nuclear matrix elements due to the jump of the principal quantum number. As was pointed out by many authors, this does not contradict Mayer's shell model, but leads to some difficulties with Feenberg's model, with respect to the $3p$ level.

(2) A series of spectacular experiments started by Langer,[9] Wu,[10] and others, led to the discovery of many of "a"-type spectra concerned with the first-forbidden transitions. It may naturally be asked in this connection why no other type of spectrum associated with the first-forbidden formulas of Konopinski and Uhlenbeck,[11] for instance, with $\int \mathbf{r}$, has so far been discovered. We will try to indicate here that this question may be answered satisfactorily by the use of Mayer's shell model. The selection rule for the matrix element $\int \mathbf{r}$ is $\Delta J=\pm 1, 0$, parity change yes. However, in Mayer's level scheme, nuclei with the same principal quantum number have the same parity. Therefore, it naturally follows from this that, if parity changes in a β-transition, the principal quantum number will also jump. For example, transitions $(4f_{7/2}\leftrightarrow 3d_{3/2})$, $(2s_{1/2}\rightarrow 3p_{3/2})$, etc., in spectroscopic notation, are such cases. Of these, the transitions $(2s_{1/2}\rightarrow 3p_{3/2})$ are actually found to be less frequent than the transitions $(4f_{7/2}\leftrightarrow 3d_{3/2})$ in Mayer's shell model.[1] Moreover, for the case $\Delta J=\pm 1, 0$, $\int \boldsymbol{\alpha}$, which represents an allowed spectrum, may happen to mask the contribution of $\int \mathbf{r}$. This provides a basis for explanation of the fact that the case with $\int \mathbf{r}$ is far less frequent than the case of "a"-type. On the other hand, in the shell model where the parity and the principal quantum number may be taken independently, the explanation would require a more complicated basis.[5,6]

(3) Two divergent opinions have so far been advanced as regards the classification of the bulk of β-emitters with ft-values $10^5\sim 10^6$; the one favoring their classification as first-forbidden, and the other proposing to classify them as allowed unfavored transitions (as seen in 1A in Table II of Konopinski).[12] If we try to make the calculation by the first-forbidden formula,[8] we will obtain considerably dispersed values for ft. However, a conventional calculation on the basis of the allowed formula gives more distinct values. If we do not regard this result as fortuitous, but take this as a result of failure to observe the seventh-power law, it follows, then, as stated by Wu[3] and also by Feenberg and Trigg,[4] that it is better to classify these transitions as allowed but unfavored.

[1] Umezawa, Nakamura, Yamaguchi, and Taketani, Prog. Theoret. Phys. 6, No. 3 (1951); Umezawa, Horie, Yamaguchi, and Yoshida, *ibid.* 6, No. 3 (1951); S. Nakamura, *ibid.* 6, No. 4 (1951).
[2] M. G. Mayer, Phys. Rev. **74**, 235 (1948); **75**, 1986 (1949); **78**, 16 (1950).
[3] C. S. Wu, Revs. Modern Phys. **22**, 386 (1950).
[4] E. Feenberg and G. Trigg, Revs. Modern Phys. **22**, 399 (1950).
[5] E. Feenberg and K. C. Hammack, Phys. Rev. **75**, 1877 (1949).
[6] L. W. Nordheim, Phys. Rev. **75**, 1894 (1949).
[7] Taketani, Nakamura, Ono, and Umezawa, Prog. Theoret. Phys. 6, No. 3 (1951).
[8] Nakamura, Shima, and Kobayashi, J. Phys. Soc. Japan **4**, 166 (1949). Under the direction of Professor Yukawa, they worked out an explicit forbidden probability, i.e., f-function, for each of the five Fermi interactions. An estimate for a special case ("a"-type spectra) was also made by Feenberg and Trigg (see reference 4).
[9] L. M. Langer and H. C. Price, Jr., Phys. Rev. **75**, 1109 (1949).
[10] C. S. Wu and L. Feldman, Phys. Rev. **78**, 318 (1950); **76**, 693 (1949).
[11] E. J. Konopinski and G. E. Uhlenbeck, Phys. Rev. **60**, 308 (1941).
[12] E. J. Konopinski, Revs. Modern Phys. **15**, 209 (1943).

Convergence of the Chapman-Enskog Method for a Completely Ionized Gas*

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THE theory of transport phenomena in an ionized gas has recently been reconsidered by Cohen, Spitzer, and McR. Routly,[1] in an approximation which is specially adapted to inverse square forces. In this connection some results on the convergence of the Chapman-Enskog method which came up in the work reported in an earlier paper[2] may be of some interest. These results refer to the case $H=0$, where the matrix Δ of Eq. (34) is real. In this case the determinants can be evaluated with much less labor and the approximation was carried to 5×5 matrices, i.e., 2 steps beyond the approximation of reference 2. The results are given in Table I. The velocity distribution of electrons in

TABLE I. Successive approximations of the determinant ratios.

i	$Z=1$	$Z=2$	$Z=3$	$Z=\infty$
		$\Delta_{00}^{(i)}/\Delta^{(i)}$		
2	1.9320	1.1590	0.8430	$3.25/Z$
3	1.9498	1.1605	0.8430	$3.3906/Z$
4	1.9616	1.1628	0.8435	$3.3945/Z$
5	1.9657	1.1634	0.8436	$3.3950/Z$
∞	—	—	—	$3.3953/Z$
		$\Delta_{01}^{(i)}/\Delta^{(i)}$		
2	0.6213	0.4393	0.3398	$1.5/Z$
3	0.5545	0.4201	0.3425	$2.0625/Z$
4	0.55983	0.4212	0.3429	$2.0391/Z$
5	0.5583	0.4207	0.3428	$2.0377/Z$
∞	—	—	—	$2.0372/Z$
		$\Delta_{11}^{(i)}/\Delta^{(i)}$		
2	0.4142	0.2929	0.2265	$1/Z$
3	0.6636	0.5433	0.4625	$3.25/Z$
4	0.6660	0.5439	0.4628	$3.3906/Z$
5	0.6665	0.5443	0.4630	$3.3945/Z$
∞	—	—	—	$3.3953/Z$

presence of an electric field is, in the notation of reference 2, given by

$$\phi=f\left(1-\frac{e(\mathbf{v}\cdot\mathbf{E})}{\nu kT}\sum_0^{i-1}(-1)^r\frac{\Delta_{0r}^{(i)}}{\Delta^{(i)}}L_r\right).$$

For $Z=1$, one obtains

$$\Delta_{02}^{(3)}/\Delta^{(3)}=-0.0630,\quad \Delta_{02}^{(4)}/\Delta^{(4)}=-0.018365,$$

and

$$\Delta_{03}^{(4)}/\Delta^{(4)}=0.039955.$$

Finally, I should like to point out some corrections to reference 2. In Eqs. (21) delete q in the third equation; in Eq. (30) replace β^2 by β^3; in Eq. (62) replace $\sqrt{2}$ by $(2\pi)^{\frac{1}{2}}$; in Eq. (65) replace H_{rs}^2 by H_{rs}^i.

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[1] Cohen, Spitzer, and McR. Routly, Phys. Rev. **80**, 230 (1950).
[2] R. Landshoff, Phys. Rev. **76**, 904 (1949).

Elastic and Electromechanical Coupling Coefficients of Single-Crystal Barium Titanate

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SMALL single crystals of barium titanate have been available to us for some time through the work of Matthias.[1] Although suitable for qualitative studies, these crystals were too small for accurate measurements of elastic and piezoelectric constants. Through the cooperation of the Signal Corps Engineering Laboratory, we have obtained larger single crystals of barium titanate produced by the Harshaw Chemical Company under Signal Corps contracts.[2] These were large multi-domain single crystals, but by being polarized with a high electric field the domains could be oriented with their ferroelectric axes predominantly in the direction of the thickness of the crystal plate.

The elastic constants were measured by using the ultrasonic pulse method shown by Fig. 1. Longitudinal or transverse waves are generated or received in fused quartz rods by X- or Y-cut quartz crystals soldered to the rods. The sample is connected to the fused quartz rods by means of a quarter-wave thickness of polystyrene, which has a very low loss and the mechanical impedances of 0.45×10^5 and 0.165×10^5 mechanical ohms per cm^2 for longitudinal and shear waves, when connected to the fused quartz rods. The velocity and attenuation can be measured by observing the ratio between the incident and transmitted waves.