STUDY OF SUPERDEFORMED STATE OF NUCLEI IN Z=70-80 DRIP-LINE REGION

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Introduction

The study of drip-line nuclei is an interesting topic in nuclear physics. We studied the ground and excited states properties for Ytterbium (Yb), Hafnium (Hf), Osmium (Os), Platinum (Pt) and Mercury (Hg) isotopes in Z= 70-80 region starting from proton to neutron drip- lines using the relativistic mean- field formalism. The NL3 parameter set is used in the calculations. We find almost spherical ground and superdeformed excited states in most of the isotopes.

I. FORMALISM

The relativistic mean field (RMF) [4] Lagrangian with NL3 parameter set [1–3] contained interaction between meson and nucleon and also self interacting sigma meson. The other mesons are the omega and rho fields. The photon field A_μ is included to take care of Coulombic interaction of protons. A set of coupled equations are obtained from the Lagrangian, which are solved numerically in an axially deformed harmonic oscillator basis taking 12 bosonic and Fermionic oscillator quanta [5]. In this model pairing and center of mass correction are added externally [4].

Result and Discussion

The binding energy (BE), charge radius and quadrupole moment deformation parameter β_2 for Yb, Hf, Os, Pt and Hg isotopes are obtained with RMF(NL3) formalism and depicted in Table-1. When we compare the ground state with all the excited state solutions, we get a well developed intrinsic excited superdeformed state in all the isotopes. In most of the cases of the considered isotopes, we get a spherical or a normal deformed solution both in RMF(NL3) and FRDM calculations, which can be seen from the Table. The interesting superdeformed solutions are obtained in an excited configuration for almost all the presently discussed isotopes. The binding energy increases with increase in mass number in the isotopic series. We have compared our calculated RMF results with FRDM predictions. We find both normal and superdeformed solutions of the above isotopes in the RMF frame-work. Also, we have evaluated the α- decay properties of some of these nuclei, which will be discussed at the time of presentation.

Conclusion

In summary, we have calculated the binding energy, charge radius, quadrupole deformation parameter of Yb, Hf, Os, Pt and Hg isotopes. We observed that the calculated values of RMF are in good agreement with the available FRDM calculations. We have seen that the RMF theory provides a reasonably good description for the whole isotopic chain of spherical and super-deformed nuclei in the considered regions of the isotopic bands. The decay and other related properties will be discussed at the time of presentation.

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TABLE I: The RMF(NL3) results for binding energy BE,charge radius r_{ch}, quadrupole deformation parameter β_2, of spherical and superdeformed nuclei compared with the corresponding Finite Range Droplet Model (FRDM) [6, 7] results. The energy is in MeV and radius results are in fm.

	RMF(NL3)			FRDM Result	
Nucleus	BE	r_{ch}	β_2	BE	β_2
^{154}Yb	1240.2	5.12	-0.09	1238.4	-0.01
	1235.1	5.30	0.50		
^{196}Yb	1511.6	5.39	0.04	1516.0	0.01
	1502.6	5.62	0.51		
^{198}Yb	1515.8	5.42	0.09	1520.2	0.02
	1508.3	5.64	0.52		
^{154}Hf	1222.7	5.13	-0.01	1219.9	0.01
	1214.8	5.31	0.47		
^{156}Hf	1243.5	5.15	0.08	1240.8	0.03
	1237.4	5.36	0.52		
^{156}Os	1195.9	5.20	-0.09	-	-
	1188.3	5.50	0.66		
^{162}Os	1268.1	5.23	0.08	1262.8	0.05
	1261.0	5.52	0.63		
^{168}Pt	1311.5	5.29	0.08	1305.6	-0.10
	1306.0	5.58	-0.64		
^{170}Pt	1331.7	5.31	0.09	1327.2	0.11
	1327.7	5.59	0.62		
^{170}Hg	1312.1	5.32	-0.02	1304.7	-0.08
	1305.8	5.64	0.67		
^{172}Hg	1333.8	5.33	-0.01	1326.9	-0.10
	1328.3	5.64	0.65		

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