

Molecular-band structure of  $^{24}\text{Mg}$  in a microscopic  
three-cluster model

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The  $\alpha$ -clustering is well known in many nuclei [1]. Because of its closed-shell character, the  $\alpha$  particle keeps a part of its identity in a dinuclear system. In this contribution, we discuss the  $\alpha$ - $^{20}\text{Ne}$  cluster structure of  $^{24}\text{Mg}$ . Since the  $^{20}\text{Ne}$  nucleus is known to have a marked  $\alpha$ - $^{16}\text{O}$  structure, the calculation is performed in a three-cluster framework, involving a  $^{16}\text{O}$  core and two  $\alpha$  particles. We have presented in ref. [2] a microscopic description of three-cluster systems, and applied it to the  $\alpha$ - $^9\text{Be}$  collision. The wave functions are defined in the generator-coordinate formalism (GCM) and are projected out on the angular momenta  $l=0$  and  $2$  of  $^{20}\text{Ne}$  and on the total spin and parity of  $^{24}\text{Mg}$ . The generator coordinate corresponding to  $^{20}\text{Ne}$  is  $2.9$  fm and the interaction used is V2 with  $m=0.6313$ .

The  $^{24}\text{Mg}$  states obtained in the GCM are plotted in fig. 1 in a  $J(J+1)$  diagram. A band structure is deduced by gathering states presenting similar reduced  $\alpha$  widths and enhanced E2 transition probabilities between them. Let us now discuss each band.

The  $0_1^+$  band. The GCM reproduces accurately the location of this well-known band. However the E2 intra-band transition probabilities are somewhat too low in our calculation.

The  $2^-$  band. We overestimate the energies of this band by about  $2$  MeV. Our calculation suggests to identify the  $7.81$  MeV level to the  $5^-$  state of the  $2^-$  band. A valuable candidate for the  $6^-$  state is the  $9.53$  level which presents a strong in-band E2 transition probability towards the  $4^-$  state [3]. The suggestion of ref. [4] for the attribution of the  $7^-$  and  $8^-$  states is consistent with our results.

The  $0_2^+$  band. This band, built on the  $0^-$  ( $6.43$  MeV) and  $2^-$  ( $8.65$  MeV) levels has been proposed by Branford et al. [5]. The  $4^-$  state of this band has been searched for by Schmalbrock et al. [6] who suggest the  $11.22$  or  $11.70$  MeV levels. The comparison between the theoretical and experimental  $B(E2)$  values supports the attribution of the  $11.22$  MeV state. The  $6^-$  state of the  $0_2^+$  band is most likely the  $12.86$  MeV level which presents a strong E2 decay to the  $11.22$  MeV state [3].

The  $0_3^+$  band. The GCM predicts the existence of an excited  $0_3^+$  band starting around  $10.7$  MeV. The states of this band are characterized by a significant fraction of the Wigner limit. According to their locations and widths, the  $2^-$  ( $11.52$  MeV) and  $4^-$  ( $13.05$  MeV) states seem to be valuable candidates. The  $6^-$  ( $14.08$  MeV) experimental state presents a large reduced  $\alpha$  width [3] and therefore can be probably assigned to the theoretical  $6^-$  state of the  $0_3^+$  band.

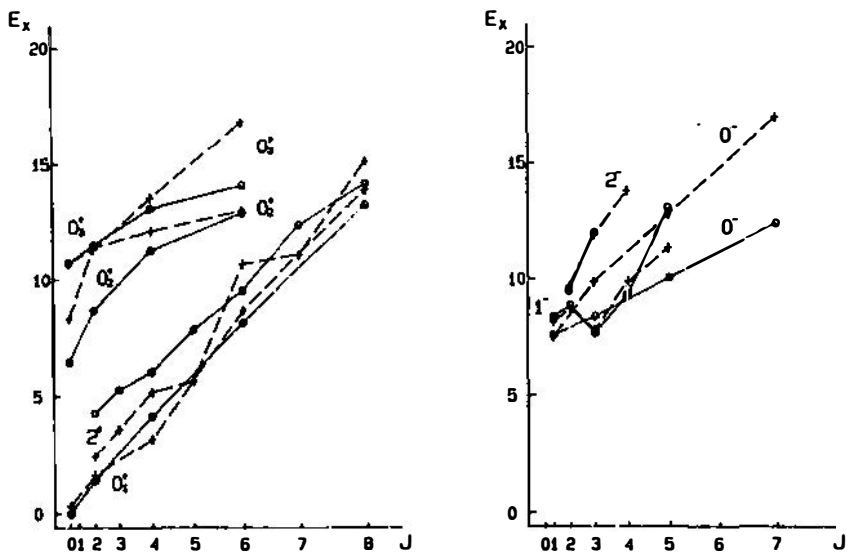
The 0<sup>-</sup> band·The existence of this band has been proposed by Branford et al.[7].Our model succeeds in reproducing the 1<sup>-</sup> energy with the same interaction as for the positive-parity states.However,the rotational constant of the 0<sup>-</sup> band is found slightly too large.

The 1<sup>-</sup> band·A 1<sup>-</sup> band built on the 1<sup>-</sup> (8.44 MeV) and 2<sup>-</sup> (8.86 MeV) states has been suggested by Fifield et al.[8].These authors also propose the 3<sup>-</sup> (10.33 MeV) and 5<sup>-</sup> (13.06 MeV) levels as members of this band.If the microscopic model agrees for the identification of the 5<sup>-</sup> state,it rather proposes the 3<sup>-</sup> (7.62 MeV) level.This level has been suggested to be the bandhead of a 3<sup>-</sup> band [7].The 9.31 MeV state is assigned in our model to the 4<sup>-</sup> state of the 1<sup>-</sup> band.The anomalous behaviour of the 1<sup>-</sup> band in a J(J+1) plot is well reproduced by the calculation.

The 2<sup>-</sup> band·The theoretical model predicts a 2<sup>-</sup> band starting around 9.5 MeV.Consequently,the experimental 9.52 level could be a 2<sup>-</sup> state.From its reduced width and its location,the 3<sup>-</sup> (12.01 MeV) state could be the next member of the 2<sup>-</sup> band.

- Chargé de recherches FNRS

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**Fig.1.** Theoretical (crosses) and suggested experimental (circles)  $\alpha+^{20}\text{Ne}$  bands