XUNDL Status Report:
Oct. 1, 2005 – Sept. 30, 2006

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November 1, 2006

USNDP-2006: November 7-9, 2006

Purpose and Overview

- To provide prompt and convenient web access to current publications in experimental nuclear-structure data (level-scheme information) through on-line retrieval at BNL; RADWARE at ORNL and Isotope-Explorer at LBNL.
- ENSDF-formatted datasets compiled from one paper, or a set of related papers from the same group.
- Covers high- and low-spin reaction and decay papers. Regular perusal of web pages of primary nuclear physics journals (PR-C, EPJ-A, PRL, NP-A, PL-B, JP-G, IJMP-E)
- Compilation work done primarily at McMaster. Database management at NNDC.
- Requires a consistent level of effort in keeping up-to-date with the published literature, communication with original authors, and training of undergraduate students in basic nuclear physics, familiarity with ENSDF, XUNDL and NSR databases; and computer codes:

  PDF to TEXT to ENSDF; FMTCHK; PANDORA: ENSDAT; Isotope-Explorer; GTOL; BrIcc; LOGFT.
- Various steps of compilation procedures have been described at earlier USNDP and NSDD meetings.
- Although the datasets are called as “unevaluated”, each dataset is sort of internally evaluated through consistency checks and communication with the authors about data-related problems and unpublished data.

Current Contents of XUNDL

- Since the start in December 1998,

  2010 datasets added up to September 30, 2006

- Covers mainly high-spin structures; but since 2003, most low-spin papers have also been compiled.

- ~1250 nuclides: ^{7}Li to ^{288}115, spread over ~225 A-chains; few datasets for hypernuclides also.

- Data from over ~1550 primary references published mainly during 1995 – 2006: year-wise distribution:

2006-1995: 150; 204; 174; 139; 150; 139; 145; 125; 130; 64; 66; 55

Work in FY-06 (Oct 1, 2005 to Sept 30, 2006)

- 380 datasets compiled since October 1, 2005; which include data from about 125 papers published in 2006 alone.
- 28 existing datasets revised/updated based on new papers from previous authors/groups
- Undergraduate student, Joel Roediger, actively participated in XUNDL work in 2005-April 2006.
- A new undergraduate student, Maxim Mitchell started in April 2006 and has been undergoing training in the XUNDL compilation procedures and basic knowledge of nuclear physics and spectroscopy.
- A copy (computer file and printout) of all communications for the last couple of years was sent to NNDC in September 2006 for archival purposes.
- Except for about 10 papers published in journal web pages in the last few weeks, we are current on the compilation of high- and low-spin primary publications

Some difficult examples

- No details of data available, neither in the publication nor through requests from the authors:
- ^{161}Lu and ^{170}Hf in PR-C
- ^{58}Ni: perhaps the most complex high-spin level scheme

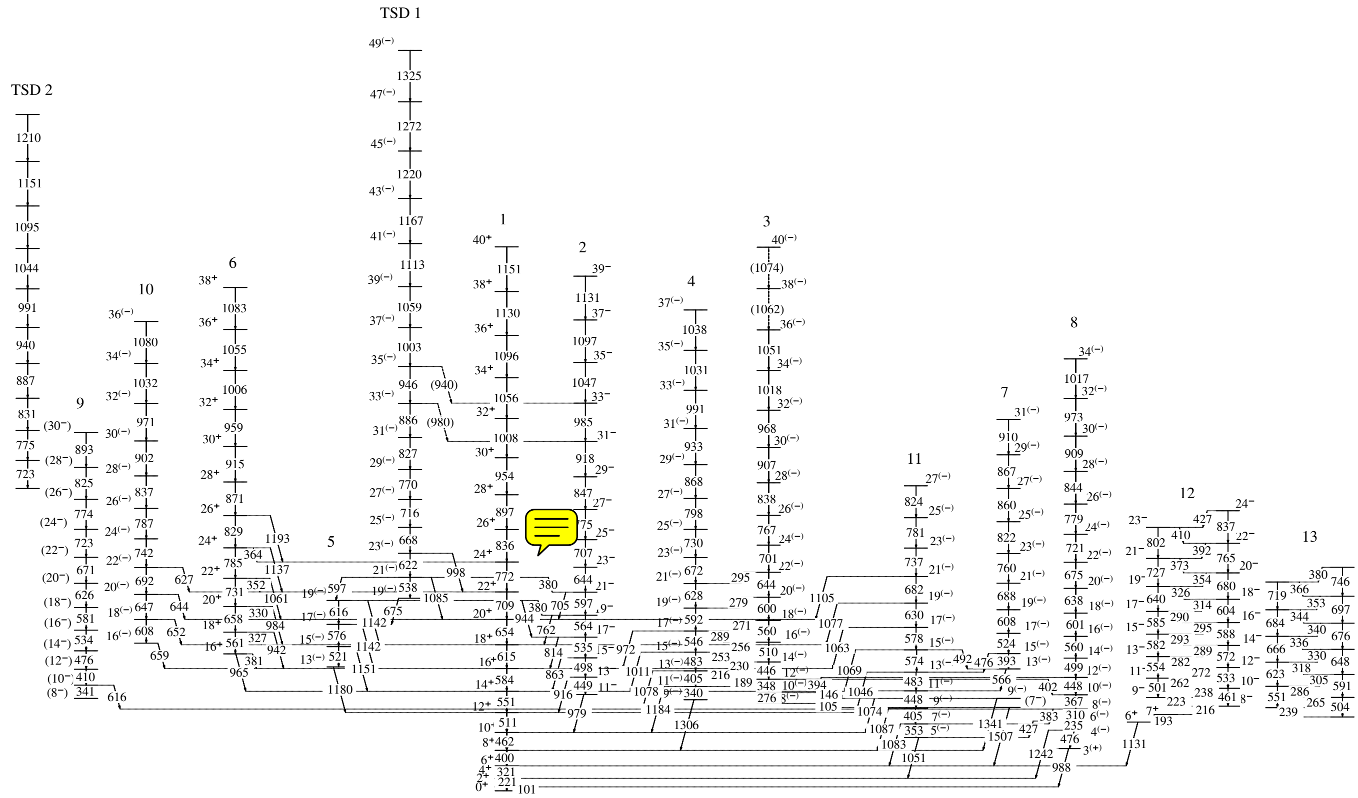

FIG. 3. Level scheme of ^{170}Hf.

The dynamic moments of inertia of TSD1 and TSD2 in ^{170}Hf show a mixed behavior as a function of frequency. Towards low and high frequencies, the $J^{(2)}$ values decrease; at intermediate frequencies, they increase. Therefore, the moments of inertia alone do not decide to which of the groups of bands they belong. A measurement of lifetimes is certainly necessary. The PES calculations for ^{170}Hf (see the example given in Fig. 1) show for all combinations of parity and signature only the TSD local minimum in addition to the ND minimum. Thus, the two new bands have to be associated with the triaxial minimum. However, a final proof of the triaxiality awaits the discovery of wobbling. From the present data, we have evidence that it is unlikely for the two bands to be members of the same wobbling family with similar alignments and with enhanced transitions between the two bands as found in the Lu isotopes [2].

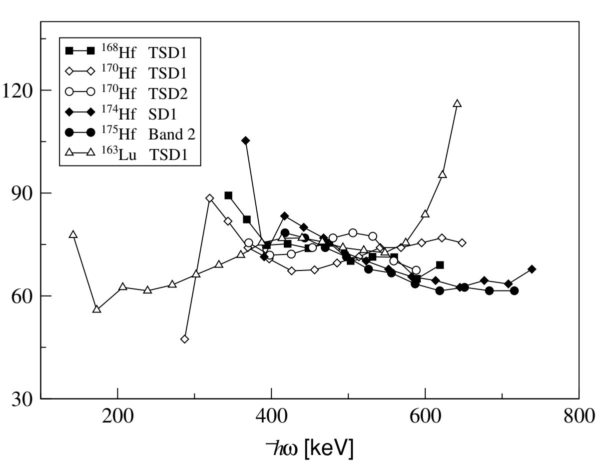

FIG. 4. Dynamic moments of inertia $J^{(2)}$ as a function of rotational frequency of TSD1 and TSD2 in ^{170}Hf compared to other TSD bands in Lu and Hf nuclei.

In our previous report on TSD2 [14], we argued on the basis of coincidences with ND transitions and similarities to TSD bands in the Lu isotopes that the spin range should be from $I \approx 22$ or 24 to 42 or 44. However, the new results on the high-spin band 2 in ^{175}Hf [10] could allow a different spin assignment to TSD2 in ^{170}Hf. If these two bands had a similar structure, the spins of TSD2 could be much higher; a spin range of about 40 to 60 would be possible. On the basis of the presently available data, it is not possible to firmly decide between the two alternatives. However, if it would be a very high-spin band, its alignment would be very large, $i_x \approx 30\ \hbar$. Such a band would be yrast at high spins and would be expected to be more strongly populated than observed experimentally. Furthermore, as mentioned above, band 2 in ^{175}Hf probably belongs to the axially symmetric minimum, which is not predicted by the PES calculations for ^{170}Hf (see Fig. 1).

The assignment of TSD1 and TSD2 to the PES minima with large triaxial deformation, $(\epsilon, \gamma) \approx (0.4, 20^\circ)$, is also supported by their aligned angular momenta i_x, which are plotted as a function of rotational frequency in Fig. 5, upper panel. For TSD2, the lower spin range with $I_0 = 24$ was assumed. The alignments were obtained from the measured spins subtracting a reference core [26], $I_{\rm ref} = J_0\omega + J_1\omega^3$,

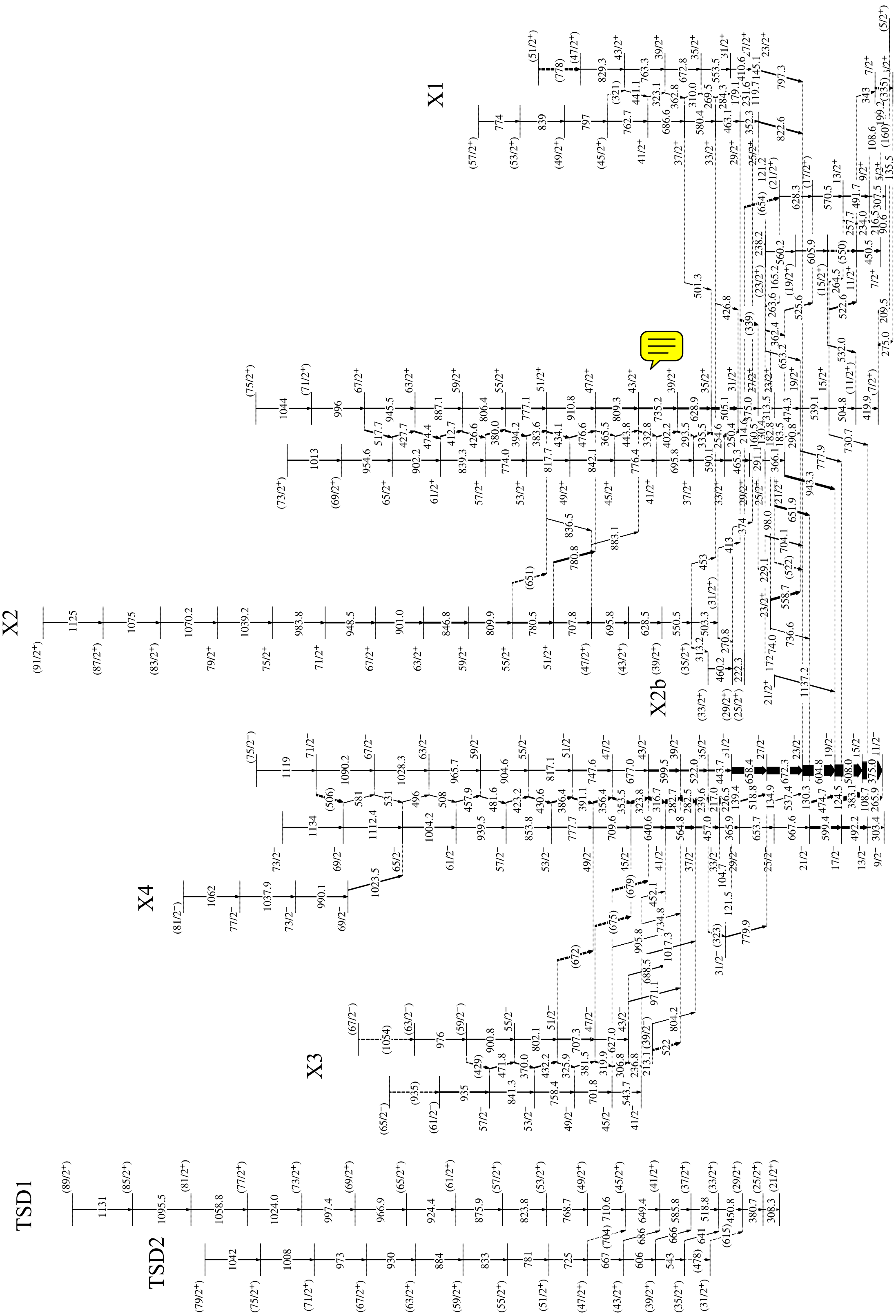

FIG. 2. Level scheme of ^{161}Lu.

was discovered by Svensson *et al.* in ^{62}Zn [22], also coupled bands with more or less intense $\Delta I = 1$ cross over transitions were identified in the Ni, Cu, and Zn isotopes, which may arise from single nucleons in (relatively) high-K Nilsson orbits of the $1f_{7/2}$ shell. The first such rotational band *below* Ni was recently found in ^{57}Co [23]. It should be noted that different from other mass regimes almost all of the bands known are linked to the states in the spherical minimum, which fixes their excitation energies and allows for at least tentative spin and parity assignments. Some of the coupled bands have been observed up to terminating spins as well [24]. Comparisons of predictions of several microscopic and macro-microscopic models to the experimental observations have usually a very high level of agreement. Last but not least there are a few candidates for magnetic rotation in ^{54}Fe, ^{55}Co, and ^{60}Ni. They await, however, confirmation in terms of lifetime measurements. Such investigations are ongoing.

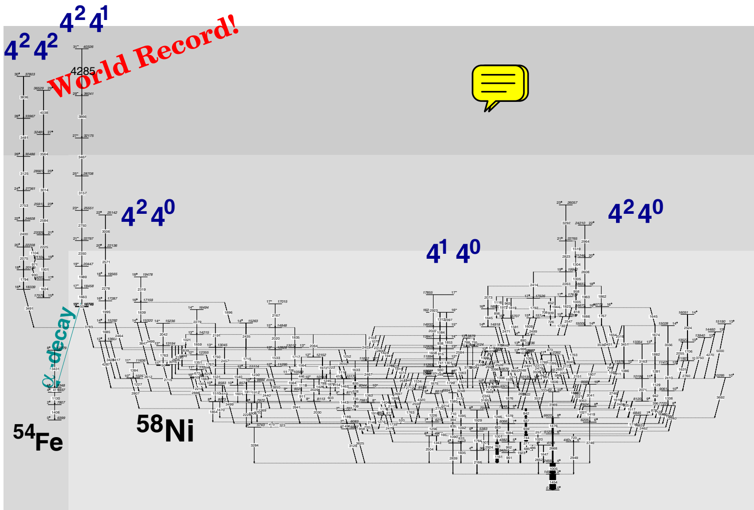

Fig. 4. Partial level scheme of ^{58}Ni.

The evolution of shapes in the mass region may be followed most beautifully in the case of ^{58}Ni [25]. Figure 4 provides an extensive (preliminary) excitation scheme of ^{58}Ni studied with three different reactions. From experiment 4 (*cf.* Table I) an extremely rich level scheme in the spherical minimum was established reaching states up to about 20 MeV excitation energy. ^{58}Ni represented the $2\alpha 2p$ channel, and was populated with a relative cross section of about 6%. The results from experiments 2 and 3 (and an earlier Gammasphere experiment) allowed for an extension to 30 MeV excitation energy, and the level scheme becomes much more simple, since only rotational bands appear above 20 MeV. The relative cross section increases

ENSDF coverage of Nuclei at the Limits of Stability

- First primary papers on new Nuclides at the limits of Stability: bound and unbound.
- First primary paper about excited state(s) in nuclides at the limits of stability.
- As part of XUNDL activity, we routinely compile papers containing types of discoveries stated above.
- With some extra work, we can prepare datasets for inclusion in ENSDF. This will be done by an evaluator not by undergraduate student.
- Advantage: prompt inclusion of such important data in ENSDF, NUDAT and other related databases.
- Need general agreement from the network for nuclides that are not part of McMaster's assignment. If necessary, the datasets can first be sent to the center responsible for that mass region for the purpose of approval.

In terms of ENSDF vs XUNDL retrievals, the various numbers are as follows:

Query	***ENSDF***	***XUNDL***	***Both***
Quick Nuclide	42493		
DS by nuclide	19038	348	5983
Browse	14412	3379	
DS by decay	6775	327	1525
ENSDF Index	5742		
DS by Z	2975	63	410
XUNDL Index		3328	
DS by reaction	2542	61	510
Quick Mass	2883		
DS by A	1568	96	196

For queries which allow the user to specify that both types if datasets be retrieved, this option is used about 20% of the time. Note that the default state is defined to be “ENSDF Only”.

Conclusions

- The current retrieval rate by the user community, as monitored by NNDC, seems about 300/month from the NNDC site. There may be other retrievals made through LBNL and RADWARE websites.

- Availability of compiled XUNDL datasets potentially accelerates ENSDF data-evaluation process.

- If there is general agreement in the network, we can undertake to prepare ENSDF datasets when first (primary) papers appear on the identification of new nuclides or those reporting excited state(s) for nuclei at the limits of stability.