E-2 mixing in K-mesic atoms

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- RESONANT ADMIXTURE OF LOW LYING ATOMIC LEVELS
- CERN EXPERIMENTS WITH ANTIPROTONIC ATOMS, Te 130
- KAONIC M0 98 CASE
- INTEREST IN M0 98 NUCLEUS

ESSENCE OF E-2 MIXING

(nL)

(7,6) --

171.13 I =1

(6,5) ------------------------------------ ADMIXED (4,3) * E2 (784)$_{\text{NUCLEAR}}$

284.34 I=0 .13

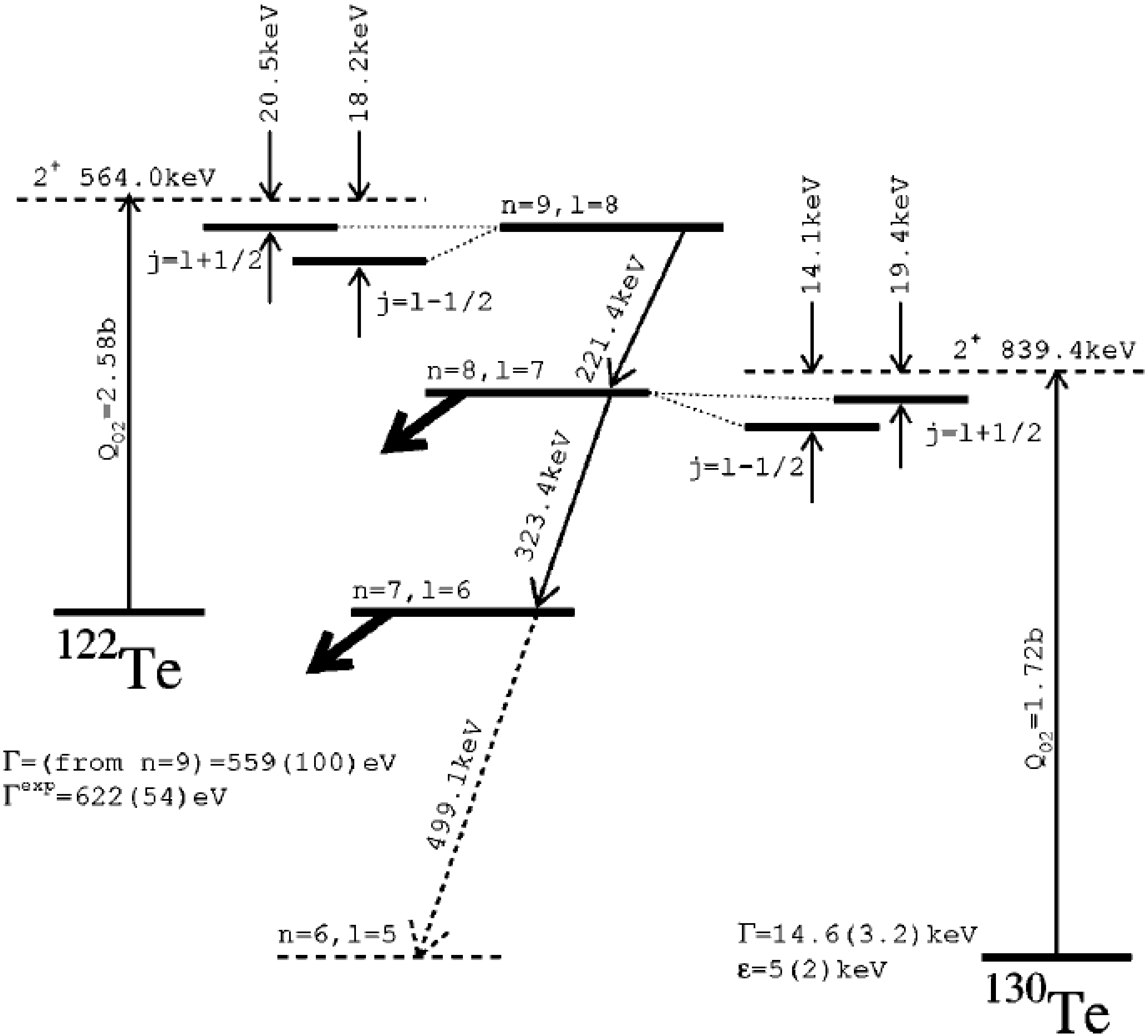
(5,4) --------------------------------

(4,3) --

STRONG LOSS OF INTENSITY
BY NUCLEAR CAPTURE

Tellurium Experiments

CERN - ANTIPROTONIC ATOM   Munich Warsaw   collaboration


20.5keV
18.2keV
2+ 564.0keV
n=9,l=8
j=l+1/2
j=l-1/2
221.4keV
14.1keV
19.4keV
2+ 839.4keV
n=8,l=7
j=l+1/2
j=l-1/2
Q02=2.58b
323.4keV
n=7,l=6
122Te
Q02=1.72b
Γ=(from n=9)=559(100)eV
Γexp=622(54)eV
499.1keV
n=6,l=5
Γ=14.6(3.2)keV
ε=5(2)keV
130Te

COULOMB INTERACTION EXCITE NUCLEUS TO 2+ ROTATIONAL LEVEL

$$H_Q = -\frac{e^2}{2r^3} Q_{2\mu} Y_{2\mu},$$

Coulomb due to nuclear deformation

| n,L , „0” > => | nL, „0” > + a | N-2 , L-2 „2+” >

a = < H_Q >^{2} / [E (n,L , „0”) - E (N-2 , L-2 „2+”)]

Induced atomic shift and width

ϵ - i Γ/2 = < H_Q > 2 / [E (n,L , „0”) - E (N-2 , L-2 „2+”)]

TABLE VII. Widths of $n,l=8,7$ levels.

Isotope	Experimental (eV)		$E2$ induced (eV)		Optical (eV)	
	$j=l+1/2$	$j=l-1/2$	$j=l+1/2$	$j=l-1/2$	$j=l+1/2$	$j=l-1/2$
^{122}Te	7.1(1.4)	8.0(1.3)	0.8	0.5	6.3(1.4)	7.5(1.3)
^{124}Te	6.6(1.6)	8.6(1.8)	1.0	0.6	5.6(1.6)	8.0(1.8)
^{126}Te	7.9(1.1)	8.9(1.5)	1.7	1.0	6.2(1.1)	7.9(1.5)
^{128}Te	10.9(2.3)	11.4(2.5)	5.8	3.3	5.1(2.3)	8.2(2.5)
^{130}Te	36(9)	52(16)	30(9)	44(16)	6.0(0.7)[a]	7.8(0.8)[a]

[a]Values for ^{130}Te are obtained by an extrapolation from ^{122}Te-^{128}Te.

TABLE VIII. Shifts and widths of the deeply bound $n,l=6,5$ level in ^{130}Te.

State (n,l)	Experimental ε (keV)		Experimental Γ (keV)		Calculated $\varepsilon - i\Gamma$ (keV)
(n,l)	$j=l+1/2$	$j=l-1/2$	$j=l+1/2$	$j=l-1/2$	
(6,5)	6.6±3.8	3.6±1.1	17.0±4.4	11.8±4.4	$6.8 - i18.2$

TABLE VI. Shifts of the $n,l=8,7$ states.

Isotope	Experimental (eV)		$E2$ induced (eV)		Optical (eV)	
	$j=l+1/2$	$j=l-1/2$	$j=l+1/2$	$j=l-1/2$	$j=l+1/2$	$j=l-1/2$
^{122}Te	3(11)	−7(12)	12	12	−9(11)	−19(12)
^{124}Te	−3(7)	−6(7)	12	12	−15(7)	−18(7)
^{126}Te	4(10)	6(11)	14	14	−10(10)	−8(11)
^{128}Te	18(6)	12(6)	24	22	−6(6)	−10(6)
^{130}Te	−56(5)	−80(5)	−46(6)	−67(6)	−10(4)[a]	−13(4)[a]

[a]Values for ^{130}Te are obtained by an extrapolation from ^{122}Te-^{128}Te.

K- 98 Mo ATOM

G.L. Godfrey Berkeley Thesis ,
C. Wiegand
Predicted by M. Leon

unearthed by Luca De Paolis

K- 98 Mo

(nL)

(7,6) --

171.13 I =1

(6,5) -------------------------------------- ADMIXED (4,3) * E2 (784)NUCLEAR

284.34 I=0 .13 +/- 0.13

(5,4) ----------------------------------

(4,3) ---

STRONG LOSS OF INTENSITY

NUMBERS FOR INDUCED SHIFT ϵ WIDTH Γ

IN TERMS OF N= 4 , L=3 SHIFT ϵ WIDTH Γ

$\epsilon - i \Gamma/2 = 1.1\ 10$ ^(-4) [15 - $\epsilon - i \Gamma/2$]

from Godfrey $\Gamma/2 = 12.7$ KeV

Expected $\epsilon \sim$ 5-10 eV , $\Gamma \sim$ 25 eV

Coupling 1.1 10 ^(-4) uncertainty of 10 % Nucl. Phys 721 (2002)

THE QUESTION OF PRECISION

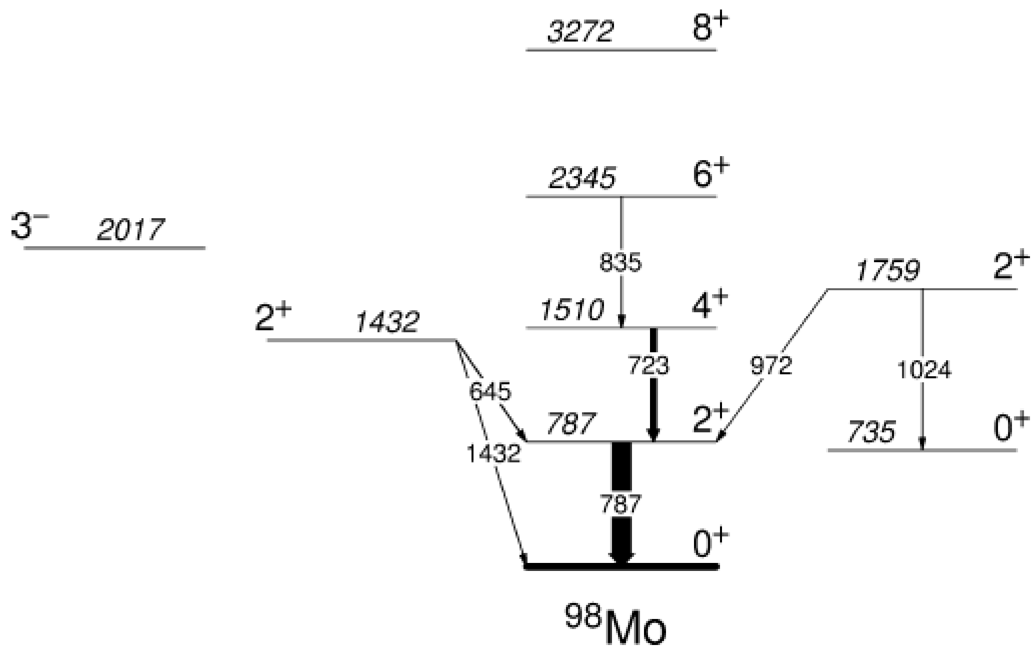


Fig. 2. Low-lying excited states of the ^{98}Mo nucleus included in calculations (adopted after Ref. [5]). The transitions observed in the experiments are marked with arrows. All energies are given in keV.

MOLYBDENUM DATA

From ENSDF - Evaluated February 2020 $^{98}_{42}Mo_{56}$

787.384[a] *17* 2^+ 3.47 ps *7* AB DEFGHI K MNOPQRST VW

787.42(1) Heck, N.Phys. 165 (1971)

M. Zielińska et al. / Nuclear Physics A 712 (2002) 3–13

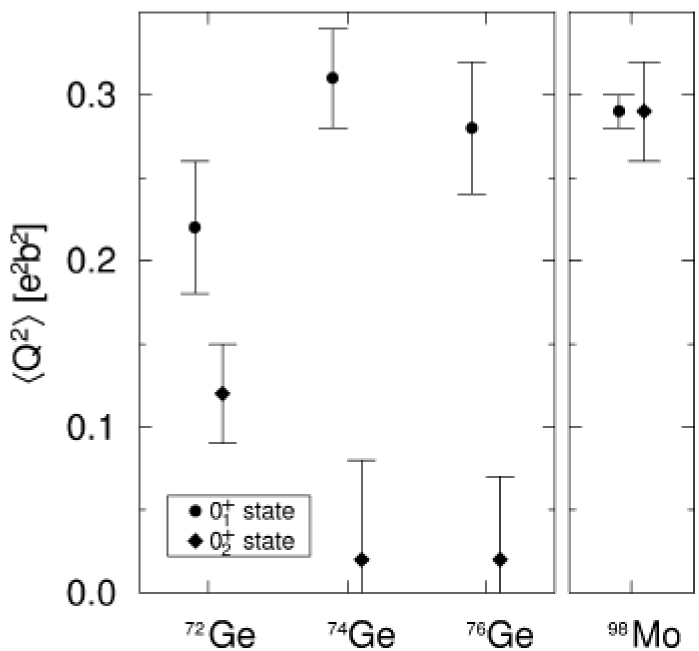


Fig. 3. Mean values of Q^2 parameter found for the two first 0^+ states in ^{98}Mo and ^{72,74,76}Ge.

PRECISION OF LOWER SHIFT DETERMINATION

DATA INPUT Q 5 % Q^2 10%

EXPERIMENTAL PRECISION : intensities, shifts

Comparison of transitions in Mo 96

The current interest in Mo 98

Theoretical : Deformation Quadrupole , Octupole
Sign of quadrupole moment, neutron skin

Experiments : Coulomb excitations /Warsaw, Tokai,Chiba, St.Petersburg

(n,γ) Warsaw , ILL Grenoble

AN OLD QUESTION ?

Atomic transitions
Correlated with

$K(-)\ p \rightarrow \Sigma(+)\ \pi(-)\ ,\ \Sigma(-)\ \pi(+)$

$K(-)\ n \rightarrow \Sigma(0)\ \pi(-)\ ,\ \Sigma(-)\ \pi(0)$

Thank you