

TDHF + Langevin approach to hot fusion reactions for superheavy elements

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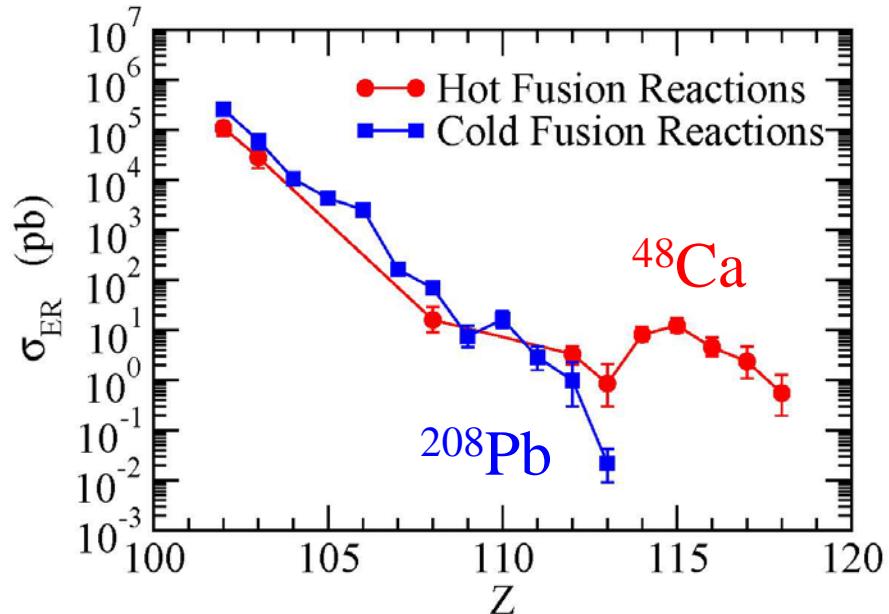
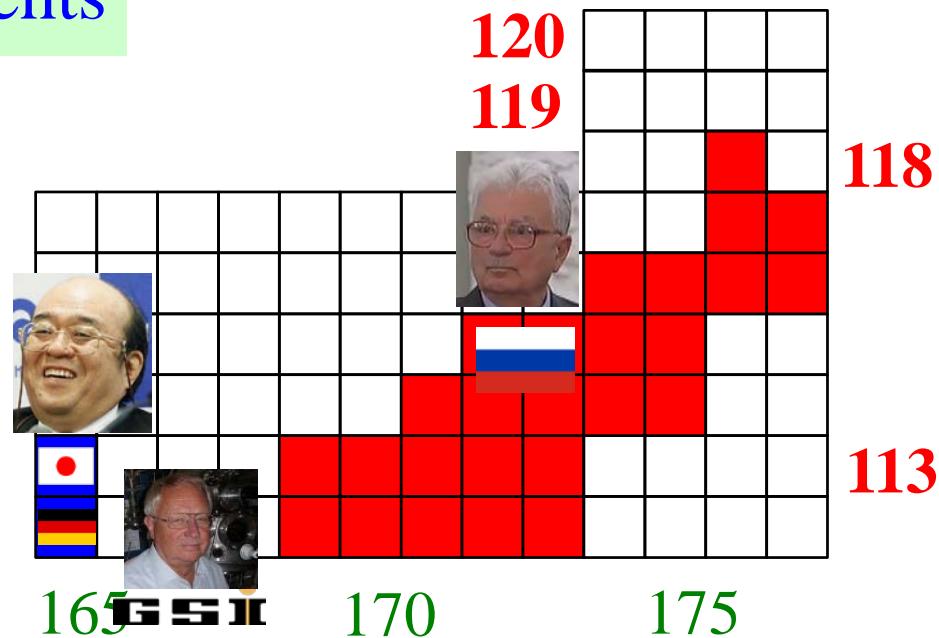
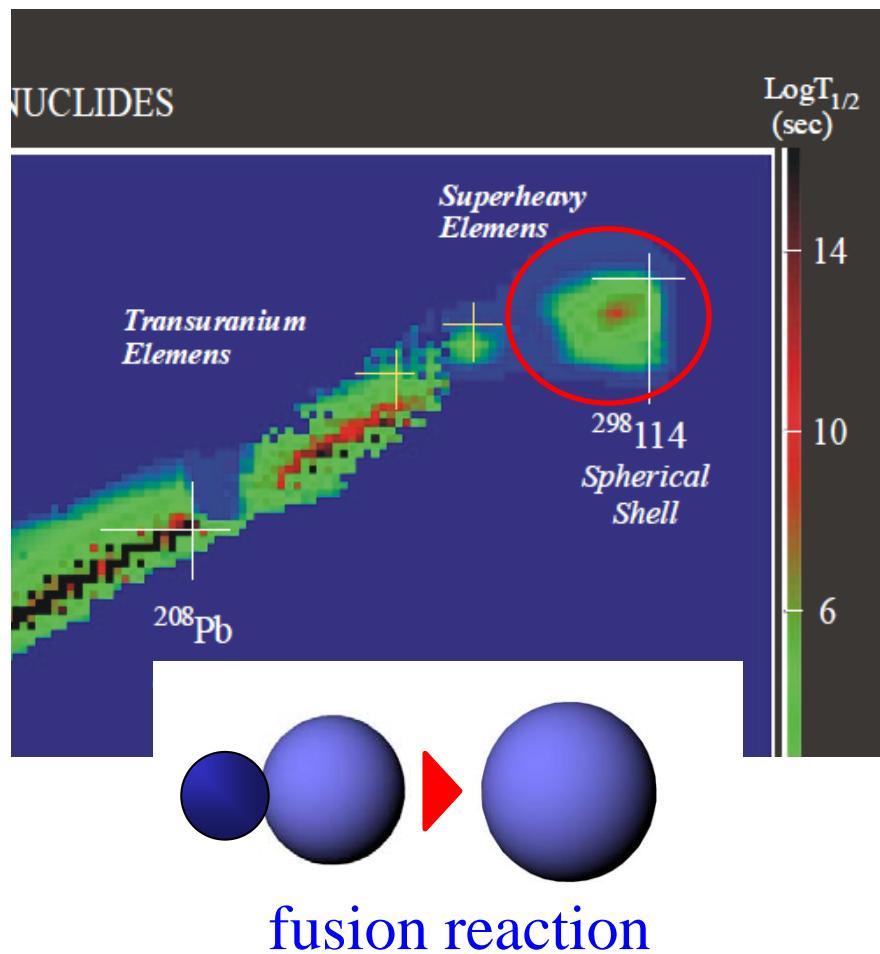


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1. Hot fusion reactions for superheavy elements
2. Towards $Z = 119$ and 120
3. TDHF + Langevin approach
4. Summary

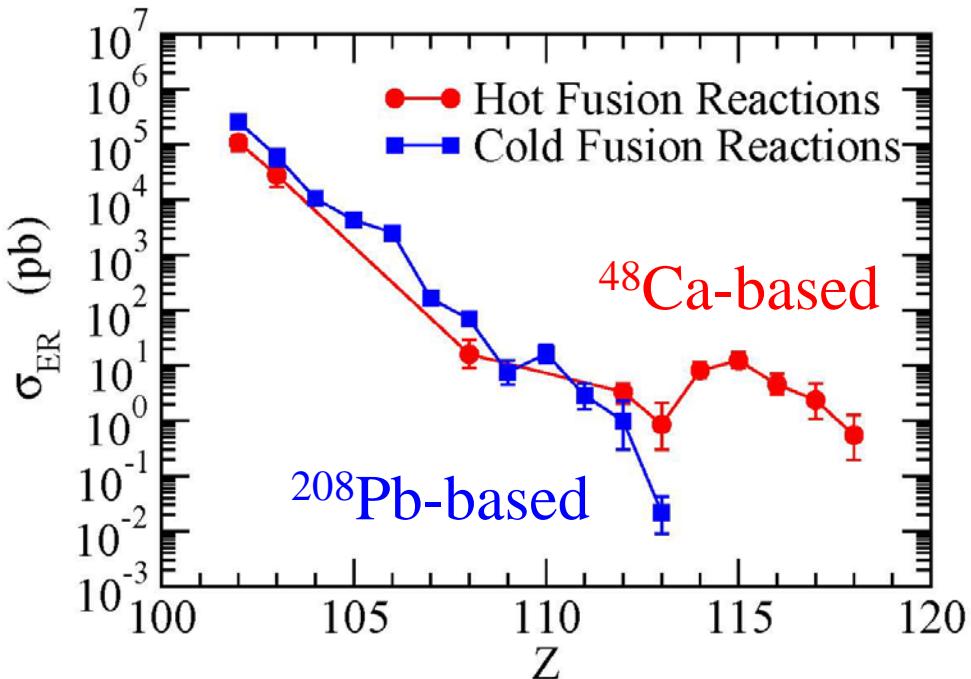
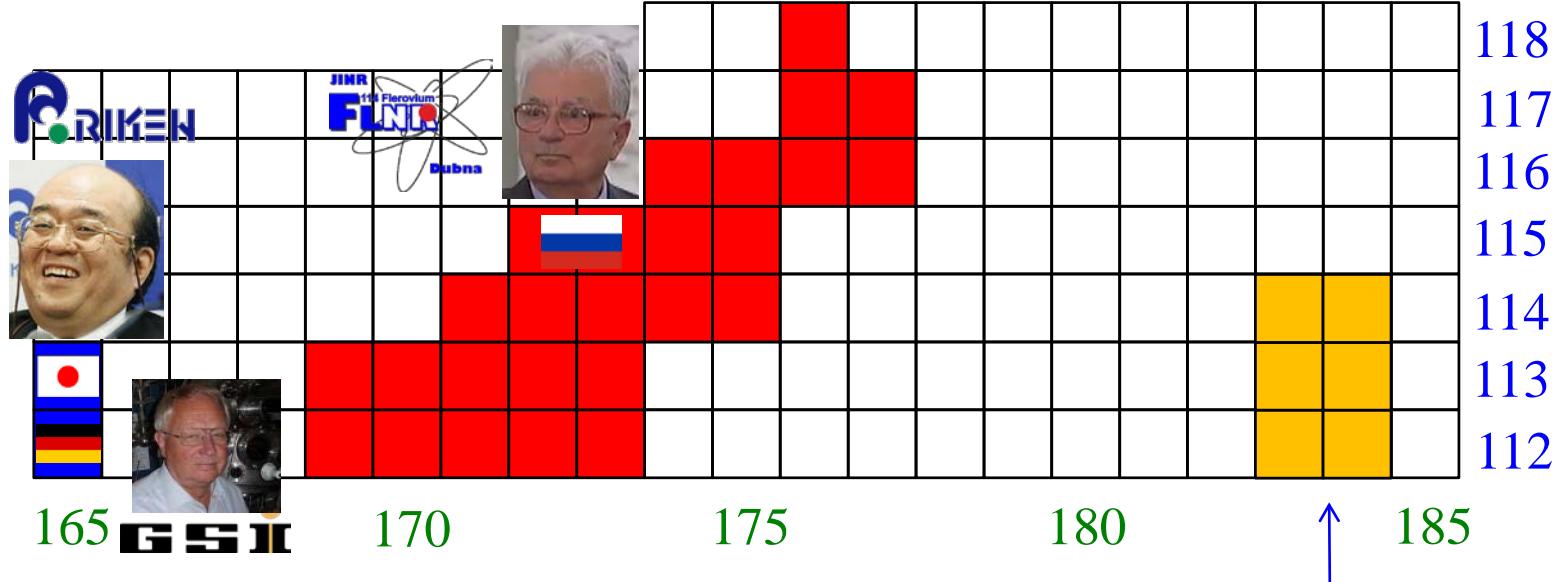
Introduction: superheavy elements



Hot fusion reactions: ^{48}Ca +actinides



$Z = 119$ and 120

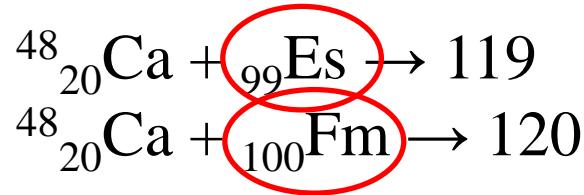


the island
of stability?

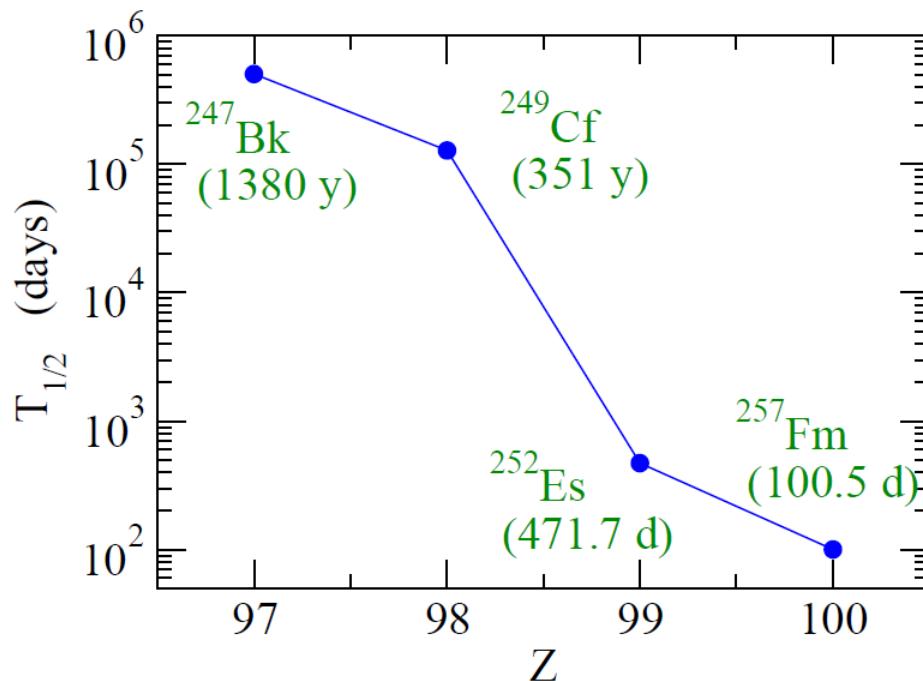
Hot fusion for
 $Z = 119$ and 120

Towards Z=119 and 120 nuclei

hot fusion reactions with ^{48}Ca :



short lived → not available with sufficient amounts

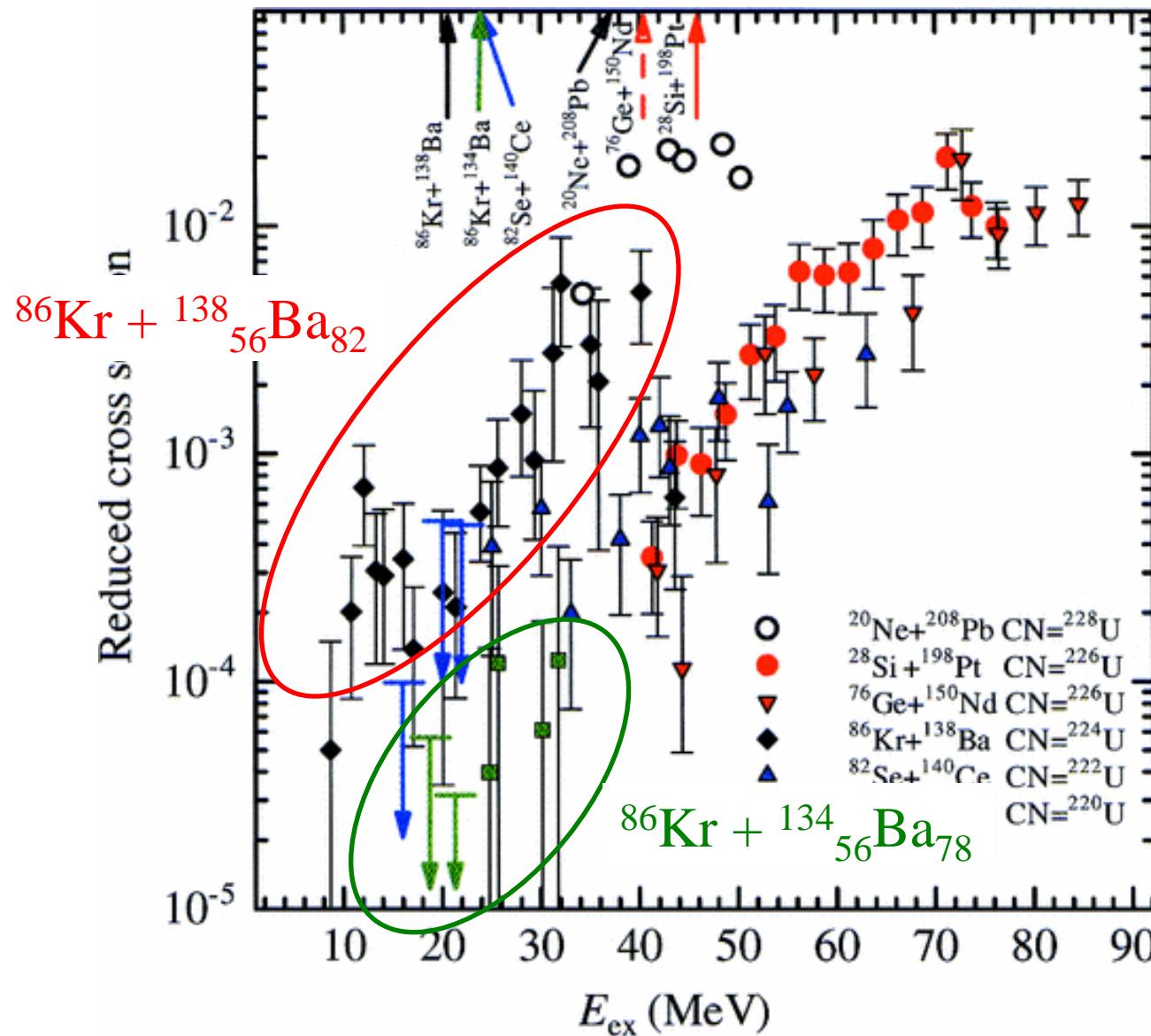


$^{48}\text{Ca} \rightarrow {}_{22}^{50}\text{Ti}, {}_{23}^{51}\text{V}, {}_{24}^{54}\text{Cr}$ projectiles

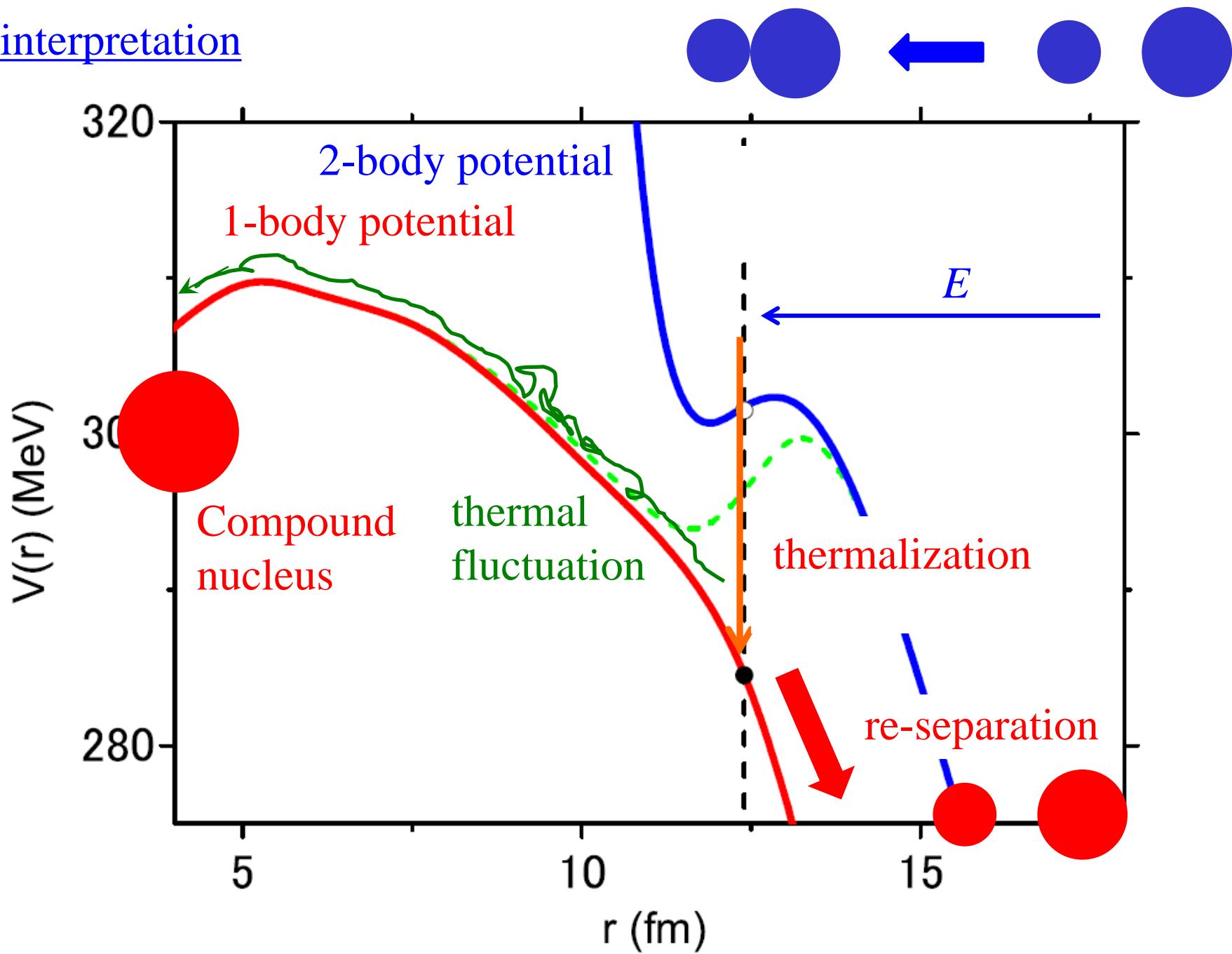
closed shell → open shells

how much will cross sections be affected?

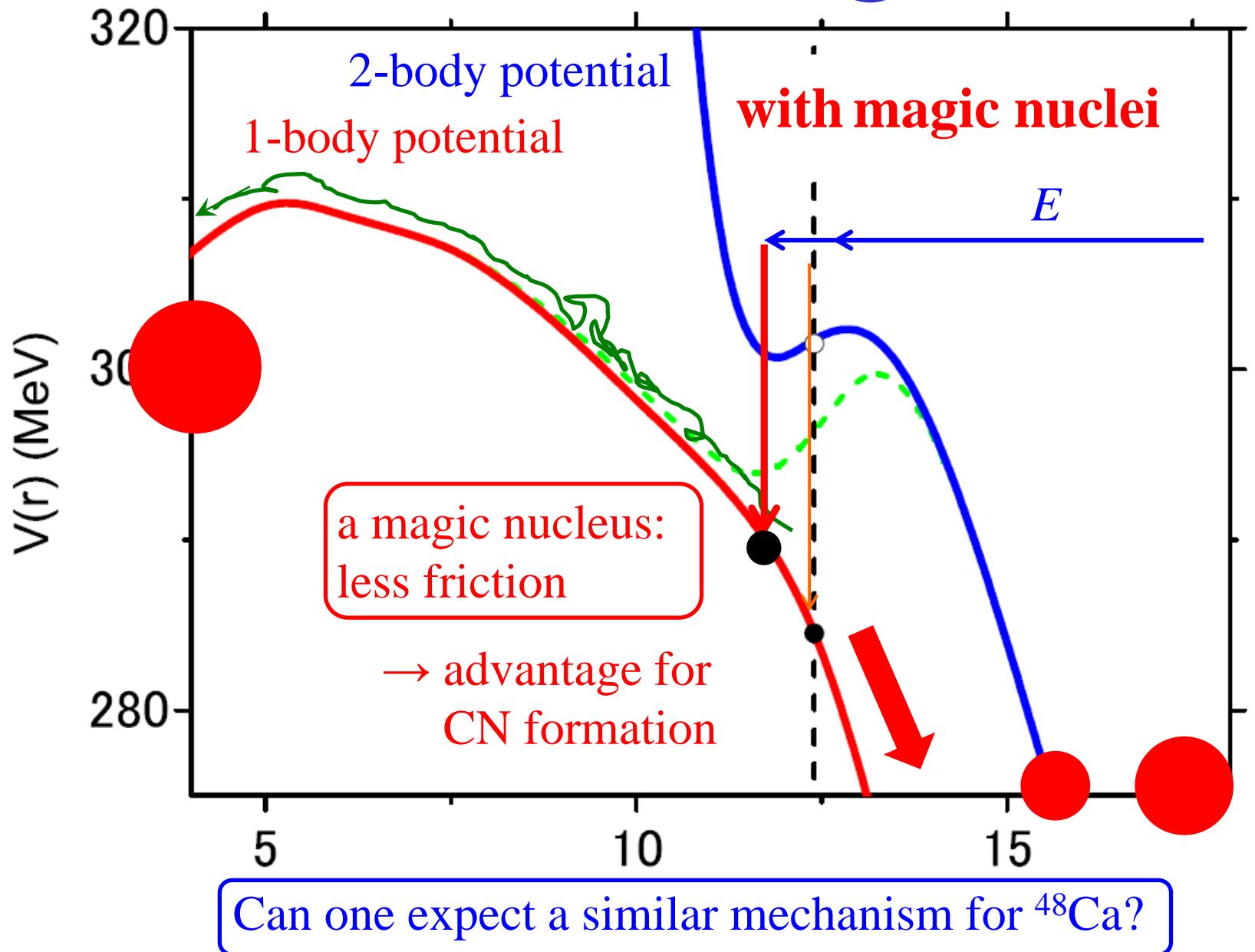
Role of magicity



An interpretation

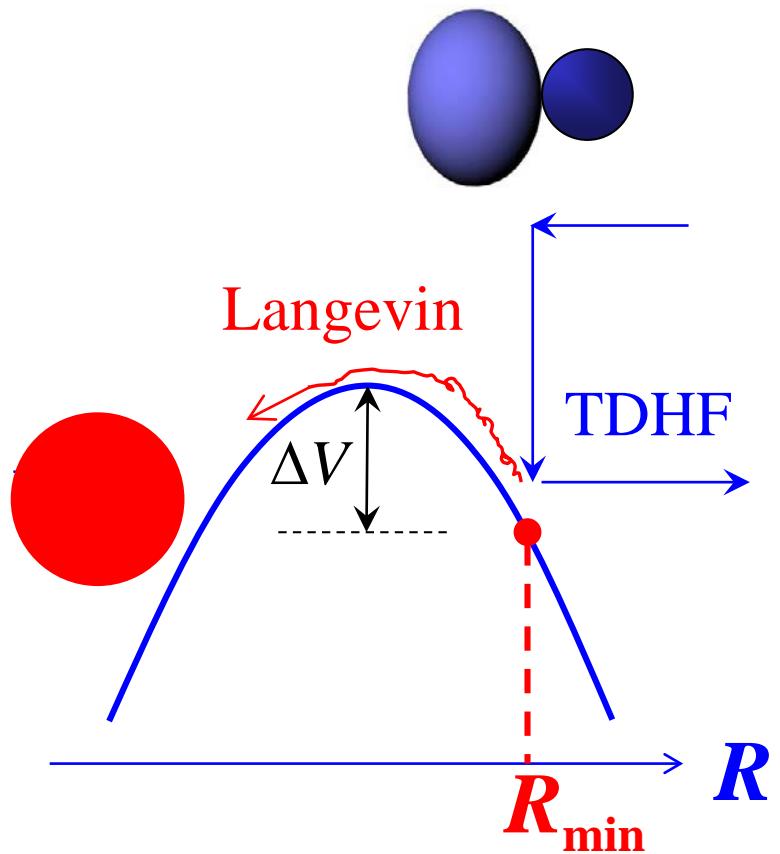


An interpretation



TDHF + Langevin approach

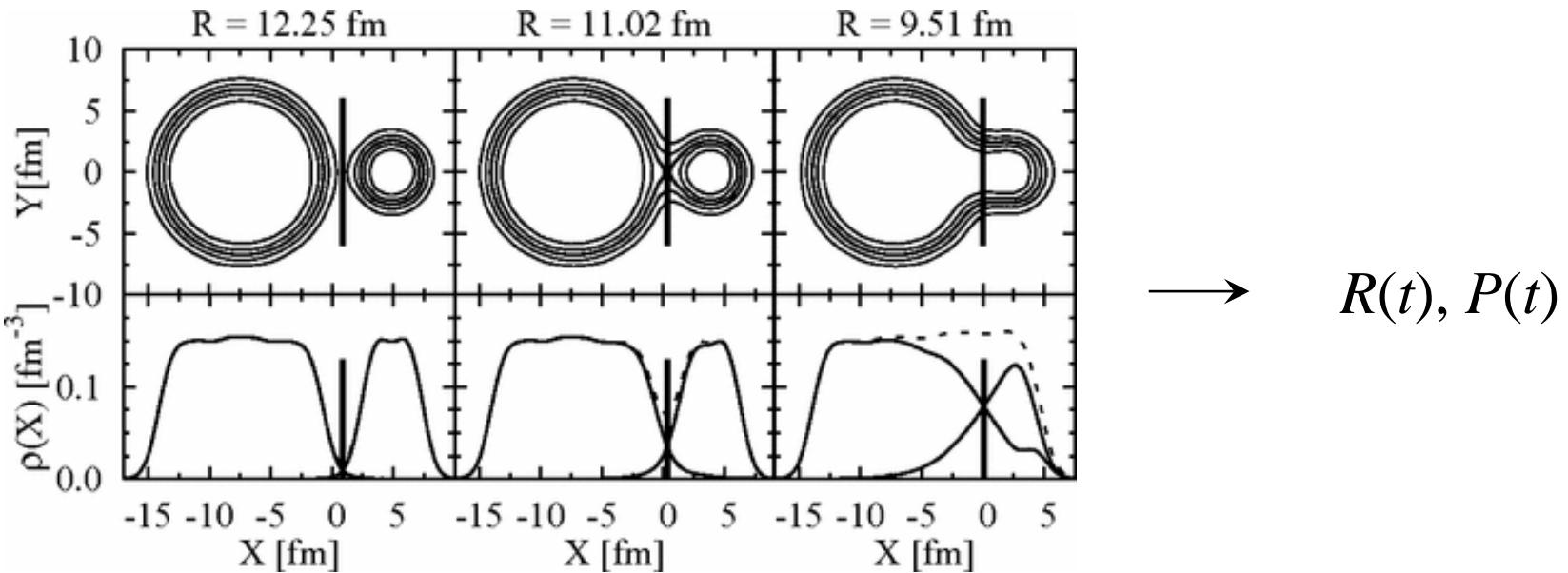
K. Sekizawa and K. Hagino, a work in progress



Mapping TDHF onto a classical equation of motion

K. Washiyama and D. Lacroix, PRC78 ('08) 024610

TDHF simulations



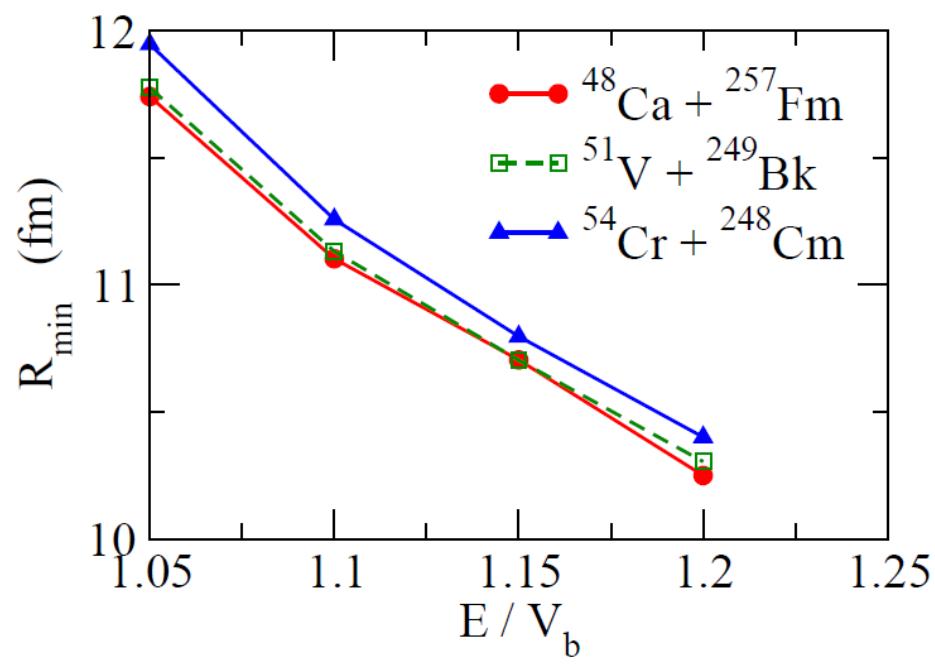
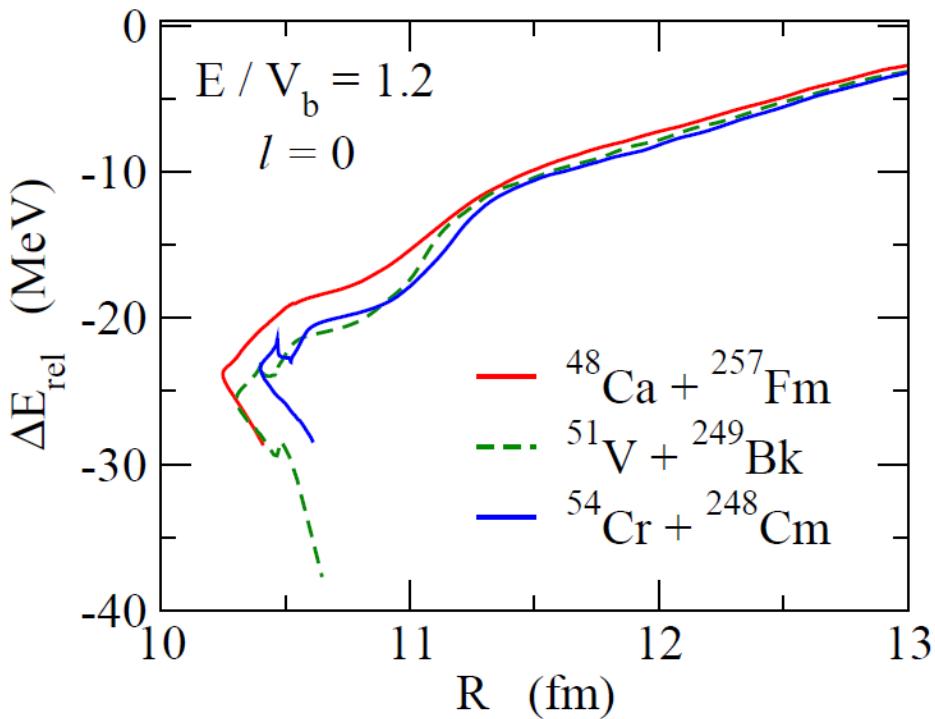
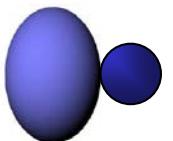
$$\dot{P} = -\frac{dV}{dR} - \frac{d}{dR} \left(\frac{P^2}{2\mu} \right) - \gamma \dot{R} \quad \rightarrow \quad V(R), \gamma(R)$$

$$\rightarrow \Delta E(t) = -E_{\text{diss}}(t) = \frac{P(t)^2}{2\mu(R(t))} + V(R(t)) - E_{\text{ini}}$$

TDHF + Langevin approach

K. Sekizawa and K. Hagino, a work in progress

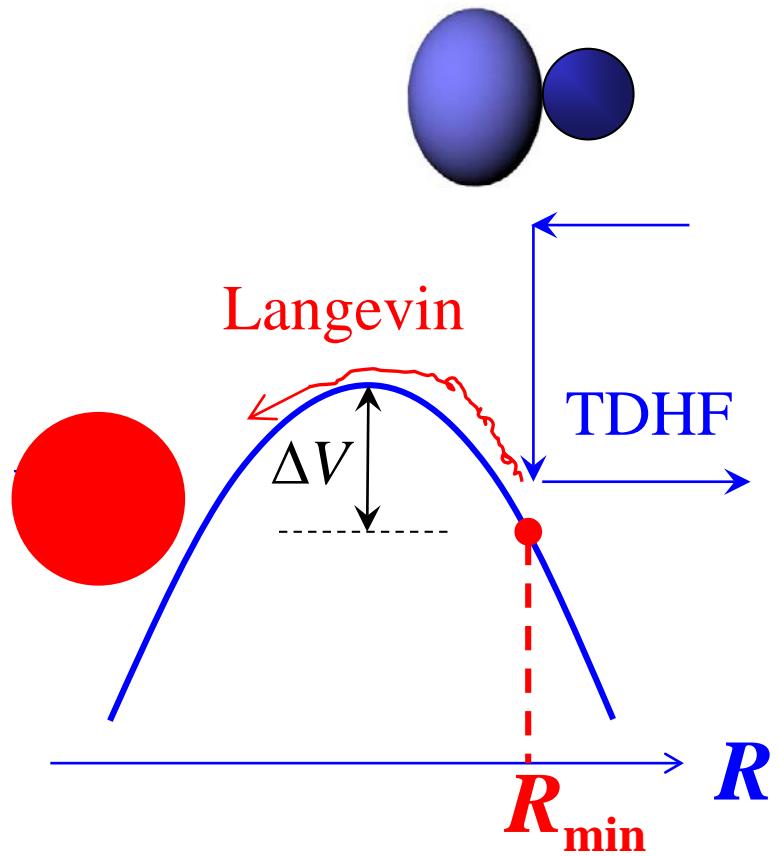
TDHF \leftarrow the distance of the closest approach (side collision)



no special role of magicity
in R_{\min} ?

TDHF + Langevin approach

TDHF \leftarrow the distance of the closest approach (side collision)



fusion-by-diffusion model

diffusion over a parabolic barrier
in the overdamped limit:

$$P_{\text{CN}}(E) = \frac{1}{2} \left[1 - \text{erf} \left(\sqrt{\frac{\Delta V}{T}} \right) \right]$$

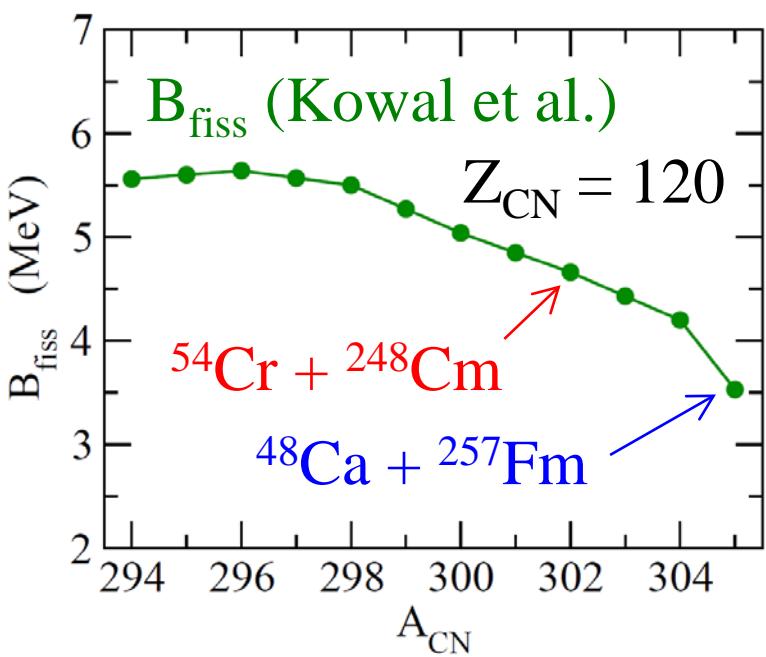
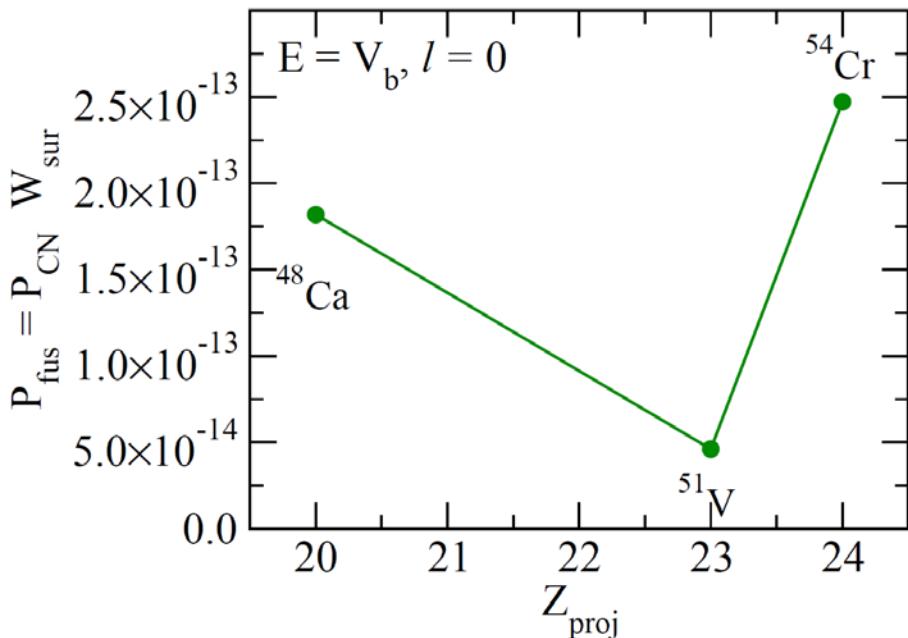
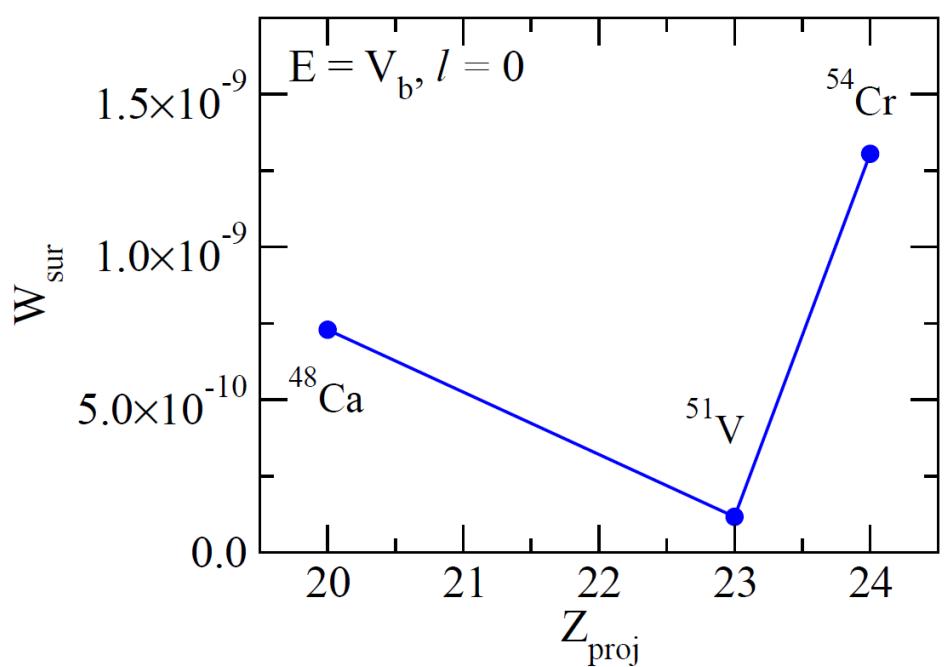
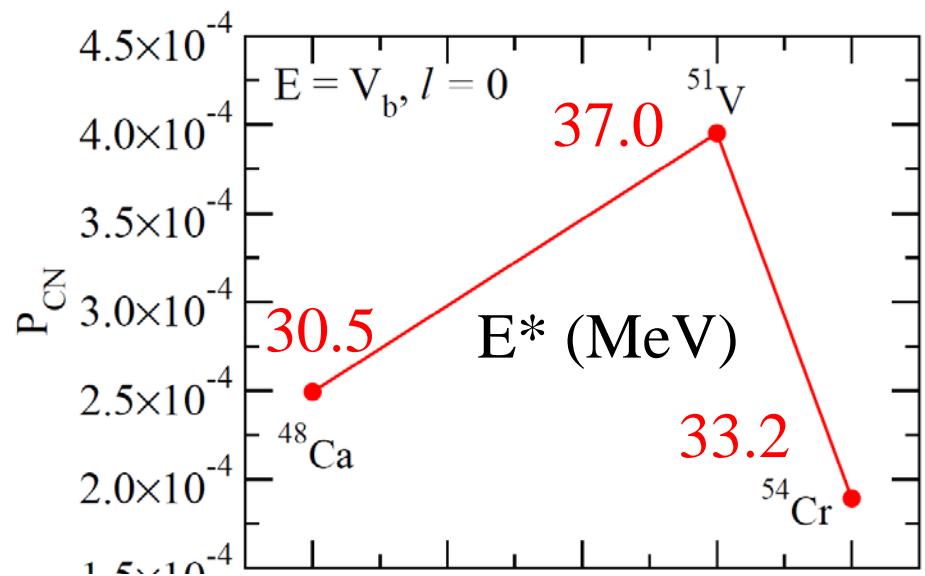
W.J. Swiatecki et al., PRC71 ('05) 014602

statistical model

$$W_{xn}(E^*) \sim \left(\frac{\Gamma_n(E^*)}{\Gamma_{\text{fiss}}(E^*)} \right)^x$$

$$P_{\text{ER}}(E) = P_{\text{CN}}(E) \cdot \sum_x W_{xn}(E^*)$$

TDHF + Langevin approach

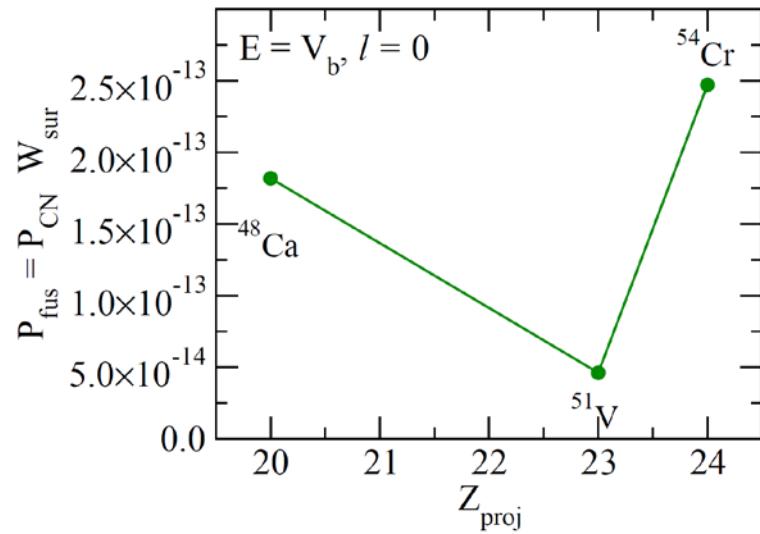
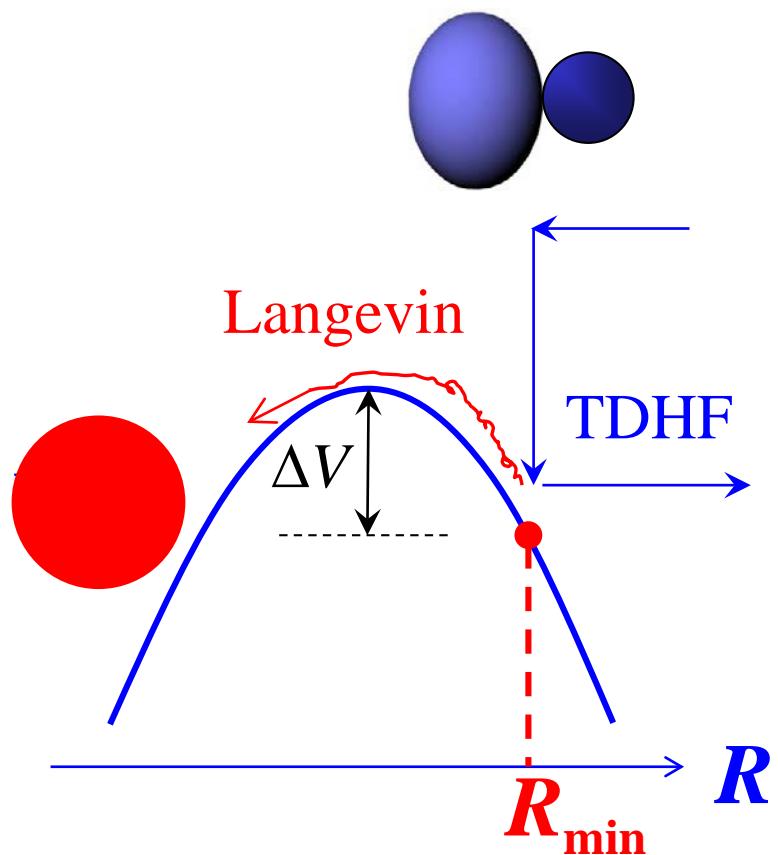


Summary

Hot fusion reactions for $Z = 119$ and 120 superheavy elements

➤ $^{48}\text{Ca} \rightarrow ^{51}\text{V}$ and ^{54}Cr

TDHF + Langevin approach



$$\frac{\sigma_{\text{fus}}(^{48}\text{Ca} + ^{257}\text{Fm} \rightarrow ^{305}120)}{\sigma_{\text{fus}}(^{54}\text{Cr} + ^{248}\text{Cm} \rightarrow ^{302}120)} < 1$$

To do:
a comparison between

- ✓ $^{48}\text{Ca} + ^{254}\text{Fm} \rightarrow ^{302}120$
- ✓ $^{54}\text{Cr} + ^{248}\text{Cm} \rightarrow ^{302}120$