

THE CALCULATION OF TRANSITION PROBABILITIES AND MULTIPOLE MOMENTS
BETWEEN THE STATES OBTAINED BY THE GENERATOR COORDINATE METHOD

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We have applied the generator coordinate method to some light nuclei to test how good approximation to the complete diagonalization this method can offer and also to try to interpret the nature of the states. For these purposes we have calculated not only the energy levels but also the transition probabilities and multipole moments.

Let the wave functions $\Psi_{JuMu}^u(r)$ and $\Psi_{JvMv}^v(r)$ be the two eigenfunctions of the system, calculated by the generator coordinate method.

$$\Psi_{JuMu}^u(\vec{r}) = \sum_k \sum_i f_k^{ju}(\beta_i) \hat{P}_{Mu}^{ju} \Phi_k(\beta_i, \vec{r})$$

where β is a set of generator coordinates and k means different configurations of Slater determinates $\Phi_k(\beta_i, \vec{r})$. The weight functions $f_k^j(\beta_i)$ are determined by solving Hill-Wheeler equation. Then the reduced matrix elements of a tensor operator \hat{T}_q^L between two states can be written:

$$\langle \Phi_{JuMu}^u || \hat{T}_q^L || \Psi_{JvMv}^v \rangle = \sum_{kk'} \sum_{ij} f_k^{ju}(\beta_i) \langle \Phi(\beta_i, k) | \hat{P}_{Mu}^{ju} || \hat{T}_q^L || \hat{P}_{Mv}^{jv} \Phi(\beta_i, k) \rangle f_k^{jv}(\beta_i)$$

We have calculated the multipole moments and reduced matrix elements between the low-lying states of the nuclei ^{19}F , ^{21}Ne and ^{23}Na and we have found the good agreement with the results of the complete diagonalization method when ever they are available. Trying to interpret the nature of the states of these nuclei, we have found some puzzles.

References: N. Mankoč-Borštnik, F. Brut, S. Jang, to be published

^{21}Ne J (exp. energy MeV)	μ (μ_0)			Q (efm 2)		
	GCM	CD	exp.	GCM	CD	exp.
1/2 (2.7961)	-0.91	-0.90				
3/2 (0.0000)	-1.08	-1.10	-0.66	10.43	10.3	10.29
5/2 (0.3505)	-0.63	-0.76		-4.10	-3.4	
7/2 (1.7456)	0.01	-0.52		-9.65	-9.5	
9/2 (2.8656)	0.33	0.05		-15.08	-14.7	
11/2 (4.4322)	1.14	0.53		-15.56	-15.3	
13/2 (6.4466)	1.58	1.47		-19.41	-19.0	

The magnetic dipole moments (μ) and electric quadrupole moments (Q) for some low-lying states of the nucleus ^{21}Ne calculated by the generator coordinate method (GCM) and compared with the results of the complete diagonalisation method (CD) and with the experimental data (exp).