Energy dependence of total kinetic energy of fission fragments for the standard and superlong modes analyzed separately by 4D Langevin model

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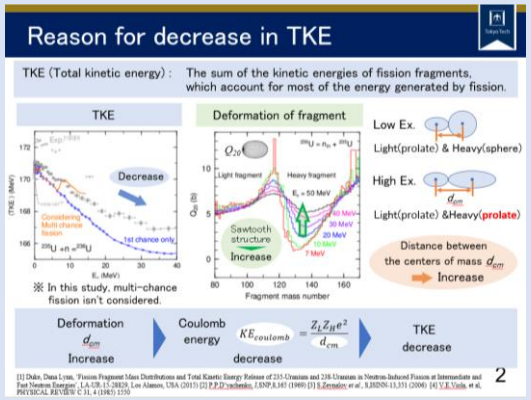
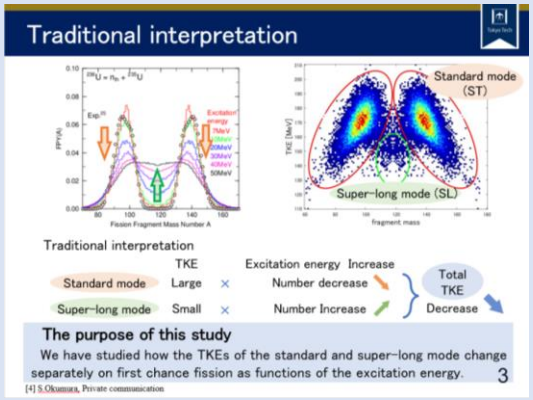
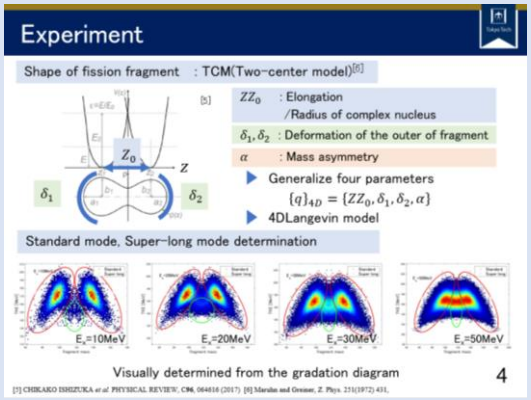
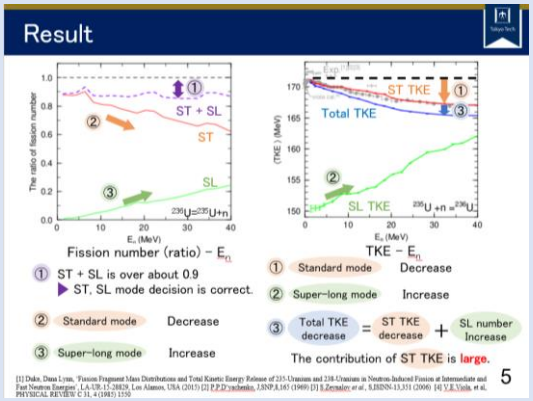
P11

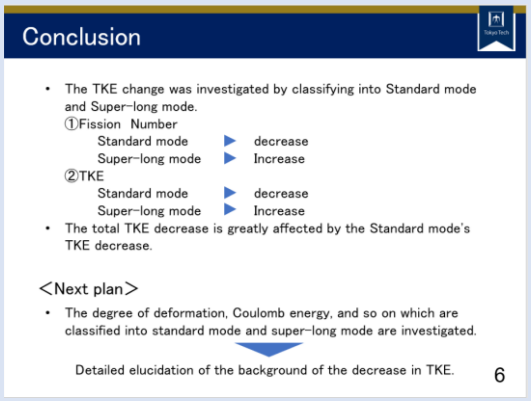
In this study, the average total kinetic energy (TKE) classified by mode in neutron-induced fission of ^{236}U was calculated. Each TKE of asymmetric and symmetric fission mode has incident neutron energy dependence.







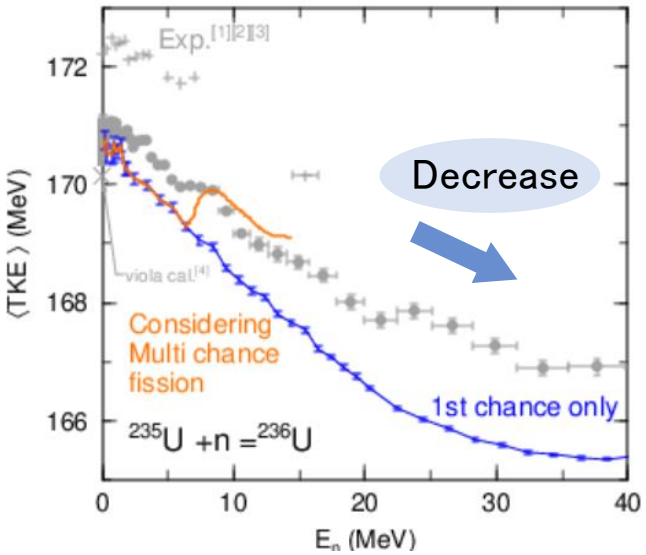




Reason for decrease in TKE

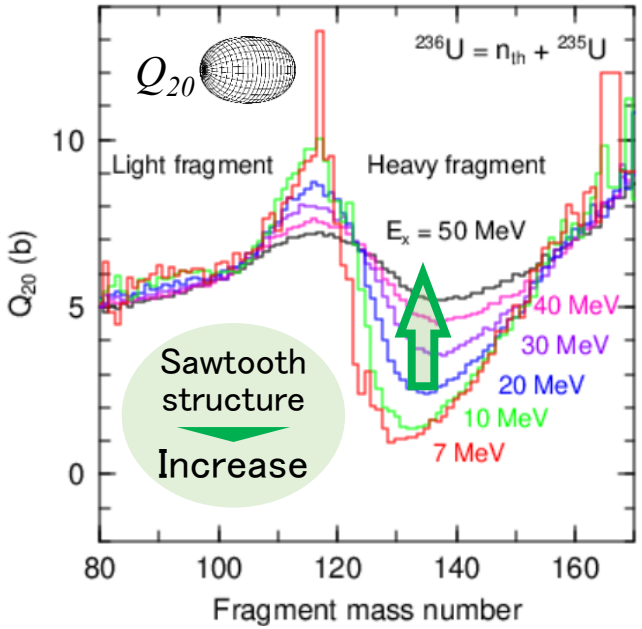
TKE (Total kinetic energy) : The sum of the kinetic energies of fission fragments, which account for most of the energy generated by fission.

TKE

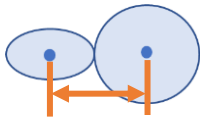


※ In this study, multi-chance fission isn't considered.

Deformation of fragment

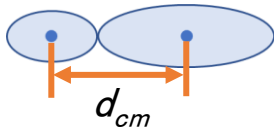


Low Ex.



Light(prolate) & Heavy(sphere)

High Ex.



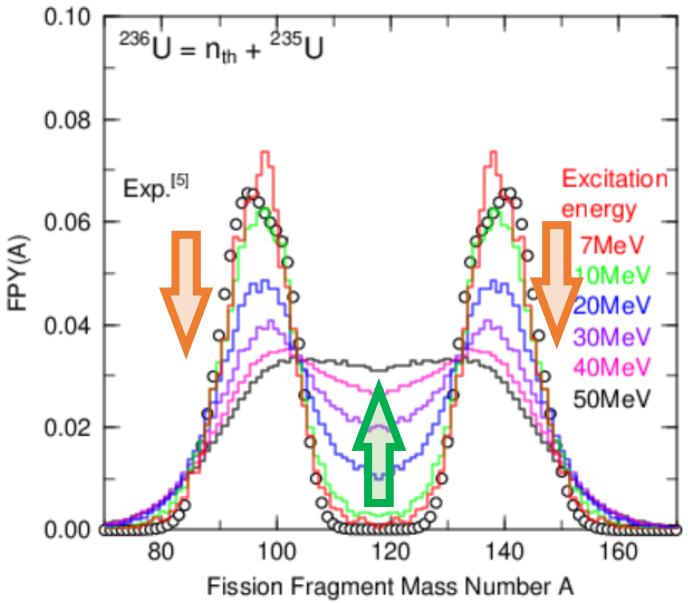
Light(prolate) &Heavy(**prolate**)

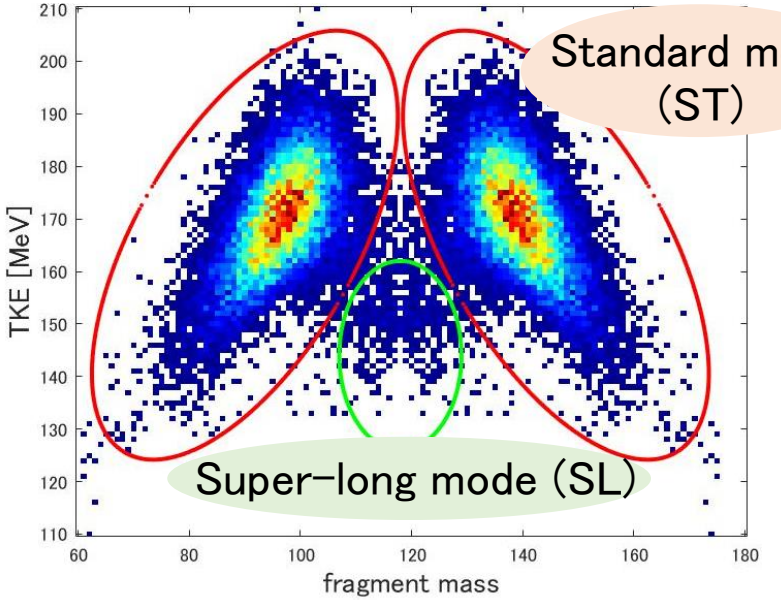
Distance between the centers of mass d_{cm} ➡ Increase

Deformation d_{cm} Increase ➡ Coulomb energy $KE_{coulomb} = \frac{Z_L Z_H e^2}{d_{cm}}$ decrease ➡ TKE decrease

[1] Duke, Dana Lynn, 'Fission Fragment Mass Distributions and Total Kinetic Energy Release of 235-Uranium and 238-Uranium in Neutron-Induced Fission at Intermediate and Fast Neutron Energies', LA-UR-15-28829, Los Alamos, USA (2015) [2] P.P.D'yachenko, J,SNP,8,165 (1969) [3] S.Zeynalov *et al.*, S,ISINN-13,351 (2006) [4] V.E.Viola, et al, PHYSICAL REVIEW C 31, 4 (1985) 1550

Traditional interpretation





Traditional interpretation

	TKE		Excitation energy Increase		
Standard mode	Large	×	Number decrease	↘	Total TKE Decrease ↘
Super−long mode	Small	×	Number Increase	↗	

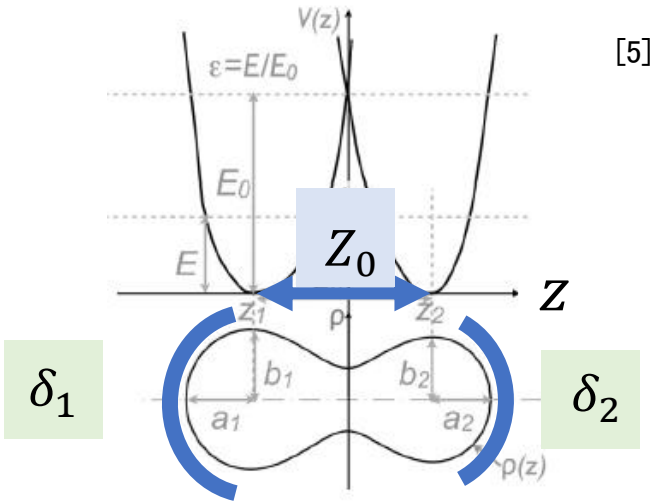
The purpose of this study

We have studied how the TKEs of the standard and super−long mode change separately on first chance fission as functions of the excitation energy.

[4] S.Okumura, Private communication

Experiment

Shape of fission fragment : TCM(Two-center model)[6]



[5]

ZZ_0 : Elongation /Radius of complex nucleus

δ_1, δ_2 : Deformation of the outer of fragment

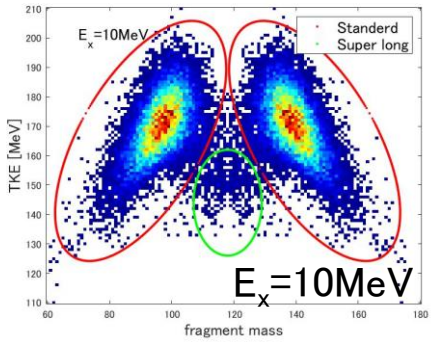
α : Mass asymmetry

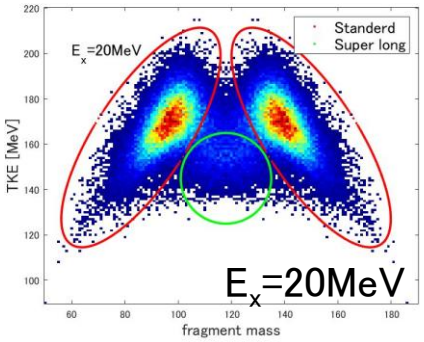
- Generalize four parameters

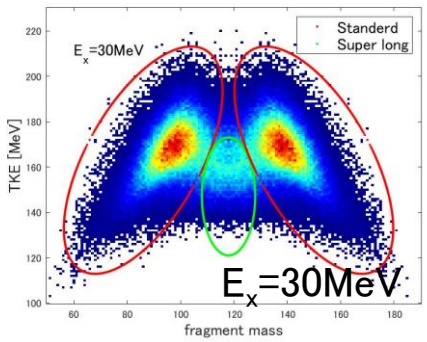
$$\{q\}_{4D} = \{ZZ_0, \delta_1, \delta_2, \alpha\}$$

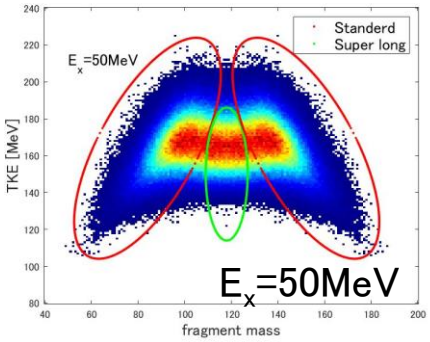
- 4DLangevin model

Standard mode, Super-long mode determination





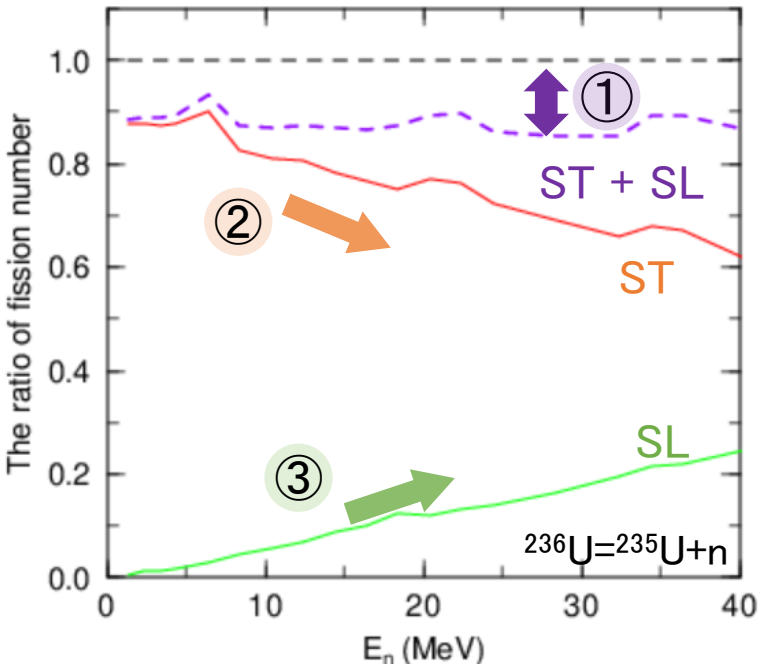




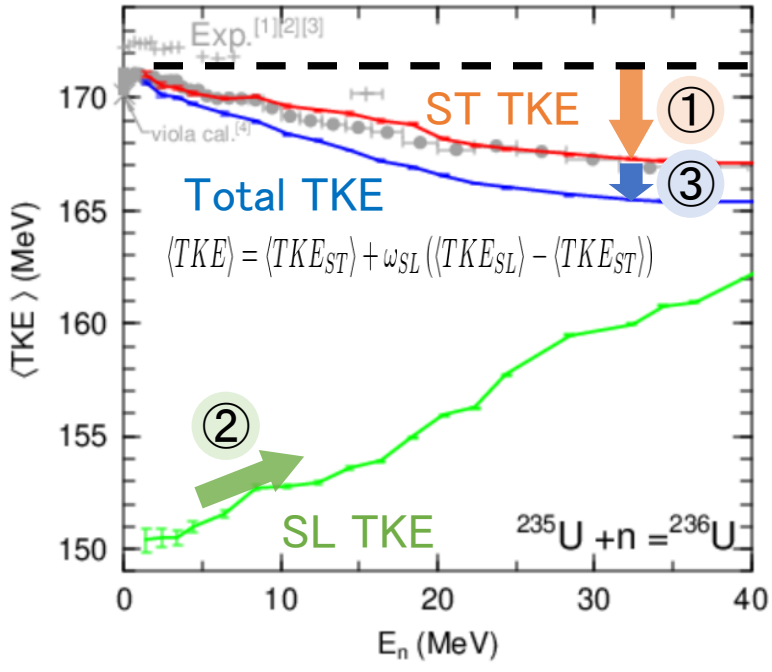
Visually determined from the gradation diagram

[5] CHIKAKO ISHIZUKA *et al.* PHYSICAL REVIEW, C**96**, 064616 (2017) [6] Maruhn and Greiner, Z. Phys. 251(1972) 431,

Result



Fission number (ratio) – E_n



TKE – E_n

① ST + SL is over about 0.9
▶ ST, SL mode decision is correct.

② Standard mode Decrease

③ Super-long mode Increase

① Standard mode Decrease $\langle TKE_{ST} \rangle$

② Super-long mode Increase

③ Total TKE decrease = ST TKE decrease + SL number Increase

The contribution of ST TKE is large.

[1] Duke, Dana Lynn, 'Fission Fragment Mass Distributions and Total Kinetic Energy Release of 235-Uranium and 238-Uranium in Neutron-Induced Fission at Intermediate and Fast Neutron Energies', LA-UR-15-28829, Los Alamos, USA (2015) [2] P.P.D'yachenko, J,SNP,8,165 (1969) [3] S.Zeynalov *et al.*, S,ISINN-13,351 (2006) [4] V.E.Viola, et al, PHYSICAL REVIEW C 31, 4 (1985) 1550

Conclusion

- The TKE change was investigated by classifying into Standard mode and Super-long mode.
  ①Fission Number
  Standard mode ▶ decrease
  Super-long mode ▶ Increase
  ②TKE
  Standard mode ▶ decrease
  Super-long mode ▶ Increase
- The total TKE decrease is greatly affected by the Standard mode's TKE decrease.

＜Next plan＞

- The degree of deformation, Coulomb energy, and so on which are classified into standard mode and super-long mode are investigated.

Detailed elucidation of the background of the decrease in TKE.