SEARCH FOR PARTICLE-HOLE INTRUDER STRUCTURES IN ^{64}Co AND ADJACENT NUCLEI

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August 2012 marks the 15th anniversary of the August 1997 CERN/ISOLDE experiment in which the Resonance Ionization Laser Ion source was employed to study neutron and γ decay of Mn isotopes. In that experiment, half-lives out to $^{69}Mn_{44}$ were determined, and the low energy for the 2_1^+ level in the N = 40 isotone, $^{66}Fe_{40}$ was measured, suggesting the presence of deformation and intruder states in nuclei with Z < 28.[Hannawald et al., Phys. Rev. Lett. **82**, 1391 (1999). This poster represents the continued study by a broad collaboration aimed at structure of nuclei near ^{68}Ni.

^{66}Co in a new Island of Inversion

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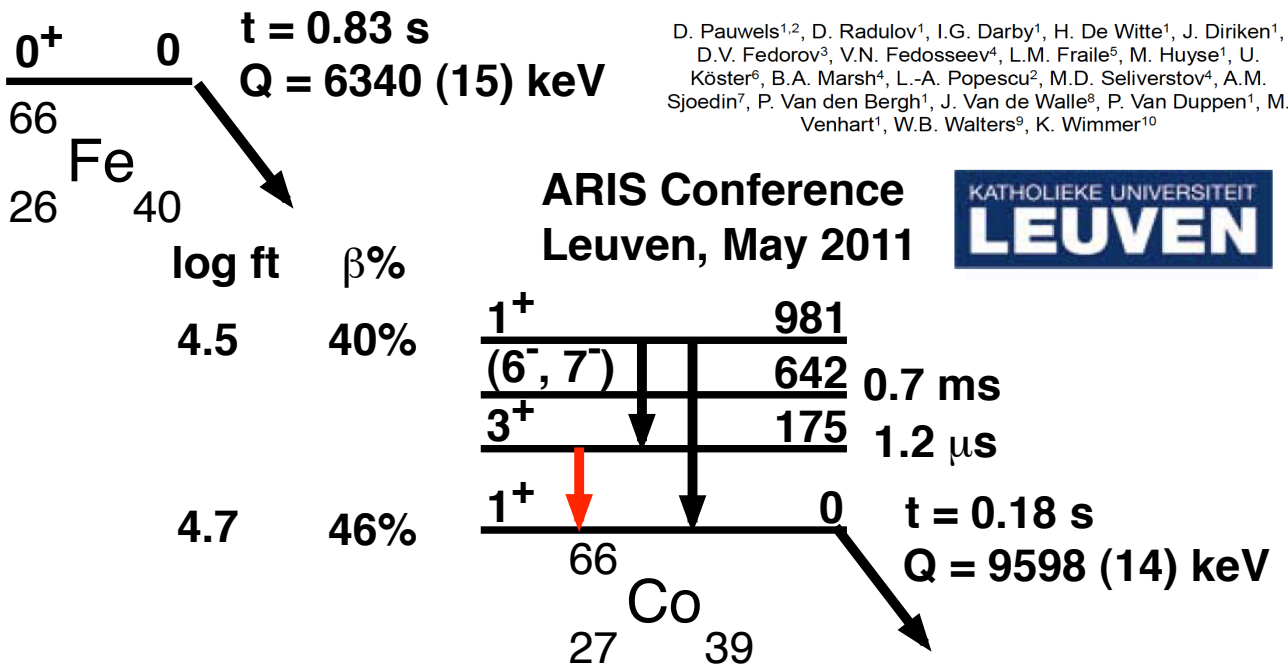
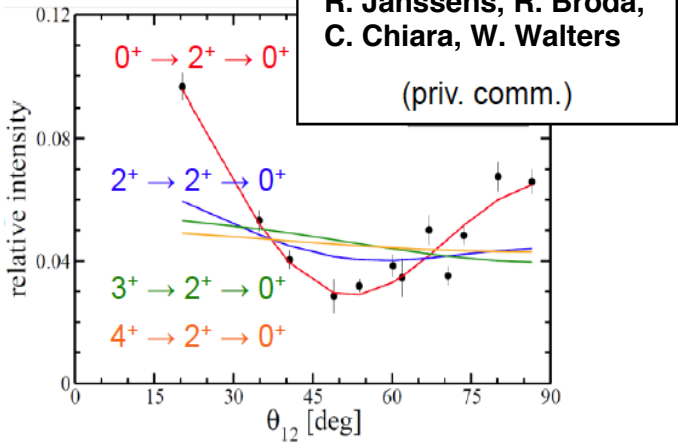
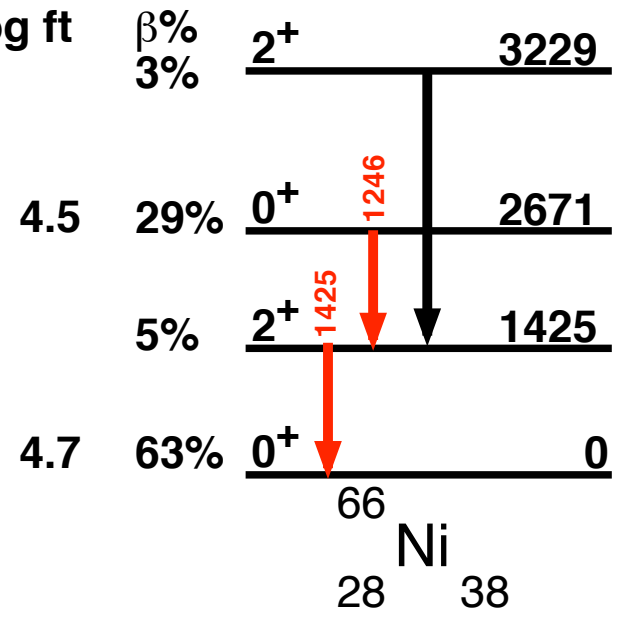
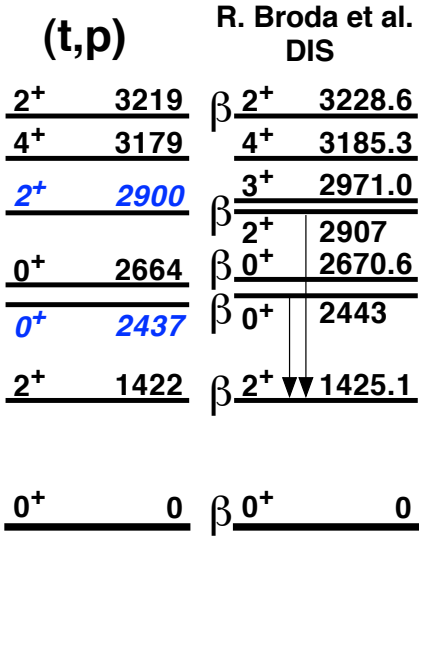


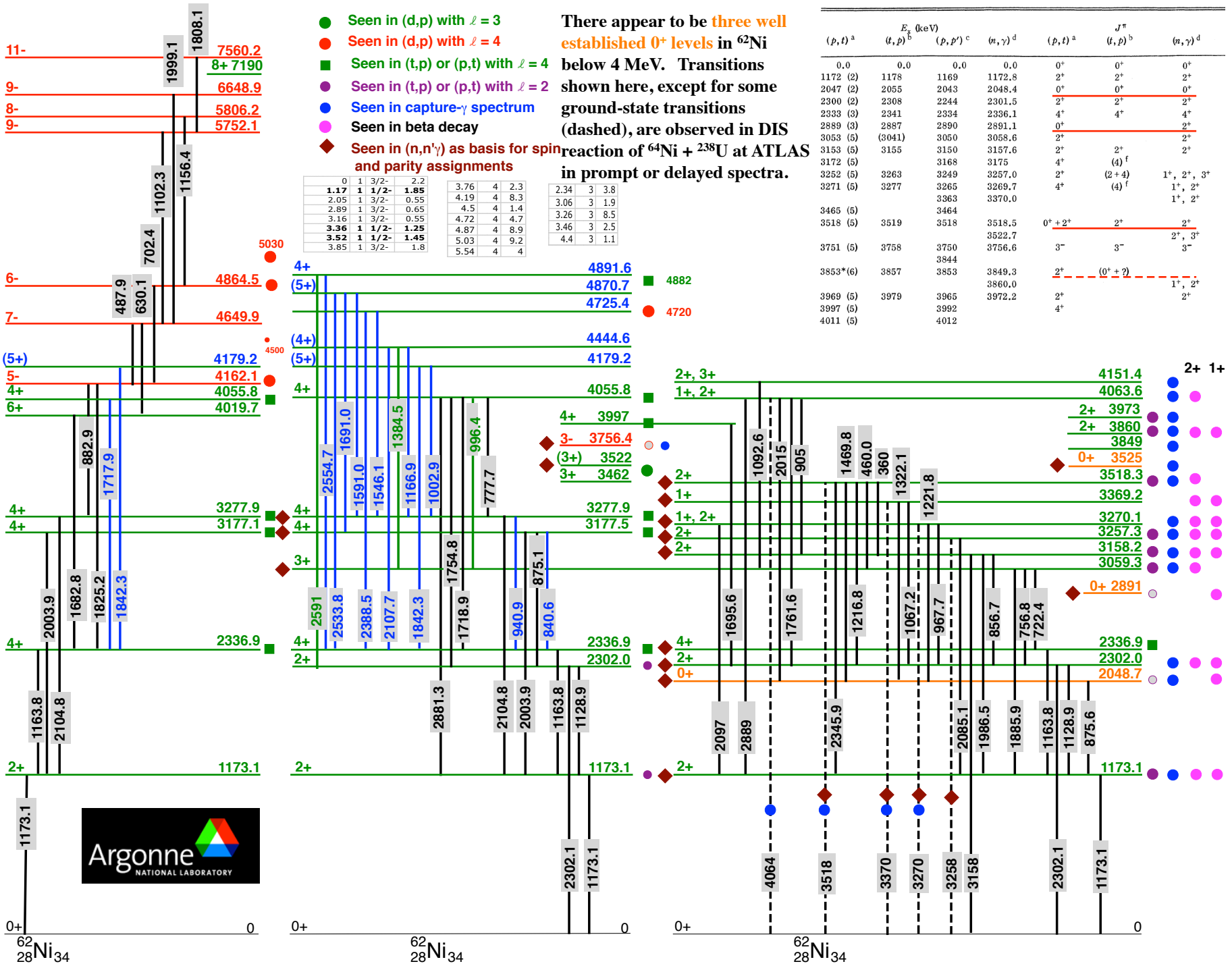
After these data were presented a year ago, an effort was initiated to identify 1^+ levels in other odd-odd Co nuclei, particularly ^{64}Co, and to identify 0^+ levels populated in lighter Ni nuclei, particularly ^{64}Ni. The salient feature of both of these A = 66 decay schemes is the stronger population of excited 0^+ or 1^+ states than the ground state. Additional data were also sought on the high-spin levels in ^{64}Co similar to the 642-keV isomer in ^{66}Co.



^{66}Ni 1426-1246 angular correlation in DIS:
R. Janssens, R. Broda, C. Chiara, W. Walters
(priv. comm.)





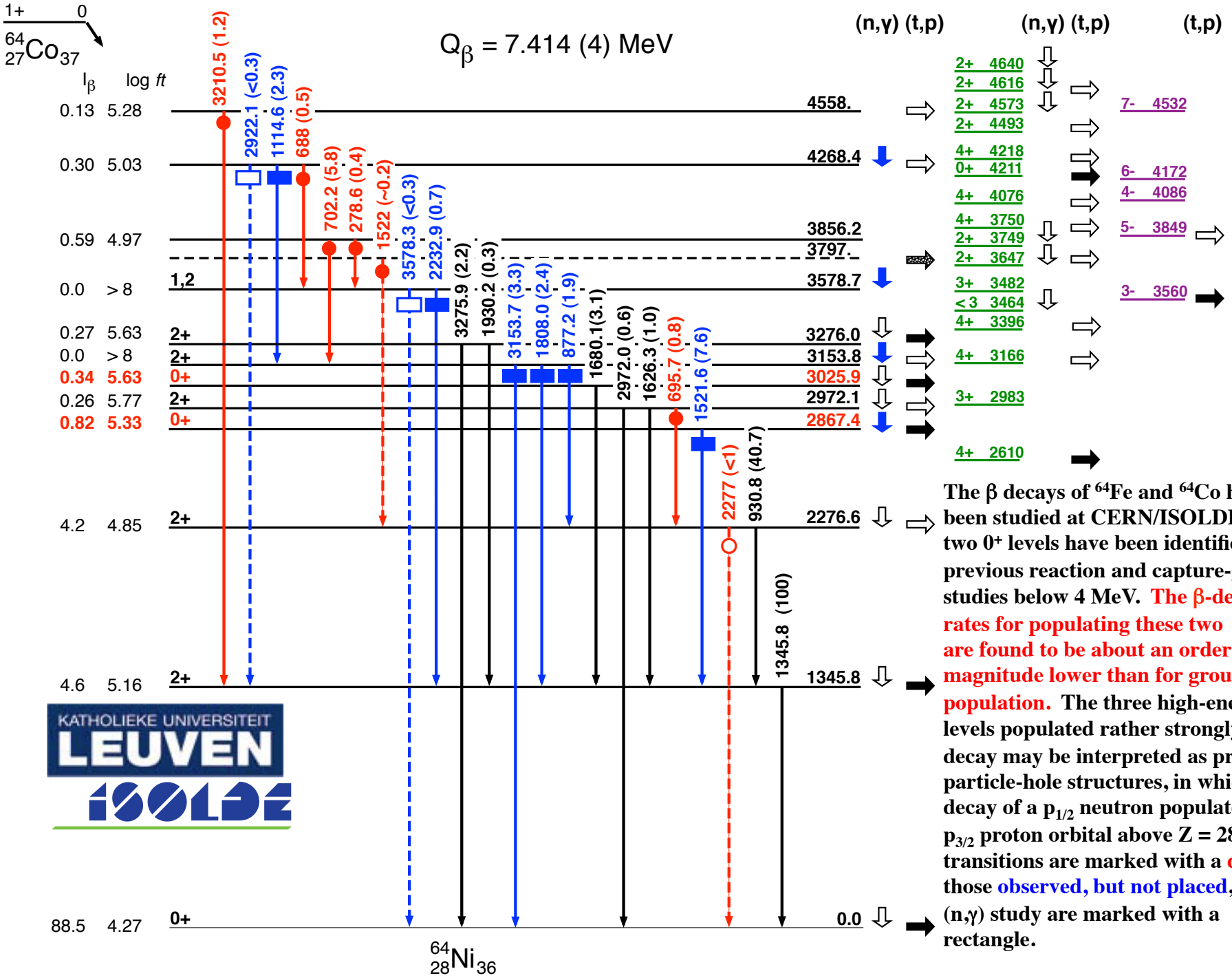


0	1	3/2-	2.2
1.17	**1**	**1/2-**	**1.85**
2.05	1	3/2-	0.55
2.89	1	3/2-	0.65
3.16	1	3/2-	0.55
3.36	**1**	**1/2-**	**1.25**
3.52	**1**	**1/2-**	**1.45**
3.85	1	3/2-	1.8

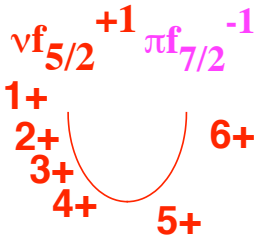
3.76	4	2.3
4.19	4	8.3
4.5	4	1.4
4.72	4	4.7
4.87	4	8.9
5.03	4	9.2
5.54	4	4

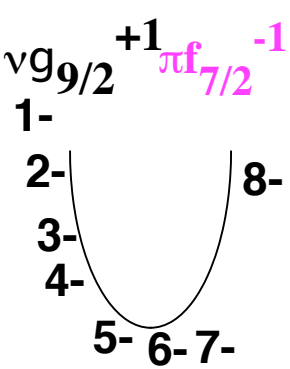
2.34	3	3.8
3.06	3	1.9
3.26	3	8.5
3.46	3	2.5
4.4	3	1.1

E_x (keV) (p,t) [a]	(t,p) [b]	(p,p') [c]	(n,γ) [d]	J^π (p,t) [a]	(t,p) [b]	(n,γ) [d]
0.0	0.0	0.0	0.0	0^+	0^+	0^+
1172 (2)	1178	1169	1172.8	2^+	2^+	2^+
2047 (2)	2055	2043	2048.4	0^+	0^+	0^+
2300 (2)	2308	2244	2301.5	2^+	2^+	2^+
2333 (3)	2341	2334	2336.1	4^+	4^+	4^+
2889 (3)	2887	2890	2891.1	0^+		2^+
3053 (5)	(3041)	3050	3058.6	2^+		2^+
3153 (5)	3155	3150	3157.6	2^+	2^+	2^+
3172 (5)		3168	3175	4^+	(4) [f]	
3252 (5)	3263	3249	3257.0	2^+	(2 + 4)	$1^+, 2^+, 3^+$
3271 (5)	3277	3265	3269.7	4^+	(4) [f]	$1^+, 2^+$
		3363	3370.0			$1^+, 2^+$
3465 (5)		3464				
3518 (5)	3519	3518	3518.5	$0^+ + 2^+$	2^+	2^+
			3522.7			$2^+, 3^+$
3751 (5)	3758	3750	3756.6	3^-	3^-	3^-
		3844				
3853*(6)	3857	3853	3849.3	2^+	$(0^+ + ?)$	
			3860.0			$1^+, 2^+$
3969 (5)	3979	3965	3972.2	2^+		2^+
3997 (5)		3992		4^+		
4011 (5)		4012				

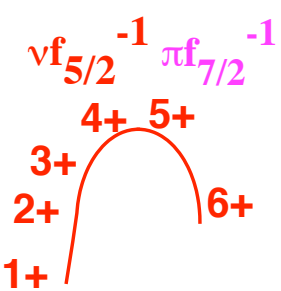


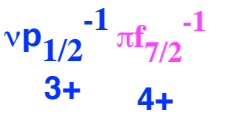
The β decays of ^{64}Fe and ^{64}Co have been studied at CERN/ISOLDE. Only two 0^+ levels have been identified in previous reaction and capture-gamma studies below 4 MeV. The β-decay rates for populating these two 0^+ levels are found to be about an order of magnitude lower than for ground-state population. The three high-energy levels populated rather strongly in β decay may be interpreted as proton particle-hole structures, in which β decay of a $p_{1/2}$ neutron populates the $p_{3/2}$ proton orbital above Z = 28. New transitions are marked with a dot, those observed, but not placed, in the (n,γ) study are marked with a rectangle.

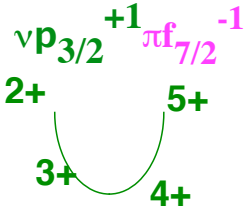


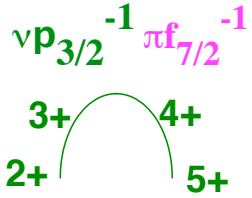


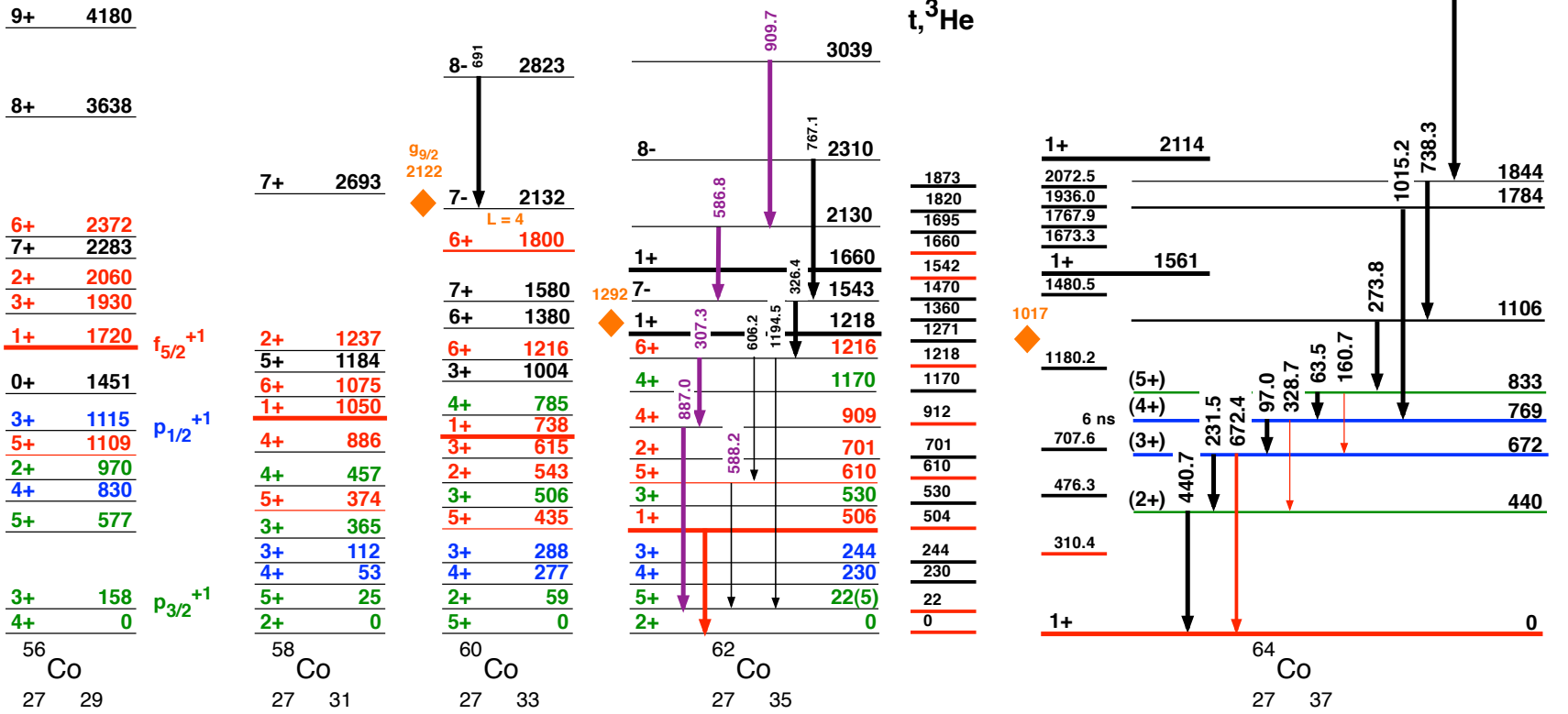
Features seen here include the inversion of the particle-hole multiplets as N increases and the neutron particles become holes. In particular, the 1+ level becomes the ground state in ^{64}Co. In addition, the fg multiplet with a 6- or 7- lowest energy is seen to move down as the Fermi surface approaches the $g_{9/2}$ neutron orbital beyond N = 40.



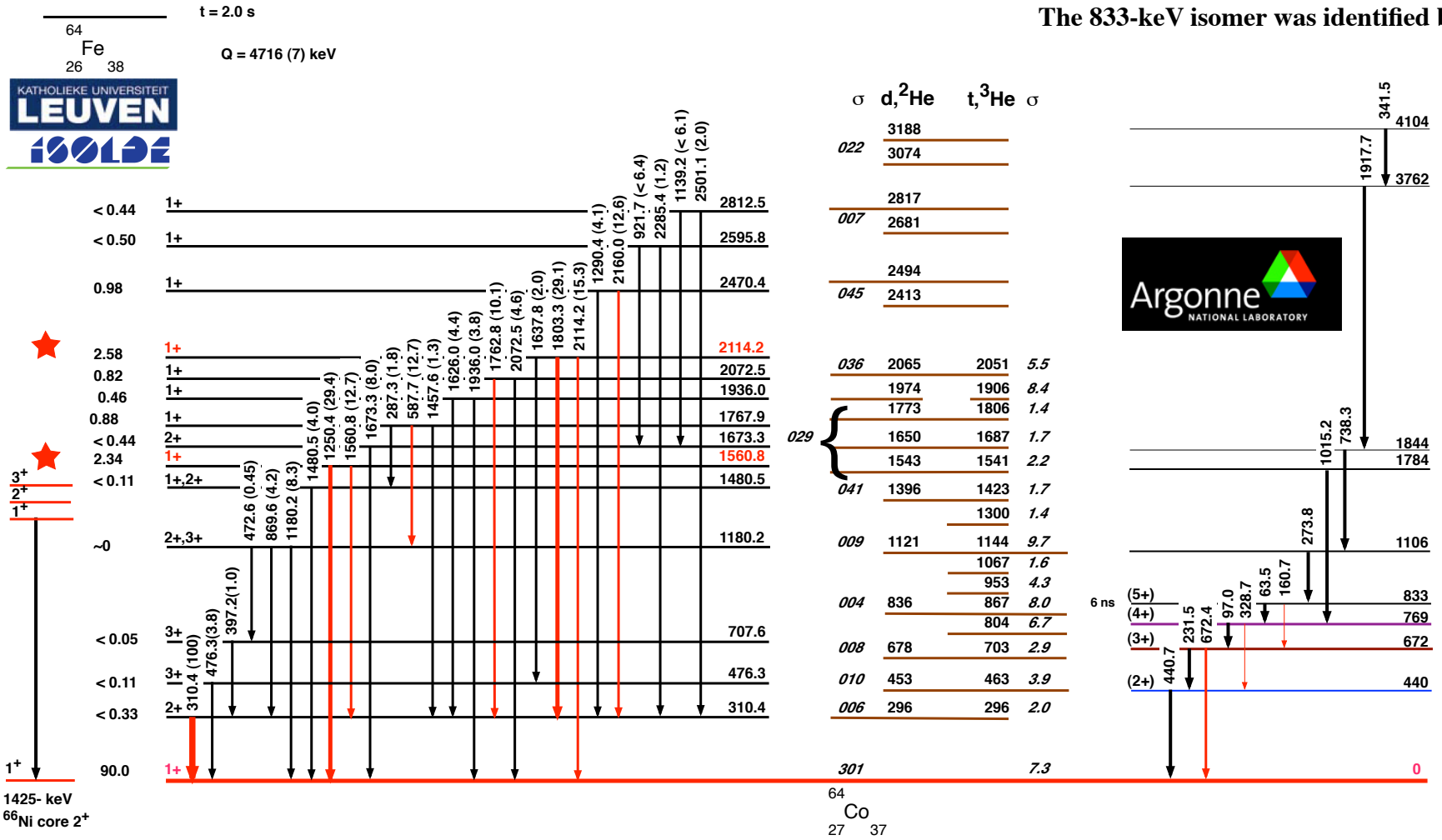








The 833-keV isomer was identified by Asai et al.



Conclusion: These data establish a <u>fundamental difference</u> in the β decay of both $^{64}Fe_{38}$ and $^{64}Co_{37}$ relative to the decay of $^{66}Fe_{40}$ and $^{66}Co_{39}$, respectively. For the A = 64 chain, ground-state to ground-state decay is dominant, and faster by an order of magnitude, than decay to excited states. The observed branching is consistent with the underlying decay of a spherical $f_{5/2}$ neutron to fill the last $f_{7/2}$ proton hole in closed-shell ^{64}Ni. Whereas, in the A = 66 chain, data support the interpretation that the ground state of $^{66}Fe_{40}$ is a mixture of spherical and deformed intruder configurations. The notion that the 1^+ ground state of ^{66}Co is also similarly mixed is supported by the strong decay to the excited 0^+ level in ^{66}Ni at 2671 keV, that is also likely to be be significantly deformed.