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SPECTROSCOPY OF SELECTED FISSION FRAGMENTS

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The spectroscopy of nuclei produced as fragments in the fission process has been undertaken using the EUROGAM II γ-ray multidetector array. The first experiment involved a spontaneously fissioning ^{248}Cm source and produced neutron-rich nuclei. The data analysis concentrated on the odd-A Ce isotopes and the present contribution details the structure of ^{151}Ce which results from the strong coupling of the odd neutron to the core. The results of a preliminary analysis of the yrast structure of ^{138}Te will also be given. In a second experiment performed at the VIVITRON accelerator in Strasbourg, nuclei on the neutron-rich side of the valley of stability were produced via the ^{28}Si + ^{176}Yb reaction at 145 MeV bombarding energy. The level schemes of ^{99}Mo, ^{101}Tc and ^{103}Ru have been extended to high spins ($\sim 20\hbar$). Two new high lying structures in ^{101}Tc are explained with the help of cranked shell model calculations.

1 Introduction

Spontaneous fission and fission induced by heavy ions are useful methods to study the yrast structure of nuclei on the neutron-rich side of the valley of stability and which are difficult to produce by fusion-evaporation reaction because of the lack of suitable target-projectile combinaison. In spontaneous fission, very neutron-rich nuclei around A $\sim$ 140 are produced. They lie in a region where the nuclei may undergo octupole correlations. This led us to investige odd-A Cerium isotopes and

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the results for ^{151}Ce will be presented, as well as preliminary results for the ^{138}Te nucleus. Prior to our work no γ-rays were known for these two nuclei. Recently heavy ions induced fission have also been used to study the spectroscopy of fission fragments. The level schemes of three nuclei among the most produced, namely ^{99}Mo, ^{101}Tc and ^{103}Ru, have been extended to higher spin. Newly observed structures in ^{101}Tc nucleus will be discussed below.
Both experiments were performed using the Eurogam II array at the Institut of Subatomic Research in Strasbourg, the first one with a ^{248}Cm source and the second with the ^{28}Si + ^{176}Y reaction at 145 MeV.

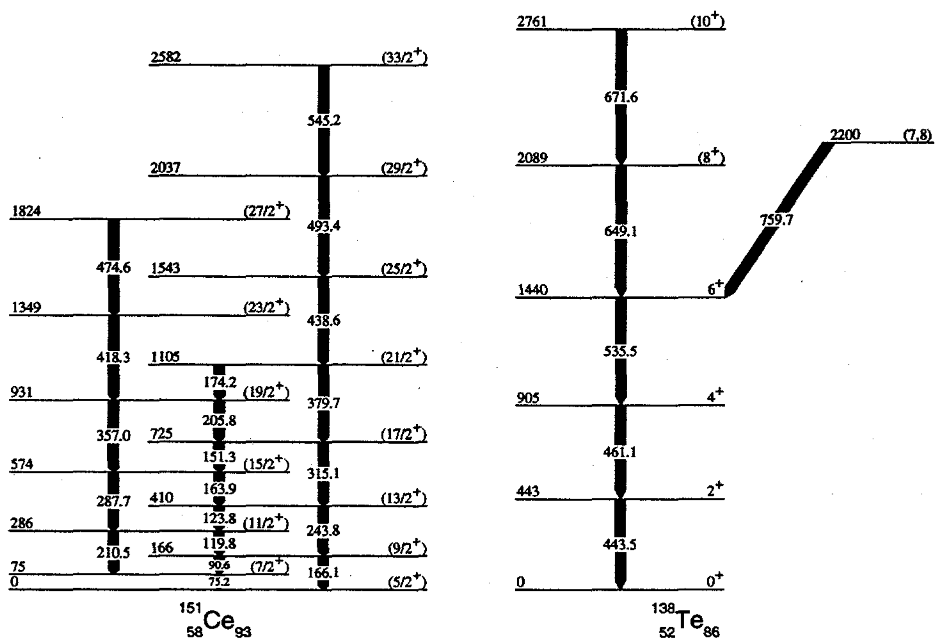

Figure 1. Levels schemes of ^{151}Ce and ^{138}Te.

2 Spontaneous fission

The level scheme obtained for ^{151}Ce, shown on figure 1, displays the characteristics features of a strongly coupled band. Gamma-rays were assigned to ^{151}Ce by using a technique based on the determination of the mean mass of the complementary fragments - here strontium isotopes - for the different Ce masses. The γ-ray multipolarities of the lowest transitions were obtained from the internal conversion coefficients deduced from intensity balance. The ground state spin-parity is assumed to be $5/2^+$ on the basis of both the systematics of N = 93 isotones and

the fit of the energy levels to a rotational formula. Moreover, the ratio of the difference between the intrinsic and rotational gyromagnetic factor to the quadrupole moment, as deduced from γ-rays branching ratios, is in good agreement with the mean value observed in neighbouring isotones for the [642]5/2$^+$ band.
No signature of octupole correlations were observed in the yrast band of ^{151}Ce; this is not so surprising since such effects are observed in the neighbouring even-even nucleus ^{148}Ce only in the yrare structure.

With the same technique, a preliminary level scheme has been built for the ^{138}Te nucleus (see figure 1). On the basis of the systematics of the N=86 isotones, spin and parity are proposed for the first three excited states. Higher spin assignments are more tentative.

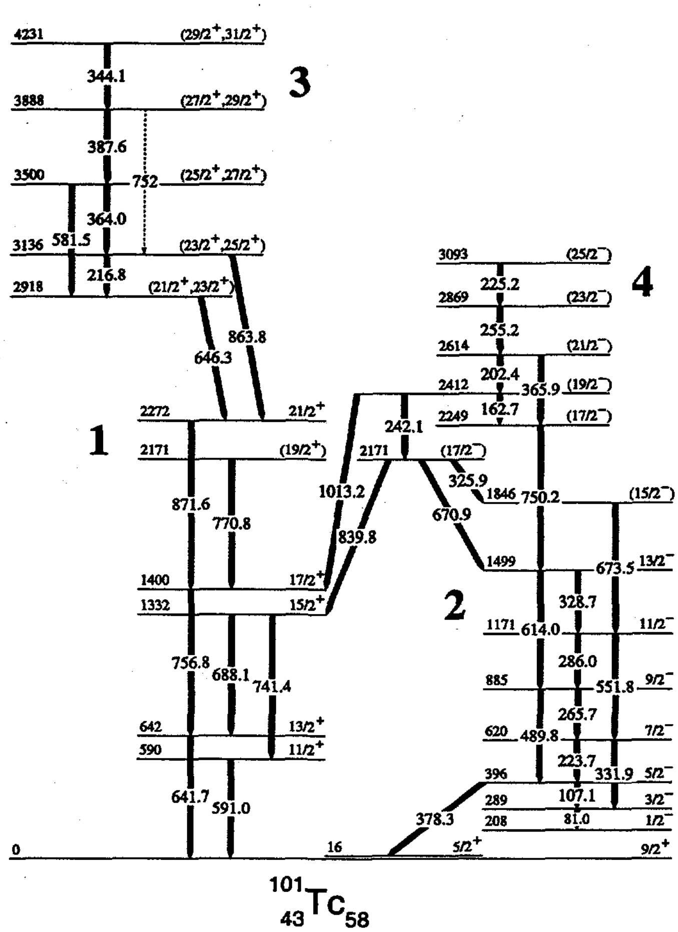

Figure 2. Levels scheme of ^{101}Tc.

3 Fission induced by heavy ions

For the ^{101}Tc nucleus (see figure 2), the level scheme can be separated in 4 bands. Most of the levels of band 1 and band 2 were already known and assigned to the $\pi g_{9/2}$ and $\pi p_{1/2}$ configurations, respectively.
The moment of inertia of band 3 as compared to band 1 shows an increase at a value $\hbar\omega$ of 0.4 MeV, the same value as in neighbouring even-even nucleus and explained as a $\nu h_{11/2}$ pair alignment in these nuclei. Theoretical calculations of the neutron routhians in the ^{100}Mo core also shows the alignment of the neutron $\nu h_{11/2}$ pair at that frequency and this leads to assign a $\pi g_{9/2}\nu(h_{11/2})^2$ configuration to band 3.
For band 4, the frequency at which the increase of the moment of inertia appears, as well as the corresponding excitation energy, are lower than in the even-even nuclei, and therefore excludes the possibility of a $\nu h_{11/2}$ pair alignment. Another possibility is an alignment of the quasiparticle proton configuration $\pi p_{1/2}(g_{9/2})^2$, but the theoretical calculation of the proton routhian in the core nucleus ^{100}Mo yields the first alignment at a frequency too large as compared to experiment. It is however possible to suggest for this band a $\pi g_{9/2}\nu h_{11/2}(d_{5/2}, g_{7/2})$ configuration on the basis of similar bands in neighbouring odd-A N=58,60,62 isotones [2].

4 Conclusion

Spontaneous fission and fission induced by heavy ions are complementary methods to analyse nuclei on the neutron rich side of the valley of stability. The two methods give the possibility to study the yrast structures up to medium spin states.
The data from the heavy ion induced fission reactions can be improved by the detection of the fragments by parallel plate avalanche counters in order to allow the determination of the multipolarities of γ-rays. Actually such an experiment has been achieved with EUROBALL III at Legnaro.

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References

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