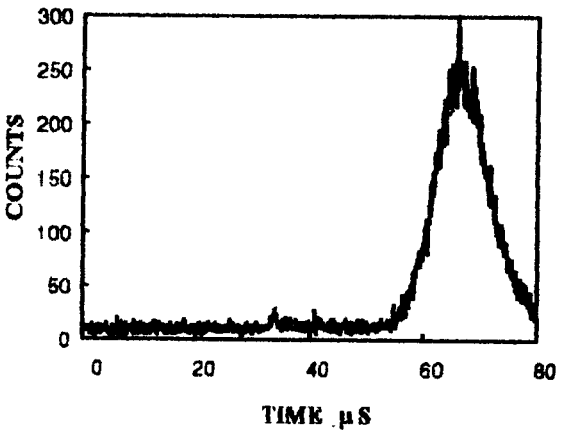

Fig. Time structure of the photoion current from LIS

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MASS SURFACE OF THE "MAGIC CROSS" AT ^{132}Sn

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The idea of possible universality in description of the shell model properties of heavy nuclei throughout the nuclidic chart was put forward by various authors(see ref.[1-3]). The conclusion was made that the properties of the magic nuclides of different mass regions can be described by the same theoretical approach but slightly varying parameters of theory. The subject of interest is whether the similarities in ordering and even in energy spacing of single particle states extend to nucleon residual interaction energies as well.
To examine this postulation [1] the masses for the nuclides of the "magic crosses" besides the lead region must be measured precisely. The "magic cross" is formed by the nuclides having two or less nucleons (holes) outside the double shell closure. Only the nuclides from the tin "magic cross" are available for mass determination nowadays. They are shown in Figure.

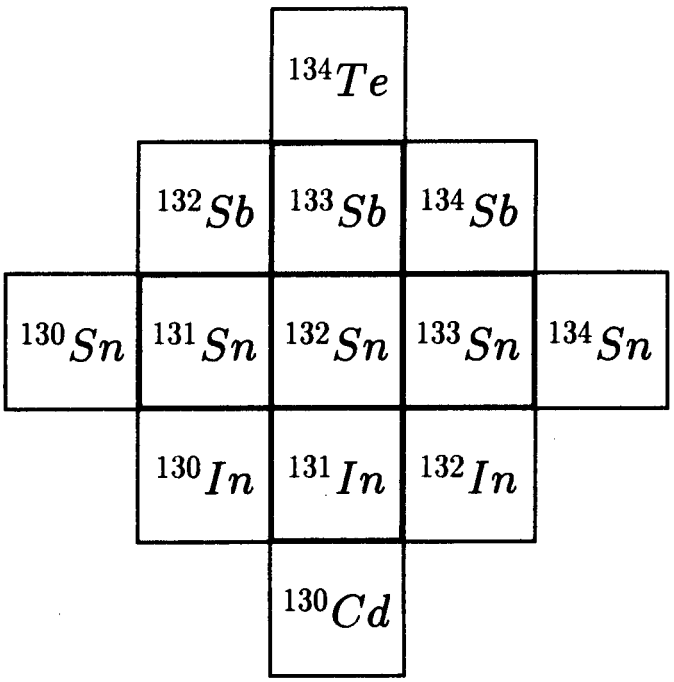

Fig. "Magic cross" nuclides

The Q_β -value measurements performed at OSIRIS-facility in Studsvik [4] open the possibility to determine the masses of near magic nuclides precisely. The mass excess values deduced from the adopted Q_β -values, which have been obtained by averaging the data of ref.[4,5] and known from literature [6,7] are presented in Table 1. The recently evaluated data in ref.[8] are given in the last column.
The data presented in Table 1 provide the complete set of the mass values needed for the determination of the single–particle energies in the absolute energy scale as well as of extra-nucleon (hole) interaction energies in nuclei.

The proton–neutron residual interaction energies for particle–particle, hole–hole and particle–hole configurations can be derived by formula,including four mass-excess (ME) values of "magic cross":

$$\Delta_{\pi\nu} = ME(\pi^{\pm}, \nu^{\pm}) + ME(0,0) - ME(\pi^{\pm}, 0) - ME(0, \nu^{\pm}) \ ,$$

where signs (+) and (–) symbolize the particles and holes for the proton(π) and neutron(ν) -configurations; (0,0) —means the closed shell nuclide.
The data for $\pi\nu$-interaction energies deduced from experimental mass-excess values of Table 1 are given in Table 2 for various well established configurations in odd–odd nuclides.

The mass data of Table 1 give also an opportunity to determine the experimental values for proton–proton and neutron–neutron nonpairing interaction energies. Using the similar approach as in the case of $\pi\nu$-interaction, we have determined the values, shown in Table 3.

Table

Mass excess values for "magic cross"nuclides

NUCLIDE	I^{π}	ME (MeV) [a]	ME (MeV) [b]
^{130}In	1^-	- 69.973(141)	- 69.993(47)
	5^+	- 69.452(55)	
^{130}Sn	0^+	- 80.166(51)	- 80.242(88)
^{130}Sb	$(4,5)^+$	- 82.345(38)	- 82.383(25)
^{131}In	$9/2^+$	- 68.131(33)	- 68.490(140)
	$1/2^-$	- 67.778(45)	- 68.199(80)
^{131}Sn	$3/2^+$	- 77.305(25)	- 77.383(73)
^{131}Sb	$7/2^+$	- 81.994(20)	- 82.021(70)
^{132}In	7^-	- 62.485(67)	- 63.020(401)
^{132}Sn	0^+	- 76.620(29)	- 76.620(26)
^{132}Sb	4^+	- 79.723(27)	- 79.923(55)
^{133}Sn	$7/2^-$	- 70.994(40)	- 71.126(104)
^{133}Sb	$7/2^+$	- 78.984(32)	- 78.956(76)
^{133}Te	$(3/2^+)$	- 82.987(30)	- 82.959(73)
^{134}Sn	0^+	- 66.639(106)	- 67.226(298)
^{134}Sb	0^-	- 74.009(56)	- 73.977(155)
^{134}Te	0^+	- 82.399(34)	- 82.394(108)

[a] this work, [b] mass evaluation of ref.[8]

J.Blomqvist [1] postulated the equality of the $\Delta\pi\nu$ for configurations $(\pi l_\pi j_\pi, \nu l_\nu j_\nu)$ and $(\pi(l_\pi + 1)(j_\pi + 1); \nu(l_\nu + 1)(j_\nu + 1))$, taking into account the similarities in ordering and energy spacings of this particular states in the tin and lead regions correspondingly. To examine such considerations we have compared the proton–neutron interaction energies,presented in Table 2 with ones for lead region determined using mass value table of ref.[8].
The values of $\Delta_{\pi\nu}$ for corresponding configurations in tin and lead "magic crosses" are close to each other and overlap within not more than 2σ.

Table 2

Experimental values of the proton-neutron interaction energies

CONFIGURATION	NUCLIDE	I^π	LEVEL	$\Delta_{\pi\nu}$,MeV
$\pi(1g9/2)^{-1}, \nu(1h11/2)^{-1}$	^{130}In	1^-	g.s.	- 1.399(150)
$\pi(1g9/2)^{-1}, \nu(2d3/2)^{-1}$	^{130}In	5^+	0.40	- 0.636(75)
$\pi(1g9/2)^{-1}, \nu 2f7/2$	^{132}In	7^-	g.s.	0.020(90)
$\pi 1g7/2, \nu(2d3/2)^{-1}$	^{132}Sb	4^+	g.s.	- 0.054(57)*)
$\pi 1g7/2, \nu(1h11/2)^{-1}$	^{132}Sb	8^-	0.20	- 0.096(76)
$\pi 1g7/2, \nu(3s1/2)^{-1}$	^{132}Sb	3^+	0.529	0.143(57)
$\pi 2d5/2, \nu(2d3/2)^{-1}$	^{132}Sb	2^+	(1.08)	(0.062(57))
$\pi 1g7/2, \nu 2f7/2$	^{134}Sb	0^-	g.s.	- 0.651(81)
$\pi 2d5/2, \nu 2f7/2$	^{134}Sb	1^-	0.872	- 0.741(81)

*) -the value $\Delta_{\pi\nu}$=-0.05(5) was estimated in ref.[9]

Table 3

Experimental values of nonpairing proton–proton and neutron–neutron interaction energies

CONFIGURATION	NUCLIDE	I^π	LEVEL	$\Delta_{\pi\pi}$ or $\Delta_{\nu\nu}$,MeV
$\nu(1h11/2)^{-1}, \nu(2d3/2)^{-1}$	^{130}Sn	(7^-)	1.947	(-0.471(64))
$\nu 2f7/2, \nu(2d3/2)^{-1}$	^{132}Sn	4^-	4.831	- 0.110(55)
$\nu 2f7/2, \nu(1h11/2)^{-1}$	^{132}Sn	8^+	4.847	- -0.336(55)
$\nu 2f5/2, \nu(1g7/2)^{-1}$	^{132}Sn	6^-	7.211	- 0.164(55)*)
$\pi 1g7/2, \pi 2d5/2$	^{134}Te	6^+	2.398	0.385(55)

*)- the value $\Delta_{\nu\nu}$ = 0.00(5) was estimated in ref.[9]

This result in addition to similarities in the scheme of the shell model orbitals for two different magic regions shows that the idea of unified description of various magic properties throughout the heavy mass part of the nuclidic chart seems correct.

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THE BETA-DECAY STRENGTH FUNCTIONS OF ^{100}Ag AND ^{104}In

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The study of the beta strength in the ^{100}Sn region has been continued by using a total absorption gamma-ray spectrometer (TAGS) on the GSI on-line mass separator. The beta-decay by neutron-deficient isotopes near the doubly-magic nucleus ^{100}Sn is dominated by the Gamow-Teller (GT) transformation of a $g_{9/2}$ proton into a $g_{7/2}$ neutron . Whenever strong beta transitions are observed in this region of the nuclear chart, they have to be associated with these two l = 4 orbits. Therefore, such data represent a firm basis for testing nuclear models. Previous studies were focused on even-even nuclides [1], that decay to a few well-resolved 1^+ levels. The excitation energies of these levels are usually below 2 MeV so that high-resolution spectroscopy can be applied. For the odd-odd and odd-mass parent nuclei near ^{100}Sn, the predominant feeding of high-lying levels is expected to be a general decay feature. However, at these energies the level density is high, and gamma transitions deexciting these levels have statistical character. Therefore, discrete-level spectroscopy is not suitable for a quantitative determination of the strength distribution, and 4π-counter technique is necessary [2].

The neutron-deficient isotopes ^{100}Ag ($t_{1/2}$ = 2.0 m, $I^\pi = 5^+$) and ^{104}In($t_{1/2}$ = 1.8 m, $I^\pi = 6^+$) were produced in the fusion-evaporation reaction between a 5 MeV/u ^{58}Ni beam and an enriched ^{50}Cr target. The mass-separated atoms were implanted into a tape and driven periodically from the separator to the TAGS detection system operating in the air. The source composition was determined by using germanium detectors for gamma-ray measurements during the collection of the sources and after their removal from the TAGS set-up.

The TAGS, which was built at PNPI, was an improved version of the spectrometer used earlier in experiments at the IRIS facility of PNPI [3]. The TAGS consists mainly of a NaI