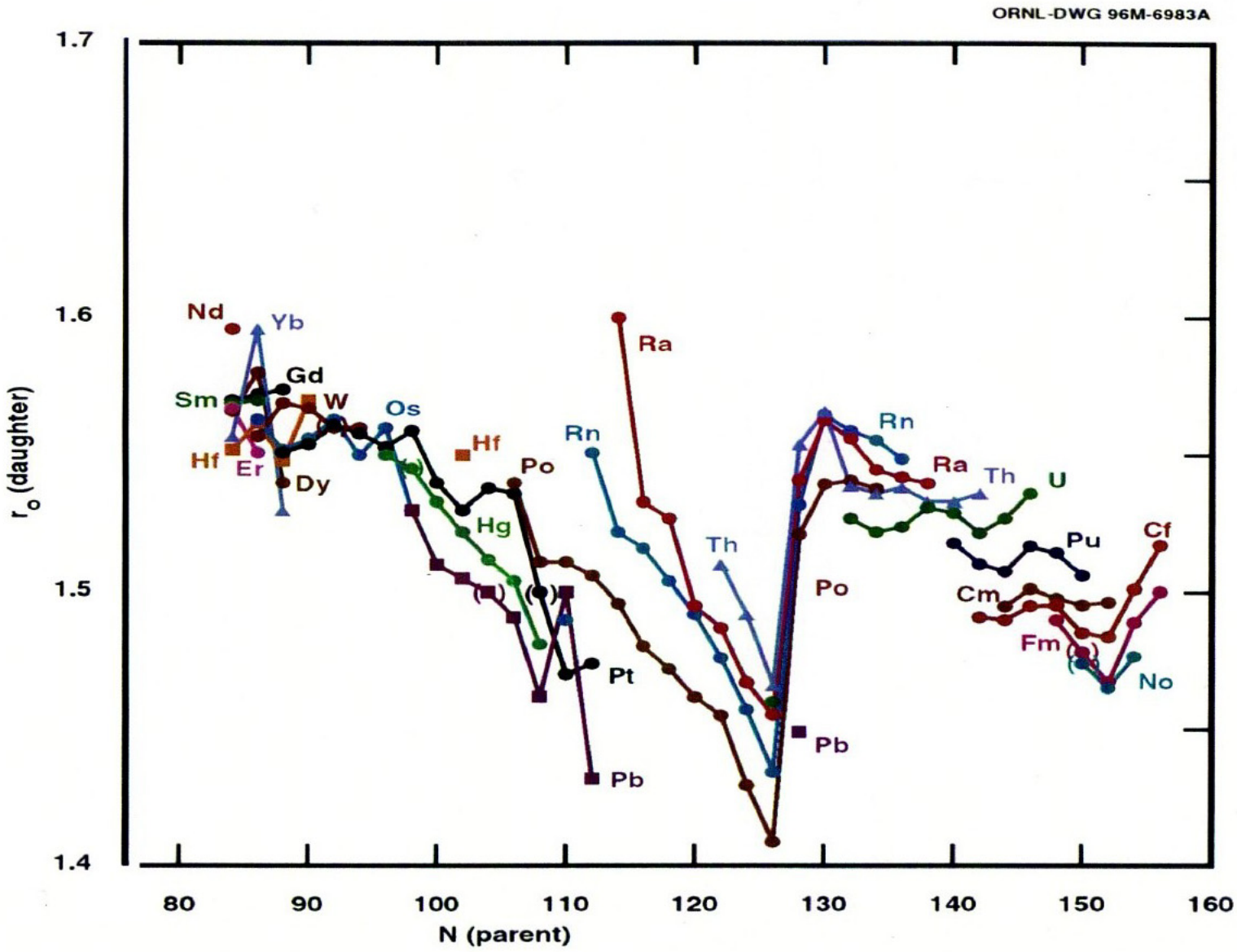
Obtaining r_0 parameters for HF calculations of alpha's from odd-A and odd-odd nuclei

Yurdanur Akovali
Oak Ridge National Laboratory

In order to calculate hindrance factors for alpha's from an odd-A and from an odd-odd nucleus, the alpha-hindrance factors program requires a r_0 parameter as an input. These parameters are chosen from the r_0 values calculated for the even-even nuclei (see Y.A.Akovali, Nucl.Data Sheets 84,1 (1998)).



r_o parameters calculated from α decays of even-even

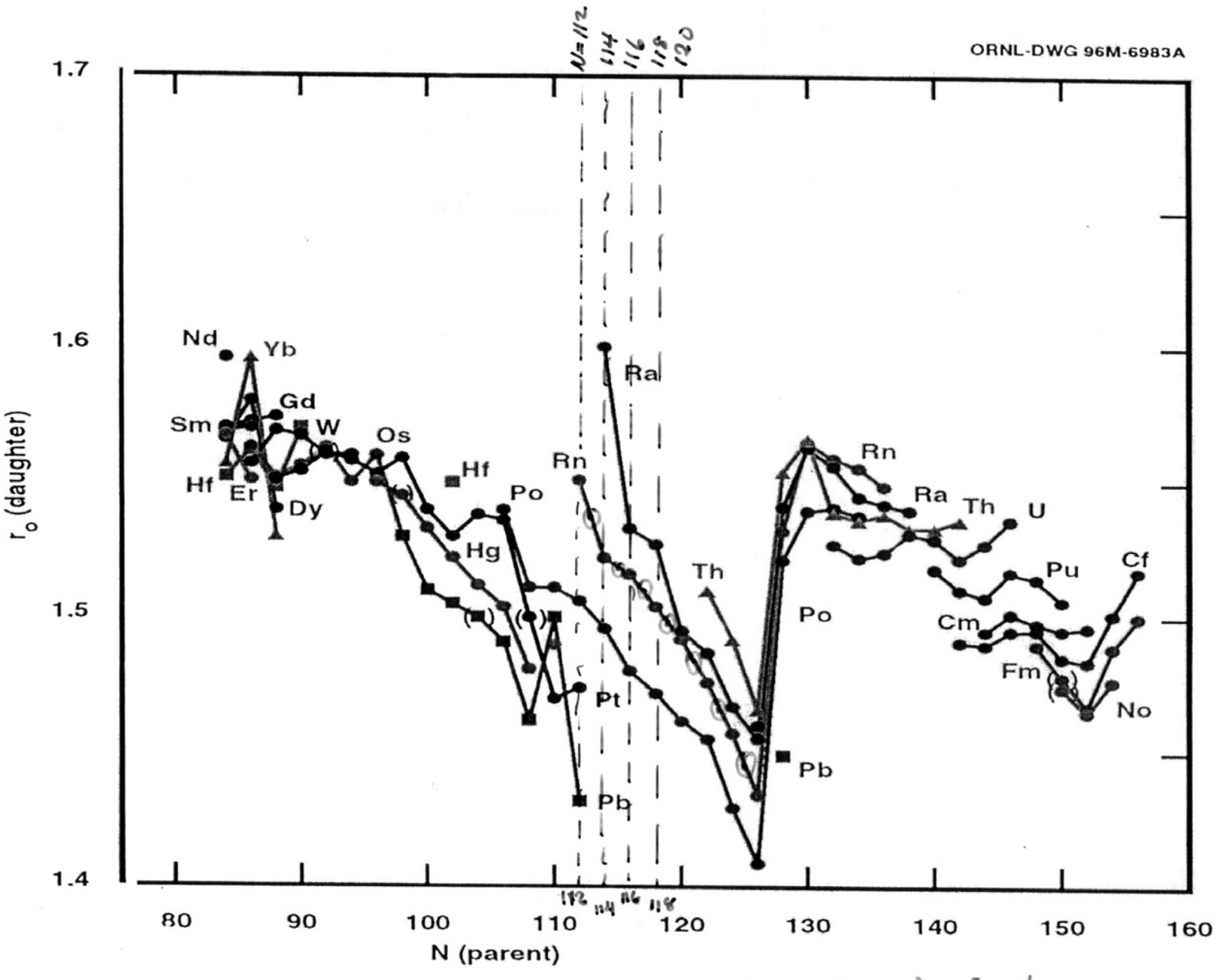
(1) For an even Z, odd N nucleus,

the r_0 parameters may be chosen as the average of the neighboring N-1 and N+1 isotopes:

$$r_0(\text{even Z,odd N})$$

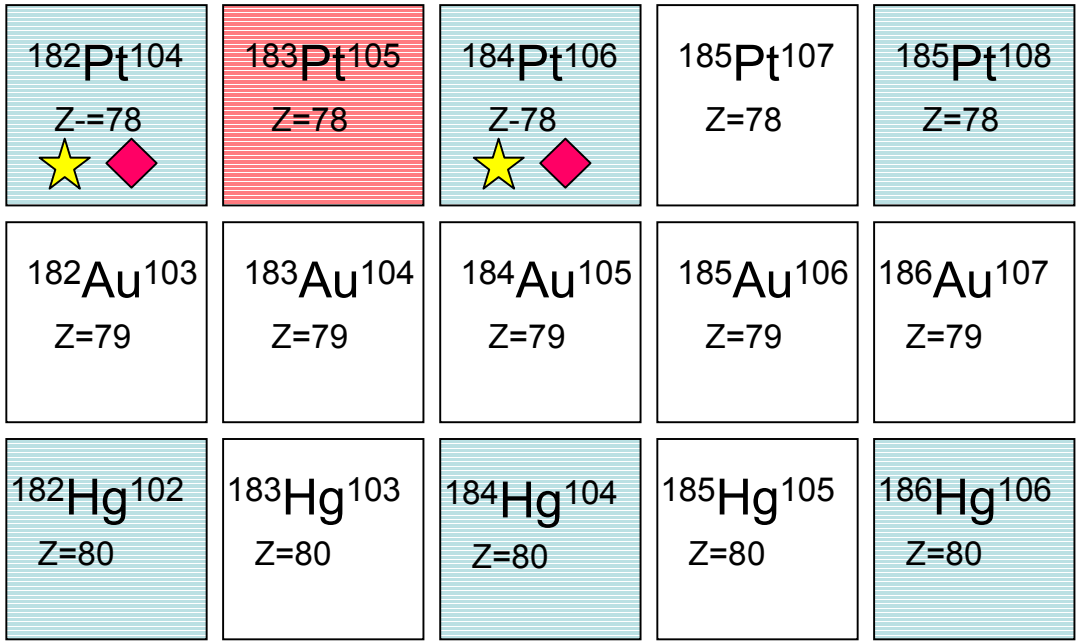
$$= \tfrac{1}{2} [r_0(Z,N-1) + r_0(Z,N+1)]$$

example :



○ r_o parameters for odd-mass Rn ($Z=86$) isotopes

Even Z, Odd N: e.g., ^{183}Pt



☆ Nearest even-even neighbors

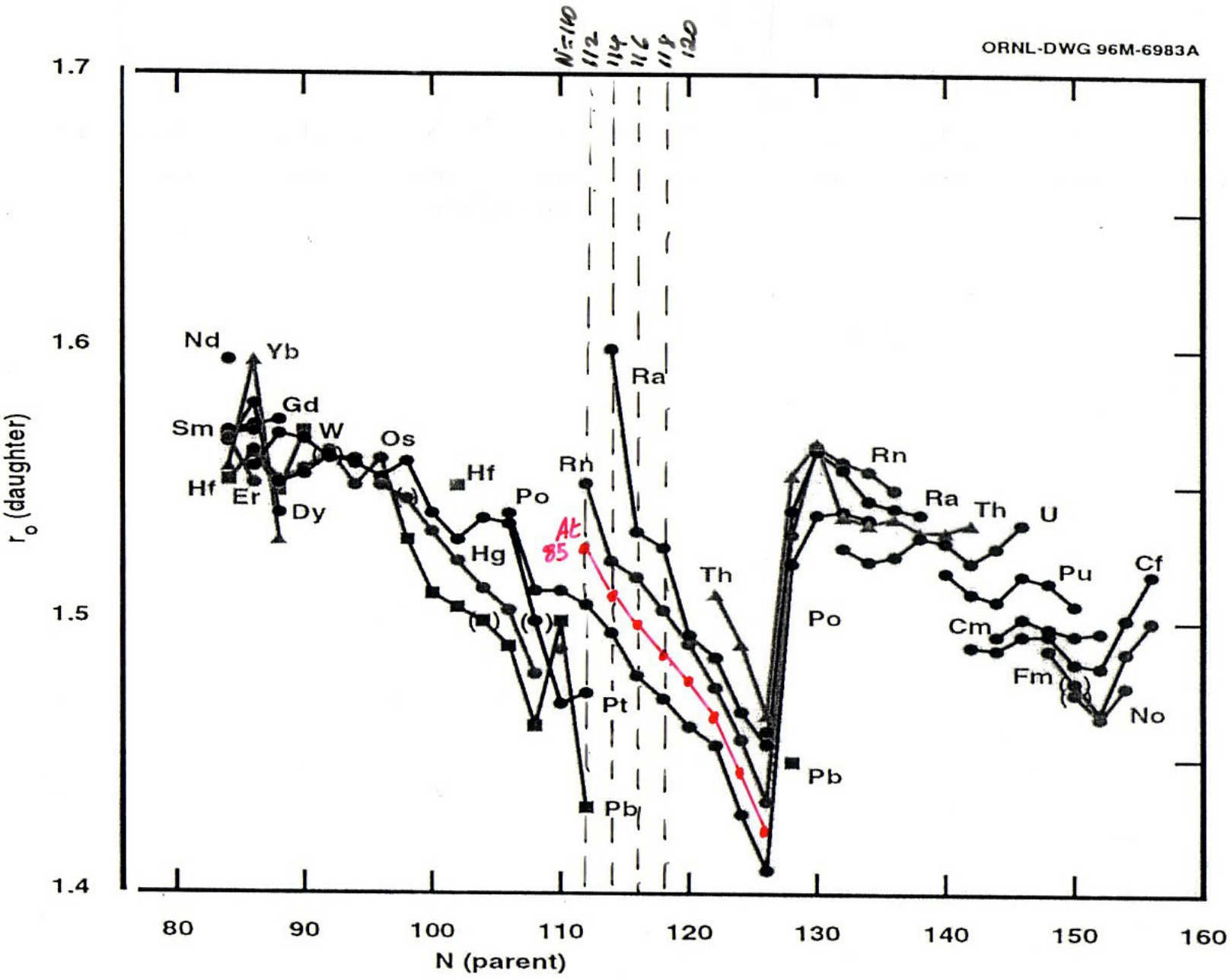
Constant Z; interpolate N

1/2[r0(Z,N-1)+r0(Z,N+1)] – TOI (☆) and ORNL (◆)

(2) For odd Z nuclei, the r0 plots are chosen to be in between the r_0 curves for the neighboring even-even nuclei. The r_0's for odd Z, even N then is the average of r_0's for Z+1 and Z-1 isotones:

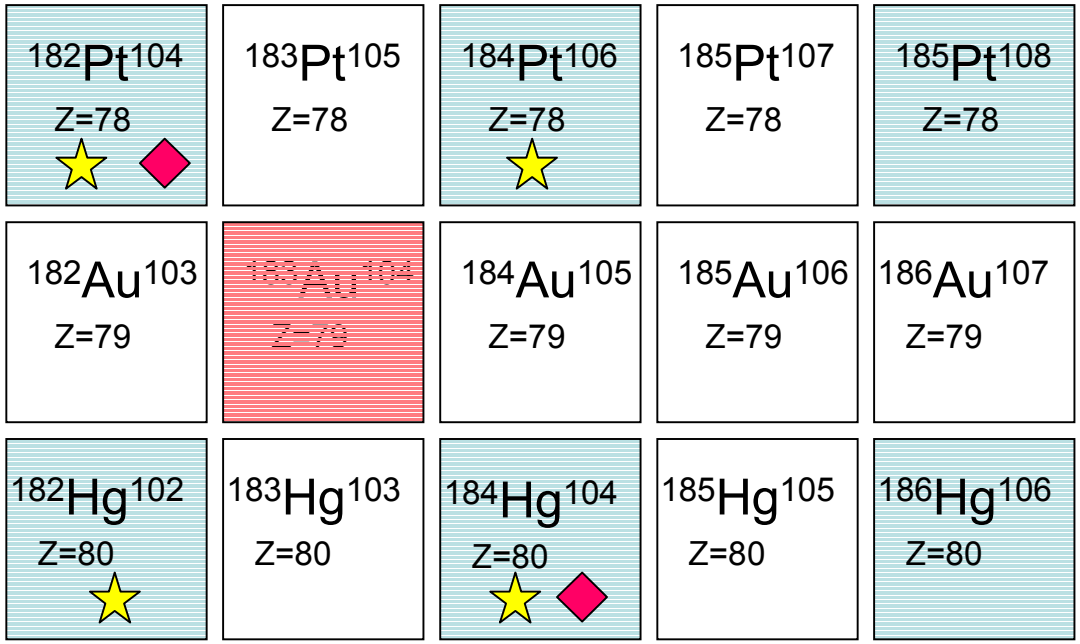
r_0(odd Z,even N)

$= ½ [r_0(Z+1,N) + r_0(Z-1,N)]$



• r_o parameters for odd Z, even N $^{At}_{85}$ isotopes

Odd Z, Even N: e.g., ^{183}Au



☆ Nearest even-even neighbors if A constant for each column

◆ ORNL: Constant N, interpolate Z:
1/2[r0(Z-1,N)+r0(Z+1,N)]
☆ TOI: use 4 nearest neighbors (interpolate Z and N):
1/4[r0(Z-1,N)+r0(Z-1,N+2)+r0(Z+1,N-2)+r0(Z+1,N)]
=1/2[r0(Z-1,N+1)+r0(Z+1,N-1)]

(3) For odd Z-odd N nuclei, the r_0 curves for the odd Z nuclei described in above are used. As it is done for even-even nuclei, r_0's for the odd N nuclei are the average of r_0's for the adjacent even N nuclei with the same Z number:

r_0(odd Z, odd N)

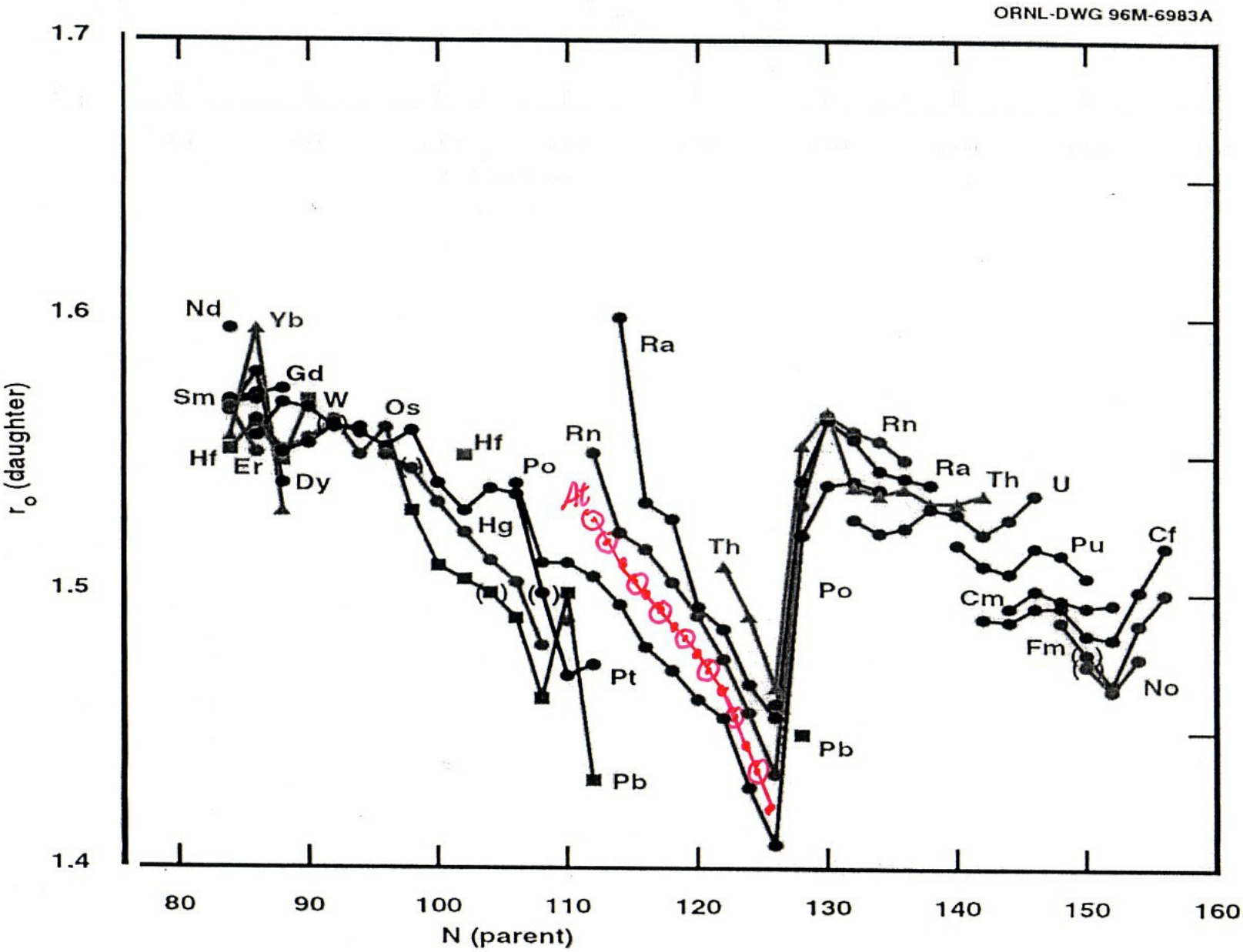
$$= \tfrac{1}{2} [r_0(Z,N+1) + r_0(Z,N-1)]$$

This is equivalent to averaging four r_0's of adjacent even-even nuclei.

r_0(odd Z, odd N)

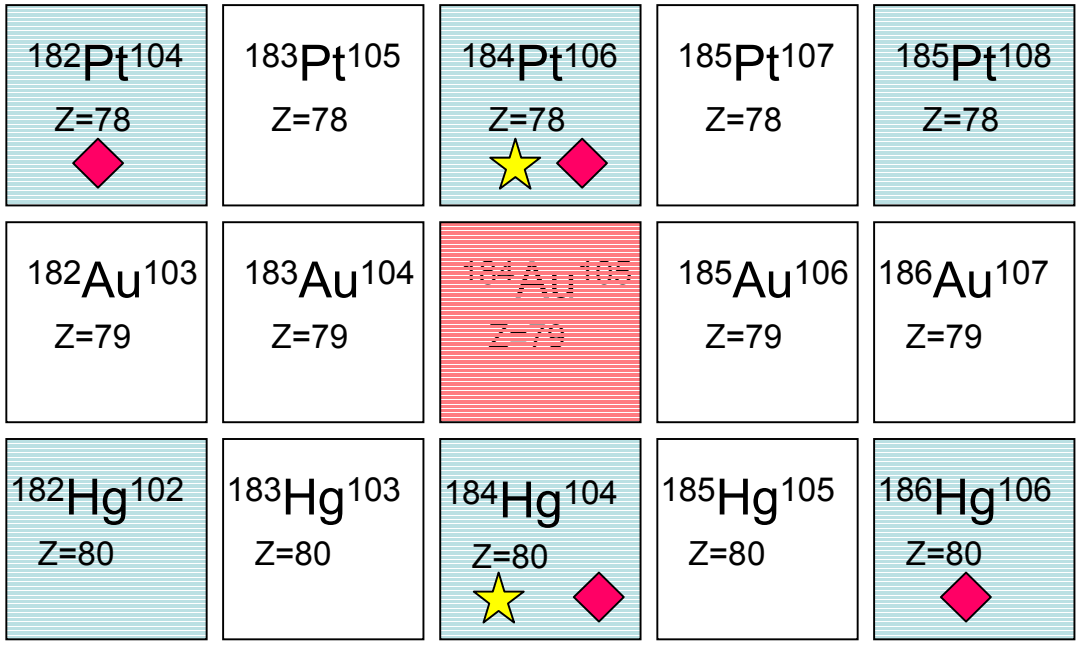
$$= 1/4 \{r_0(Z+1,N+1) + r_0(Z+1,N-1) + r_0(Z-1,N+1) + r_0(Z-1,N-1)$$

example:



⊙ r_o parameters for odd-odd At isotopes

Odd Z, Odd N: e.g., ^{184}Au



☆ Nearest even-even neighbors if A constant for each column

◆ ORNL: Interpolate N, interpolate Z:
1/2[r0(Z,N+1)+r0(Z,N-1)]
=1/4[r0(Z-1,N+1)+r0(Z-1,N-1)+r0(Z+1,N+1)+r0(Z+1,N-1)]
☆ TOI: Interpolate N, interpolate Z (use 2 nearest neighbors):
1/2[r0(Z-1,N+1)+r0(Z+1,N-1)]

The evaluators must use their judgments, and may exclude any of the r0's for the adjacent even-even nuclei in these averaging, depending on their accuracies, preciseness, and fit to systematic trend.