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TITLE: CALCULATED MASSES AND DECAY PROPERTIES FOR HEAVY AND SUPERHEAVY ELEMENTS

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Calculated masses and decay properties for heavy and superheavy elements

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Within the framework of the macroscopic-microscopic method, models have been developed that allow the calculation of nuclear masses and fission barriers to an accuracy of approximatively 1 MeV, on the average. In one such calculation Möller and Nix studied nuclei from ^{16}O to the heaviest known elements[1-3]. In that calculation the rms deviations between calculated and experimental masses and fission barriers were 0.835 MeV and 1.331 MeV respectively. We have now used that model to extend the calculations to additional nuclei up to Z=122. A table where we list calculated ground-state masses, Q_α , Q_β and Q_{EC} will be published elsewhere. However, since there were some masses missing in the 1980 calculation for Z=108 and Z=109 that are now of interest in connection with the recent discoveries of these elements we give the results for these missing elements here. Thus for ^{264}108 and ^{265}108 our new calculation gives the mass excesses 120.90 and 121.95 MeV. For the isotopes $^{264-268}$109 the results are 128.26, 127.77, 128.52, 128.19 and 129.05 MeV. Experimentally, Armbruster and collaborators have obtained the masses 120.97 MeV and 128.06 MeV for ^{265}108 and ^{266}109, respectively.

Our results for the superheavy region are quite different compared to earlier calculations, compare for instance with the calculation in 1972 by Fiset and Nix[4]. The maximum shell correction now occurs at Z=114 and N=178, cf. figure 1. The most longlived nuclei in the superheavy region are now ^{288}110 and ^{290}110, both with a calculated halflife of around 200 days. We feel that these new results are probably more correct than the older results. In the present version of the model the spin-orbit interaction strengths for protons and neutrons and the range a of the Yukawa folding function (which regulates the surface diffuseness of the single-particle potential) have been carefully determined by comparing calculated and experimental levels in several deformed and spherical regions of the periodic system[5]. To obtain a model valid throughout the periodic system we keep the range constant and use an expression, linear in A, for the spin-orbit strength[1]. In addition, in the study[1-3] of nuclear ground-state properties from ^{16}O to the heaviest of the known elements it was found that the agreement between calculated and experimental results were usually excellent throughout the entire region. When the macroscopic model parameters were determined in 1980 the last element for which we included experimental masses was $_{102}No$. In the present extrapolation towards the superheavy region we note that the difference between the experimental and calculated mass for $^{266}109$ is only 0.46 MeV. Thus the model extrapolates well 7 Z units beyond the last element to which the model parameters were adjusted. We are at present studying other nuclear properties in the trans-fermium region to learn more about the reliability of the model for predicting the properties of the superheavy region, but already at this stage the extrapolation properties appear promising.

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REFERENCES

1) P. Möller and J. R. Nix, Nucl. Phys. **A361** (1981) 117

2) P. Möller and J. R. Nix, At. Data and Nucl. Data Tables **26** (1981) 165

3) R. Bengtsson, P Möller, J. R. Nix and J-y. Zhang, Phys. Scr. **29** (1984) 402

4) E. O. Fiset and J. R. Nix, Nucl. Phys. **A193** (1972) 647

5) P. Möller, S. G. Nilsson and J. R. Nix, Nucl. Phys. **A229** (1974) 292

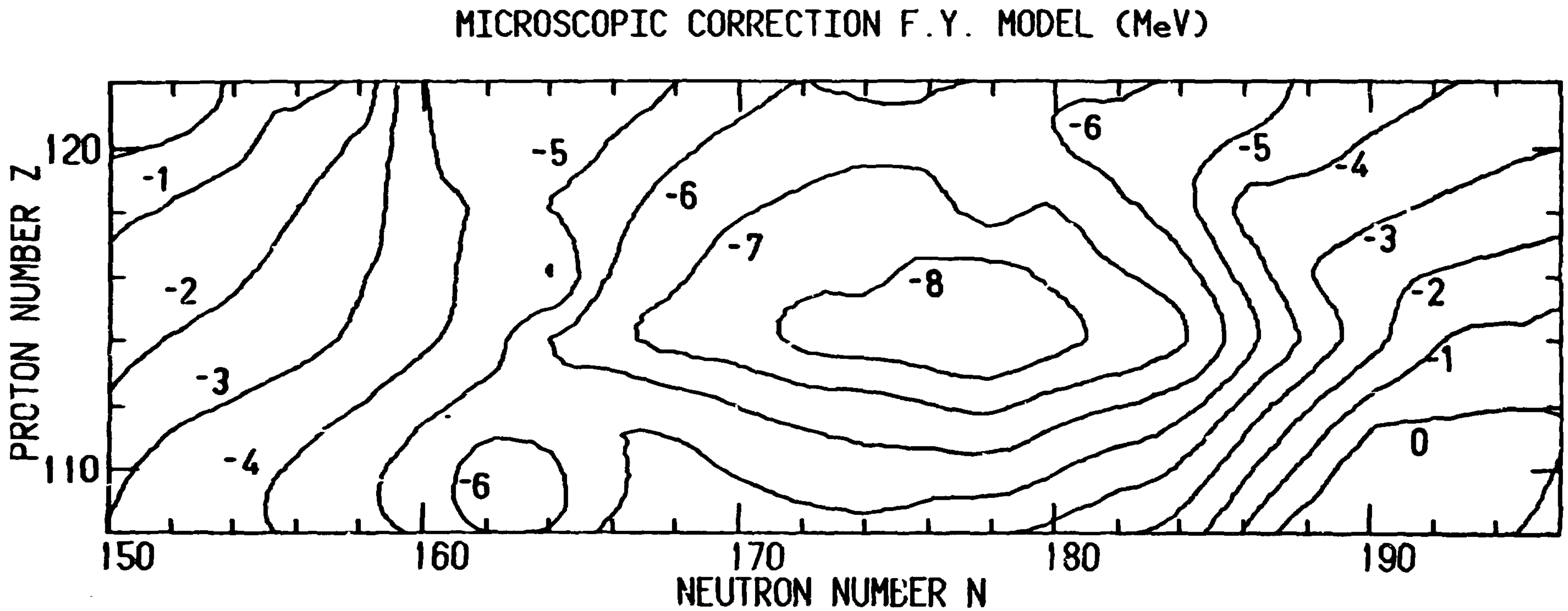
MICROSCOPIC CORRECTION F.Y. MODEL (MeV)
PROTON NUMBER Z
NEUTRON NUMBER N
120
110
150
160
170
180
190
-1
-2
-3
-4
-5
-6
-7
-8
-6
-6
-5
-4
-3
-2
-1
0

FIGURE 1