ISOSPIN SELECTION RULES IN ^{28}Si (*)

P. M. CORRÊA

Laboratório de Física e Engenharia Nucleares, Sacavém, Portugal

ABSTRACT — More than 300 electromagnetic transitions in ^{28}Si, concerning levels with well known J^{π} and T are classified according to their character and strength and examined from a statistical point of view. Reliable upper limits are obtained for the transition strengths, based upon a quantitative criterion and useful as spectroscopic tools. Isospin selection rules for dipole and electric quadrupole radiation in self-conjugate nuclei are studied in ^{28}Si. Preferential decay to highly excited energy states is found to be a characteristical feature of this nucleus.

1 — INTRODUCTION

The effect of isospin selection rules in ^{28}Si was studied by Lawergren [1]. Since then, however, a large amount of experimental data obtained with Ge(Li) detectors was published, namely more reliable spin and isospin assignments and decay schemes and lifetime measurements. Therefore, the check of isospin selection rules relevant to electromagnetic transitions in this nucleus can now be made with a much greater experimental support.

Usually, the electromagnetic transition matrix element is splitted into two parts [2]:

$$< J_b M_b ; T_b T_{3b} | H_0(L,M) + H_1(L,M) | J_a M_a ; T_a T_{3a} > \qquad (1)$$

H_0 and H_1 being the isoscalar and isovector interactions, respectively. It can easily be seen that [2]:

— both contributions vanish unless $\Delta T = 0, \pm 1$;

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— the isoscalar part can only contribute to $\Delta T = 0$ transitions;
— the isovector part vanishes for $\Delta T = 0$ transitions in selfconjugate nuclei.

It can be shown that the isoscalar contribution to El transitions vanishes in all cases in the long-wavelength approximation [2]. This result can be considered as almost exact, because the effect of the higher order terms, neglected in this approximation, is indeed very small (for a 10 MeV transition in ^{28}Si, e. g., their contribution would be less than about 6.5×10^{-4} of the corresponding isovector transition strength):

$$B(E1; \text{isoscalar}) \approx 0 \tag{2}$$

Por electric quadrupole transitions, one expects [2] that E2, $\Delta T = 1$ are retarded relatively to E2, $\Delta T = 0$ transitions by an average factor equal to $(e_p + e_n)^2 / (e_p - e_n)^2$ e_p and e_n being the effective charges of the proton and the neutron, respectively. Therefore, the expected retardation factor is 4, for $e_p / e = 1.5$ and $e_n / e = 0.5$, and 9 for $e_p / e = 2$ and $e_n / e = 1$.

For magnetic transitions, on the other hand, an estimate of the average enhancement exhibited by isovector transitions when compared with isoscalar transitions can also be obtained [2]:

$$\frac{(\mu_p - \mu_n - 1/(L+1))^2}{(\mu_p + \mu_n - 1/(L+1))^2} \tag{3}$$

where μ_p and μ_n are the magnetic moments of the proton and the neutron, respectively, in nuclear magnetons, and L is the multipolarity of the transition. This expression gives enhancement factors of 122 and 64 for $L = 1$ and $L = 2$, respectively, but is not expected to be very accurate.

Shortly, the following isospin selection rules to the electromagnetic transitions in ^{28}Si can be derived:

A: E1, $\Delta T = 0$ transitions are forbidden.
B: E2, $\Delta T = 1$ transitions are retarded relatively to E2, $\Delta T = 0$ transitions by a factor of 5 to 10.
C: M1, $\Delta T = 0$ transitions are expected to be about 100 times weaker than the average M1, $\Delta T = 1$ transitions.

These rules are not expected to be obeyed rigidly in actual nuclei for several reasons [3], the most important of which is usually supposed to be the isotopic spin impurity in the initial or final states. Taking this impurity into account, a T-forbidden E1 transition between states $|a>$ and $|b>$ will have a non-zero matrix element of the form [2]:

$$\mathfrak{M}_{ab}(E1; T_a - T_b = 0) = \sum_i \frac{<a|V_c|i>}{E_a - E_i} \mathfrak{M}_{ib}(E1; |T_i - T_b| = 1) \quad (4)$$

where V_c is the Coulomb interaction, responsible for the isospin admixture between states $|i>$ and $|a>$. The isospin impurity in the excited state will be proportional to

$$\sum_i \left[\frac{<a|V_c|i>}{E_a - E_i} \right]^2 \quad (5)$$

In the past, isospin selection rules have been studied on statistical collections of electromagnetic transition intensities (ref. [1], [4], [5], [6] among others). The use of larger Ge(Li) detectors, associated with better electronics and sophisticated data handling systems, have been giving and will give information about many more weak transitions, therefore distorting the transition strength distributions and lowering their mean values. Although statistical studies can be delicate and although refined nuclear models can account for individual cases of electromagnetic transitions, it is nevertheless interesting to examine the experimental data from a statistical point of view, by considering the average behaviour of the transition rates. However, as can be seen from expressions (4) and (5), it will not be legitimate to obtain a mean value for the isospin impurity from the ratio of the average T-forbidden and T-allowed transition rates, as it has been done in some cases.

Even if the mean values of the transition strengths are rather delicate quantities, that must be regarded carefully, their upper limits, that can be extracted from the statistical collections, are quite reliable. The biggest difficulty connected with these is the choice of an appropriate probability acceptance criterion, since there is no established theoretical model for the shape of the distribution corresponding to a certain type of transitions. However, because of the usefulness of these upper limits in nuclear spectroscopy, it is worthwhile to make an effort to define them quantitatively.

2 — EXPERIMENTAL DATA SOURCES

Transition strengths were calculated by comparison with the Weisskopf single-particle strengths [4]:

$$|M|^2 = \frac{\Gamma \exp}{\Gamma \text{Weisskopf}} \tag{6}$$

It must be emphasized that only transitions between states of well known and unique J^π and T values were accepted. Electric transitions up to $L = 3$ and magnetic transitions of $L = 1$ and $L = 2$ were considered, both with $\Delta T = 0$ and 1. Mixing-ratios were never taken into account, because there are not enough δ-measurements in ^{28}Si. Transitions of the $EL + M(L+1)$ type were supposed to be pure electric. Transitions of the $ML + E(L+1)$ type were supposed to be either pure magnetic (if the existence of an electric component with a strength equal to the corresponding upper limit would not introduce a carrection to the strength of the magnetic component greater than 54 % (*)) or mixed; in both cases they were simultaneously included in special ML and $E(L+1)$ collections, denoted by an asterisk. Transition strengths were only included in the statistical collections (fig. 1 and 2) when their relative error (combination of the errors in branching-ratio and lifetime or gamma-width of the initial state) was smaller than 54 %.

The radiative widths of the (p, γ) resonances were obtained from the resonance strength, assuming that $\Gamma_p >> \Gamma_\gamma$, i. e.:

$$\Gamma_\gamma \approx \frac{\omega \gamma}{2J + 1} \tag{7}$$

At least three cases are known [7] where this assumption is not correct (resonances at $E_p = 1183$, 1365 and 1647 keV), but corrections for the known value of Γ_p / Γ_γ would not change the conclusions obtained from the statistical collections.

(*) The choice of this limit corresponds to the fact that an error of 54 % in the transition strength gives a maximum corrective factor of 2.15, that is, the extension of one class in the histograms of figs. 1 and 2. In the same way, an error of 79 % gives a maximum corrective factor of 4.65, that is, two classes in those histograms.

Most of the data used in this work (E_x, T, J^{π}, τ or $\omega\gamma$ and decay scheme) were taken from Meyer et al. [8]. A few exceptions are indicated below:

a) The energies of the bound states were taken from Endt and van der Leun [9], as well as the lifetimes of the bound states at 1.779, 4.979, 6.276, 6.879, 8.413, 10.901, and 11.445 MeV.

b) The lifetimes of the levels at 7.933 MeV (9 ± 6 fs), 8.543 MeV (13 ± 10 fs) and 9.316 MeV (10 ± 5 fs) were taken from Gonidec [10].

c) The decay schemes of the levels at 7.417 and 10.901 MeV were taken from Endt and van der Leun [9]. The decay scheme of the level at 9.702 MeV was taken from Lam et al. [11].

d) Data concerning the resonance at $E_p = 1439$ keV were obtained from Forsblom [12] and Lyons et al. [13].

e) The J^{π} value of the resonance at $E_p = 1724$ keV was taken from Tveter [7].

f) The strength and decay scheme of the upper member of the doublet at $E_p = 1363/1365$ keV were taken from Cunha et al. [14].

g) The strengths, J^{π} values and decay schemes of both members of the doublet at $E_p = 1575/1579$ keV were taken from Gonidec [10].

A list of all the calculated transition strengths is presented in table 8.

3 — EXPRESSIONS AND DEFINITIONS

The transition rates, calculated by means of expression (6), were classified according to their character and intensity. The resultant distributions are presented in figs. 1 and 2, as well as the mean transition strength, defined by:

$$\log < W > = \frac{1}{N} \sum_i n_i \log W_i \tag{8}$$

For each collection, the error in the mean transition strength (table 1) was calculated by the expression:

$$\varepsilon\{\log < W >\} = \frac{1}{N}\left[\sum_i n_i^2(\varepsilon\{\log W_i\})^2\right]^{1/2} \qquad (9)$$
$$\varepsilon\{\log W_i\} = 0.167 \text{ (half a class)}$$

In these expressions, W_i and n_i are the central value and the number of transitions of each class of the distribution, and N is the total number of transitions of the distribution.

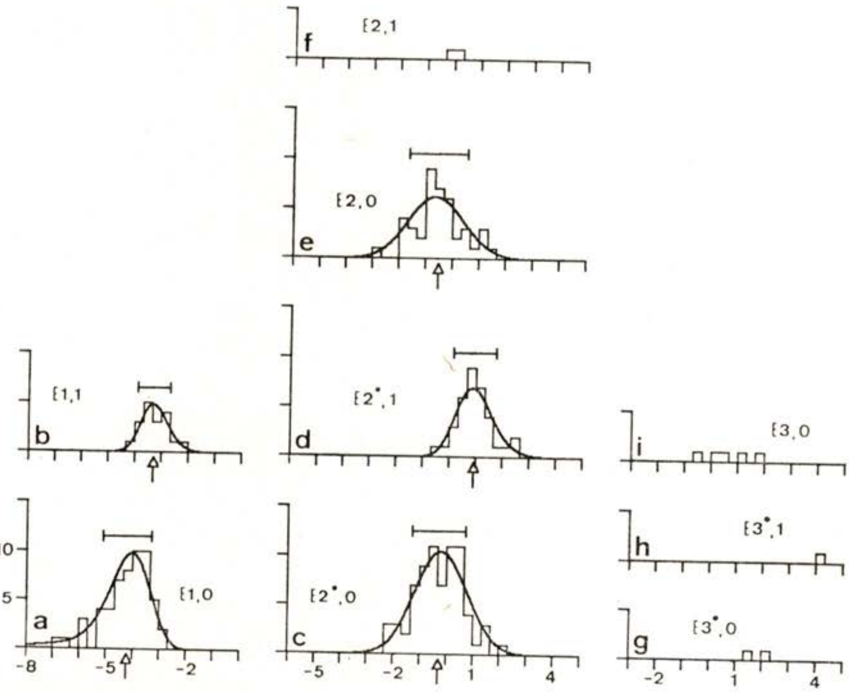

Fig. 1 — Distributions of electric transition strengths. The vertical arrows below the histograms indicate the mean strengths; the horizontal bars above the histograms indicate the intervals corresponding to 68.3 % of the total area, around the mean. The abcissas are log(W) and the ordinates are the number of transition strengths accepted inside each class. The amplitude of all classes is one third of an order of magnitude. The smooth curves are computer-made fits to the most significant distributions, as explained in section 3.

For the statistically significant distributions, the transition strength upper limits were calculated assuming that $x = \log W_i$ followed a function of the form:

$$f(x) = k \,.\, \exp[-(a + bx + cx^2 + dx^3)] \qquad (10)$$

smoothly connected at both sides by decreasing exponentials, at the central value of the first (last) class to the left (right) of which there were no observed transitions. Rightmost values of x were obtained, which defined 99.0, 99.5 and 99.9 % of the area under these curves; all adopted upper limits (table 2) define areas between 99.5 and 99.9 % of the total area. For these distributions, the intervals corresponding to 68.3 % of the total area (around the mean) were also obtained; they correspond to the horizontal bars in the histograms of figs. 1 and 2 and to the value of σ in table 1.

For the other collections, the upper limits are quite arbitrary and correspond only to values reasonably higher than the strongest

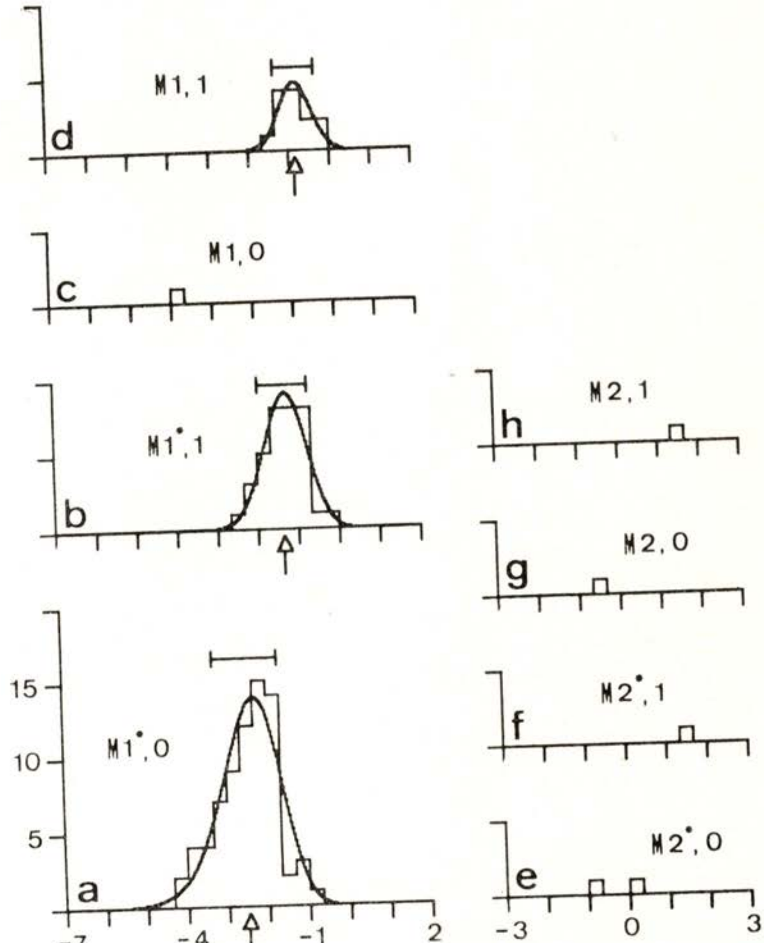

Fig. 2 — Distributions of magnetic transition strengths (see fig. 1 caption for details).

observed (and accepted) transition stength (values between brackets in table 2).

The data in the diagrams (figs. 1 and 2) corresponding to pure transitions can be directly interpreted, but those diagrams which correspond to (possibly) mixed transitions, denoted by an asterisk, must be regarded carefully, since mixing ratios were not considered. In the discussion of the data the following quantities will be considered:

a) Enhancement (or retardation) of (E, M) L, $\Delta T = 1$ radiation relatively to (E, M) L, $\Delta T = 0$ radiation:

$$k_{(E,M)L} = \frac{<|M_{(E,M)L,1}|^2>}{<|M_{(E,M)L,0}|^2>} \tag{11}$$

In particular:

$$k_{M1} = \frac{<|M_{M1,1}|^2>}{<|M_{M1,0}|^2>} = \frac{<\delta_0^2>}{<\delta_1^2>} \tag{11a}$$

b) Apparent enhancement (or retardation):

$$k^*_{(E,M)L} = \frac{<|M^*_{(E,M)L,1}|^2>}{<|M^*_{(E,M)L,0}|^2>} \tag{12}$$

c) Mixing-ratios of E2/M1 radiation, with $\Delta T = 0$ and 1:

$$<\delta_0^2> = \frac{1}{\dfrac{<|M^*_{E2,0}|^2>}{<|M_{E2,0}|^2>} - 1} \tag{13}$$

$$<\delta_1^2> = \frac{1}{\dfrac{<|M^*_{E2,1}|^2>}{<|M_{E2,1}|^2>} - 1} = \frac{1}{\dfrac{1}{k_{E2}} \dfrac{<|M^*_{E2,1}|^2>}{<|M_{E2,0}|^2>} - 1} \tag{14}$$

d) Relation between the mixing-ratios of E2/M1 radiation for $\Delta T = 0$ and 1:

$$<\delta_0^2> = \frac{1}{\dfrac{k_{E2}}{k^*_{E2}}\left(1 + \dfrac{1}{<\delta_1^2>}\right) - 1} \tag{15}$$

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and the subsequent limit for $<|\delta_1|>$:

$$<|\delta_1|> \leqslant \left[\frac{k^*_{E2}}{k_{E2}} - 1\right]^{-1/2} \qquad (16)$$

e) Statistical factor $G_{\Delta T}$ containing the angular and spin dependence of the M1 transition matrix element. Using the definition quoted by Lawergren [1]:

$$\frac{<|M_{M1,0}|^2>}{<|M_{M1,1}|^2>} = \left[-\frac{1.8 + <G_0>}{9.4 + <G_1>}\right]^2 \qquad (17)$$

and simplifying it by assuming $<G_0> = <G_1> = <G>$, as done by that author, one obtains:

$$<G> = -\frac{9.4 + 1.8\,(k_{M1})^{1/2}}{1 + (k_{M1})^{1/2}} \qquad (18)$$

4 — ISOSPIN SELECTION RULES

The values of the quantities defined in section 3 are presented in tables 1, 2 and 3. Relatively to table 3, it was assumed that E2 radiation is not affected by isospin selection rules ($k_{E2} = 1$; see discussion in subsection 4.2).

4.1 — *The dipole transitions*

Lawergren [1] has considered a number of E1 transitions (10 with $\Delta T = 0$ and 8 with $\Delta T = 1$) much smaller than that considered in this work (55 and 18, respectively). However, the value now obtained k_{E1} is in good agreement with the one given by that author. It can be seen from table 3 that there is also agreement with the values that can be obtained from the works by Skorka et al. [5] an Endt and van der Leun [6]. Since rule A should prevent any E1, $\Delta T = 0$ transitions, the value of k_{E1} is somehow related to the isospin admixture in ^{28}Si.

Figs. 2.a-d present data from 14 M1 transitions (1 with $\Delta T = 0$ and 13 with $\Delta T = 1$) and 108 M1* transitions (73 with $\Delta T = 0$ and 35 with $\Delta T = 1$), to compare with the 36 used by Lawergren [1]

TABLE 1

Type of radiation	$<\|M\|^2>$ (W. u.) Present	Ref. [5] *a)*	Ref. [1] *b)*	Ref. [6] *b,c)*	σ *d)* Present	Ref. [5]
E1, $\Delta T = 0$	$(6.4 \pm 0.9) \times 10^{-5}$	1.8×10^{-4}	2×10^{-4}	3×10^{-5}	7.9	7.2
E1, $\Delta T = 1$	$(5.5 \pm 1.0) \times 10^{-4}$	1.5×10^{-3}	10^{-3}	3×10^{-4}	4.0	6.6
E2, $\Delta T = 0$	$(3.1 \pm 0.5) \times 10^{-1}$	1.5	--	3	12.6	10.0
E2, $\Delta T = 1$	---	0.44	--	7×10^{-1}	-	12.0
M1, $\Delta T = 0$	---	8.8×10^{-3}	7×10^{-3}	10^{-3}	-	3.4
M1, $\Delta T = 1$	$(1.5 \pm 0.3) \times 10^{-1}$	2×10^{-1}	9×10^{-2}	5×10^{-2}	3.2	7.2
E2*, $\Delta T = 0$	$(5.5 \pm 0.7) \times 10^{-1}$	--	--	--	10.0	-
E2*, $\Delta T = 1$	9.1 ± 1.4	--	--	--	6.3	-
M1*, $\Delta T = 0$	$(3.3 \pm 0.5) \times 10^{-3}$	--	--	--	6.3	-
M1*, $\Delta T = 1$	$(4.6 \pm 0.8) \times 10^{-2}$	--	--	--	4.0	-

a) $20 \leqslant A \leqslant 40$.

b) Estimates obtained from the reported distributions of transition rates.

c) $A < 45$.

d) See text (section 3) for definition.

(25 and 11, respectively). On the other hand, this author does not refer any precautions taken into account for the effect of unknown mixing-ratios. As a matter of fact, if we calculate the apparent enhancement of M1 radiation, directly from the data of figs. 2.a, b, we obtain $k^{*}_{M1} = 14 \pm 4$, which is in much better agreement with the value given in ref. [1] than $k_{M1} = 45 \pm 30$, obtained through expression (11a). Table 3 shows that there is no serious disagreement between the present value for k_{M1} and those that can be obtained from refs. [5], [6]. Anyway, the enhancement of M1, $\Delta T = 1$ radiation relatively to M1, $\Delta T = 0$ radiation is found to be weaker than predicted by rule C, showing once more that isospin admixture is present in the ^{28}Si nucleus (see subsectian 4.2).

TABLE 2

Type of radiation	Upper limits (W. u.) *c*) Present	Ref. [6]
E1, $\Delta T = 0$	5×10^{-3}	3×10^{-3}
E1, $\Delta T = 1$	2×10^{-2}	10^{-1}
E2, $\Delta T = 0$	10^{2}	10^{2}
E2, $\Delta T = 1$	(10) *a*)	10
E3, $\Delta T = 0$	(2×10^{2})	10^{2}
E3, $\Delta T = 1$	(50) *b*)	--
M1, $\Delta T = 0$	(5×10^{-1})	3×10^{-2}
M1, $\Delta T = 1$	2	10
M2, $\Delta T = 0$	(1)	10^{-1}
M2, $\Delta T = 1$	(10^{2})	3
E2*, $\Delta T = 0$	5×10^{2}	--
E2*, $\Delta T = 1$	5×10^{3}	--
E3*, $\Delta T = 0$	(5×10^{2})	--
E3*, $\Delta T = 1$	(5×10^{4})	--
M1*, $\Delta T = 0$	2×10^{-1}	--
M1*, $\Delta T = 1$	2	--
M2*, $\Delta T = 0$	(5)	--
M2*, $\Delta T = 1$	(10^{2})	--

a) Several transitions with strengths between 2 and 5 W. u. can only be accepted on the basis of a 79 % error criterion.

b) Not illustrated. The suggested upper limit was found from two transitions that can only be considered on the basis of a 79 % error criterion.

c) See text (section 3) for definition.

The fact that rule A is much more seriously violated than rule C is not surprising. The effects of isospin impurities on M1 and E1 radiation differ greatly because the M1 transition operator has no radial dependence; thus, the only isospin impurities relevant to M1 transitions come from states with the same configuration but one unit different in isospin (if we write for M1 radiation an expression similar to (4), states $|i\rangle$ will have the same configuration as $|a\rangle$ but will be one unit different in isospin). It must be expected, then, that the E1 active isospin impurities present in a specific state have their origin in states much closer in energy to this one than in the case of M1 transitions; therefore, apart from the Coulomb matrix element, the violation of the E1 isospin selection rule must be easier than that of the M1 rule, as can be seen from expressions (4) and (5).

4.2 — *The electric quadrupole transitions*

Figs. 1.c, d show an apparent enhancement of the E2*, $\Delta T = 1$ transitions (35 examples) relatively to the E2*, $\Delta T = 0$ transitions (73 examples), which must be due to the assumption of «pure electric character» of the (possibly) mixed E2/M1 transitions. This indicates that the average mixing-ratios must depend on ΔT.

Unfortunately, the statistics of E2, $\Delta T = 1$ transitions is not good enough to obtain a mean value. If we assume that E2 radiation is not affected by isospin selection rules ($\langle |M_{E2,1}|^2 \rangle \approx \langle |M_{E2,0}| \rangle^2$;

TABLE 3

	Present	Ref. [1]	Ref. [5] *a)*	Ref [6] *b)*
k_{E1}	9 ± 2	7	8.3	10
k_{M1}	45 ± 30	10 *c)*	23	50
$\langle G \rangle$	$-(2.8 \pm 0.9)$	-3.7	-3.1	-2.7
$\langle \lvert\delta_0\rvert \rangle / \langle \lvert\delta_1\rvert \rangle$	6 ± 2	-	-	-
Max. val. of $\langle \lvert\delta_1\rvert \rangle$	0.3	-	-	-

a) Calculations made over the reported mean values for $20 \leqslant A \leqslant 40$.
b) Calculations made over the estimates referred in table 1.
c) See subsection 4. 1

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$e_p/c=1$ and $e_n/e=0$), the values obtained for $<|\delta_0|>/<|\delta_1|>$ and for the upper limit of $<|\delta_1|>$ (and, of course, the value for k_{M1}) are those shown in table 3. If, however, we assume $k_{E2}=0.29$ (Skorka et al. [5], $20\leqslant A\leqslant 40$), we obtain $<|\delta_0|>/<|\delta_1|>= =11\pm 4$ and $<|\delta_1|>\leqslant 0.15$ (and $k_{M1}=130\pm 80$); assuming also that $k_{E2}\approx(e_p-e_n)^2/(e_p+e_n)^2$, this value for k_{E2} implies that the effective charges of the proton and the neutron are related as $e_p/e_n\approx 3$.

In either assumption, the absolute value of the mixing-ratio for the $\Delta T=1$, E2/M1 transitions is predicted to be usually very small, but the one of the $\Delta T=0$, E2/M1 transitions is predicted to be of the order of unit. It is interesting to remark that none of the 73 M1*, $\Delta T=0$ transitions considered could be supposed «pure», on the basis of the criterion expressed in section 2, whereas 9 of the 35 M1*, $\Delta T=1$ transitions were supposed to be «pure»

4.3 — *Transitions of higher multipolarity*

Figs. 1 and 2 include also some data on electric octupole and magnetic quadrupole transitions, but the statistics is too poor to draw any conclusions. A few transitions included in table 8 deserve, however, a special reference.

4.3.1 — The M3, $\Delta T=0$ transition: 12.240 MeV, $J^\pi=3^+$, $T=0\rightarrow 0$ $J^\pi=0^+$, $T=0$, with a strength of 6 W.u., resulting from a branching-ratio of 0.1%, and the M3/E4, $\Delta T=0$ transition 13.427 MeV, $J^\pi=5^+$, $T=0\rightarrow 11.780$ MeV, $J^\pi=2^+$, $T=0$, with a strength of $|M^*_{M3}|^2=5.9\times 10^8$ (or $|M^*_{E4}|^2=2.5\times 10^{12}$) W u., resulting from a branching-ratio of 2.5%. Endt and van der Leun [6] present in their compilation only one isoscalar M3, with a strength of 0.55 ± 0.02 W.u., extracted from the mirror pair $^{24}Na/^{24}Al$ (0.47/0.44 MeV $\rightarrow$ 0).

4.3.2 — The M2/E3, $\Delta T=0$ transitions:

13.417 MeV, $J^\pi=1^-$, $T=0\rightarrow 8.589$ MeV, $J^\pi=3^+$, $T=0$

B.r. = 1.8 % $|M^*_{M2}|^2=5.5$ W.u.

$|M^*_{E3}|^2=1800$ W.u.

13.104 MeV, $J^\pi = 2^+$, $T = 0 \rightarrow 8.413$ MeV, $J^\pi = 4^-$, $T = 0$

B.r. = 0.9 % $|M^*_{M2}|^2 = 3.2$ W.u.

$|M^*_{E3}|^2 = 1100$ W.u.

13.034 MeV, $J^\pi = 2^+$, $T = 0 \rightarrow 8.413$ MeV, $J^\pi = 4^-$, $T = 0$

B.r. = 1 % $|M^*_{M2}|^2 = 4.4$ W.u.

$|M^*_{E3}|^2 = 1600$ W.u.

12.974 MeV, $J^\pi = 1^-$, $T = 0 \rightarrow 8.589$ MeV, $J^\pi = 3^+$, $T = 0$

B.r. = 5 % $|M^*_{M2}|^2 = 6$ W.u.

$|M^*_{E3}|^2 = 2400$ W.u.

4.3.3 — The E3, $\Delta T = 0$ transition: 13.108 MeV, $J^\pi = 3^-$, $T = 0 \rightarrow 8.543$ MeV, $J^\pi = 6^+$, $T = 0$, with a strength of $|M_{E3}|^2 = 4600$ W.u., corresponding to a branching-ratio of 40 % [10]. The $E_x = 13.108$ MeV is the upper level of an overlapped doublet ($E_p = 1575/1579$ keV) in the $^{28}Al + p$ reaction, that was claimed to have been resolved by Gonidec [10]. Its (p,γ) strength is reported to be about ten times smaller than that of its partner. Due to the calculated E3 strength it is reasonable to suppose that some (non reported) troubles have occurred in the doublet resolution, either in the assignment of the transition (it would not be confortable to assign it to the lower member of the doublet, however, because in that case it would be a very strong E4, $\Delta T = 0$), or in the estimate of the branching-ratio or the resonance strength values. The J^π assignment can also be wrong.

4.3.4 — The M2/E3, $\Delta T = 0$ transition: 12.901 MeV, $J^\pi = 2^+$, $T = 0 \rightarrow 8.143$ MeV, $J^\pi = 4^-$, $T = 0$, with a strength of $|M^*_{M2}|^2 = 16$ ($|M^*_{E3}|^2 = 6000$) W. u., corresponding to a branching-ratio of 1 % [14]. Once again such high, unreasonable, strengths can arise from uncertainties in the resolution of the doublet ($E_p = 1363/1365$ keV; $E_x = 12.901$ MeV corresponds to the upper member): the branching-ratio is too small to allow a reliable assignment about the origin of the gamma ray.

4.3.5 — The following transitions:

$$13.248 \text{ MeV}, J^{\pi}=5^{-}, T=1 \rightarrow 0, J^{\pi}=0^{+}, T=0$$
$$\text{B. r.}=0.1\% \quad |M_{E5}|^2=3.5\times10^{6} \text{ W. u.}$$

$$13.248 \text{ MeV}, J^{\pi}=5^{-}, T=1 \rightarrow 9.316 \text{ MeV}, J^{\pi}=3^{+}, T=1$$
$$\text{B. r.}=1.2\% \quad |M^{*}_{M2}|^2=76 \text{ W. u.}$$
$$|M^{*}_{E3}|^2=3.8\times10^{4} \text{ W. u.}$$

The branching-ratios observed by Meyer et al. [8] are very small, but any observable branch corresponding to these transitions (e. g., one tenth of the reported values) would still give too high strengths. The $E_x=13.248$ MeV is the upper member of the doublet at $E_p=1723/1724$ keV. The lower member, with $J^{\pi}=3^{-}$, was reported to have no gamma-decay [15]. However, if this is not the case and if the transitions observed by Meyer et al. [8] can be ascribed to the lower member of the doublet, their characters and strengths will be, assuming $\Gamma\gamma=10$ meV for both:

13.247 MeV → 0	E3, $\Delta T=0$	$\lvert M_{E3}\rvert^2=8$ W. u.
13.247 MeV → 9.316 MeV	E1, $\Delta T=1$	$\lvert M_{E1}\rvert^2=2.5\times10^{-2}$ W. u.

which seem to be much more reasonable. Evidence in this direction can be obtained from the work by Lam et al. [11]. These authors have exhaustively studied the 13.248 MeV level and did not report these transitions.

4.4 — *The statistical factor $G_{\Delta T}$.*

A rough estimate of the expected theoretical value of G can be obtained by averaging over all possible combinations of single-particle transitions in ^{28}Si. This average value, $<G>=-2$ [1] is in better agreement with the figure obtained in the present work than with that reported by Lawergren. The arguments about the retardation of E2, $\Delta T=1$ transitions relatively to E2, $\Delta T=0$ transitions (subsection 4.2) do not change appreciably the value given in table 3 ($k_{E2}=0.29$ would imply $<G>=-(2.4\pm0.8)$).

5 — SPINS AND PARITIES

The upper limits for the transition strengths, presented in table 2, were used to restrict the possible spins and parities of levels with unknown J^π. Table 4 shows the relevant results, in comparison with those of ref. [8].

TABLE 4

E_x (MeV)	J^π assignments Present	Previous [8]
8.945	$(4+, 5^-, 6+)$	$\pi = (-)^J$
9.418	$(2+, 3^-)$	$(2+, 3^-, 4+)$
9.762	$(2, 3, 4^-)$	$(2-4)$
9.794	$(2, 3, 4+)$	$(1-4)$
10.210	$(2+, 3^-)$	$(2+, 3, 4+)$
10.312	$(2+, 3)$	$(4+)$
10.372	(2)	$(3+)$ *a)*
10.916	$(2+, 3^-, 4+)$	$\pi = (-)^J$
12.074	$(2^-, 3^-)$	$(2+)$ *b)*
12.715	(2)	$(1+, 2)$
13.205	$(2)+$	$(2, 3)+$
13.230	$(2+, 3^-)$	$(2,3^-)$ *c)*
13 984	$(3^-, 4)$	$(2+, 3^-)$

a) Ref. [9] quotes $J^\pi = (3)^+$. *b)* Ref. [9] quotes $J^\pi = 2^{(+)}$.
c) Ref. [9] quotes $J^\pi = (2,3)^+$

6 — PREFERENTIAL DECAY TO HIGHLY EXCITED STATES

A particular feature of the ^{28}Si nucleus is the occurrence of many strong gamma-transitions from (p,γ) resonances to highly excited energy states (see, e.g., ref. [16]). A picture of this can be seen in tables 5-7 (only transitions whose strengths have errors of less than 54 % are represented).

6.1 — *E1 transitions*

It can be seen from table 5 that about 50 % of the full E1 strength corresponds to transitions from the resonances to the levels at 9.316 and 9.381 MeV ($J^{\pi}=3^{+}$, T = 1 and $J^{\pi}=2^{+}$, T = 1, respectively), and that only about 15 % of the full strength corresponds to transitions to g.s. or to the first two excited states. On the other hand, the E1

TABLE 5

FINAL LEVELS (NUMBER: ENERGY(MEV) Jπ,T)

1:	0.000 0+,0	2:	1.779 2+,0	3:	4.618 4+,0	4:	4.979 0+,0
5:	6.276 3+,0	6:	6.691 0+,0	7:	6.879 3-,0	8:	6.889 4+,0
9:	7.381 2+,0	10:	7.417 2+,0	11:	7.799 3+,0	12:	7.933 2+,0
13:	8.259 2+,0	14:	8.328 1+,0	15:	8.413 4-,0	16:	8.543 6+,0
17:	8.589 3+,0	18:	8.904 1-,0	19:	9.316 3+,1	20:	9.381 2+,1
21:	9.480 2+,0	22:	9.702 5-,0	23:	10.180 3-,0	24:	10.418 3+,0
25:	10.668 3+,0	26:	11.780 2+,0				

NORMALIZED STRENGTHS LESS THAN 0.00005 ARE REPRESENTED BY <; FROM 0.00005 TO 0.0005 BY .; FROM 0.0005 TO 0.005 BY :; FROM 0.005 TO 0.05 BY *; AND FROM 0.05 TO 0.5 BY >. THE SYMBOL T BEFORE THE STRENGTH IS FOR ISOVECTOR TRANSITIONS.

****

DECAY TABLE E1 TRANSITIONS (0.100E-01 W.U. <> 10)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	SUM
6.879 3-,0		:	:																								0
8.413 4-,0			:																								0
8.904 1-,0	>	>																									0
9.702 5-,0			.					.																			0
10.180 3-,0		*	>																								0
10.195 3-,0		1	>		>			>				>	>						T>	T1							2
12.217 2-,0		>			>					>		>					>			T8							9
12.482 3-,0		>	>		>				>											T1							1
12.664 4-,1					T2			T>									T3										5
12.726 2+,0							>																				0
12.742 3-,1		T>			T1					T>	T>	T>					T>		1	1							4
12.802 3-,0		>	>					>		>																	0
12.974 1-,0	*			*																							0
12.991 3-,0		*	*								>						>		T2								2
13.034 2+,0							>																				0
13.051 2-,0		1																									1
13.104 2+,0							>																				0
13.173 3-,0		*	*		*					*	*								T>								0
13.248 5-,1								T>																			0
13.272 2-,0		1										>							T1								2
13.361 3-,0		*	*		*			>		>									T1								1
13.417 1-,0	*	*																								2	2
SUM	0	4	1	0	3	0	0	1	0	0	0	1	0	0	0	0	3	0	5	11	0	0	0	0	0	2	

FULL SUM 31

decay strength of the three represented T = 1 excited states (from the total of 22) is about 30 % of the full E1 strength, in accordance with isospin selection rules.

TABLE 6

DECAY TABLE M1 TRANSITIONS (0.100E+01 W.U. <> 10)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	SUM
8.328 1+,0	:																										0
10.669 3+,0																			T1								1
10.901 1+,1	T2																										2
11.445 1+,1	T8																										8
12.291 2+,0																			T1	T2							3
12.331 1+,1	T1					T>			T1																		2
12.542 3+,1											T2	T1															3
12.664 4-,1															T3												3
12.917 2+,1																	T1										1
13.248 5-,1																						T7					7
SUM	11	0	0	0	0	0	0	0	1	0	2	1	0	0	3	0	1	0	2	2	0	7	0	0	0	0	

FULL SUM 30

6.2 — *M1 transitions*

Most of the pure M1 transitions have $\Delta T = 1$ (see subsection 4.1). However, it is remarkable (table 6) that two of the T = 0 excited states (from a total of 10) contribute with about 15 % to the full M1 strength, corresponding once again to transitions to the levels at 9.316 and 9.381 MeV. Besides. 35 % of the full M1 strength correspond to transitions to g.s., in comparison with 65 % corresponding to levels with excitation energy higher than 7 MeV.

6.3 — *E2 transitions*

The E2 strength is mainly concentrated in the g.s. rotational band (0 — 1.779 MeV — 4.617 MeV): 40 % of the full E2 strength or even more if we consider also the decay of the fourth member of the band (8.543 MeV). There are, however, two strong E2 transitions to highly excited states (13.173 MeV → 9.702 MeV and 13.427 MeV → 10.418 MeV), which, by themselves, contribute with about

30 % to the full E2 strength. There has been an intense search (e.g., ref. [10] and references therein) for a second rotational band in ^{28}Si. As can be seen from table 7, there is no clear evidence of this.

TABLE 7

DECAY TABLE E2 TRANSITIONS (0.250E+02 W.U. <> 10)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	SUM
1.779 2+,0	5																										5
4.618 4+,0		9																									9
4.979 0+,0		4																									4
6.691 0+,0		>																									0
6.889 4+,0		>																									0
7.381 2+,0	>																										0
7.417 2+,0	>			2																							2
8.259 2+,0	*		>	1																							1
9.702 5-,0							*																				0
12.072 2+,0	*		*					>																			0
12.195 3-,0																											1
12.291 2+,0						>																					0
12.439 2+,0	*		*																								0
12.475 4+,0		>																									0
12.552 4+,0		*							>	>		>	>														0
12.726 2+,0	>			>																							0
12.817 4+,0		:														>											0
12.855 4+,0		*																									0
12.901 2+,0	*		>					>																			0
12.917 2+,1			T1																								1
12.924 2+,1			T>																								0
13.034 2+,0			>					>																			0
13.104 2+,0	*																										0
13.173 3-,0																						2					2
13.417 1-,0							>																				0
13.427 5+,0																	>							9			9
13.806 2+,0			>																								0
13.973 2+,0			>																								0
SUM	5	13	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	9	0	0	

FULL SUM 35

7 — CONCLUSIONS

The isospin selection rules for dipole transitions in self-conjugate nuclei seen well verified in ^{28}Si. However, the results obtained show a certain amount of isospin admixture. Hindrance factors of 9 ± 2 and (at least) 45 ± 30 were obtained for electric and magnetic radiation, respectively. The E2/M1 mixing-ratios are affected by the isospin selection rules, the average value for $\Delta T = 0$ transitions being about (at least) six times greater than the corresponding value for $\Delta T = 1$ transitions. On the other hand, an upper limit of 0.3 was obtained for the expected absolute value of this last quantity.

Reliable upper limits of transition strengths were obtained for several types of electromagnetic transitions in ^{28}Si, on the basis of a quantitative criterion, and qualitative estimates were suggested for other types. Possible spins and parities of some levels of ^{28}Si with unknown J^{π} could be restricted to a smaller number than previously by considering those upper limits.

It is a pleasure to thank Dr. C. M. da Silva for the stimulating discussions at the beginning of this work. It must be stressed that this work would not have been possible without the cooperation and friendship of J. D. Cunha.

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TABLE 8

```
ELECTROMAGNETIC TRANSITION RATES  (WU)

NUCLEUS  [28;14]SI


  1.779 2+,0     TO:
  0.000 0+,0 DT=0  E2 0.130E+02 +- 0.58E+00

  4.618 4+,0     TO:
  1.779 2+,0 DT=0  E2 0.214E+02 +- 0.37E+01  M3 0.191E+08 +- 0.34E+07

  4.979 0+,0     TO:
  1.779 2+,0 DT=0  E2 0.105E+02 +- 0.23E+01

  6.276 3+,0     TO:
  1.779 2+,0 DT=0  M1 0.266E-03 +- 0.27E-04  E2 0.662E-01 +- 0.66E-02
  4.618 4+,0 DT=0  M1 0.430E-03 +- 0.52E-04  E2 0.788E+00 +- 0.95E-01

  6.691 0+,0     TO:
  1.779 2+,0 DT=0  E2 0.552E+00 +- 0.14E+00

  6.879 3-,0     TO:
  0.000 0+,0 DT=0  E3 0.128E+02 +- 0.16E+01
  1.779 2+,0 DT=0  E1 0.104E-05 +- 0.14E-06  M2 0.182E+00 +- 0.25E-01
  4.618 4+,0 DT=0  E1 0.109E-05 +- 0.29E-06  M2 0.966E+00 +- 0.26E+00

  6.889 4+,0     TO:
  1.779 2+,0 DT=0  E2 0.101E+01 +- 0.20E+00  M3 0.278E+06 +- 0.56E+05

  7.381 2+,0     TO:
  0.000 0+,0 DT=0  E2 0.338E+00 +- 0.86E-01
  1.779 2+,0 DT=0  M1 0.139E-01 +- 0.35E-02  E2 0.224E+01 +- 0.56E+00

  7.417 2+,0     TO:
  0.000 0+,0 DT=0  E2 0.244E+00 +- 0.47E-01
  1.779 2+,0 DT=0  M1 0.202E-03 +- 0.14E-03  E2 0.320E-01 +- 0.23E-01
  4.979 0+,0 DT=0  E2 0.494E+01 +- 0.17E+01

  7.799 3+,0     TO:
  1.779 2+,0 DT=0  M1 0.503E-03 +- 0.88E-04  E2 0.699E-01 +- 0.12E-01
  4.618 4+,0 DT=0  M1 0.487E-04 +- 0.22E-04  E2 0.243E-01 +- 0.11E-01
  6.276 3+,0 DT=0  M1 0.129E-01 +- 0.23E-02  E2 0.280E+02 +- 0.50E+01

  7.933 2+,0     TO:
  0.000 0+,0 DT=0  E2 0.458E+00 +- 0.31E+00
  1.779 2+,0 DT=0  M1 0.672E-03 +- 0.57E-03  E2 0.895E-01 +- 0.76E-01
  4.618 4+,0 DT=0  E2 0.342E+01 +- 0.24E+01  M3 0.224E+07 +- 0.16E+07
  4.979 0+,0 DT=0  E2 0.445E+01 +- 0.33E+01

  8.259 2+,0     TO:
  0.000 0+,0 DT=0  E2 0.142E-01 +- 0 55E-02
  1.779 2+,0 DT=0  M1 0.310E-02 +- 0.11E-02  E2 0.372E+00 +- 0.13E+00
  4.618 4+,0 DT=0  E2 0.380E+00 +- 0.17E+00  M3 0.206E+06 +- 0.90E+05
  4.979 0+,0 DT=0  E2 0.272E+01 +- 0.96E+00

  8.328 1+,0     TO:
  0.000 0+,0 DT=0  M1 0.103E-03 +- 0.21E-04
  1.779 2+,0 DT=0  M1 0.822E-04 +- 0.20E-04  E2 0.966E-02 +- 0.24E-02
```

TABLE 8 *(continuation)*

8.413	4-,0	TO:								
1.779	2+,0	DT=0	M2	0.204E+00	+-	0.54E-01	E3	0.355E+02	+-	0.95E+01
4.618	4+,0	DT=0	E1	0.192E-05	+-	0.88E-06	M2	0.605E+00	+-	0.28E+00
6.879	3-,0	DT=0	M1	0.161E-01	+-	0.40E-02	E2	0.344E+02	+-	0.87E+01
8.543	6+,0	TO:								
4.618	4+,0	DT=0	E2	0.130E+02	+-	0.10E+02	M3	0.610E+07	+-	0.47E+07
8.589	3+,0	TO:								
1.779	2+,0	DT=0	M1	0.186E-01	+-	0.75E-02	E2	0.202E+01	+-	0.81E+00
6.276	3+,0	DT=0	M1	0.319E-01	+-	0.17E-01	E2	0.301E+02	+-	0.16E+02
8.904	1-,0	TO:								
0.000	0+,0	DT=0	E1	0.635E-04	+-	0.18E-04				
1.779	2+,0	DT=0	E1	0.140E-03	+-	0.39E-04	M2	0.125E+02	+-	0.35E+01
9.316	3+,1	TO:								
1.779	2+,0	DT=1	M1	0.532E-02	+-	0.27E-02	E2	0.472E+00	+-	0.24E+00
6.276	3+,0	DT=1	M1	0.305E-01	+-	0.15E-01	E2	0.166E+02	+-	0.83E+01
9.381	2+,1	TO:								
0.000	0+,0	DT=1	E2	0.870E-02	+-	0.73E-02				
1.779	2+,0	DT=1	M1	0.134E-01	+-	0.81E-02	E2	0.117E+01	+-	0.70E+00
6.276	3+,0	DT=1	M1	0.838E-02	+-	0.56E-02	E2	0.438E+01	+-	0.29E+01
9.702	5-,0	TO:								
1.779	2+,0	DT=0	E3	0.233E+00	+-	0.12E+00	M4	0.406E+05	+-	0.20E+05
4.618	4+,0	DT=0	E1	0.150E-06	+-	0.75E-07	M2	0.263E-01	+-	0.13E-01
6.879	3-,0	DT=0	E2	0.253E-01	+-	0.13E-01	M3	0.229E+05	+-	0.12E+05
6.889	4+,0	DT=0	E1	0.413E-06	+-	0.21E-06	M2	0.236E+00	+-	0.12E+00
8.413	4-,0	DT=0	M1	0.823E-03	+-	0.41E-03	E2	0.250E+01	+-	0.13E+01
10.180	3-,0	TO:								
1.779	2+,0	DT=0	E1	0.443E-04	+-	0.20E-04	M2	0.284E+01	+-	0.13E+01
4.618	4+,0	DT=0	E1	0.458E-03	+-	0.19E-03	M2	0.671E+02	+-	0.27E+02
10.418	3+,0	TO:								
4.618	4+,0	DT=0	M1	0.892E-03	+-	0.41E-03	E2	0.134E+00	+-	0.61E-01
6.276	3+,0	DT=0	M1	0.139E-01	+-	0.42E-02	E2	0.408E+01	+-	0.12E+01
10.669	3+,0	TO:								
1.779	2+,0	DT=0	M1	0.122E-03	+-	0.58E-04	E2	0.776E-02	+-	0.37E-02
6.276	3+,0	DT=0	M1	0.387E-02	+-	0.15E-02	E2	0.101E+01	+-	0.40E+00
7.933	2+,0	DT=0	M1	0.626E-02	+-	0.25E-02	E2	0.422E+01	+-	0.17E+01
8.589	3+,0	DT=0	M1	0.111E-01	+-	0.48E-02	E2	0.129E+02	+-	0.56E+01
9.316	3+,1	DT=1	M1	0.115E+00	+-	0.39E-01	E2	0.317E+03	+-	0.11E+03
9.381	2+,1	DT=1	M1	0.333E-01	+-	0.18E-01	E2	0.101E+03	+-	0.53E+02
10.901	1+,1	TO:								
0.000	0+,0	DT=1	M1	0.229E+00	+-	0.30E-01				
1.779	2+,0	DT=1	M1	0.184E+00	+-	0.29E-01	E2	0.111E+02	+-	0.17E+01
11.445	1+,1	TO:								
0.000	0+,0	DT=1	M1	0.774E+00	+-	0.86E-01				
12.072	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.711E-01	+-	0.23E-01				
1.779	2+,0	DT=0	M1	0.844E-03	+-	0.27E-03	E2	0.401E-01	+-	0.13E-01
4.618	4+,0	DT=0	E2	0.403E-01	+-	0.15E-01	M3	0.523E+04	+-	0.19E+04
4.979	0+,0	DT=0	E2	0.148E-01	+-	0.89E-02				

TABLE 8 *(continuation)*

```
 6.276 3+,0 DT=0   M1 0.979E-03 +- 0.36E-03   E2 0.147E+00 +- 0.54E-01
 6.889 4+,0 DT=0   E2 0.620E+00 +- 0.23E+00   M3 0.166E+06 +- 0.61E+05
 7.381 2+,0 DT=0   M1 0.509E-03 +- 0.31E-03   E2 0.117E+00 +- 0.71E-01
 7.417 2+,0 DT=0   M1 0.111E-02 +- 0.67E-03   E2 0.258E+00 +- 0.16E+00
 7.799 3+,0 DT=0   M1 0.160E-02 +- 0.97E-03   E2 0.442E+00 +- 0.27E+00
 7.933 2+,0 DT=0   M1 0.148E-02 +- 0.90E-03   E2 0.436E+00 +- 0.26E+00
 8.259 2+,0 DT=0   M1 0.178E-02 +- 0.11E-02   E2 0.616E+00 +- 0.37E+00
 8.589 3+,0 DT=0   M1 0.264E-02 +- 0.16E-02   E2 0.110E+01 +- 0.66E+00
 9.316 3+,1 DT=1   M1 0.157E-02 +- 0.95E-03   E2 0.104E+01 +- 0.63E+00
 9.381 2+,1 DT=1   M1 0.472E-02 +- 0.29E-02   E2 0.329E+01 +- 0.20E+01

12.195 3-,0      TO:
 0.000 0+,0 DT=0   E3 0.105E+01 +- 0.55E+00
 1.779 2+,0 DT=0   E1 0.780E-03 +- 0.14E-03   M2 0.326E+02 +- 0.59E+01
 4.618 4+,0 DT=0   E1 0.416E-03 +- 0.76E-04   M2 0.329E+02 +- 0.60E+01
 6.276 3+,0 DT=0   E1 0.873E-04 +- 0.46E-04   M2 0.113E+02 +- 0.60E+01
 6.879 3-,0 DT=0   M1 0.840E-02 +- 0.21E-02   E2 0.150E+01 +- 0.38E+00
 6.889 4+,0 DT=0   E1 0.113E-03 +- 0.60E-04   M2 0.182E+02 +- 0.96E+01
 7.933 2+,0 DT=0   E1 0.780E-04 +- 0.41E-04   M2 0.195E+02 +- 0.10E+02
 8.259 2+,0 DT=0   E1 0.139E-03 +- 0.73E-04   M2 0.406E+02 +- 0.21E+02
 8.413 4-,0 DT=0   M1 0.800E-02 +- 0.42E-02   E2 0.282E+01 +- 0.15E+01
 8.904 1-,0 DT=0   E2 0.282E+01 +- 0.15E+01   M3 0.188E+07 +- 0.99E+06
 9.316 3+,1 DT=1   E1 0.152E-03 +- 0.80E-04   M2 0.830E+02 +- 0.44E+02
 9.381 2+,1 DT=1   E1 0.119E-02 +- 0.30E-03   M2 0.683E+03 +- 0.17E+03

12.217 2-,0      TO:
 0.000 0+,0 DT=0   M2 0.234E+00 +- 0.85E-01
 1.779 2+,0 DT=0   E1 0.258E-03 +- 0.82E-04   M2 0.107E+02 +- 0.34E+01
 6.276 3+,0 DT=0   E1 0.128E-03 +- 0.47E-04   M2 0.164E+02 +- 0.60E+01
 6.879 3-,0 DT=0   M1 0.175E-02 +- 0.11E-02   E2 0.310E+00 +- 0.19E+00
 7.417 2+,0 DT=0   E1 0.127E-03 +- 0.46E-04   M2 0.250E+02 +- 0.91E+01
 7.933 2+,0 DT=0   E1 0.495E-03 +- 0.18E-03   M2 0.122E+03 +- 0.45E+02
 8.259 2+,0 DT=0   E1 0.165E-03 +- 0.99E-04   M2 0.476E+02 +- 0.29E+02
 8.328 1+,0 DT=0   E1 0.108E-03 +- 0.65E-04   M2 0.325E+02 +- 0.20E+02
 8.413 4-,0 DT=0   E2 0.964E+00 +- 0.58E+00   M3 0.480E+06 +- 0.29E+06
 8.589 3+,0 DT=0   E1 0.401E-03 +- 0.15E-03   M2 0.138E+03 +- 0.50E+02
 8.904 1-,0 DT=0   M1 0.210E-02 +- 0.13E-02   E2 0.962E+00 +- 0.58E+00
 9.316 3+,1 DT=1   E1 0.523E-03 +- 0.31E-03   M2 0.282E+03 +- 0.17E+03
 9.381 2+,1 DT=1   E1 0.783E-02 +- 0.25E-02   M2 0.441E+04 +- 0.14E+04

12.240 3+,0      TO:
 0.000 0+,0 DT=0   M3 0.600E+01 +- 0.36E+01
 1.779 2+,0 DT=0   M1 0.256E-02 +- 0.81E-03   E2 0.118E+00 +- 0.37E-01
 4.618 4+,0 DT=0   M1 0.399E-02 +- 0.13E-02   E2 0.347E+00 +- 0.11E+00
 6.889 4+,0 DT=0   M1 0.622E-03 +- 0.37E-03   E2 0.109E+00 +- 0.66E-01
 7.381 2+,0 DT=0   M1 0.474E-03 +- 0.29E-03   E2 0.101E+00 +- 0.61E-01
 7.417 2+,0 DT=0   M1 0.127E-01 +- 0.40E-02   E2 0.276E+01 +- 0.88E+00
 7.933 2+,0 DT=0   M1 0.511E-03 +- 0.31E-03   E2 0.139E+00 +- 0.84E-01
 8.413 4-,0 DT=0   E1 0.366E-04 +- 0.22E-04   M2 0.113E+02 +- 0.68E+01
 8.589 3+,0 DT=0   M1 0.419E-03 +- 0.25E-03   E2 0.159E+00 +- 0.95E-01
 9.480 2+,0 DT=0   M1 0.971E-03 +- 0.58E-03   E2 0.642E+00 +- 0.39E+00

12.291 2+,0      TO:
 0.000 0+,0 DT=0   E2 0.145E-02 +- 0.87E-03
 1.779 2+,0 DT=0   M1 0.683E-02 +- 0.21E-02   E2 0.312E+00 +- 0.97E-01
 4.618 4+,0 DT=0   E2 0.123E-01 +- 0.73E-02   M3 0.150E+04 +- 0.90E+03
 4.979 0+,0 DT=0   E2 0.508E-01 +- 0.30E-01
 6.276 3+,0 DT=0   M1 0.231E-02 +- 0.83E-03   E2 0.321E+00 +- 0.12E+00
 6.691 0+,0 DT=0   E2 0.356E+00 +- 0.13E+00
 7.933 2+,0 DT=0   M1 0.176E-02 +- 0.11E-02   E2 0.467E+00 +- 0.28E+00
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TABLE 8 *(continuation)*

8.328	1+,0	DT=0	M1	0.156E-02	+-	0.93E-03	E2	0.501E+00	+-	0.30E+00
8.589	3+,0	DT=0	M1	0.223E-02	+-	0.13E-02	E2	0.822E+00	+-	0.49E+00
9.316	3+,1	DT=1	M1	0.603E-01	+-	0.22E-01	E2	0.343E+02	+-	0.12E+02
9.381	2+,1	DT=1	M1	0.204E+00	+-	0.64E-01	E2	0.121E+03	+-	0.38E+02
2.295	3+,0	TO:								
1.779	2+,0	DT=0	M1	0.120E-01	+-	0.40E-02	E2	0.545E+00	+-	0.18E+00
4.618	4+,0	DT=0	M1	0.758E-02	+-	0.26E-02	E2	0.648E+00	+-	0.22E+00
6.889	4+,0	DT=0	M1	0.723E-03	+-	0.45E-03	E2	0.125E+00	+-	0.77E-01
7.381	2+,0	DT=0	M1	0.369E-02	+-	0.14E-02	E2	0.771E+00	+-	0.30E+00
7.417	2+,0	DT=0	M1	0.377E-02	+-	0.14E-02	E2	0.800E+00	+-	0.31E+00
7.799	3+,0	DT=0	M1	0.147E-02	+-	0.90E-03	E2	0.366E+00	+-	0.23E+00
7.933	2+,0	DT=0	M1	0.689E-03	+-	0.42E-03	E2	0.182E+00	+-	0.11E+00
8.328	1+,0	DT=0	E2	0.293E+00	+-	0.18E+00	M3	0.134E+06	+-	0.83E+05
9.316	3+,1	DT=1	M1	0.144E-01	+-	0.89E-02	E2	0.818E+01	+-	0.50E+01
9.381	2+,1	DT=1	M1	0.385E-02	+-	0.24E-02	E2	0.228E+01	+-	0.14E+01
12.331	1+,1	TO:								
0.000	0+,0	DT=1	M1	0.603E-01	+-	0.19E-01				
1.779	2+,0	DT=1	M1	0.809E-02	+-	0.30E-02	E2	0.366E+00	+-	0.14E+00
6.691	0+,0	DT=1	M1	0.269E-01	+-	0.19E-01				
7.381	2+,0	DT=1	M1	0.118E+00	+-	0.44E-01	E2	0.243E+02	+-	0.90E+01
7.417	2+,0	DT=1	M1	0.127E-01	+-	0.77E-02	E2	0.265E+01	+-	0.16E+01
7.933	2+,0	DT=1	M1	0.496E-01	+-	0.18E-01	E2	0.129E+02	+-	0.48E+01
8.328	1+,0	DT=1	M1	0.353E-01	+-	0.21E-01	E2	0.111E+02	+-	0.67E+01
12.439	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.345E-01	+-	0.12E-01				
1.779	2+,0	DT=0	M1	0.112E-03	+-	0.43E-04	E2	0.497E-02	+-	0.19E-02
4.618	4+,0	DT=0	E2	0.173E-01	+-	0.67E-02	M3	0.204E+04	+-	0.78E+03
6.276	3+,0	DT=0	M1	0.177E-03	+-	0.11E-03	E2	0.234E-01	+-	0.14E-01
6.889	4+,0	DT=0	E2	0.396E-01	+-	0.24E-01	M3	0.926E+04	+-	0.57E+04
7.417	2+,0	DT=0	M1	0.932E-04	+-	0.57E-04	E2	0.186E-01	+-	0.11E-01
7.799	3+,0	DT=0	M1	0.166E-02	+-	0.64E-03	E2	0.387E+00	+-	0.15E+00
7.933	2+,0	DT=0	M1	0.194E-03	+-	0.12E-03	E2	0.481E-01	+-	0.30E-01
8.328	1+,0	DT=0	M1	0.255E-03	+-	0.16E-03	E2	0.760E-01	+-	0.47E-01
9.316	3+,1	DT=1	M1	0.107E-01	+-	0.36E-02	E2	0.551E+01	+-	0.19E+01
9.381	2+,1	DT=1	M1	0.929E-03	+-	0.57E-03	E2	0.501E+00	+-	0.31E+00
12.475	4+,0	TO:								
1.779	2+,0	DT=0	E2	0.572E+00	+-	0.18E+00	M3	0.360E+05	+-	0.12E+05
4.618	4+,0	DT=0	M1	0.720E-03	+-	0.43E-03	E2	0.588E-01	+-	0.36E-01
6.276	3+,0	DT=0	M1	0.733E-03	+-	0.44E-03	E2	0.961E-01	+-	0.58E-01
7.381	2+,0	DT=0	E2	0.770E-01	+-	0.46E-01	M3	0.214E+05	+-	0.13E+05
7.417	2+,0	DT=0	E2	0.186E+00	+-	0.11E+00	M3	0.524E+05	+-	0.32E+05
7.799	3+,0	DT=0	M1	0.239E-02	+-	0.14E-02	E2	0.551E+00	+-	0.33E+00
7.933	2+,0	DT=0	E2	0.455E+00	+-	0.27E+00	M3	0.159E+06	+-	0.96E+05
8.259	2+,0	DT=0	E2	0.727E+00	+-	0.44E+00	M3	0.295E+06	+-	0.18E+06
8.589	3+,0	DT=0	M1	0.595E-03	+-	0.36E-03	E2	0.199E+00	+-	0.12E+00
9.316	3+,1	DT=1	M1	0.166E-02	+-	0.10E-02	E2	0.839E+00	+-	0.51E+00
12.489	3-,0	TO:								
0.000	0+,0	DT=0	E3	0.100E+01	+-	0.60E+00				
1.779	2+,0	DT=0	E1	0.267E-03	+-	0.85E-04	M2	0.106E+02	+-	0.34E+01
4.618	4+,0	DT=0	E1	0.266E-03	+-	0.85E-04	M2	0.195E+02	+-	0.62E+01
6.276	3+,0	DT=0	E1	0.200E-03	+-	0.73E-04	M2	0.234E+02	+-	0.86E+01
6.879	3-,0	DT=0	M1	0.185E-01	+-	0.59E-02	E2	0.296E+01	+-	0.94E+00
7.381	2+,0	DT=0	E1	0.154E-03	+-	0.56E-04	M2	0.267E+02	+-	0.98E+01
8.413	4-,0	DT=0	M1	0.723E-02	+-	0.26E-02	E2	0.219E+01	+-	0.80E+00
9.381	2+,1	DT=1	E1	0.797E-03	+-	0.29E-03	M2	0.374E+03	+-	0.14E+03

TABLE 8 *(continuation)*

(5)

12.542	3+,1	TO:								
1.779	2+,0	DT=1	M1	0.125E+00	+-	0.42E-01	E2	0.545E+01	+-	0.18E+01
4.618	4+,0	DT=1	M1	0.208E-01	+-	0.80E-02	E2	0.167E+01	+-	0.64E+00
6.276	3+,0	DT=1	M1	0.206E-01	+-	0.79E-02	E2	0.264E+01	+-	0.10E+01
6.879	3-,0	DT=1	E1	0.233E-03	+-	0.14E-03	M2	0.330E+02	+-	0.20E+02
6.889	4+,0	DT=1	M1	0.350E-02	+-	0.22E-02	E2	0.552E+00	+-	0.34E+00
7.799	3+,0	DT=1	M1	0.192E+00	+-	0.74E-01	E2	0.430E+02	+-	0.17E+02
7.933	2+,0	DT=1	M1	0.905E-01	+-	0.35E-01	E2	0.215E+02	+-	0.83E+01
8.589	3+,0	DT=1	M1	0.102E-01	+-	0.63E-02	E2	0.330E+01	+-	0.20E+01
9.480	2+,0	DT=1	M1	0.955E-01	+-	0.59E-01	E2	0.513E+02	+-	0.32E+02
12.552	4+,0	TO:								
1.779	2+,0	DT=0	E2	0.612E-01	+-	0.20E-01	M3	0.380E+04	+-	0.12E+04
4.618	4+,0	DT=0	M1	0.138E-03	+-	0.51E-04	E2	0.110E-01	+-	0.41E-02
6.276	3+,0	DT=0	M1	0.534E-03	+-	0.20E-03	E2	0.684E-01	+-	0.25E-01
6.889	4+,0	DT=0	M1	0.379E-03	+-	0.14E-03	E2	0.595E-01	+-	0.22E-01
7.381	2+,0	DT=0	E2	0.150E+00	+-	0.56E-01	M3	0.404E+05	+-	0.15E+05
7.417	2+,0	DT=0	E2	0.388E+00	+-	0.14E+00	M3	0.106E+06	+-	0.39E+05
7.799	3+,0	DT=0	M1	0.102E-03	+-	0.62E-04	E2	0.229E-01	+-	0.14E-01
7.933	2+,0	DT=0	E2	0.343E+00	+-	0.13E+00	M3	0.116E+06	+-	0.43E+05
8.259	2+,0	DT=0	E2	0.304E+00	+-	0.11E+00	M3	0.119E+06	+-	0.44E+05
9.316	3+,1	DT=1	M1	0.893E-03	+-	0.54E-03	E2	0.430E+00	+-	0.26E+00
12.664	4-,1	TO:								
1.779	2+,0	DT=1	M2	0.936E-01	+-	0.57E-01	E3	0.606E+01	+-	0.37E+01
4.618	4+,0	DT=1	E1	0.242E-04	+-	0.15E-04	M2	0.170E+01	+-	0.10E+01
6.276	3+,0	DT=1	E1	0.175E-02	+-	0.56E-03	M2	0.195E+03	+-	0.63E+02
6.879	3-,0	DT=1	M1	0.170E-02	+-	0.10E-02	E2	0.256E+00	+-	0.15E+00
6.889	4+,0	DT=1	E1	0.409E-03	+-	0.15E-03	M2	0.557E+02	+-	0.21E+02
8.413	4-,0	DT=1	M1	0.276E+00	+-	0.89E-01	E2	0.769E+02	+-	0.25E+02
8.589	3+,0	DT=1	E1	0.326E-02	+-	0.10E-02	M2	0.891E+03	+-	0.29E+03
9.702	5-,0	DT=1	M1	0.272E-01	+-	0.16E-01	E2	0.156E+02	+-	0.94E+01
12.726	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.127E+00	+-	0.39E-01				
1.779	2+,0	DT=0	M1	0.234E-02	+-	0.71E-03	E2	0.983E-01	+-	0.30E-01
4.979	0+,0	DT=0	E2	0.145E+00	+-	0.51E-01				
6.276	3+,0	DT=0	M1	0.646E-03	+-	0.38E-03	E2	0.783E-01	+-	0.46E-01
6.879	3-,0	DT=0	E1	0.536E-04	+-	0.19E-04	M2	0.711E+01	+-	0.25E+01
7.381	2+,0	DT=0	M1	0.349E-03	+-	0.21E-03	E2	0.616E-01	+-	0.37E-01
7.933	2+,0	DT=0	M1	0.727E-03	+-	0.43E-03	E2	0.159E+00	+-	0.95E-01
8.259	2+,0	DT=0	M1	0.299E-03	+-	0.18E-03	E2	0.756E-01	+-	0.45E-01
8.589	3+,0	DT=0	M1	0.942E-03	+-	0.56E-03	E2	0.277E+00	+-	0.16E+00
9.316	3+,1	DT=1	M1	0.773E-02	+-	0.27E-02	E2	0.335E+01	+-	0.12E+01
9.381	2+,1	DT=1	M1	0.107E-02	+-	0.63E-03	E2	0.481E+00	+-	0.29E+00
12.742	3-,1	TO:								
0.000	0+,0	DT=1	E3	0.814E+00	+-	0.50E+00				
1.779	2+,0	DT=1	E1	0.968E-04	+-	0.33E-04	M2	0.365E+01	+-	0.12E+01
6.276	3+,0	DT=1	E1	0.637E-03	+-	0.22E-03	M2	0.691E+02	+-	0.23E+02
6.879	3-,0	DT=1	M1	0.217E-01	+-	0.74E-02	E2	0.319E+01	+-	0.11E+01
7.417	2+,0	DT=1	E1	0.127E-03	+-	0.49E-04	M2	0.203E+02	+-	0.78E+01
7.799	3+,0	DT=1	E1	0.169E-03	+-	0.65E-04	M2	0.314E+02	+-	0.12E+02
7.933	2+,0	DT=1	E1	0.402E-03	+-	0.15E-03	M2	0.787E+02	+-	0.30E+02
8.413	4-,0	DT=1	M1	0.258E-02	+-	0.16E-02	E2	0.695E+00	+-	0.43E+00
8.589	3+,0	DT=1	E1	0.232E-03	+-	0.89E-04	M2	0.609E+02	+-	0.23E+02
9.316	3+,1	DT=0	E1	0.571E-03	+-	0.22E-03	M2	0.221E+03	+-	0.85E+02
9.381	2+,1	DT=0	E1	0.571E-03	+-	0.22E-03	M2	0.229E+03	+-	0.88E+02
9.702	5-,0	DT=1	E2	0.370E+01	+-	0.23E+01	M3	0.288E+07	+-	0.18E+07

TABLE 8 *(continuation)*

10.180	3-,0	DT=1	M1	0.453E-02	+-	0.28E-02	E2	0.348E+01	+-	0.21E+01
12.802	3-,0	TO:								
0.000	0+,0	DT=0	E3	0.115E+01	+-	0.71E+00				
1.779	2+,0	DT=0	E1	0.286E-03	+-	0.96E-04	M2	0.107E+02	+-	0.36E+01
4.618	4+,0	DT=0	E1	0.835E-04	+-	0.32E-04	M2	0.565E+01	+-	0.21E+01
6.276	3+,0	DT=0	E1	0.403E-04	+-	0.25E-04	M2	0.429E+01	+-	0.26E+01
6.879	3-,0	DT=0	M1	0.470E-01	+-	0.16E-01	E2	0.675E+01	+-	0.23E+01
6.889	4+,0	DT=0	E1	0.122E-03	+-	0.46E-04	M2	0.158E+02	+-	0.60E+01
7.417	2+,0	DT=0	E1	0.419E-03	+-	0.16E-03	M2	0.655E+02	+-	0.25E+02
8.413	4-,0	DT=0	M1	0.825E-02	+-	0.31E-02	E2	0.216E+01	+-	0.82E+00
9.316	3+,1	DT=1	E1	0.221E-03	+-	0.14E-03	M2	0.823E+02	+-	0.50E+02
9.381	2+,1	DT=1	E1	0.303E-03	+-	0.19E-03	M2	0.117E+03	+-	0.72E+02
12.817	4+,0	TO:								
1.779	2+,0	DT=0	E2	0.132E-02	+-	0.48E-03	M3	0.784E+02	+-	0.28E+02
4.618	4+,0	DT=0	M1	0.817E-03	+-	0.26E-03	E2	0.613E-01	+-	0.19E-01
6.276	3+,0	DT=0	M1	0.147E-03	+-	0.53E-04	E2	0.173E-01	+-	0.63E-02
6.889	4+,0	DT=0	M1	0.197E-02	+-	0.62E-03	E2	0.283E+00	+-	0.89E-01
8.543	6+,0	DT=0	E2	0.208E+00	+-	0.75E-01	M3	0.819E+05	+-	0.30E+05
8.589	3+,0	DT=0	M1	0.570E-02	+-	0.18E-02	E2	0.161E+01	+-	0.51E+00
12.855	4+,0	TO:								
1.779	2+,0	DT=0	E2	0.102E+00	+-	0.33E-01	M3	0.598E+04	+-	0.19E+04
4.618	4+,0	DT=0	M1	0.602E-02	+-	0.19E-02	E2	0.447E+00	+-	0.14E+00
6.276	3+,0	DT=0	M1	0.473E-01	+-	0.15E-01	E2	0.550E+01	+-	0.18E+01
6.879	3-,0	DT=0	E1	0.660E-04	+-	0.40E-04	M2	0.838E+01	+-	0.51E+01
6.889	4+,0	DT=0	M1	0.792E-02	+-	0.29E-02	E2	0.112E+01	+-	0.41E+00
7.381	2+,0	DT=0	E2	0.144E+00	+-	0.87E-01	M3	0.346E+05	+-	0.21E+05
7.417	2+,0	DT=0	E2	0.149E+00	+-	0.90E-01	M3	0.362E+05	+-	0.22E+05
7.799	3+,0	DT=0	M1	0.117E-01	+-	0.43E-02	E2	0.231E+01	+-	0.85E+00
8.589	3+,0	DT=0	M1	0.686E-02	+-	0.41E-02	E2	0.190E+01	+-	0.11E+01
9.316	3+,1	DT=1	M1	0.392E-01	+-	0.14E-01	E2	0.158E+02	+-	0.58E+01
10.418	3+,0	DT=0	M1	0.581E-02	+-	0.35E-02	E2	0.493E+01	+-	0.30E+01
10.668	3+,0	DT=0	M1	0.107E+00	+-	0.39E-01	E2	0.113E+03	+-	0.41E+02
12.901	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.134E-01	+-	0.38E-02				
1.779	2+,0	DT=0	M1	0.443E-02	+-	0.99E-03	E2	0.181E+00	+-	0.41E-01
4.618	4+,0	DT=0	E2	0.197E+00	+-	0.56E-01	M3	0.207E+05	+-	0.59E+04
6.276	3+,0	DT=0	M1	0.151E-01	+-	0.34E-02	E2	0.173E+01	+-	0.39E+00
6.889	4+,0	DT=0	E2	0.733E+00	+-	0.21E+00	M3	0.146E+06	+-	0.42E+05
7.417	2+,0	DT=0	M1	0.231E-02	+-	0.13E-02	E2	0.387E+00	+-	0.21E+00
7.799	3+,0	DT=0	M1	0.574E-02	+-	0.16E-02	E2	0.111E+01	+-	0.32E+00
7.933	2+,0	DT=0	M1	0.155E-02	+-	0.85E-03	E2	0.317E+00	+-	0.17E+00
8.413	4-,0	DT=0	M2	0.159E+02	+-	0.87E+01	E3	0.605E+04	+-	0.33E+04
8.589	3+,0	DT=0	M1	0.475E-02	+-	0.26E-02	E2	0.129E+01	+-	0.71E+00
9.316	3+,1	DT=1	M1	0.248E-01	+-	0.71E-02	E2	0.973E+01	+-	0.28E+01
9.381	2+,1	DT=1	M1	0.437E-01	+-	0.12E-01	E2	0.178E+02	+-	0.51E+01
12.917	2+,1	TO:								
1.779	2+,0	DT=1	M1	0.150E+00	+-	0.49E-01	E2	0.609E+01	+-	0.20E+01
4.618	4+,0	DT=1	E2	0.212E+01	+-	0.79E+00	M3	0.222E+06	+-	0.83E+05
6.276	3+,0	DT=1	M1	0.471E-01	+-	0.18E-01	E2	0.539E+01	+-	0.20E+01
6.889	4+,0	DT=1	E2	0.175E+01	+-	0.11E+01	M3	0.347E+06	+-	0.21E+06
7.381	2+,0	DT=1	M1	0.814E-02	+-	0.50E-02	E2	0.134E+01	+-	0.81E+00
7.417	2+,0	DT=1	M1	0.531E-01	+-	0.20E-01	E2	0.885E+01	+-	0.33E+01
7.799	3+,0	DT=1	M1	0.268E-01	+-	0.16E-01	E2	0.515E+01	+-	0.31E+01
8.259	2+,0	DT=1	M1	0.246E-01	+-	0.15E-01	E2	0.571E+01	+-	0.35E+01
8.589	3+,0	DT=1	M1	0.988E-01	+-	0.37E-01	E2	0.266E+02	+-	0.10E+02

TABLE 8 *(continuation)*

9.480	2+,0	DT=1	M1	0.748E-01	+-	0.46E-01	E2	0.319E+02	+-	0.19E+02
10.668	3+,0	DT=1	M1	0.243E+00	+-	0.15E+00	E2	0.242E+03	+-	0.15E+03
12.924	2+,1	TO:								
0.000	0+,0	DT=1	E2	0.306E-02	+-	0.19E-02				
1.779	2+,0	DT=1	M1	0.125E+00	+-	0.40E-01	E2	0.537E+01	+-	0.16E+01
4.618	4+,0	DT=1	E2	0.587E+00	+-	0.22E+00	M3	0.613E+05	+-	0.23E+05
6.276	3+,0	DT=1	M1	0.373E-01	+-	0.14E-01	E2	0.425E+01	+-	0.16E+01
6.691	0+,0	DT=1	E2	0.235E+00	+-	0.14E+00				
6.879	3-,0	DT=1	E1	0.166E-03	+-	0.10E-03	M2	0.206E+02	+-	0.12E+02
6.889	4+,0	DT=1	E2	0.138E+01	+-	0.83E+00	M3	0.273E+06	+-	0.17E+06
7.381	2+,0	DT=1	M1	0.386E-01	+-	0.14E-01	E2	0.633E+01	+-	0.23E+01
7.417	2+,0	DT=1	M1	0.262E-02	+-	0.16E-02	E2	0.436E+00	+-	0.26E+00
7.799	3+,0	DT=1	M1	0.130E-01	+-	0.79E-02	E2	0.250E+01	+-	0.15E+01
7.933	2+,0	DT=1	M1	0.529E-01	+-	0.20E-01	E2	0.107E+02	+-	0.39E+01
8.259	2+,0	DT=1	M1	0.324E-01	+-	0.20E-01	E2	0.750E+01	+-	0.45E+01
8.328	1+,0	DT=1	M1	0.677E-02	+-	0.41E-02	E2	0.162E+01	+-	0.98E+00
8.589	3+,0	DT=1	M1	0.296E-01	+-	0.18E-01	E2	0.793E+01	+-	0.48E+01
10.668	3+,0	DT=1	M1	0.763E-01	+-	0.46E-01	E2	0.756E+02	+-	0.46E+02
12.974	1-,0	TO:								
0.000	0+,0	DT=0	E1	0.779E-05	+-	0.40E-05				
1.779	2+,0	DT=0	E1	0.152E-05	+-	0.83E-06	M2	0.548E-01	+-	0.30E-01
4.979	0+,0	DT=0	E1	0.125E-04	+-	0.64E-05				
6.879	3-,0	DT=0	E2	0.761E-01	+-	0.42E-01	M3	0.148E+05	+-	0.81E+04
7.417	2+,0	DT=0	E1	0.124E-04	+-	0.68E-05	M2	0.182E+01	+-	0.10E+01
8.589	3+,0	DT=0	M2	0.595E+01	+-	0.33E+01	E3	0.237E+04	+-	0.13E+04
9.316	3+,1	DT=1	M2	0.147E+02	+-	0.81E+01	E3	0.844E+04	+-	0.46E+04
12.991	3-,0	TO:								
0.000	0+,0	DT=0	E3	0.514E+00	+-	0.31E+00				
1.779	2+,0	DT=0	E1	0.602E-05	+-	0.22E-05	M2	0.217E+00	+-	0.81E-01
4.618	4+,0	DT=0	E1	0.314E-04	+-	0.12E-04	M2	0.203E+01	+-	0.76E+00
6.276	3+,0	DT=0	E1	0.110E-04	+-	0.67E-05	M2	0.110E+01	+-	0.67E+00
6.879	3-,0	DT=0	M1	0.224E-02	+-	0.84E-03	E2	0.303E+00	+-	0.11E+00
7.799	3+,0	DT=0	E1	0.107E-03	+-	0.40E-04	M2	0.180E+02	+-	0.67E+01
7.933	2+,0	DT=0	E1	0.713E-05	+-	0.43E-05	M2	0.126E+01	+-	0.77E+00
8.413	4-,0	DT=0	M1	0.253E-02	+-	0.94E-03	E2	0.608E+00	+-	0.23E+00
8.589	3+,0	DT=0	E1	0.169E-03	+-	0.63E-04	M2	0.395E+02	+-	0.15E+02
9.316	3+,1	DT=1	E1	0.193E-02	+-	0.63E-03	M2	0.649E+03	+-	0.21E+03
13.034	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.572E-03	+-	0.34E-03				
1.779	2+,0	DT=0	M1	0.162E-02	+-	0.51E-03	E2	0.646E-01	+-	0.20E-01
4.618	4+,0	DT=0	E2	0.175E+00	+-	0.55E-01	M3	0.178E+05	+-	0.56E+04
6.276	3+,0	DT=0	M1	0.257E-03	+-	0.15E-03	E2	0.283E-01	+-	0.17E-01
6.879	3-,0	DT=0	E1	0.579E-04	+-	0.21E-04	M2	0.691E+01	+-	0.25E+01
6.889	4+,0	DT=0	E2	0.168E+00	+-	0.61E-01	M3	0.321E+05	+-	0.12E+05
7.381	2+,0	DT=0	M1	0.115E-02	+-	0.42E-03	E2	0.181E+00	+-	0.66E-01
7.417	2+,0	DT=0	M1	0.131E-02	+-	0.47E-03	E2	0.209E+00	+-	0.76E-01
7.799	3+,0	DT=0	M1	0.637E-03	+-	0.38E-03	E2	0.117E+00	+-	0.70E-01
7.933	2+,0	DT=0	M1	0.184E-02	+-	0.67E-03	E2	0.356E+00	+-	0.13E+00
8.259	2+,0	DT=0	M1	0.123E-02	+-	0.45E-03	E2	0.272E+00	+-	0.99E-01
8.413	4-,0	DT=0	M2	0.439E+01	+-	0.26E+01	E3	0.158E+04	+-	0.95E+03
9.316	3+,1	DT=1	M1	0.830E-03	+-	0.50E-03	E2	0.303E+00	+-	0.18E+00
9.381	2+,1	DT=1	M1	0.333E-02	+-	0.12E-02	E2	0.128E+01	+-	0.46E+00
9.480	2+,0	DT=0	M1	0.163E-02	+-	0.98E-03	E2	0.650E+00	+-	0.39E+00
13.051	2-,0	TO:								
0.000	0+,0	DT=0	M2	0.222E+00	+-	0.14E+00				

TABLE 8 *(continuation)*

1.779	2+,0	DT=0	E1	0.127E-02	+-	0.41E-03	M2	0.453E+02	+-	0.15E+02
6.276	3+,0	DT=0	E1	0.539E-04	+-	0.33E-04	M2	0.532E+01	+-	0.32E+01
6.879	3-,0	DT=0	M1	0.486E-01	+-	0.16E-01	E2	0.643E+01	+-	0.21E+01
7.381	2+,0	DT=0	E1	0.157E-03	+-	0.95E-04	M2	0.222E+02	+-	0.13E+02
7.799	3+,0	DT=0	E1	0.281E-03	+-	0.17E-03	M2	0.461E+02	+-	0.28E+02
7.933	2+,0	DT=0	E1	0.714E-04	+-	0.43E-04	M2	0.124E+02	+-	0.75E+01
8.328	1+,0	DT=0	E1	0.182E-03	+-	0.11E-03	M2	0.369E+02	+-	0.22E+02
13.104	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.202E-01	+-	0.36E-02				
1.779	2+,0	DT=0	M1	0.367E-03	+-	0.76E-04	E2	0.144E-01	+-	0.30E-02
6.276	3+,0	DT=0	M1	0.151E-02	+-	0.51E-03	E2	0.163E+00	+-	0.55E-01
6.879	3-,0	DT=0	E1	0.741E-04	+-	0.23E-04	M2	0.866E+01	+-	0.26E+01
7.799	3+,0	DT=0	M1	0.393E-02	+-	0.75E-03	E2	0.704E+00	+-	0.13E+00
8.413	4-,0	DT=0	M2	0.321E+01	+-	0.25E+01	E3	0.112E+04	+-	0.87E+03
8.589	3+,0	DT=0	M1	0.869E-02	+-	0.18E-02	E2	0.215E+01	+-	0.45E+00
9.316	3+,1	DT=1	M1	0.157E-01	+-	0.31E-02	E2	0.552E+01	+-	0.11E+01
13.108	3-,0	TO:								
4.618	4+,0	DT=0	E1	0.402E-05	+-	0.25E-05	M2	0.253E+00	+-	0.16E+00
8.543	6+,0	DT=0	E3	0.460E+04	+-	0.25E+04	M4	0.242E+10	+-	0.13E+10
10.180	3-,0	DT=0	M1	0.683E-02	+-	0.36E-02	E2	0.402E+01	+-	0.21E+01
13.173	3-,0	TO:								
0.000	0+,0	DT=0	E3	0.684E+00	+-	0.41E+00				
1.779	2+,0	DT=0	E1	0.107E-04	+-	0.34E-05	M2	0.373E+00	+-	0.12E+00
4.618	4+,0	DT=0	E1	0.516E-05	+-	0.19E-05	M2	0.320E+00	+-	0.12E+00
6.276	3+,0	DT=0	E1	0.298E-04	+-	0.95E-05	M2	0.284E+01	+-	0.91E+00
7.381	2+,0	DT=0	E1	0.697E-05	+-	0.42E-05	M2	0.941E+00	+-	0.57E+00
7.417	2+,0	DT=0	E1	0.986E-05	+-	0.36E-05	M2	0.135E+01	+-	0.50E+00
7.799	3+,0	DT=0	E1	0.344E-04	+-	0.13E-04	M2	0.540E+01	+-	0.20E+01
9.316	3+,1	DT=1	E1	0.301E-03	+-	0.97E-04	M2	0.918E+02	+-	0.29E+02
9.702	5-,0	DT=0	E2	0.427E+01	+-	0.14E+01	M3	0.255E+07	+-	0.82E+06
13.188	2+,1	TO:								
0.000	0+,0	DT=1	E2	0.722E-02	+-	0.45E-02				
1.779	2+,0	DT=1	M1	0.779E-01	+-	0.27E-01	E2	0.302E+01	+-	0.11E+01
6.276	3+,0	DT=1	M1	0.117E-01	+-	0.46E-02	E2	0.123E+01	+-	0.49E+00
7.381	2+,0	DT=1	M1	0.263E-01	+-	0.10E-01	E2	0.393E+01	+-	0.15E+01
7.799	3+,0	DT=1	M1	0.173E-01	+-	0.11E-01	E2	0.301E+01	+-	0.19E+01
7.933	2+,0	DT=1	M1	0.177E-01	+-	0.11E-01	E2	0.323E+01	+-	0.20E+01
8.259	2+,0	DT=1	M1	0.155E-01	+-	0.97E-02	E2	0.322E+01	+-	0.20E+01
10.668	3+,0	DT=1	M1	0.625E-01	+-	0.39E-01	E2	0.496E+02	+-	0.31E+02
13.248	5-,1	TO:								
0.000	0+,0	DT=1	E5	0.348E+07	+-	0.21E+07				
1.779	2+,0	DT=1	E3	0.174E+02	+-	0.10E+02	M4	0.145E+07	+-	0.87E+06
4.618	4+,0	DT=1	E1	0.325E-04	+-	0.20E-04	M2	0.198E+01	+-	0.12E+01
6.276	3+,0	DT=1	M2	0.646E+01	+-	0.39E+01	E3	0.102E+04	+-	0.61E+03
6.889	4+,0	DT=1	E1	0.436E-03	+-	0.16E-03	M2	0.489E+02	+-	0.18E+02
8.413	4-,0	DT=1	M1	0.241E-02	+-	0.15E-02	E2	0.520E+00	+-	0.31E+00
9.316	3+,1	DT=0	M2	0.755E+02	+-	0.45E+02	E3	0.375E+05	+-	0.23E+05
9.702	5-,0	DT=1	M1	0.743E+00	+-	0.24E+00	E2	0.298E+03	+-	0.95E+02
13.272	2-,0	TO:								
0.000	0+,0	DT=0	M2	0.169E+00	+-	0.10E+00				
1.779	2+,0	DT=0	E1	0.558E-03	+-	0.18E-03	M2	0.192E+02	+-	0.63E+01
7.933	2+,0	DT=0	E1	0.389E-03	+-	0.15E-03	M2	0.619E+02	+-	0.23E+02
9.316	3+,1	DT=1	E1	0.135E-02	+-	0.51E-03	M2	0.392E+03	+-	0.15E+03
9.381	2+,1	DT=1	E1	0.260E-03	+-	0.16E-03	M2	0.778E+02	+-	0.47E+02

TABLE 8 *(conclusion)*

13.361	3-,0	TO:								
0.000	0+,0	DT=0	E3	0.285E+01	+-	0.11E+01				
1.779	2+,0	DT=0	E1	0.305E-04	+-	0.99E-05	M2	0.103E+01	+-	0.34E+00
4.618	4+,0	DT=0	E1	0.111E-04	+-	0.41E-05	M2	0.657E+00	+-	0.24E+00
6.276	3+,0	DT=0	E1	0.425E-04	+-	0.16E-04	M2	0.384E+01	+-	0.14E+01
6.889	4+,0	DT=0	E1	0.645E-04	+-	0.24E-04	M2	0.698E+01	+-	0.26E+01
7.381	2+,0	DT=0	E1	0.152E-04	+-	0.92E-05	M2	0.193E+01	+-	0.12E+01
7.417	2+,0	DT=0	E1	0.226E-03	+-	0.73E-04	M2	0.290E+02	+-	0.94E+01
7.799	3+,0	DT=0	E1	0.275E-04	+-	0.17E-04	M2	0.404E+01	+-	0.24E+01
7.933	2+,0	DT=0	E1	0.333E-04	+-	0.20E-04	M2	0.513E+01	+-	0.31E+01
8.589	3+,0	DT=0	E1	0.51[illegible]E-04	+-	0.31E-04	M2	0.103E+02	+-	0.63E+01
9.316	3+,1	DT=1	E1	0.940E-03	+-	0.31E-03	M2	0.269E+03	+-	0.85E+02
13.417	1-,0	TO:								
0.000	0+,0	DT=0	E1	0.174E-04	+-	0.56E-05				
1.779	2+,0	DT=0	E1	0.245E-04	+-	0.78E-05	M2	0.820E+00	+-	0.26E+00
4.618	4+,0	DT=0	E3	0.568E+02	+-	0.21E+02	M4	0.803E+07	+-	0.30E+07
6.276	3+,0	DT=0	M2	0.137E+01	+-	0.50E+00	E3	0.206E+03	+-	0.76E+02
6.879	3-,0	DT=0	E2	0.199E+00	+-	0.73E-01	M3	0.335E+05	+-	0.12E+05
7.417	2+,0	DT=0	E1	0.146E-04	+-	0.88E-05	M2	0.184E+01	+-	0.11E+01
8.589	3+,0	DT=0	M2	0.546E+01	+-	0.33E+01	E3	0.180E+04	+-	0.11E+04
9.316	3+,1	DT=1	M2	0.261E+02	+-	0.96E+01	E3	0.119E+05	+-	0.44E+04
11.780	2+,0	DT=0	E1	0.152E-02	+-	0.56E-03	M2	0.257E+04	+-	0.95E+03
13.427	5+,0	TO:								
4.618	4+,0	DT=0	M1	0.189E-01	+-	0.61E-02	E2	0.123E+01	+-	0.40E+00
6.889	4+,0	DT=0	M1	0.144E-01	+-	0.47E-02	E2	0.170E+01	+-	0.55E+00
8.543	6+,0	DT=0	M1	0.364E-02	+-	0.22E-02	E2	0.770E+00	+-	0.47E+00
8.589	3+,0	DT=0	E2	0.121E+01	+-	0.45E+00	M3	0.373E+06	+-	0.14E+06
10.418	3+,0	DT=0	E2	0.217E+02	+-	0.80E+01	M3	0.172E+08	+-	0.64E+07
11.780	2+,0	DT=0	M3	0.586E+09	+-	0.22E+09	E4	0.254E+13	+-	0.94E+12
13.806	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.322E-02	+-	0.20E-02				
1.779	2+,0	DT=0	M1	0.552E-02	+-	0.19E-02	E2	0.192E+00	+-	0.67E-01
4.618	4+,0	DT=0	E2	0.600E+00	+-	0.21E+00	M3	0.513E+05	+-	0.18E+05
6.276	3+,0	DT=0	M1	0.178E-02	+-	0.70E-03	E2	0.158E+00	+-	0.62E-01
9.480	2+,0	DT=0	M1	0.371E-02	+-	0.23E-02	E2	0.998E+00	+-	0.62E+00
13.973	2+,0	TO:								
0.000	0+,0	DT=0	E2	0.721E-02	+-	0.54E-02				
1.779	2+,0	DT=0	M1	0.651E-02	+-	0.33E-02	E2	0.221E+00	+-	0.11E+00
4.618	4+,0	DT=0	E2	0.724E+00	+-	0.37E+00	M3	0.596E+05	+-	0.31E+05
6.276	3+,0	DT=0	M1	0.125E-01	+-	0.64E-02	E2	0.107E+01	+-	0.55E+00
7.381	2+,0	DT=0	M1	0.306E-02	+-	0.17E-02	E2	0.355E+00	+-	0.19E+00
8.328	1+,0	DT=0	M1	0.508E-02	+-	0.28E-02	E2	0.804E+00	+-	0.44E+00
8.589	3+,0	DT=0	M1	0.439E-01	+-	0.23E-01	E2	0.764E+01	+-	0.39E+01
9.316	3+,1	DT=1	M1	0.868E-02	+-	0.48E-02	E2	0.202E+01	+-	0.11E+01