Nuclear Structure to Leading Order

REVIEWS OF MODERN PHYSICS, VOLUME 90, JULY–SEPTEMBER 2018

Microscopic clustering in light nuclei

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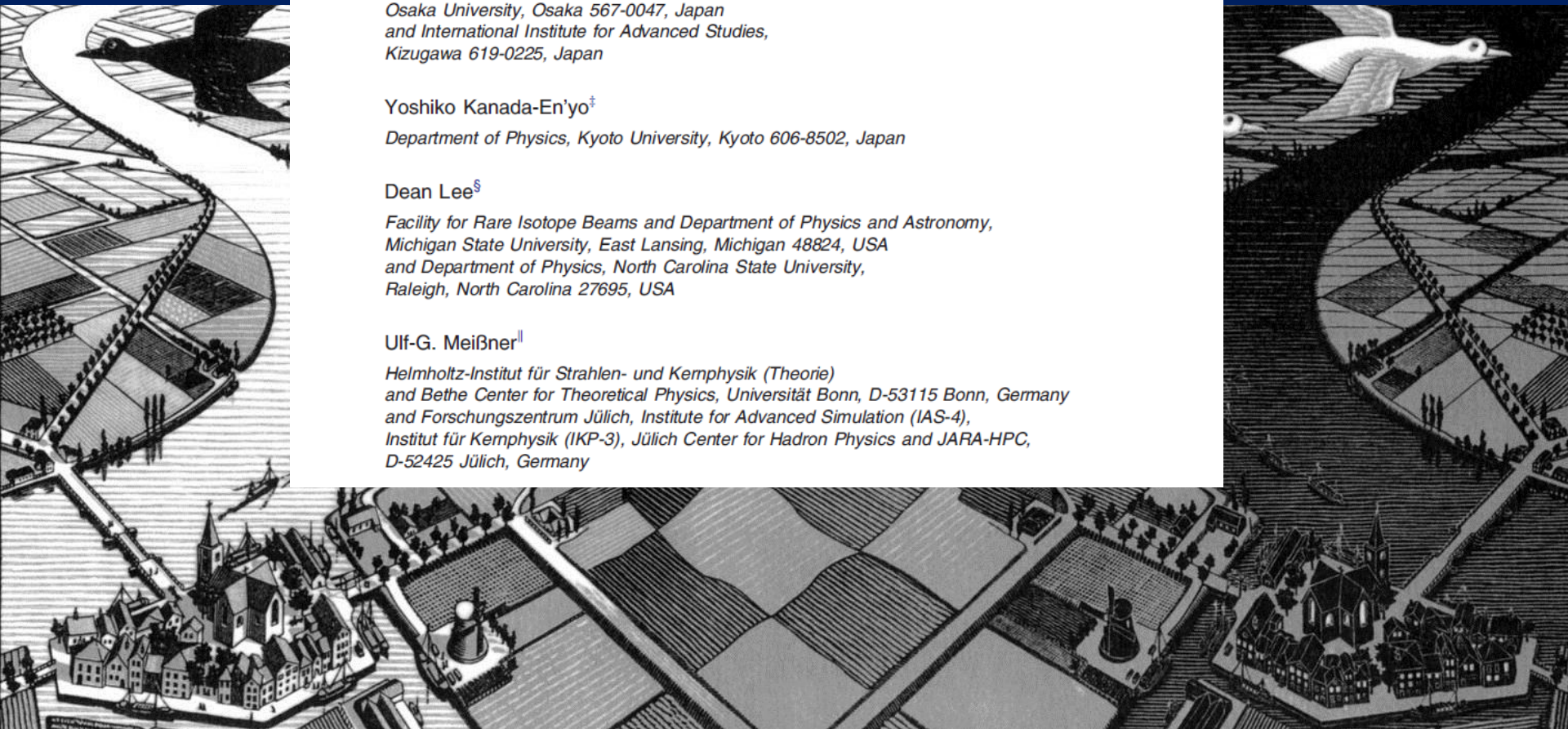
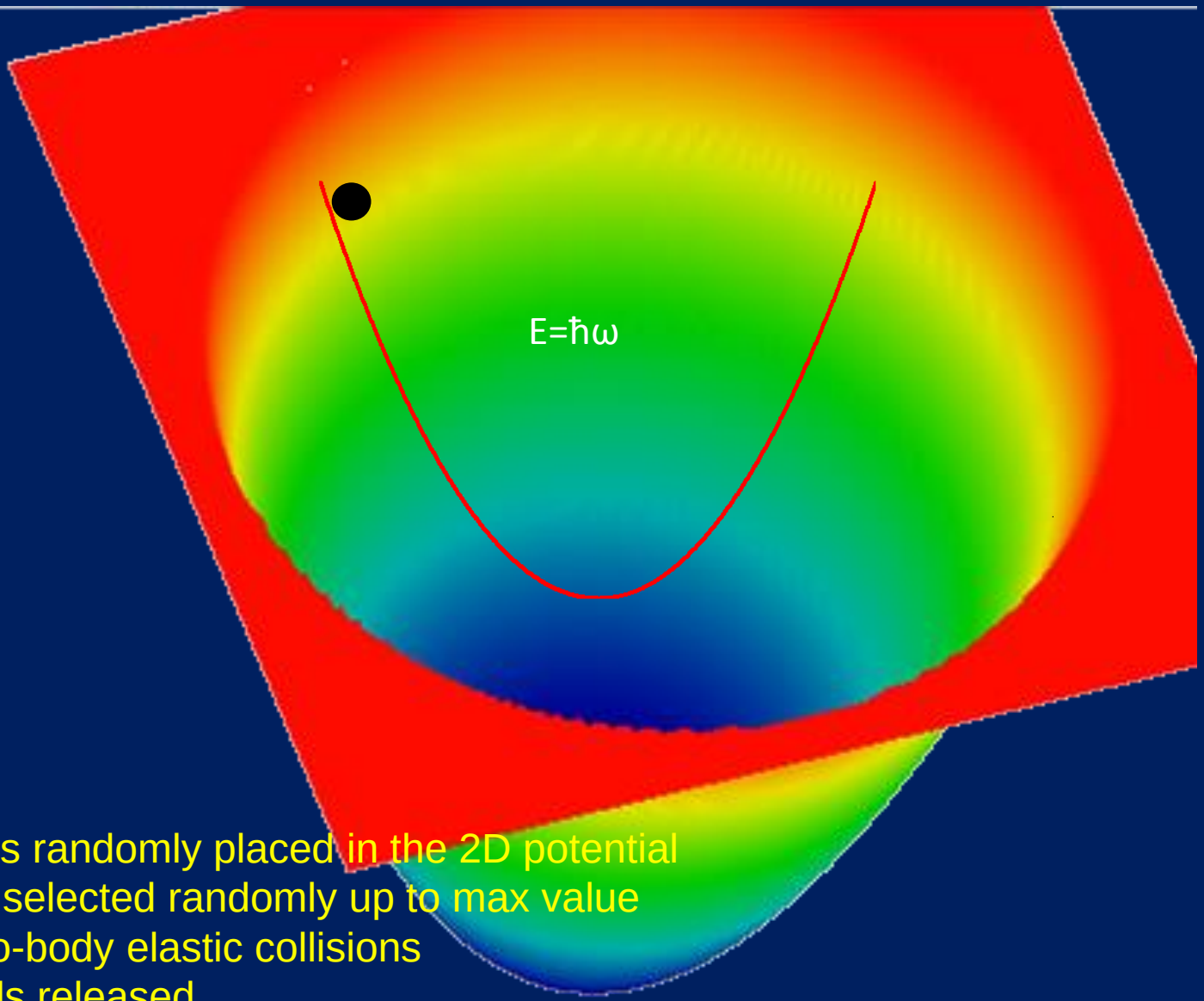
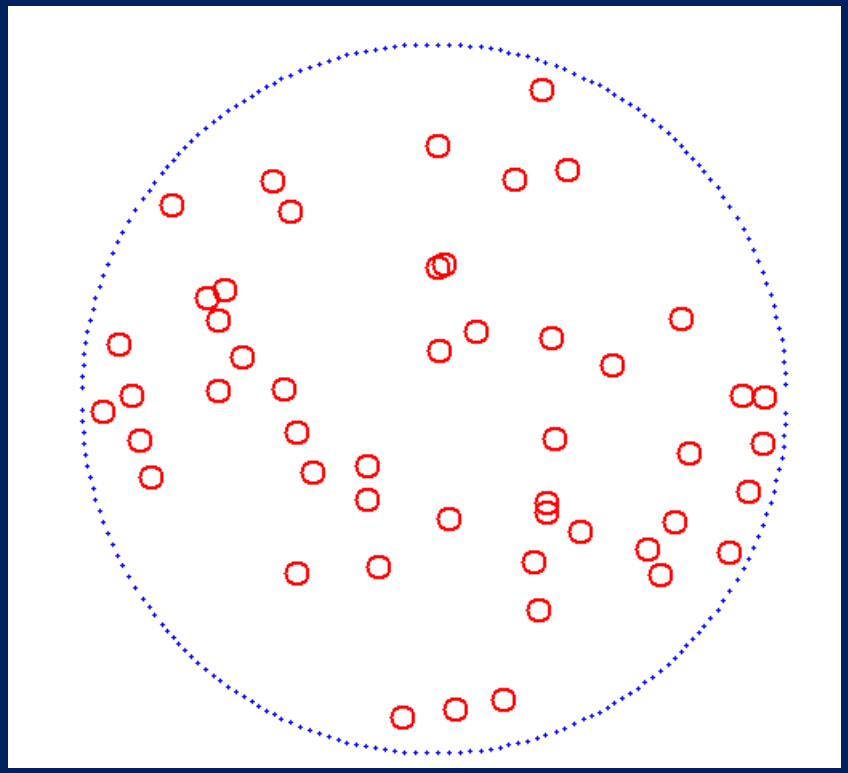


What happens when particles are put in a parabolic potential?

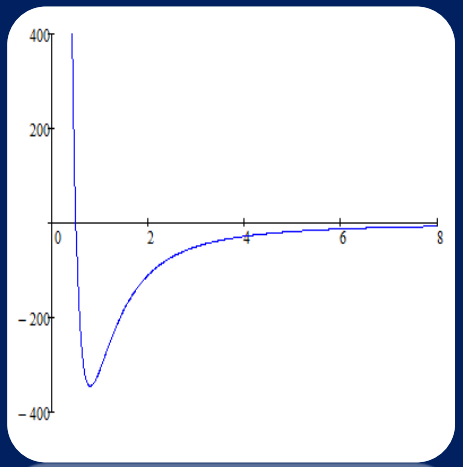


Rules:

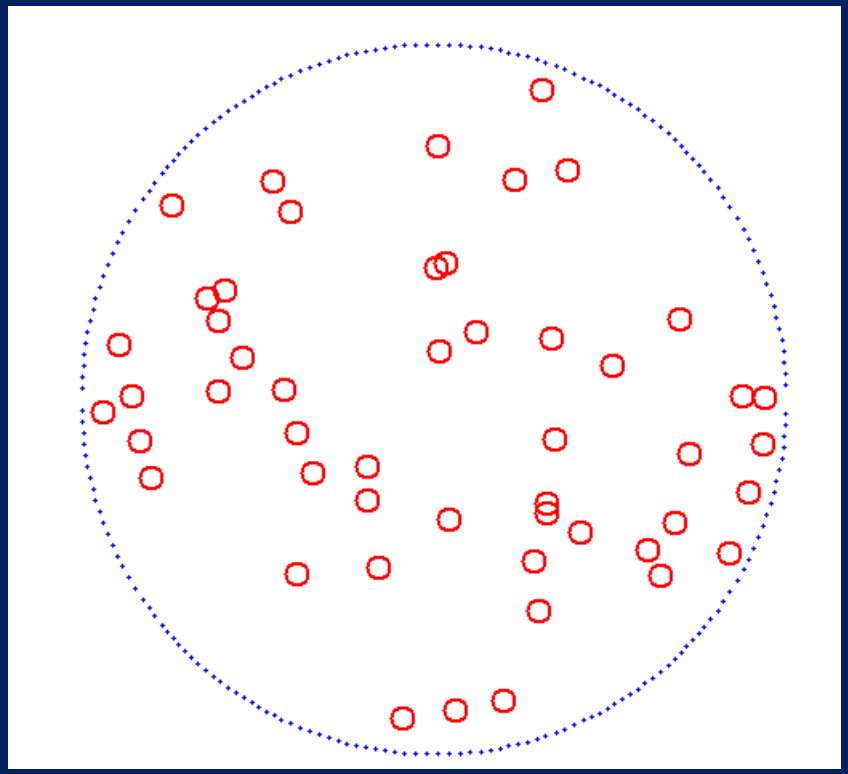
1. balls randomly placed in the 2D potential
2. KE selected randomly up to max value
3. Two-body elastic collisions
4. Balls released



No Interaction

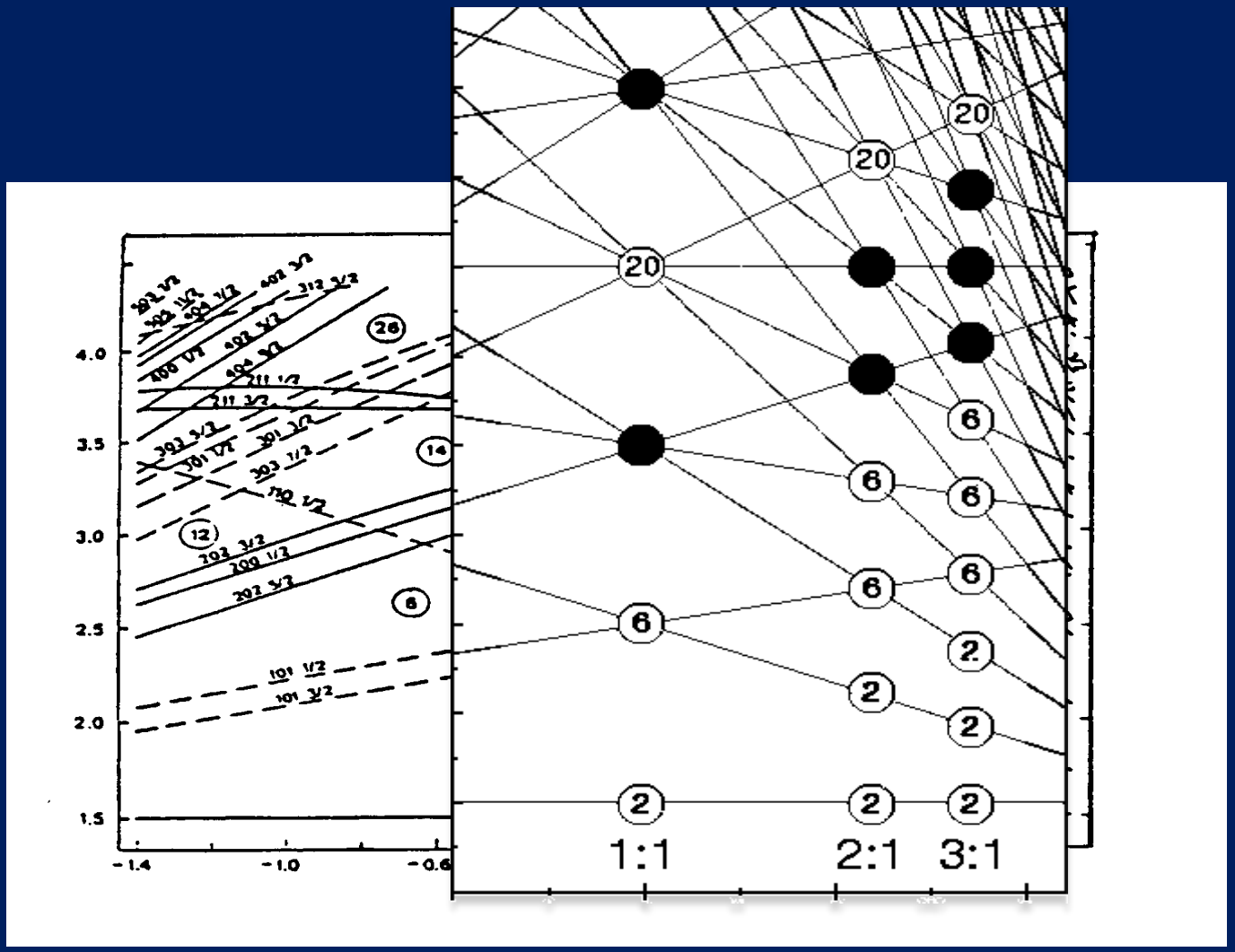


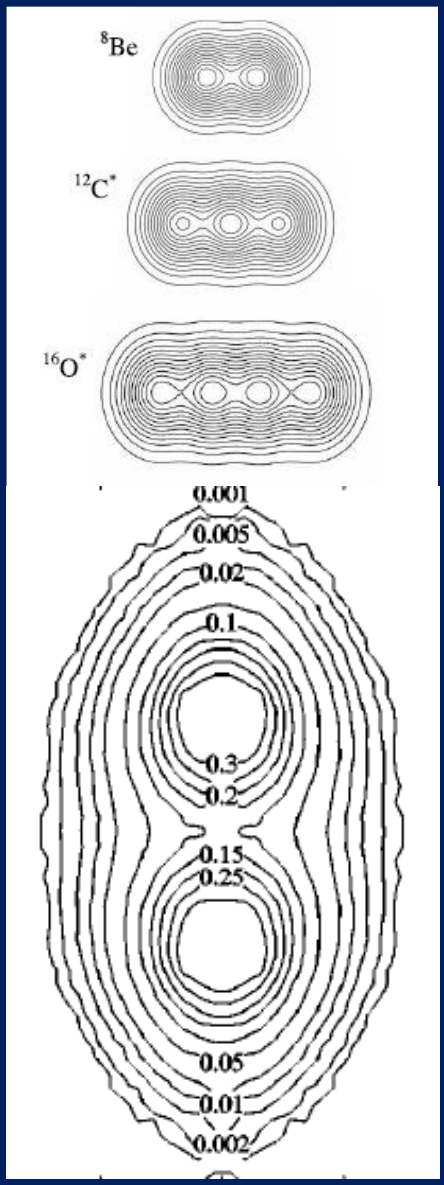
Finite Interaction



Clusters from the mean-field: ^{24}Mg

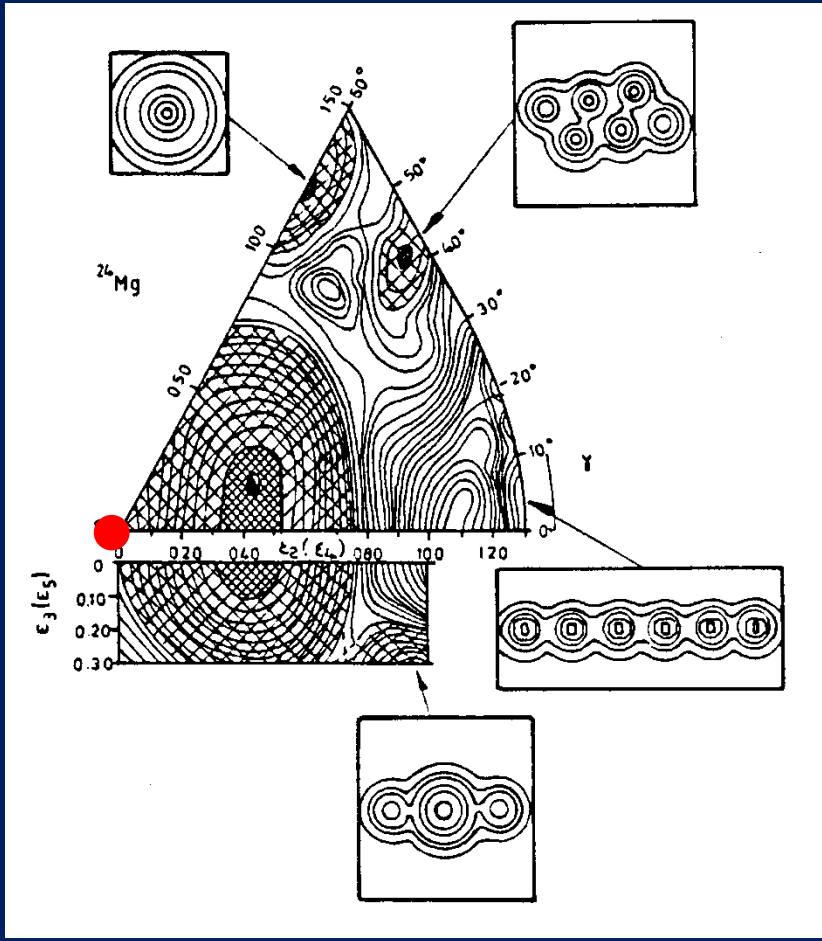
Nilsson-Strutinsky to Harmonic Oscillator

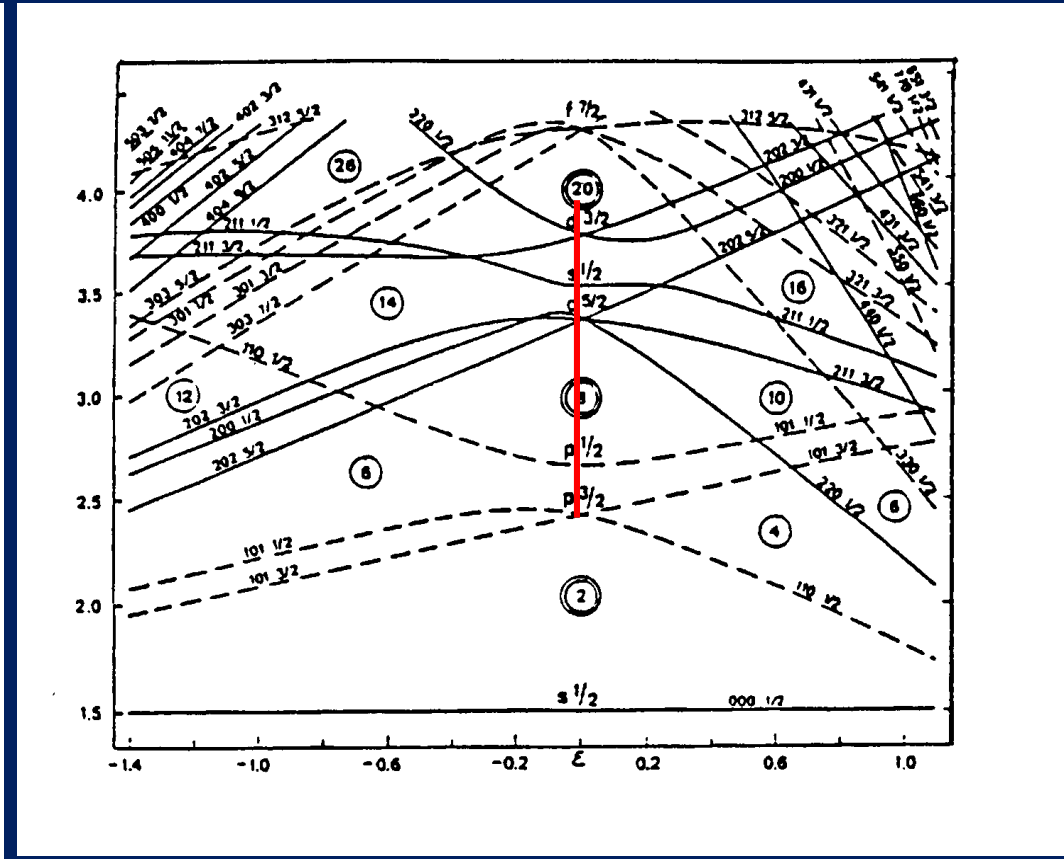




Clusters from the mean-field: ^{24}Mg

Nilsson-Strutinsky, Alpha Cluster Model

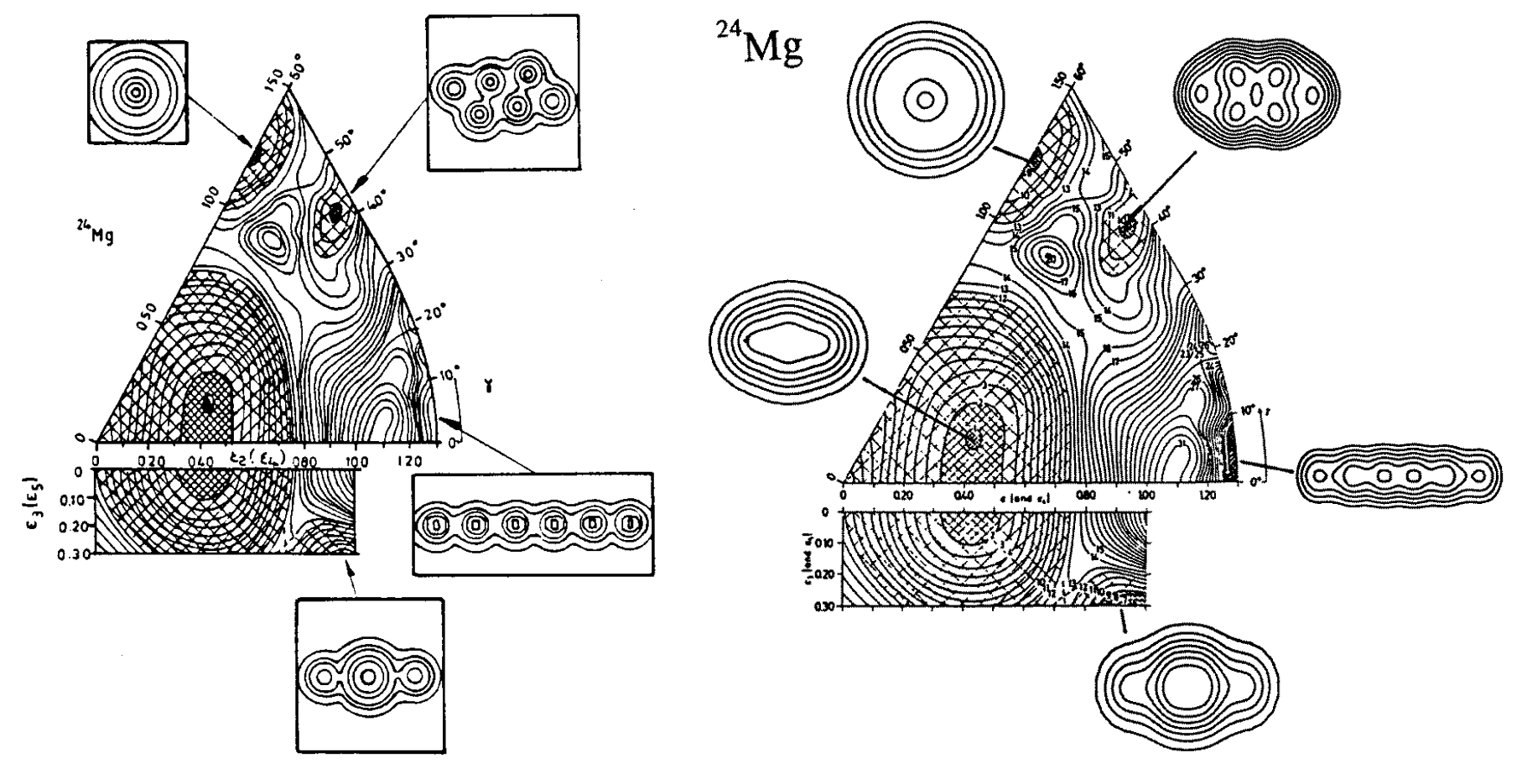




Fulton and Rae – J. Phys.G

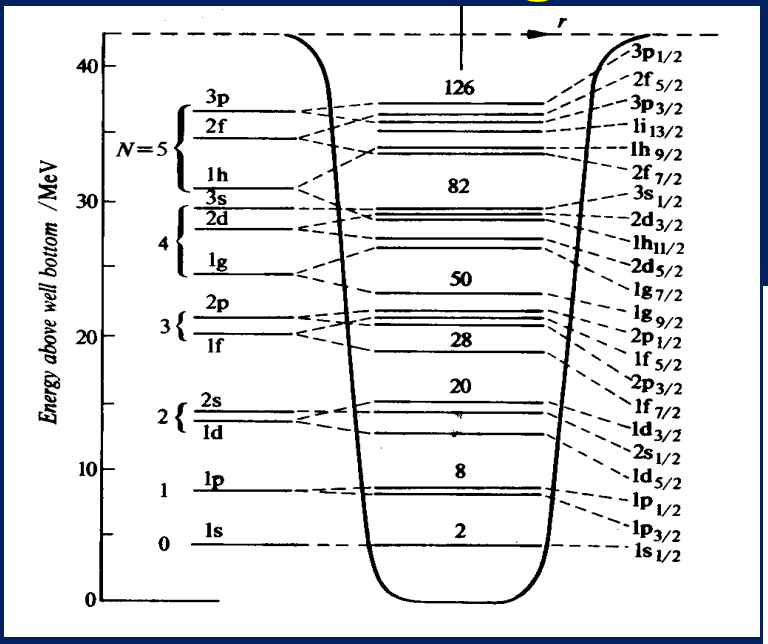
Clusters from the mean-field: Symmetries

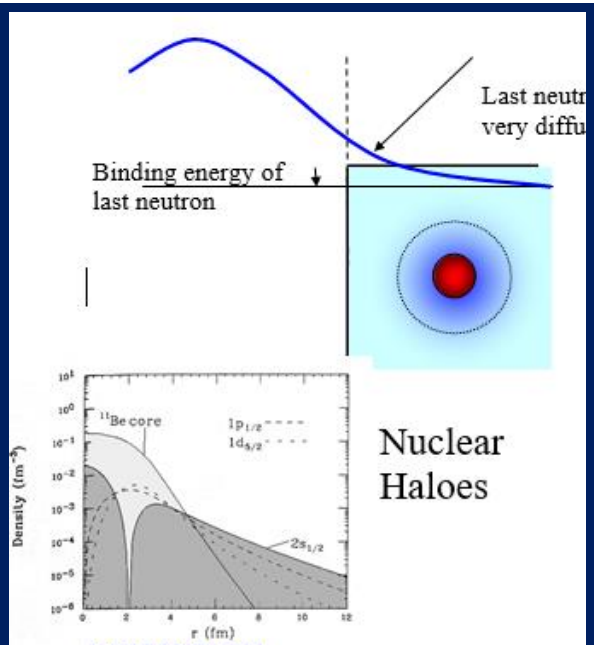
Nilsson-Strutinsky, Alpha Cluster Model, Harmonic Oscillator

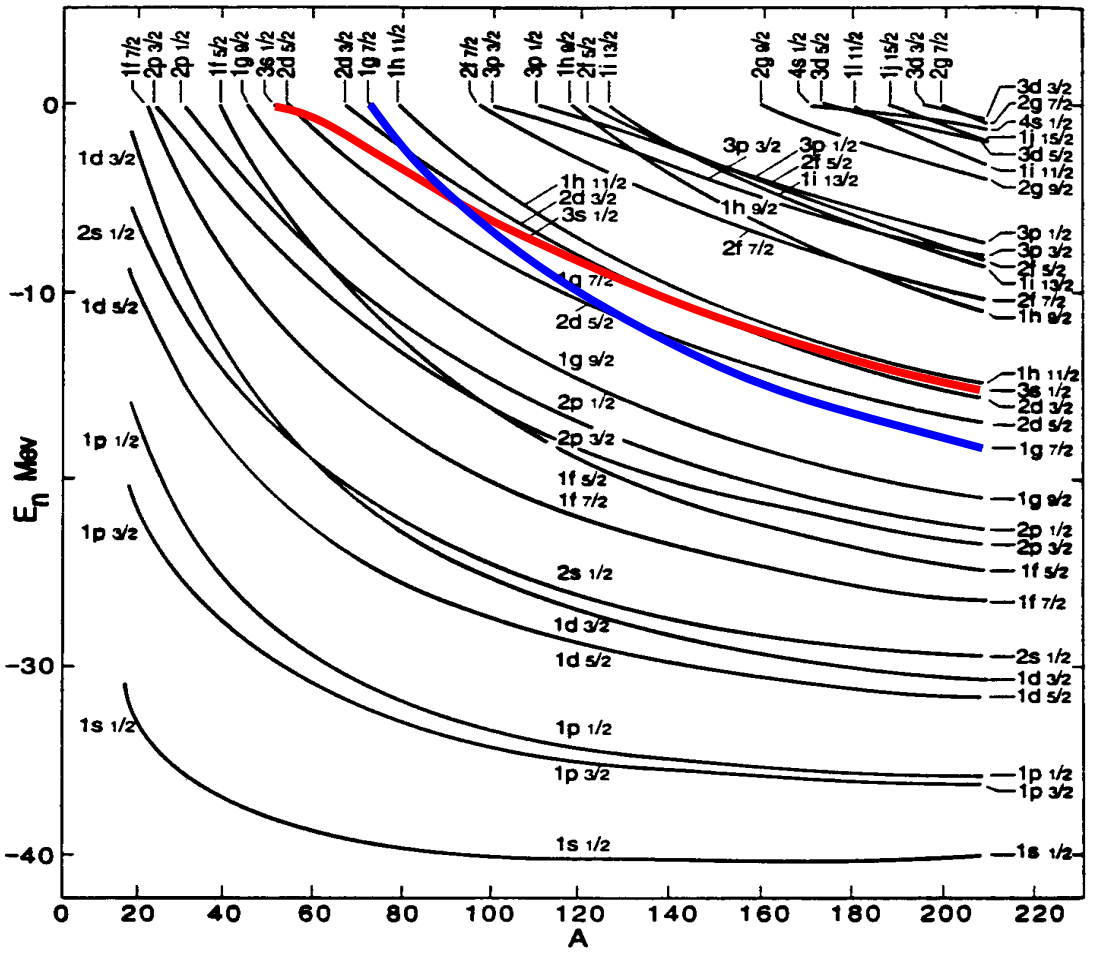


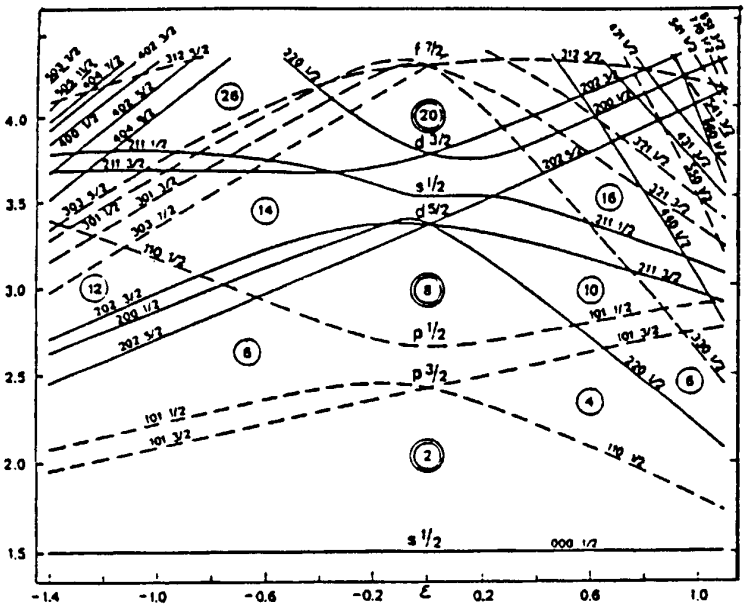
Fulton, Rae, Leander, Larsson, Freer, Merchant

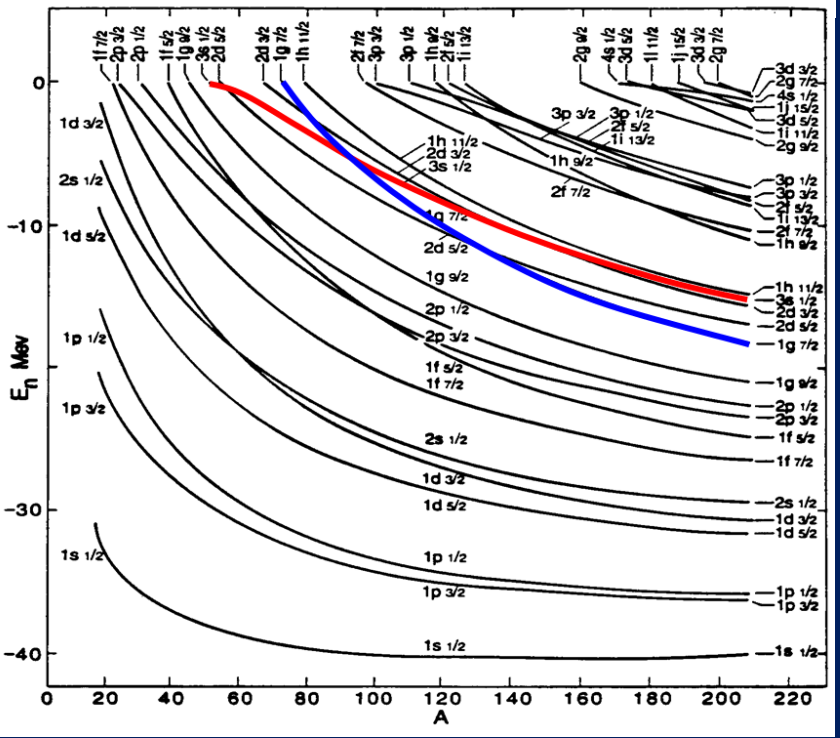
Weak Binding

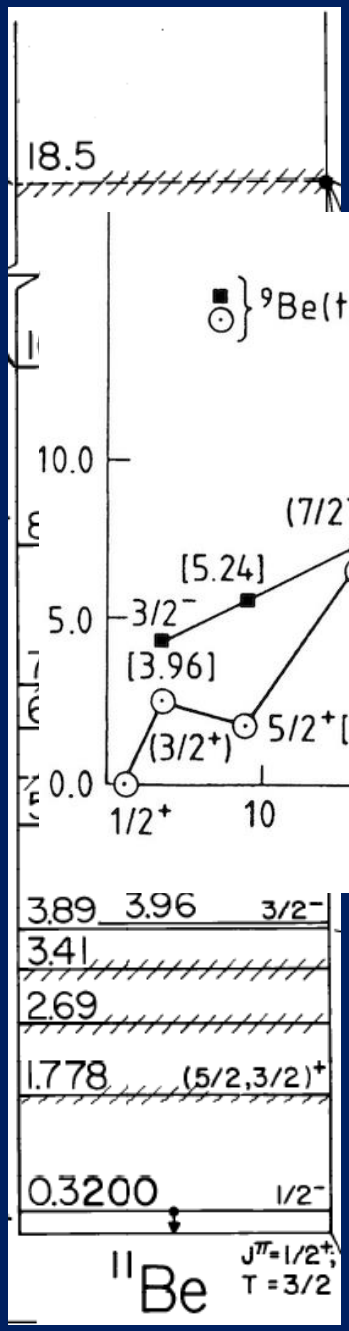







f 7/2
d 3/2
s 1/2
d 5/2
p 1/2
p 3/2
s 1/2
ε

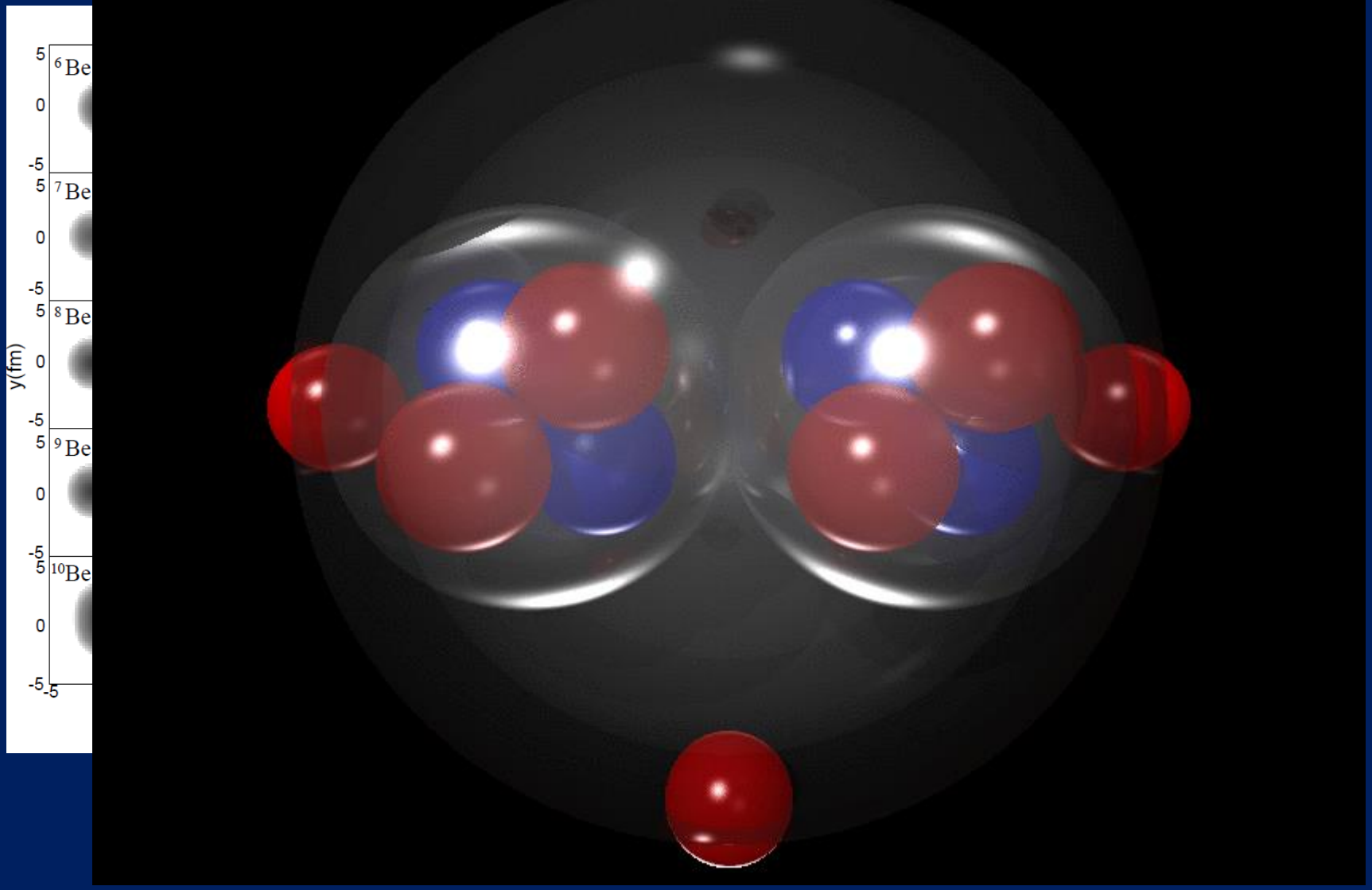

E_n Mev
A

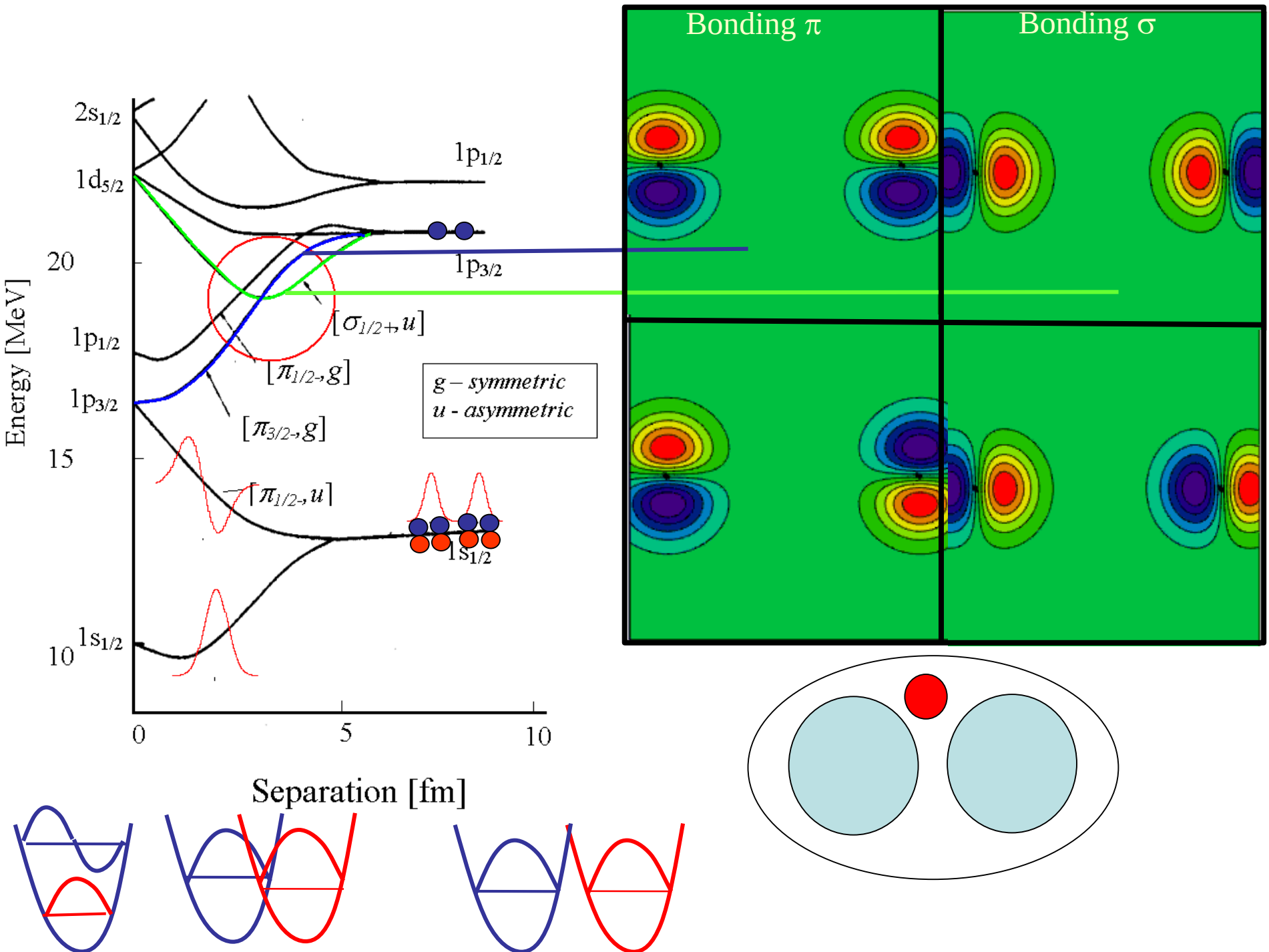

18.5
3.89
3.96
3/2⁻
3.41
2.69
1.778
(5/2,3/2)⁺
0.3200
1/2⁻
¹¹Be
J^π=1/2⁺;
T = 3/2

⁹Be(t,p)¹¹Be
¹¹Be
[8.84]
(7/2⁻)
[5.24]
7/2⁺
3/2⁻
[3.96]
(9/2⁺)(K=1/2 GS-Band),
[3.89]
a≅2.0
(3/2⁺)
5/2⁺[1.78]
1/2⁺
J(J+1)

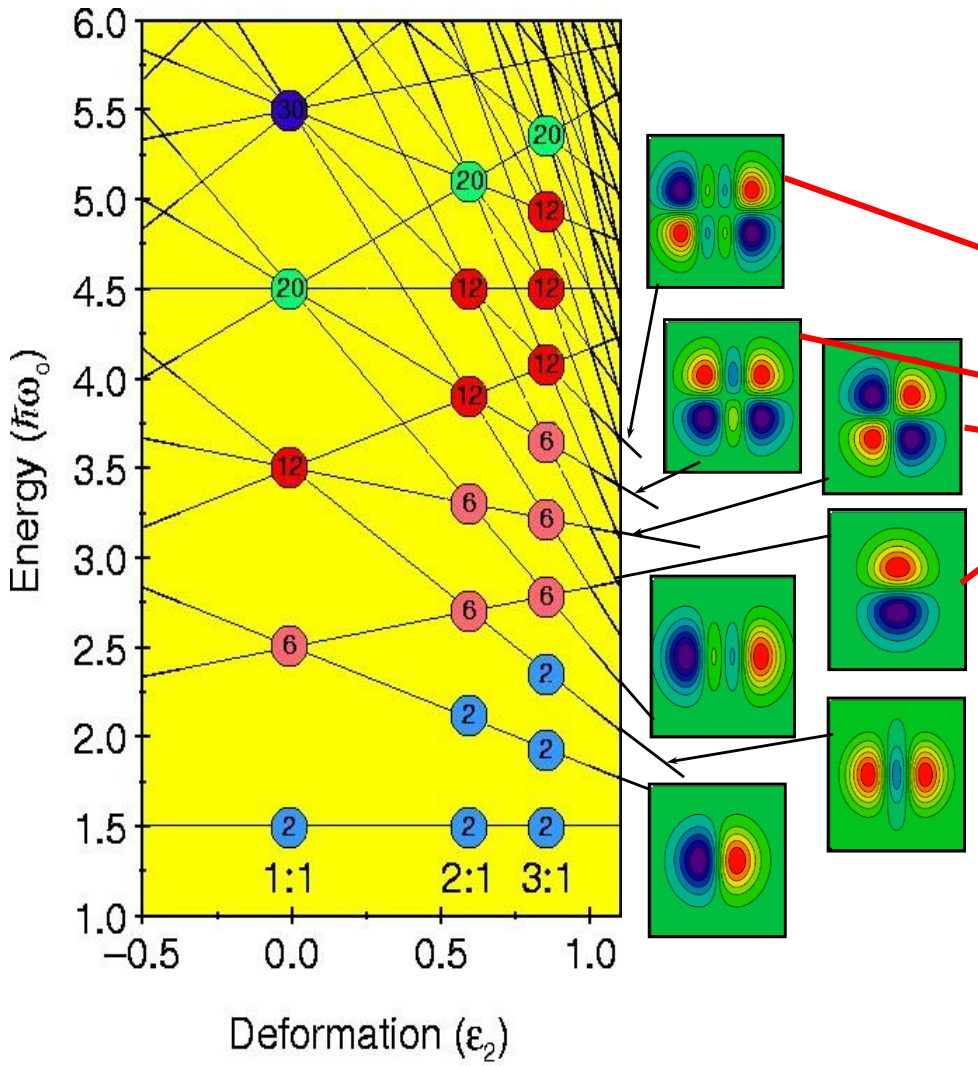
How to understand ^{11}Be:

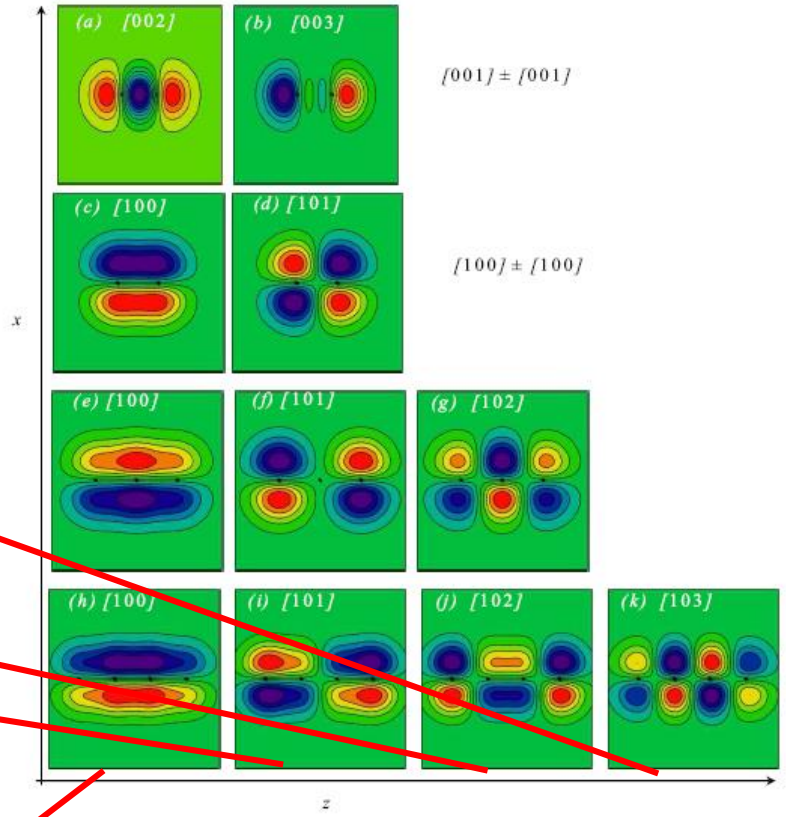
Ant



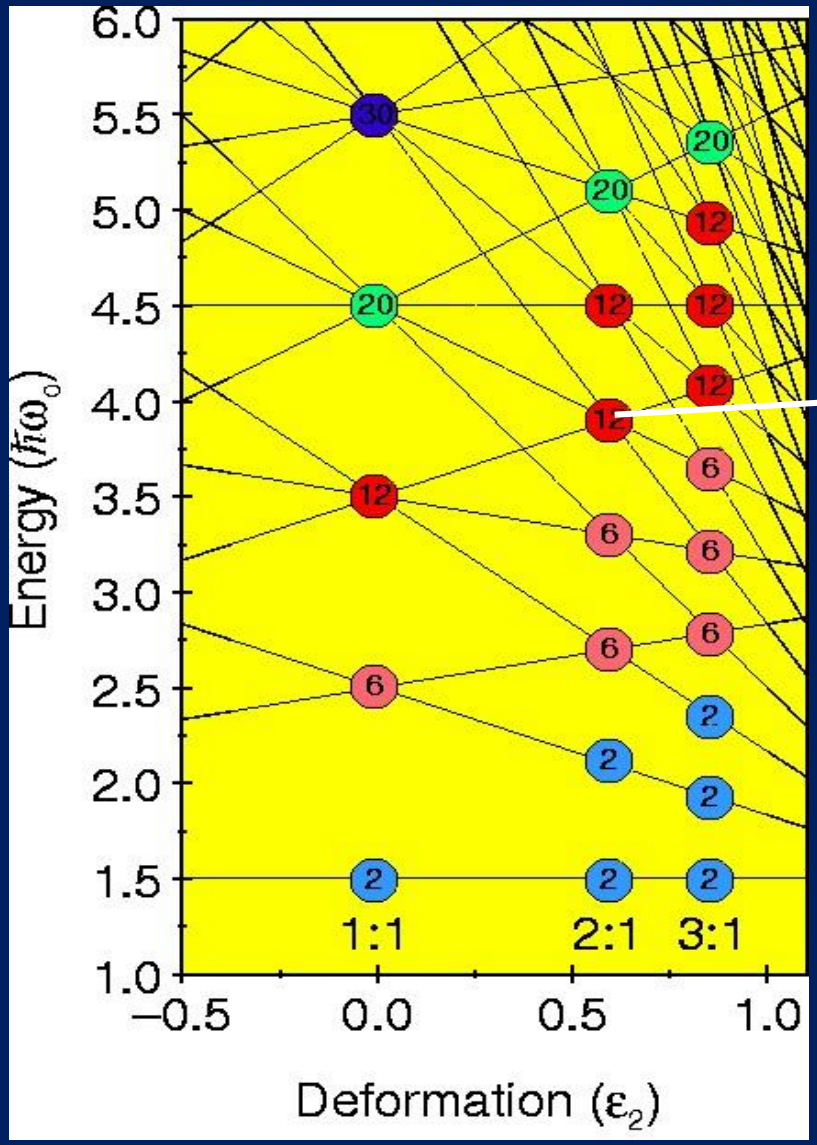

Bonding π
Bonding σ
2s1/2
1d5/2
1p1/2
1p3/2
1p1/2
1p3/2
1s1/2
1s1/2
[σ1/2+,u]
[π1/2-,g]
[π3/2-,g]
[π1/2-,u]
g – symmetric
u - asymmetric
Energy [MeV]
20
15
10
0
5
10
Separation [fm]

Connection to the deformed harmonic oscillator

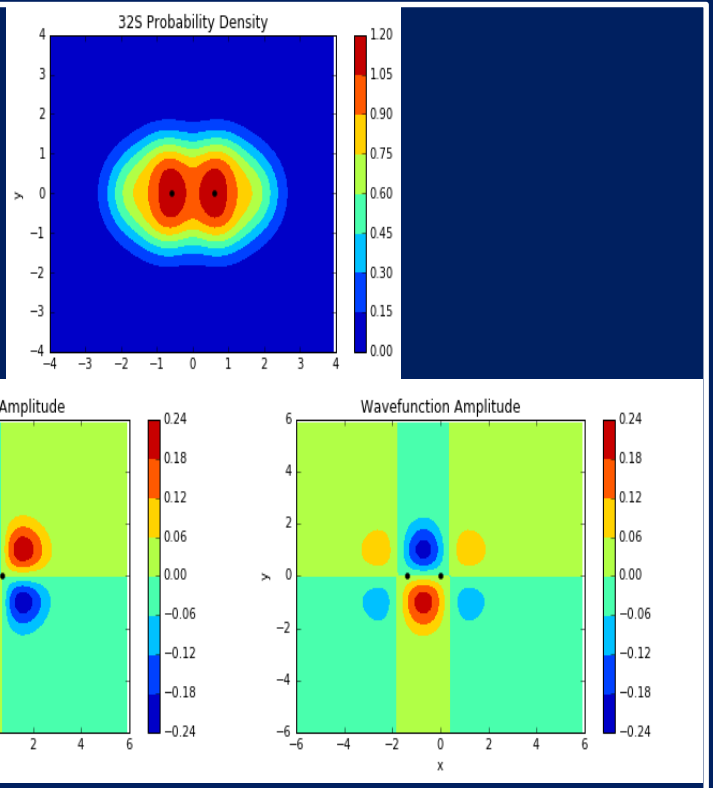




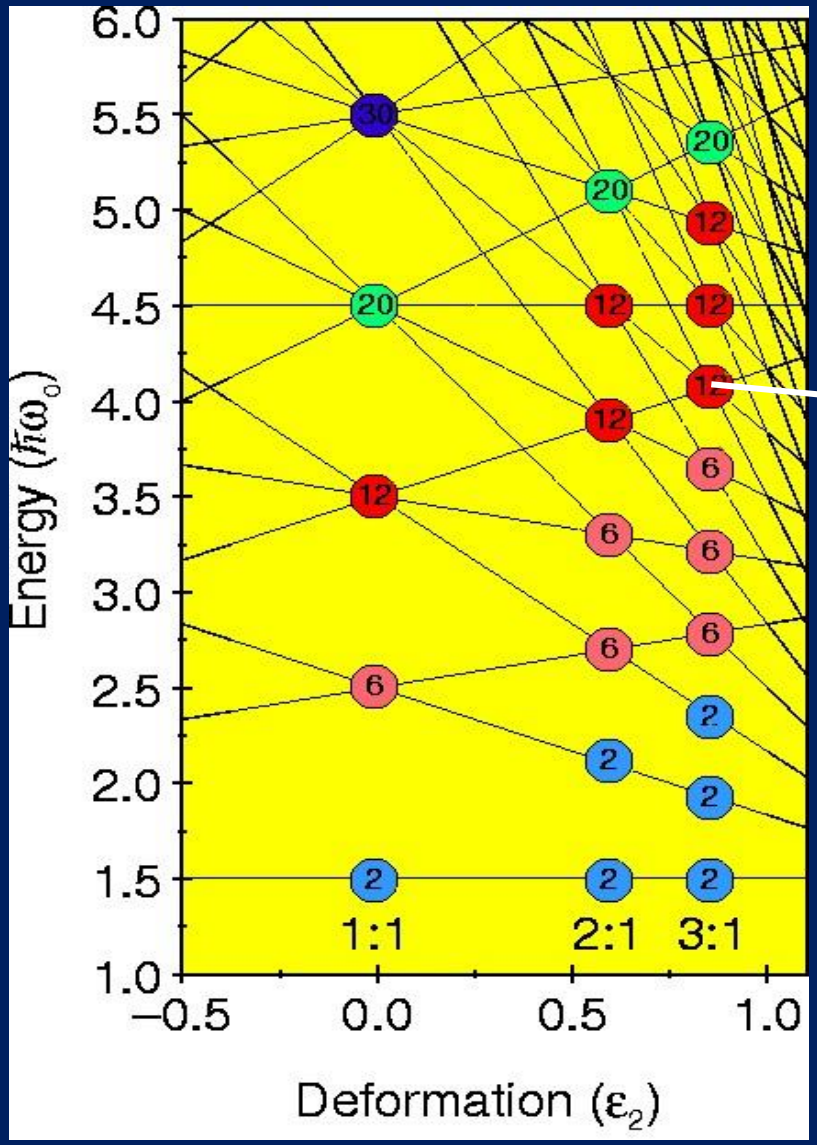
Solutions of N-centres using the Huckel approach



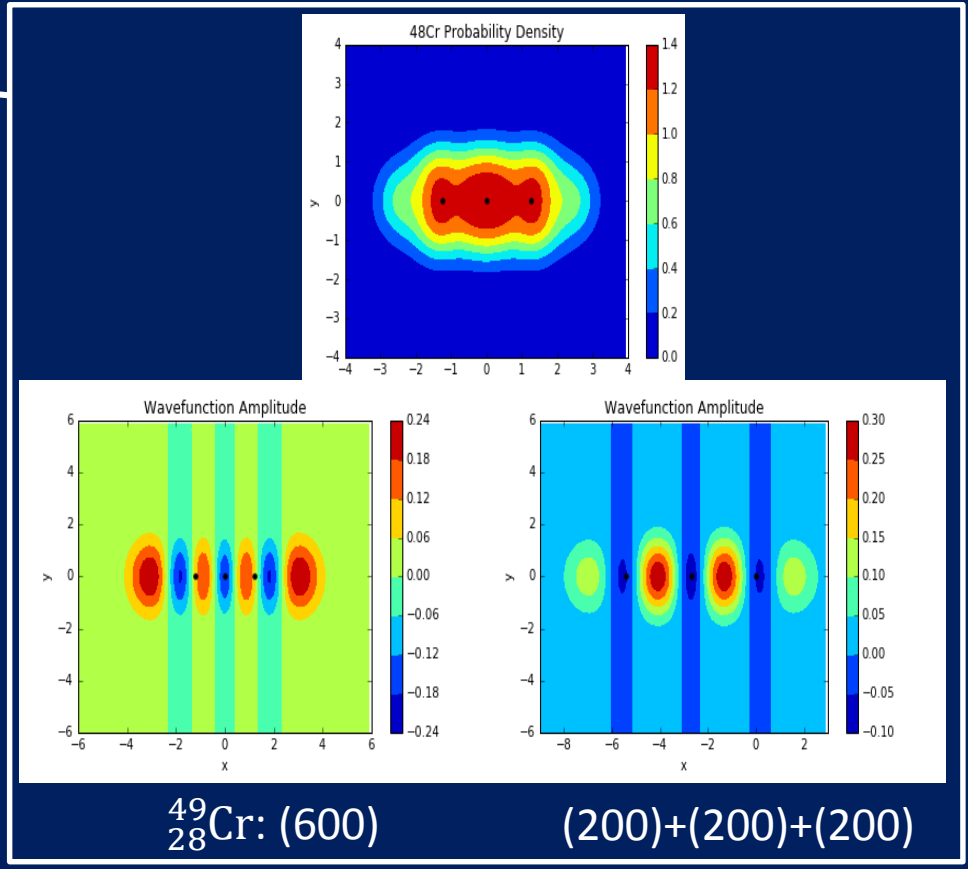
$^{16}O+n+^{16}O$



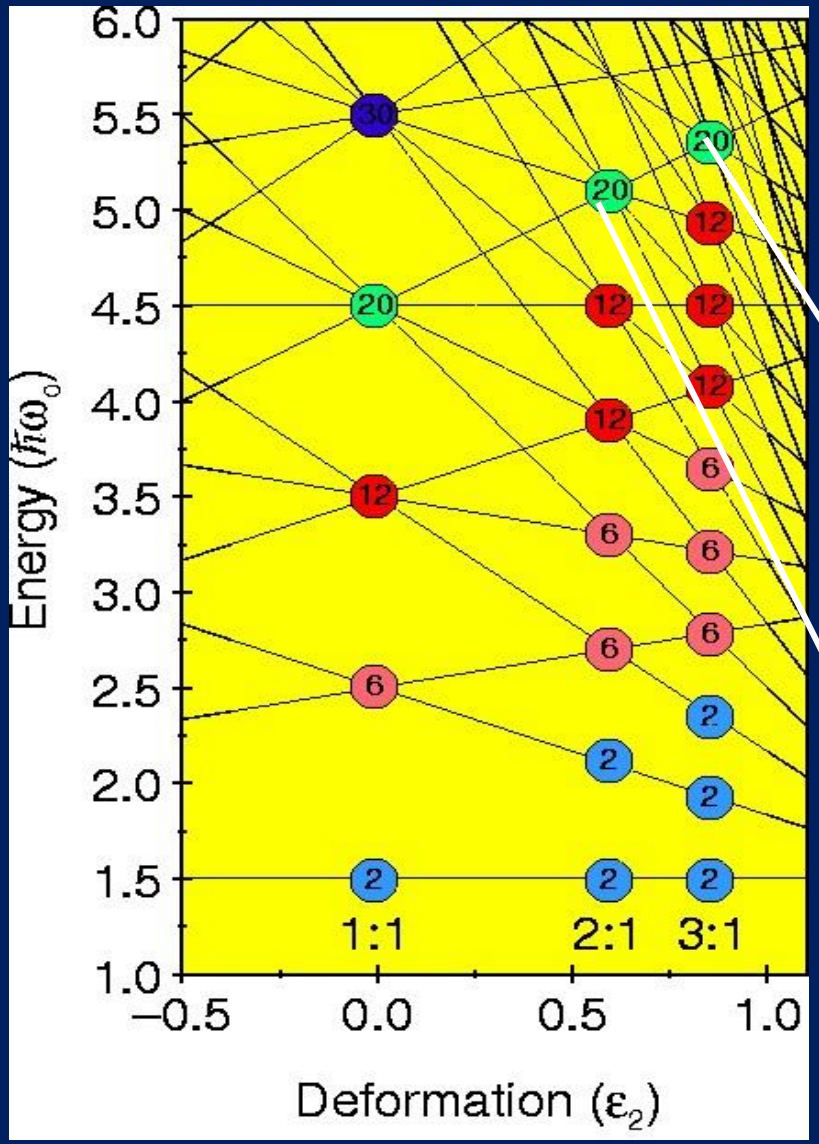
$^{33}_{16}S$: (210) (110)+(110)



$^{16}O+n+^{16}O+^{16}O$

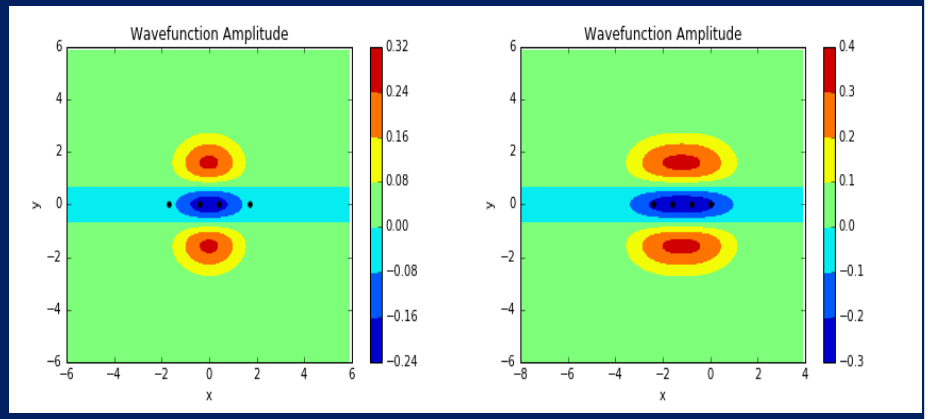


$^{49}_{28}Cr$: (600) (200)+(200)+(200)



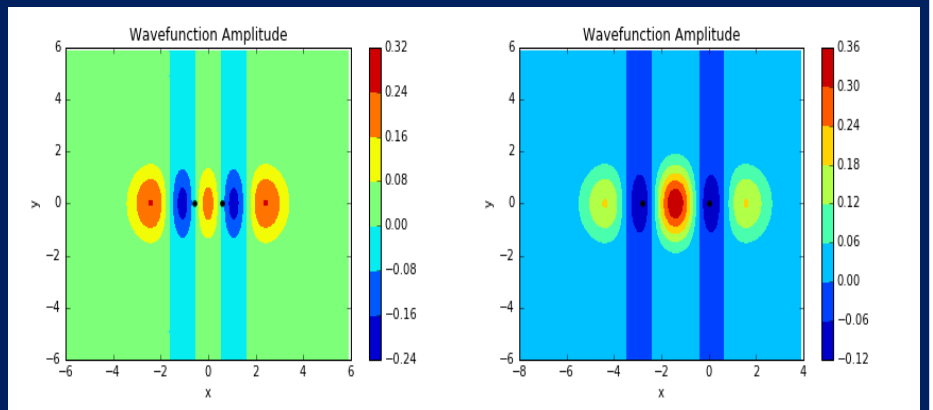
Canavan and Freer; to be published

^{40}Ca+n+^{40}Ca+^{40}Ca



$^{65}_{32}$Ge: (020) (020)+(020)+(020)

^{40}Ca+n+^{40}Ca

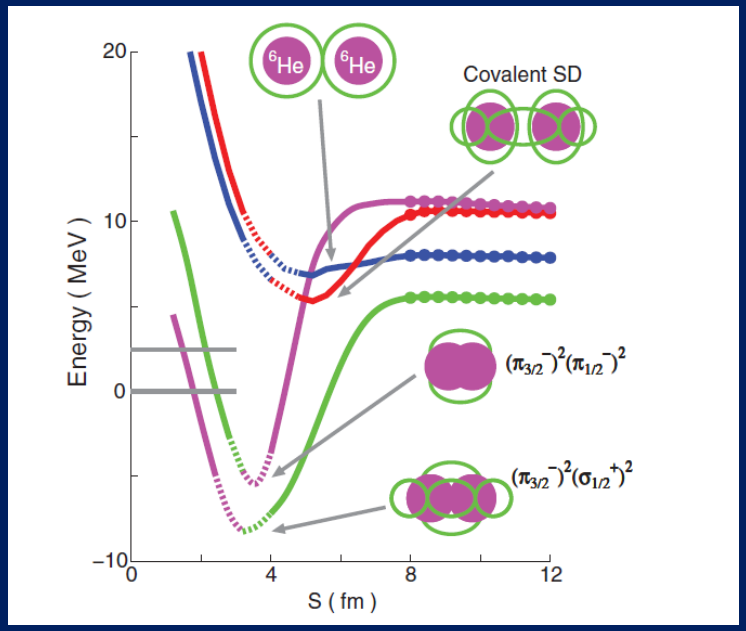


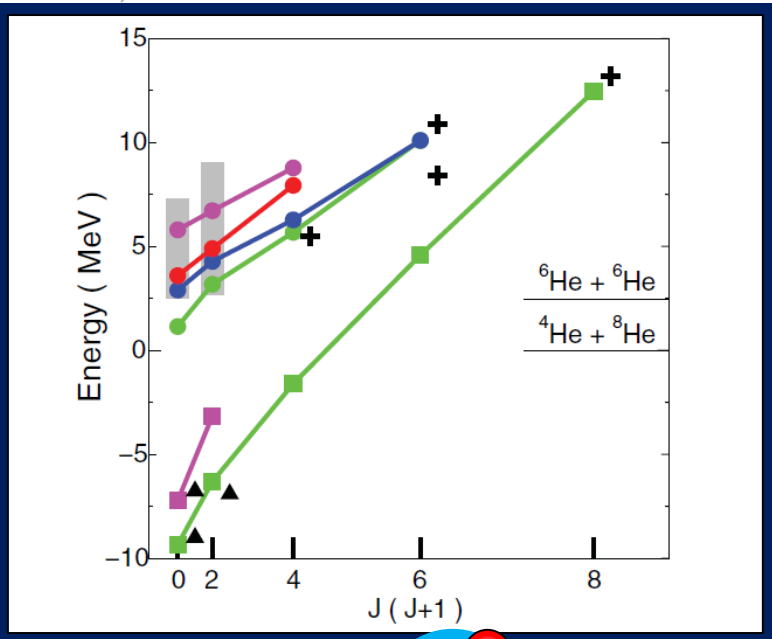
$^{81}_{40}$Zr: (401) (201)+(201)

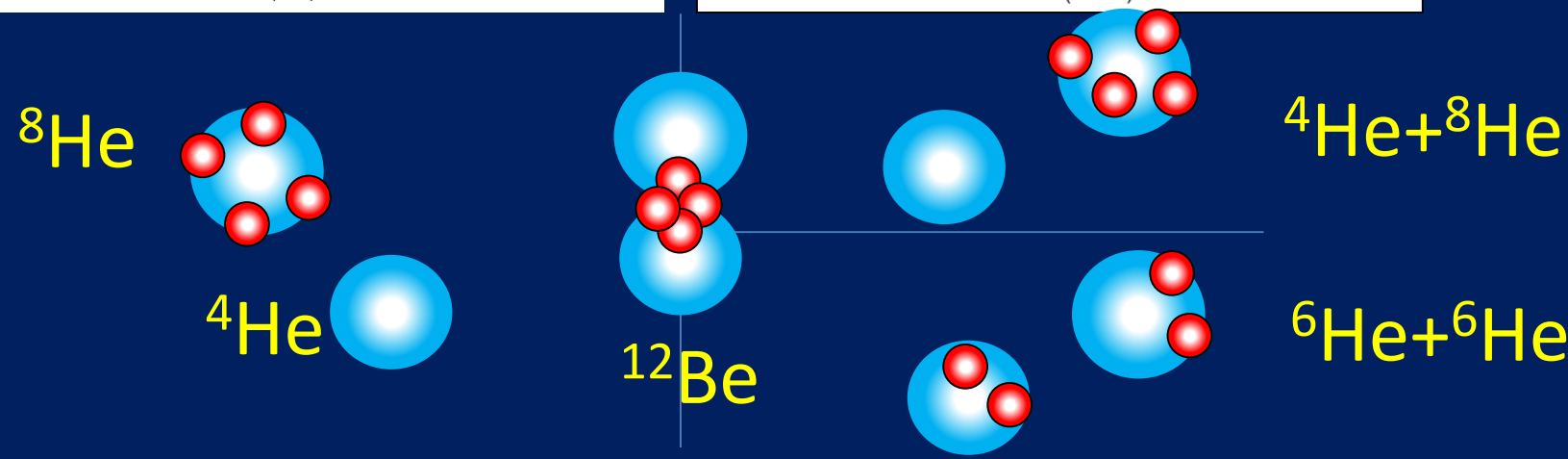
PRL 100, 182502 (2008) PHYSICAL REVIEW LETTERS week ending 9 MAY 2008

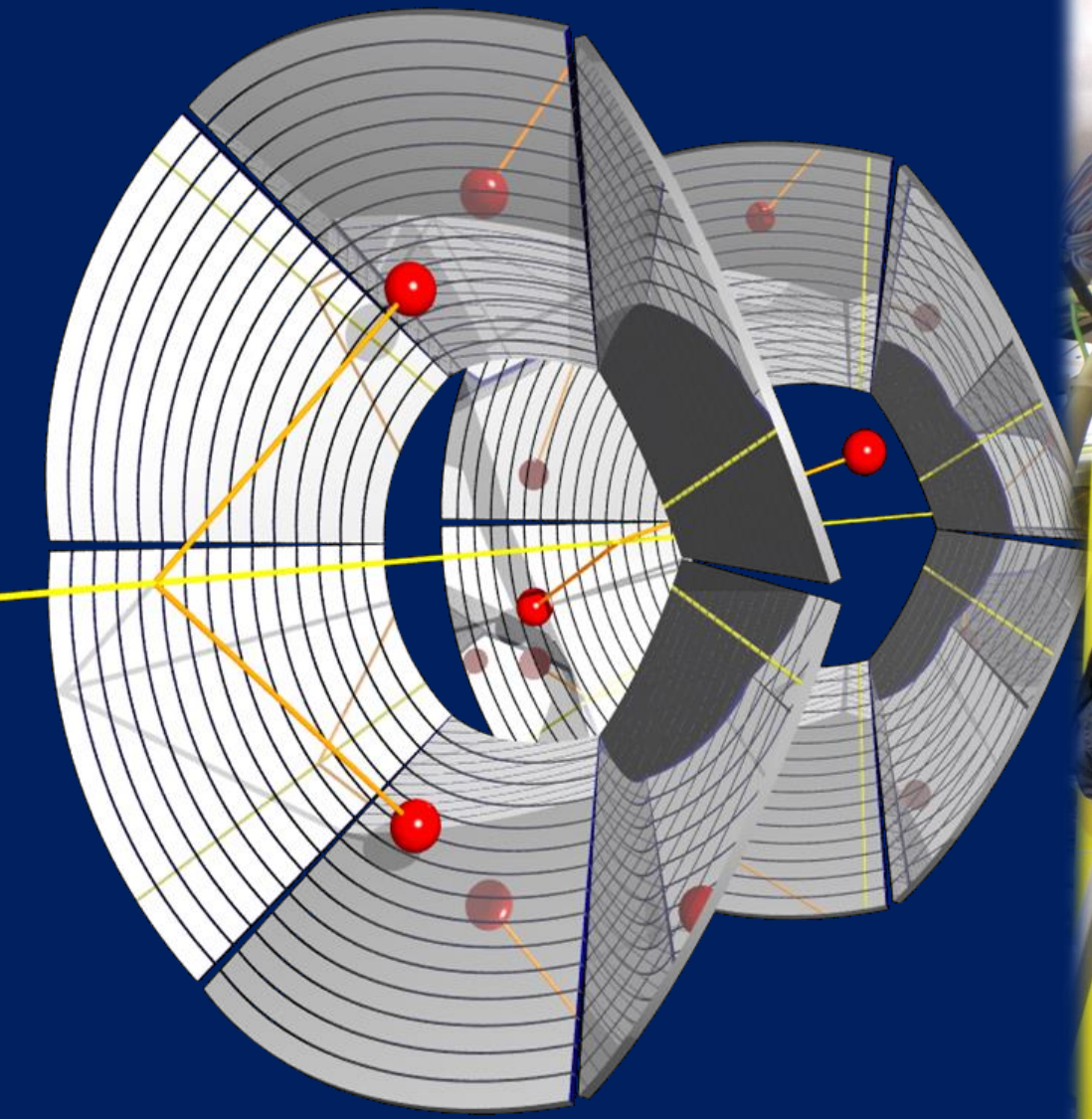
Coexistence of Covalent Superdeformation and Molecular Resonances in an Unbound Region of ^{12}Be

M. Ito,[1] N. Itagaki,[2] H. Sakurai,[1] and K. Ikeda[1]

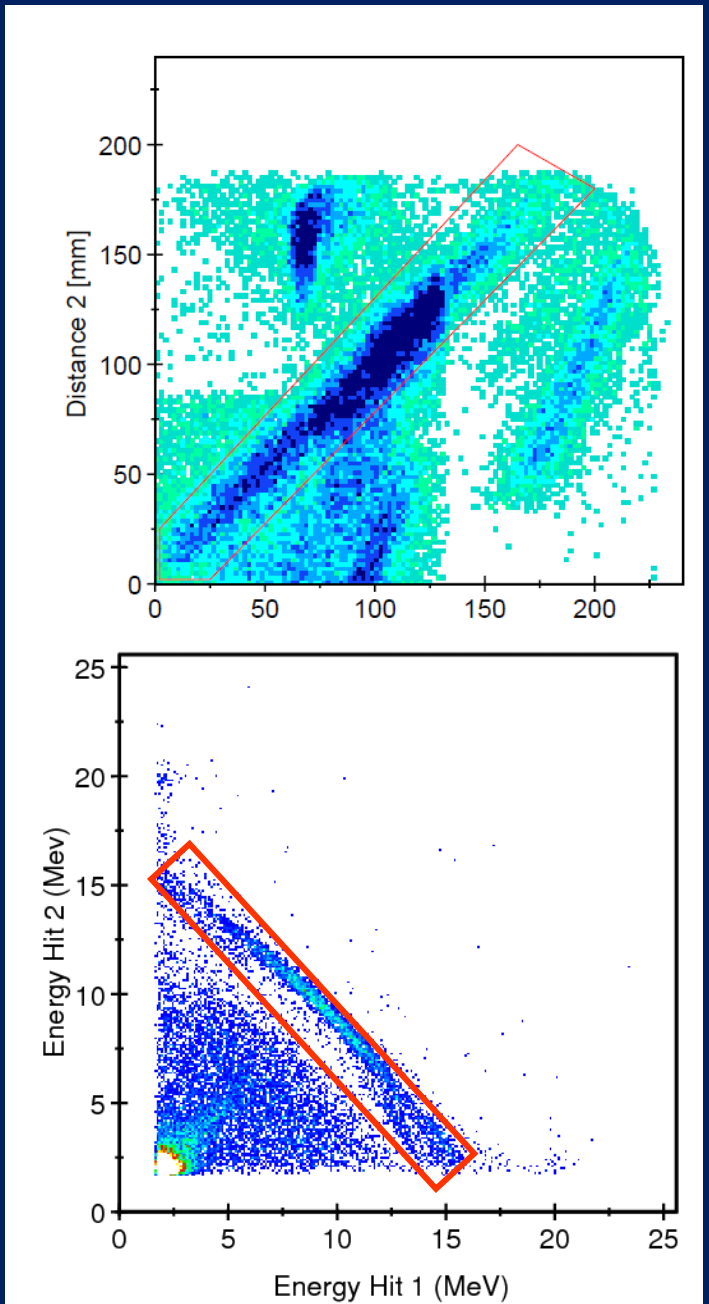


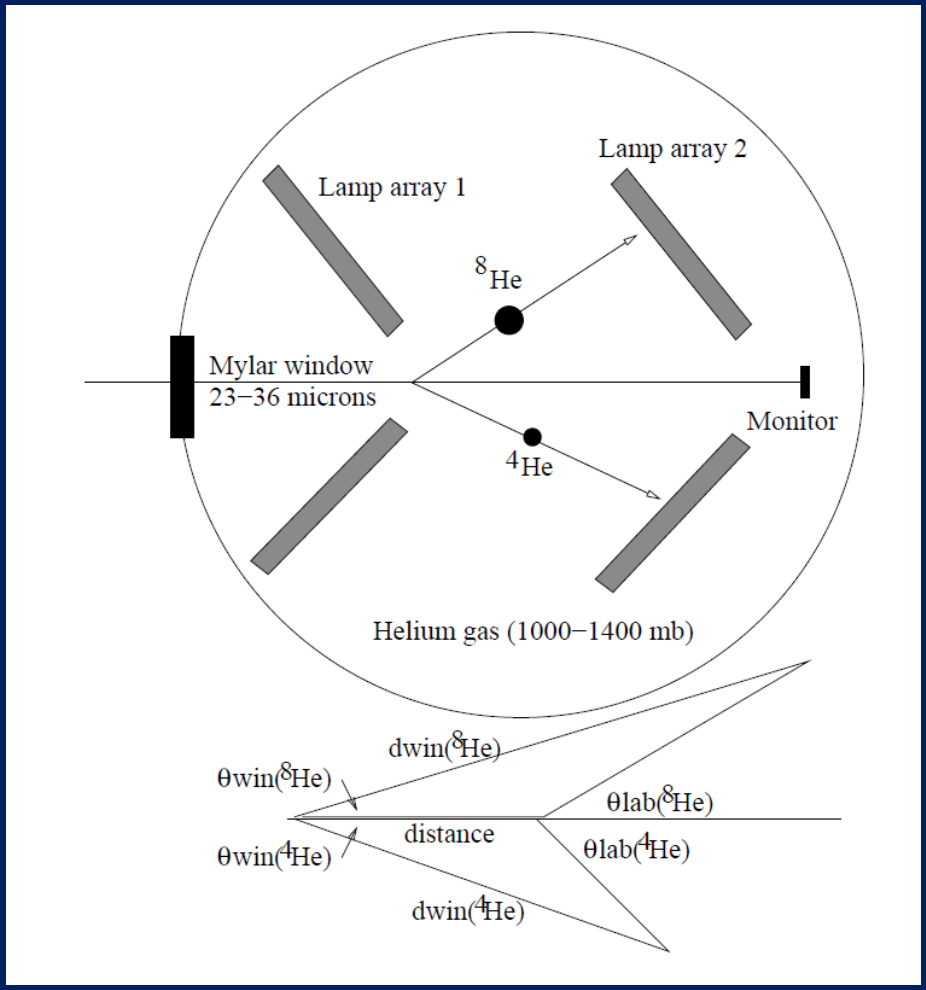


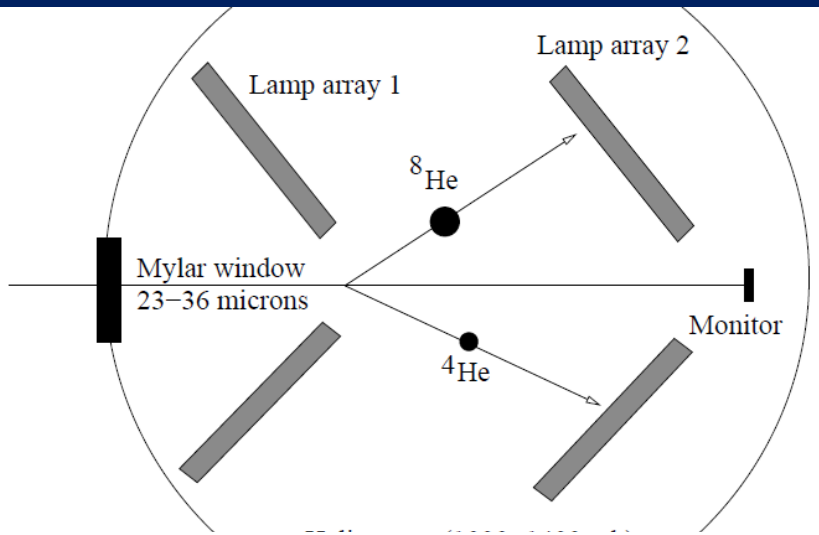




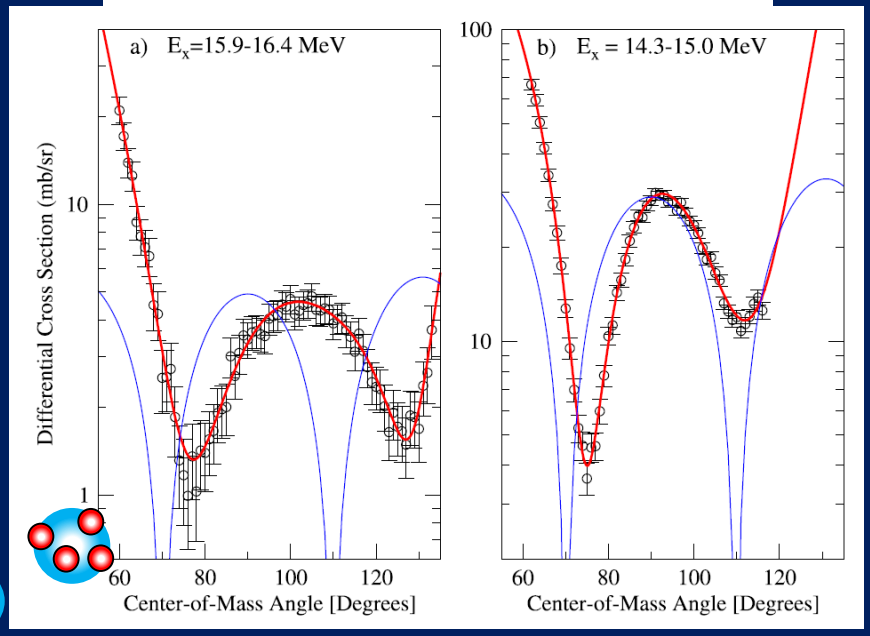
$^{8}He+^{4}He$ resonant scattering

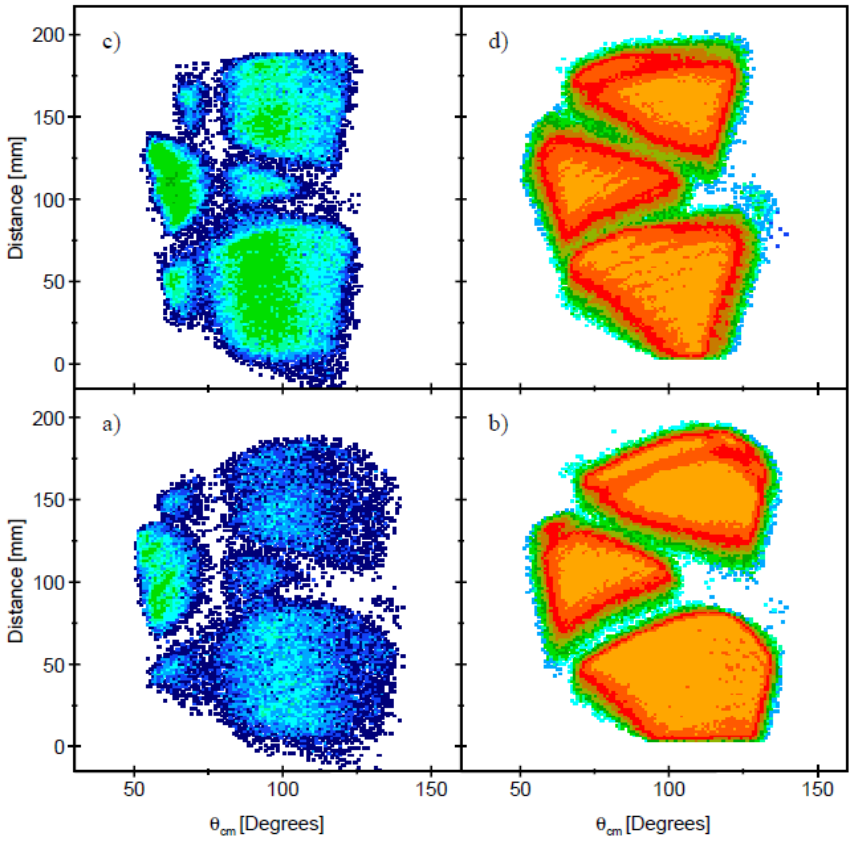


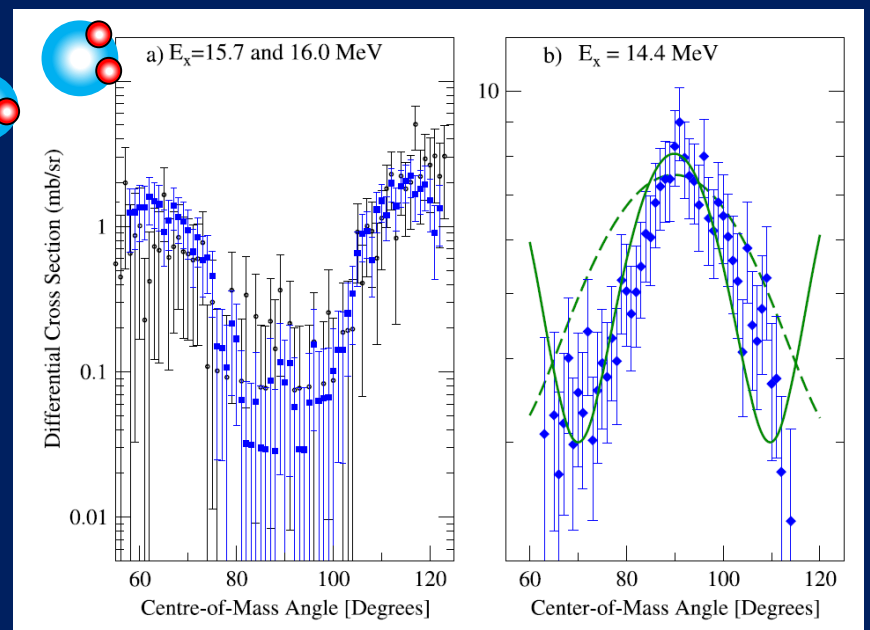




$$W(\theta) = \left| \sum_{L=0}^{L=4} a_L e^{i\varphi_L} P_L(\cos\theta) \right|^2$$







PRL **100,** 182502 (2008) PHYSICAL REVIEW LETTERS week ending 9 MAY 2008

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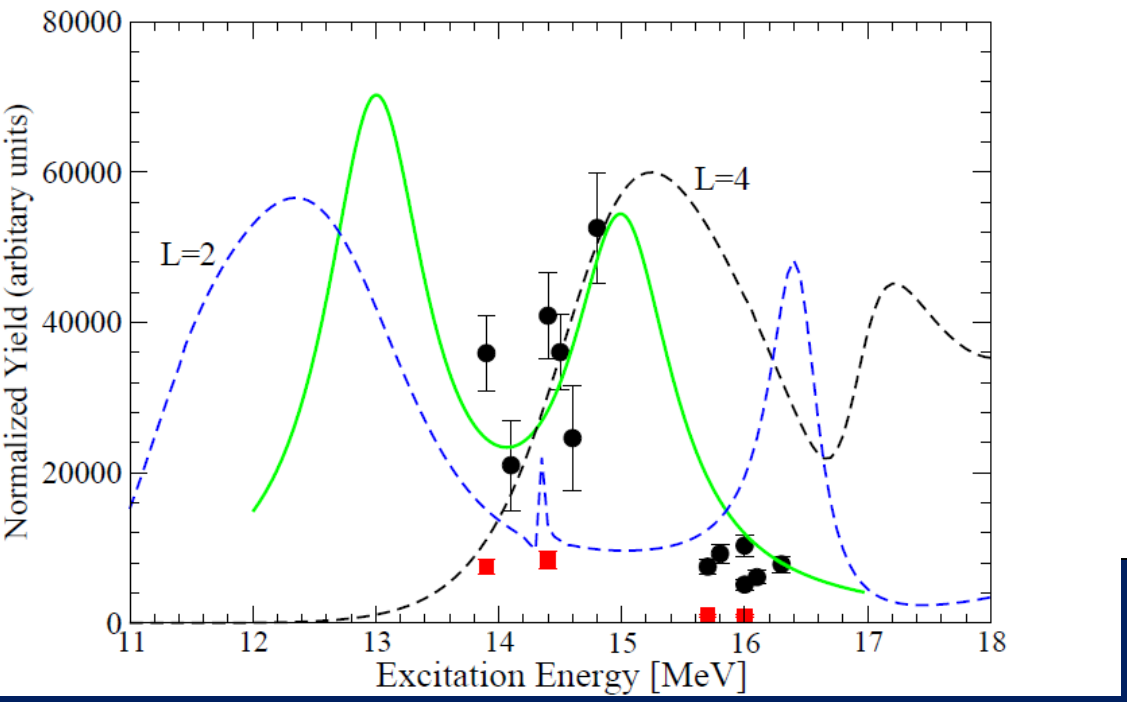

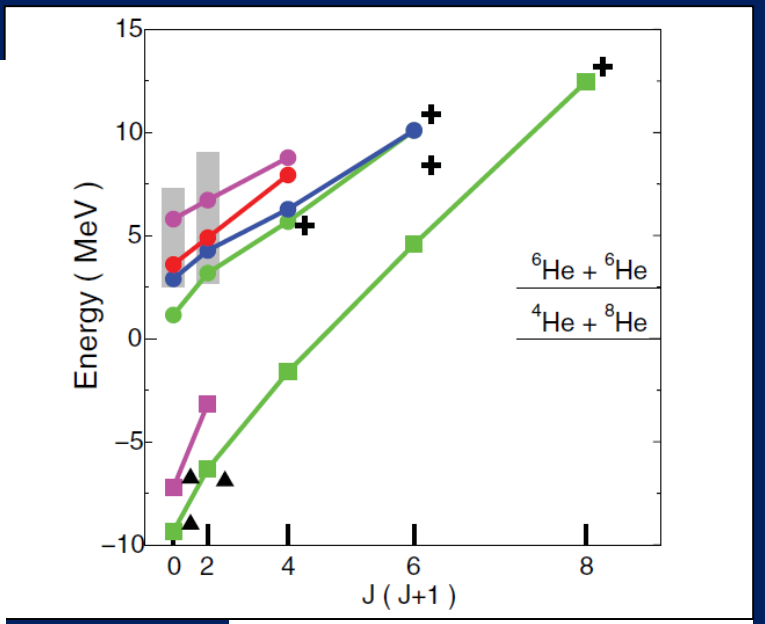

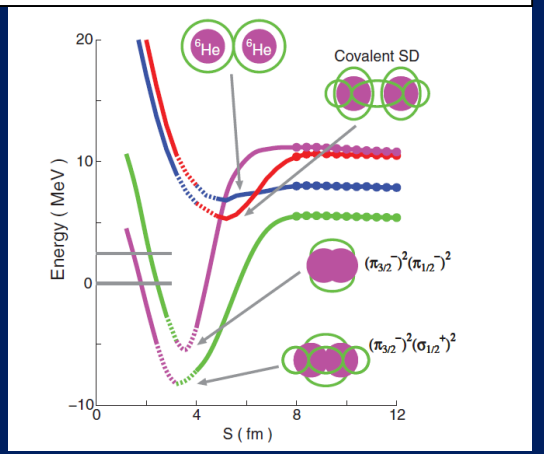

M. Freer et al, Physics Letters B 775 (2017) 58–62

Nuclear Structure to First Order