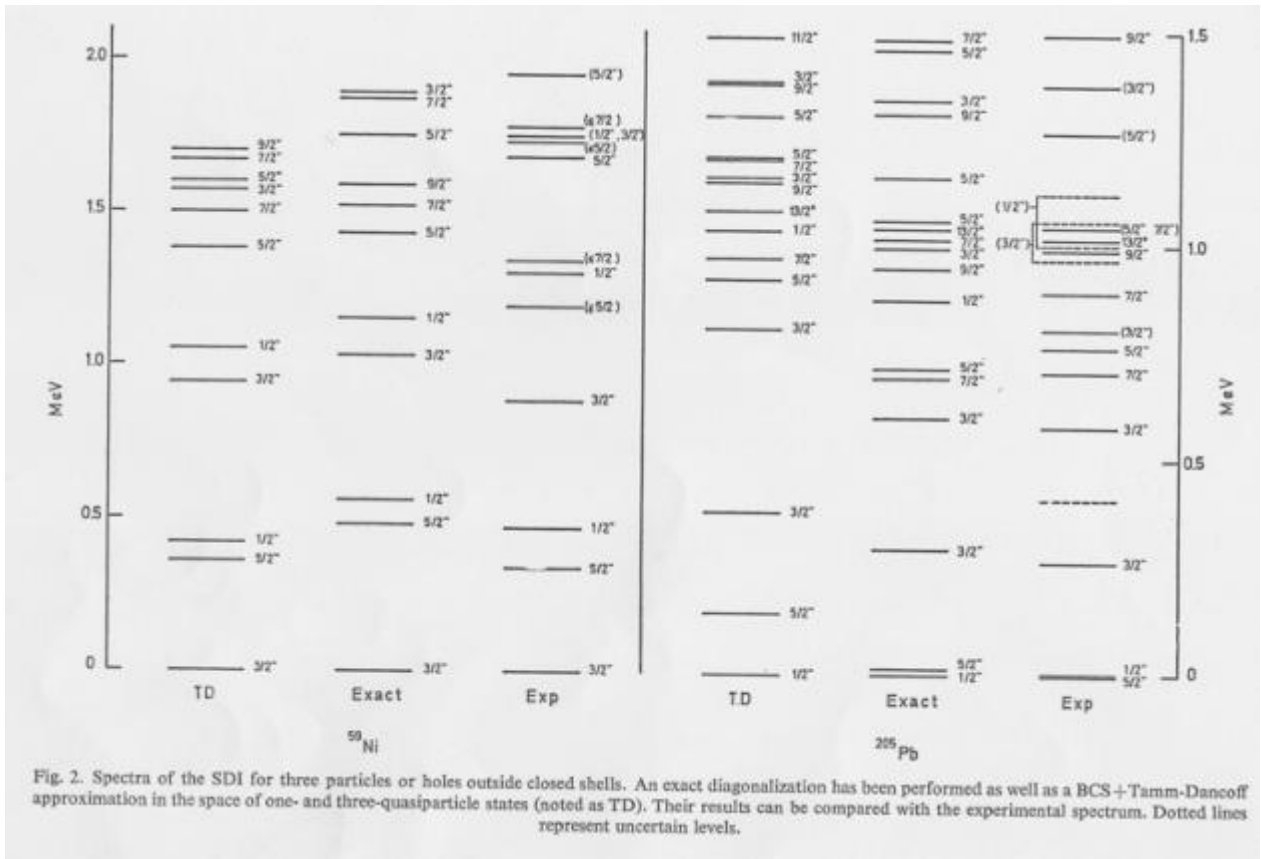


FIGURE 1

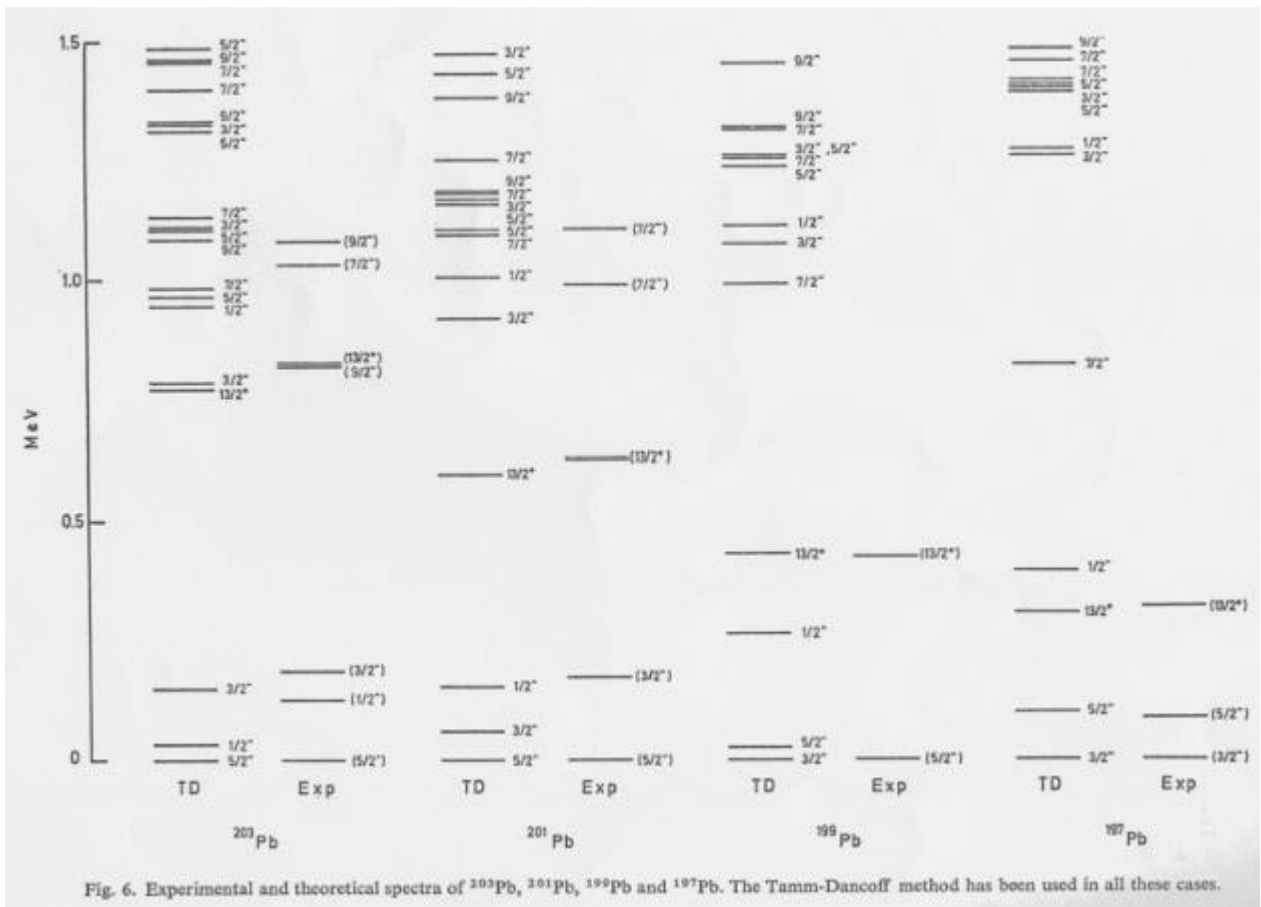


FIGURE 2

4-ANALYSIS OF A LARGE VARIETY OF TWO BODY INTERACTIONS vs GENERALIZED SENIORITY BREAKING

The work of ref(2) was mainly inspired by the theory that J.B.FRENCH et al (5,6) developed in the second part of the sixties that was called the spectral distribution method. In ref (2) measures of generalized seniority breaking were attempted in two particle subspaces throughout the periodic table .All possible kinds of two body matrix elements were considered which required a long survey of the existing literature. Important similarities were found in the magnitude of the conserving part compared to the violating part. Probably ORIOL got there the conclusion that all the details of two body forces were not always relevant.

(5) J.B.FRENCH Phys.Lett.26B(1967)75

(6) C.M.VINCENT Phys.Rev.163 (1967)104

Two books more recent are devoted to the description of the method

(7) S.S.M.WONG ,Nuclear Statistical Spectroscopy .Oxford University Press 1986.

(8) V.K.B KOTA and Rizwan ul HAQ ,Spectral Distribution in Nuclei and Statistical Spectroscopy .World Scientific 2010

5-ORIOL'S FIRST WORK ON TBRE

During the year 1970 ORIOL collaborated with J.FLORES in ORSAY and worked with him his first work on TBRE.

This work was a white stone in ORIOL's career.He had in mind to use his experience on shell model matrices and wanted to get rid of details of two body forces...He carried on this study when visiting FLORES in mexico with other coworkers:BRODY,MELLO and YEPES.

(9) O.BOIGAS and J.FLORES Phys.Lett.34B (1971)261

6-EXTENSION OF THE SPECTRAL DISTRIBUTION METHOD TO MANY QUASI PARTICLE SUBSPACES

Reference (3) was the last work where ORIOL worked with quasi particles. The purpose was to extend FRENCH's work to subspaces with any number of quasi particles. It was possible to extend the formulas for centroids and mostly widths of quasiparticle subspaces .It was shown that the propagation was possible and that our previous codes on two and three quasiparticle contained all the necessary ingredients. Examples of centroids and width are shown in Fig.3 and 4 for 15 even isotopes of Sn.

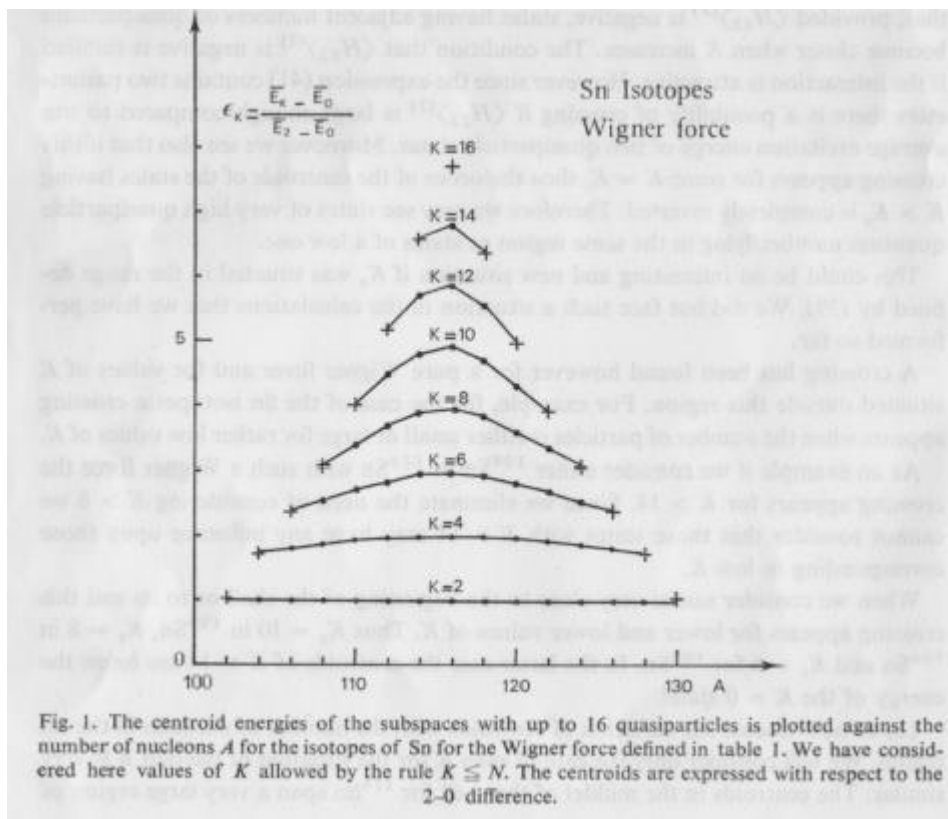


Fig. 1. The centroid energies of the subspaces with up to 16 quasiparticles is plotted against the number of nucleons A for the isotopes of Sn for the Wigner force defined in table 1. We have considered here values of K allowed by the rule $K \leq N$. The centroids are expressed with respect to the 2-0 difference.

FIGURE 3

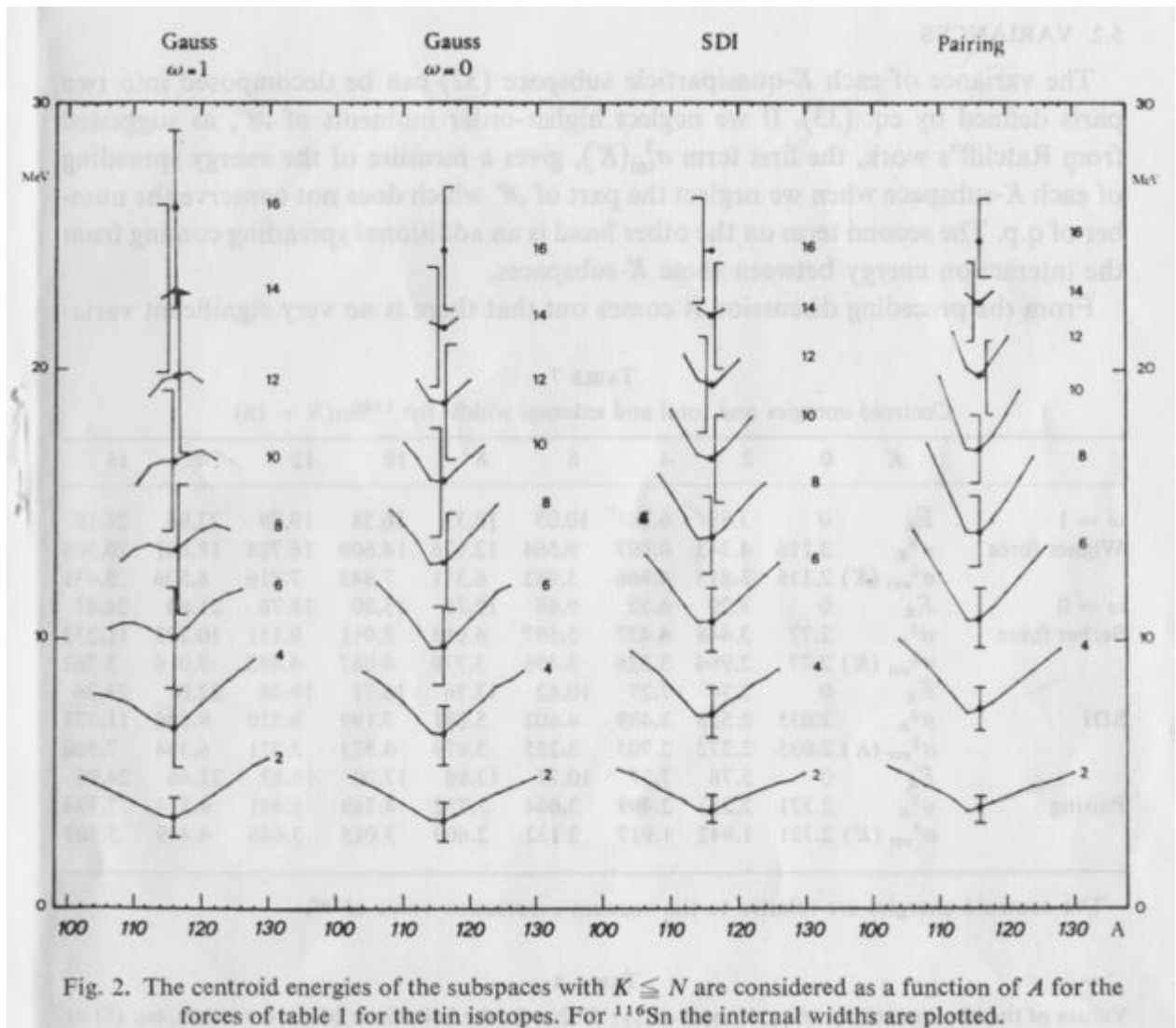


FIGURE 4

7- ORIOL's THESIS

Figure (5) is a copy of the front page of ORIOL's project for his thesis. This project interfered destructively with his stay in MADRID in 1972 and 1973. It was based on ref (9) and contained in addition 5 other articles that he had worked when staying at the University of MEXICO. It is well known that ORIOL did not pass his thesis. After coming back to ORSAY ORIOL devoted himself fully to the theory of random matrices and quantum chaos as well as to sum rules. He produced more than 90 articles on these subjects, many of them are now classical ones.

ORSAY
Série A, n°
N° d'ordre:
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# THÈSES

PRESENTEES,

AU CENTRE D'ORSAY  
UNIVERSITÉ PARIS-SUD

POUR OBTENIR

LE GRADE DE DOCTEUR ES-SCIENCES PHYSIQUES

PAR

BOHIGAS Oriol  
\_\_\_\_\_

1<sup>re</sup> THESE. — Ensembles de matrices aléatoires et propriétés statistiques de noyaux atomiques

2<sup>e</sup> THESE. — Propositions données par la Faculté.

Soutenues le \_\_\_\_\_ devant la Commission d'examen

MM. B. JANCOVICI    Président.

R. ARVIEU  
R. BALIAN  
M. L. MEHTA    } Examineurs.  
A. MICHAUDON

FIGURE 5