Table 1. Excitation probabilities $P(2_1^+)$ and $P(3_1^-)$ and values of $B(E2;0_1^+\to2_1^+)$ and $B(E3;0_1^+\to3_1^-)$

Excitation energies $E_x(2_1^+)$ and $E_x(3_1^-)$ are taken from Tamura *et al.* (1987), Hashizume *et al.* (1987) and Kitao *et al.* (1986)

Nucleus	$E(^{12}C)$[A] (MeV)	$E_x(2_1^+)$ (keV)	$P(2_1^+)$ ($\times10^{-3}$)	$B(E2; 0_1^+\to2_1^+)$ (e^2 b^2)	$E_x(3_1^-)$ (keV)	$P(3_1^-)$ ($\times10^{-4}$)	$B(E3; 0_1^+\to3_1^-)$ (e^2 b^3)
^{118}Sn	36·98	1230	8·45(15)	0·207(6)	2328	2·79(21)	0·118(9)
	37·98	1230	9·58(17)	0·202(6)	2328	3·88(23)	0·125(8)
^{120}Sn	36·98	1171	8·99(9)	0·194(4)	2400	3·07(21)	0·149(11)
	37·98	1171	10·43(11)	0·194(4)	2400	3·08(22)	0·113(12)
^{122}Sn	36·98	1140	8·89(9)	0·182(4)	2492	1·96(18)	0·082(8)
	37·98	1140	10·19(9)	0·181(4)	2492	2·87(19)	0·091(7)

[A] Uncertainties in bombarding energies $E(^{12}C)$ were ±0·04 MeV.

Table 3. Values of $B(E3;0_1^+\to3_1^-)$ (in e^2 b^3) for isotopes of tin

Experimental results are presented in the upper part of the table, and calculated values in the lower part

Reference	Method	^{112}Sn	^{114}Sn	^{116}Sn	^{118}Sn	^{120}Sn	^{122}Sn	^{124}Sn
Present work	Coulex				0·122(6)	0·131(10)	0·087(6)	
Jonsson (1981)	Coulex	0·087(12)	0·100(12)	0·127(17)	0·097(14)	0·090(17)	0·110(17)	0·073(10)
Curtis (1969)	(e, e′)			0·074	0·112	0·103		
Barreau (1967)	(e, e′)			0·120(15)		0·113(14)		0·076(11)
Lightbody (1976)	(e, e′)			0·163(13)				
Veje (1966)	Theory		0·062	0·069	0·077	0·084	0·091	0·098
Lombard (1966)	Theory	0·085	0·088	0·097	0·107	0·118	0·132	0·137
Gillet (1969)	Theory		0·111	0·113	0·122	0·118	0·097	0·063

found to be negligible. The correction for virtual excitation of states in the giant dipole resonance was approximately 0·5%. The uncertainties in the $B(E3; 0_1^+ \rightarrow 3_1^-)$ values are almost entirely statistical. In the determination of these $B(E3; 0_1^+ \rightarrow 3_1^-)$ values, the most significant second-order effect is potentially that involving the unknown static quadrupole moment $Q(3_1^-)$. The results given were obtained assuming $Q(3_1^-) = 0$. If the magnitude of $Q(3_1^-)$ were as large as 0·3 *e*b [cf. $Q(3_1^-) = -0 \cdot 34 \pm 0 \cdot 15$ *e*b for ^{208}Pb (Spear *et al.* 1983)], the value of $B(E3; 0_1^+ \rightarrow 3_1^-)$ would change by less than 3%, i.e. no more than about half the statistical uncertainty.

Data used for Coulomb-excitation analysis should be obtained at bombarding energies sufficiently low for Coulomb–nuclear interference effects to be negligible. If possible, the maximum safe bombarding energy should be determined for each experimental configuration by taking data at a number of bombarding energies and checking that the energy dependence of the excitation probabilities obtained is consistent with pure Coulomb excitation (Spear *et al.* 1978*a*). Low count rates and time constraints restricted the present work to two bombarding energies. However, for ^{12}C projectiles and ^{118,120,122}Sn targets, the distances of closest approach of the nuclear surfaces (Fewell *et al.* 1979) are approximately 6·5 and 6·1 fm for bombarding energies of 37 and 38 MeV respectively; in the light of previous experience (Spear *et al.* 1978*a*, 1978*b*), nuclear contributions under these conditions should be negligible, particularly at the level of precision pertaining to the $B(E3; 0_1^+ \rightarrow 3_1^-)$ determinations. This expectation is supported by the overall consistency of the results obtained at the two bombarding energies.

Table 2. Experimental values of $B(E2; 0_1^+ \rightarrow 2_1^+)$ (in e^2 b^2) for ^{118,120,122}Sn

Authors	^{118}Sn	^{120}Sn	^{122}Sn
Present work	0·204(4)	0·194(3)	0·182(3)
Raman *et al.* (1987)[A]	0·209(8)	0·202(4)	0·192(4)
Graetzer *et al.* (1975)	0·199(6)	0·197(4)	0·188(4)

[A] Adopted values.

The numerous previous determinations of $B(E2; 0_1^+ \rightarrow 2_1^+)$ for the tin isotopes have been compiled by Raman *et al.* (1987). As may be seen from Table 2, the present results are near the lower limits of the 'adopted values' of those authors. They are, however, in excellent agreement with the Coulomb-excitation results of Graetzer *et al.* (1975).

The values of $B(E3; 0_1^+ \rightarrow 3_1^-)$ determined in the present work are compared with those of previous experiments, and calculations, in Table 3. Results for some isotopes not studied in the present work are included. The present results are substantially more precise than those of the previous Coulomb-excitation work of Jonsson *et al.* (1981), which used the gamma–gamma coincidence technique. The accuracy of the inelastic-electron-scattering data is limited by the model dependence of the analyses; Curtis *et al.* (1969), for example, did not assign conventional errors for this reason. The three theoretical calculations are all based upon the spherical shell model, all allow for core excitations, and none of them introduces effective charges. They differ from each other in their assumptions about the residual interaction and their choice of single-particle energies. The calculation of Gillet *et al.* (1969) is more sophisticated than the other two; a more realistic finite-range interaction is used, and the input data are taken from neighbouring odd-mass nuclei, with no adjustable parameters.

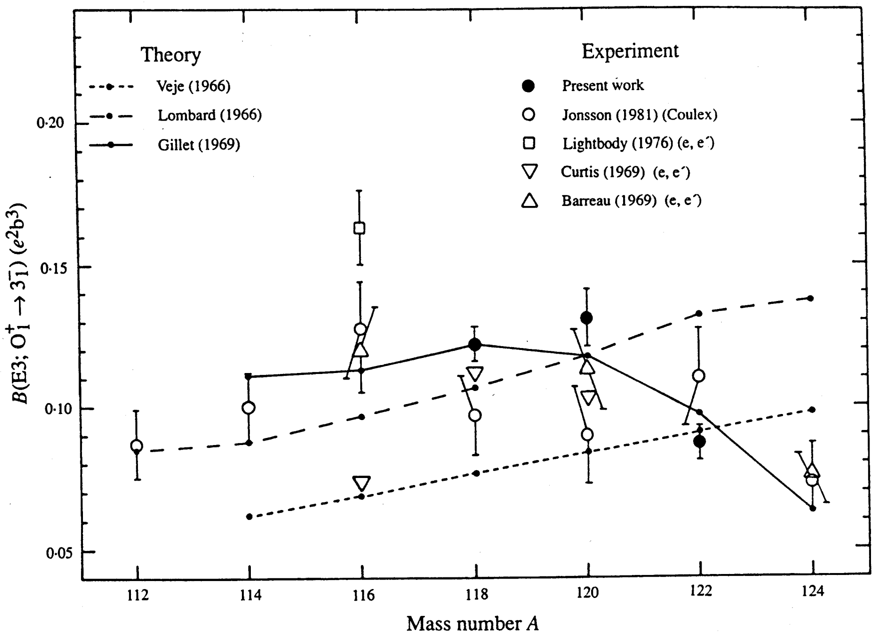

Fig. 2. Comparison of experimental and theoretical values of $B(E3; 0_1^+ \rightarrow 3_1^-)$ for the tin isotopes.

The experimental and theoretical values are further compared in Fig. 2. The overall agreement between theory and experiment is impressive, given that the calculations do not resort to the use of effective charges, and are generally not expected to provide a precise fit to experiment. If some discrimination between the three calculations is sought, it appears that the mass dependence of the present data favours the work of Gillet *et al.* (1969). This preference is supported by the available data for ^{124}Sn. It is of interest that if core excitations were excluded the calculations of Gillet *et al.* would underestimate $B(E3; 0_1^+ \rightarrow 3_1^-)$ values by factors of approximately 3 to 10, even if the neutron were allowed to have an effective charge of *e*.

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