Fission process: Isospin and Nucleosynthesis

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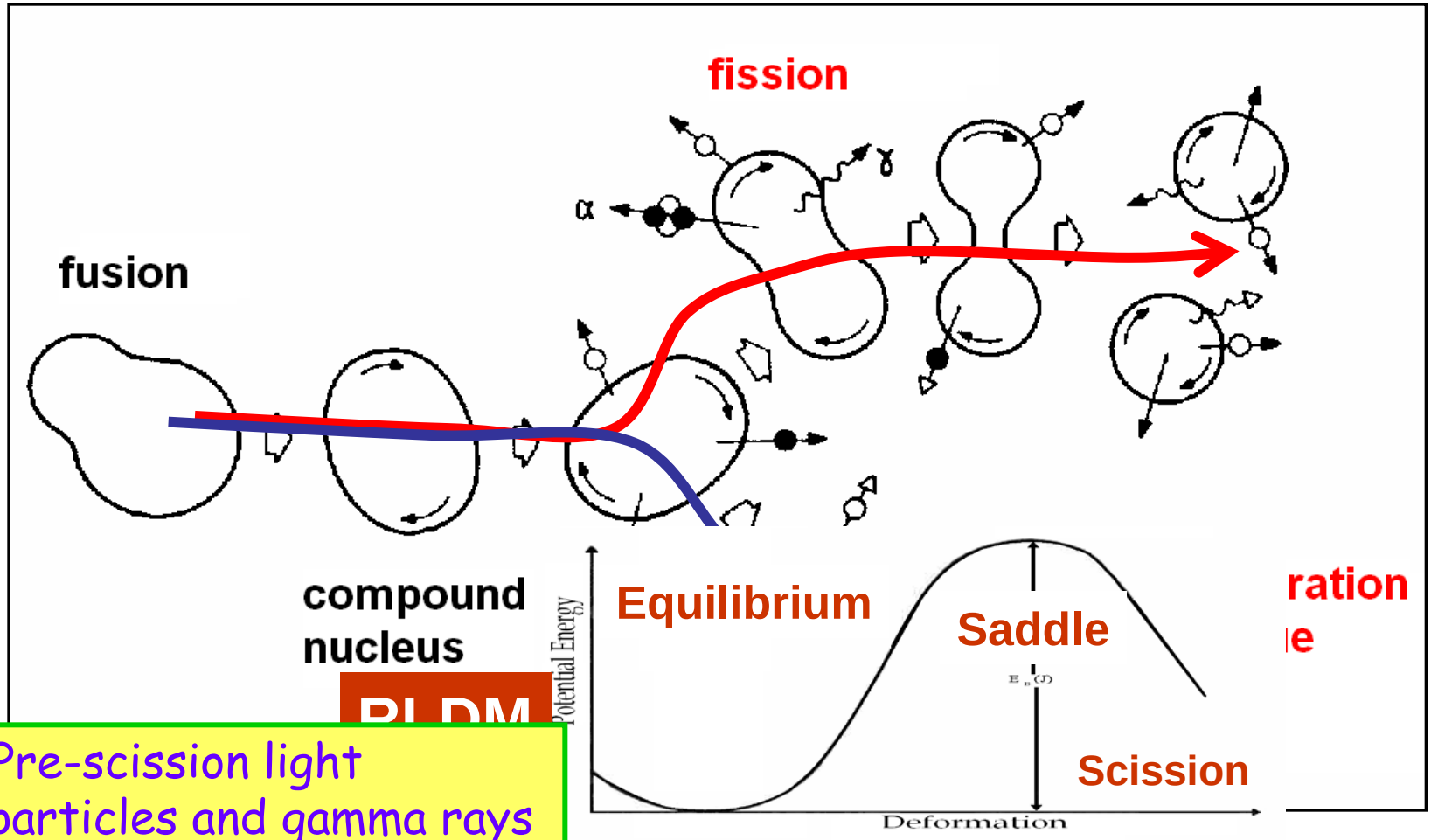
- **Fission as a tool to study nuclear viscosity**
- **Fission of neutron rich nuclei: predictions with a dynamical model**
- **Proposed reactions with SPES RIB's**

Fusion Reactions (≤10MeV/A)



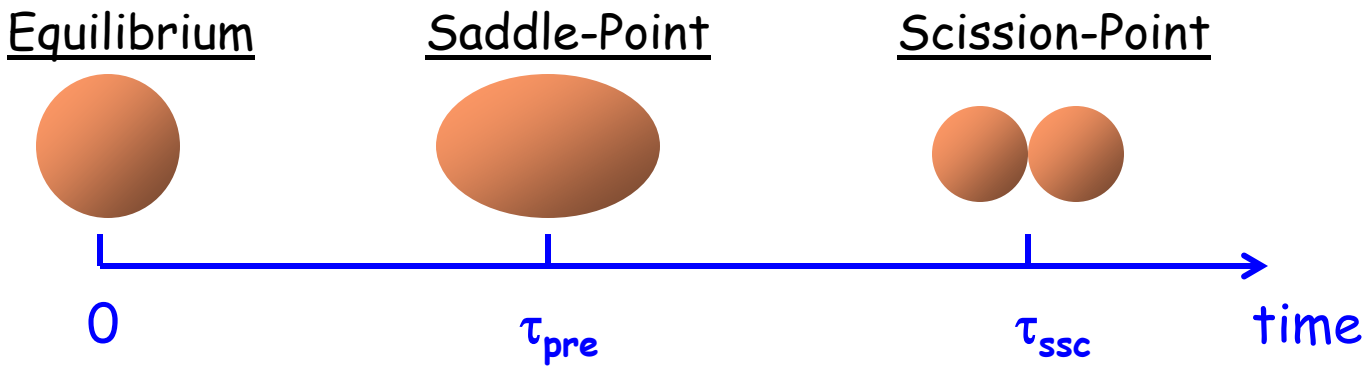
Pre-scission light particles and gamma rays can provide information on fission dynamics.

Evidences of dynamical effects

Excess of pre-scission *n*, *p*, α, γ with respect to statistical model predictions

implies

<u>Dynamical effect</u>: path from equilibrium to scission slowed-down by the **nuclear viscosity**



Theoretical approaches: statistical model, dynamical models → t, viscosity

Open Questions in Fission Dynamics

1. Fission time scale;
2. Strength (β: $\sim$(2-30)x10^{21} s^{-1}) and Nature of dissipation: one-body or two-body;
3. Dependence of the viscosity on the temperature and on the shape.

Study of systems of intermediate fissility with 8pLP at LNL

Studies of nuclear viscosity: Stochastic approach

Langevin equations

Collective variables (shape of the nucleus) assimilated to Brownian particles interacting stochastically with a "heat bath" (internal degrees of freedom).

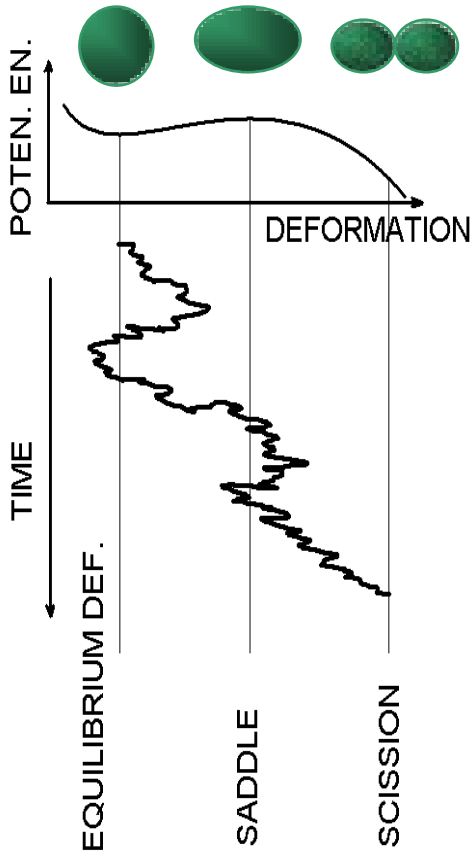
1-dimension Langevin equation

$$M\ddot{R} = \tilde{F}(R) + F_{frict.}(R,\dot{R}) + F_L(R,t)$$

Conservative from FRLDM

Friction

Fluctuating depending on friction and temperature

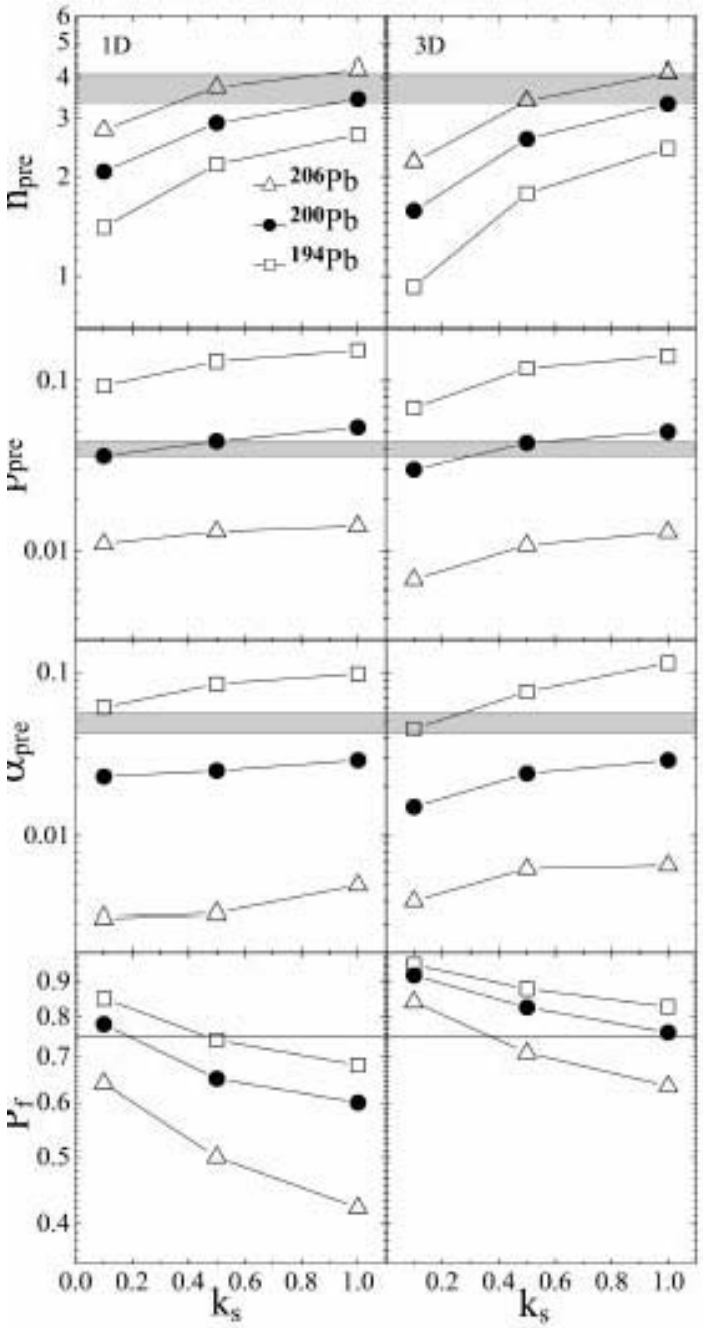


Stochastic shape evolution

Three dimensional Langevin equations with 1 or 2 body dissipation

ISOSPIN EFFECTS ON FISSION PROCESS

Increase of n prescission multiplicities and decrease pf cp prescission mult.



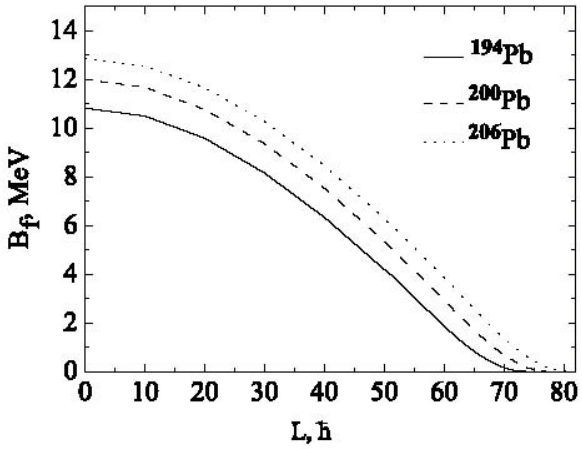


Fig. 2. The fission barriers B_f for the ^{194}Pb (solid curve), ^{200}Pb (dashed curve), and ^{206}Pb (dotted curve) nuclei as a function of angular momentum L.

Going to more n-rich nuclei:

^{118}Sn + ^{64}Zn ^{134}Sn + ^{70}Zn E_{lab}=100 MeV

C.N.	k_s	n_{pre}	p_{pre}	α_{pre}
^{182}Hg	0.5	68	94	93
	1.0	130	165	209
^{204}Hg	0.5	76	20	40
	1.0	138	80	210

M(Ks)-M(Ks=0.1)/M(Ks=0.1) in %

More constraints to obtain Ks

	B_f (L=50 ħ) (MeV)	Prescission M_n	$<T_{fiss}>$ (10^{-21} s)
^{124}Ce	16.3	0.046	61
^{144}Ce	29.7	2.1	10^3

Table 1. Predictions of a dynamical model based on three dimensional Langevin equations for the composite nuclei 124Ce and 144Ce at Ex ~122 MeV and Lcrit =74 and 81 ħ respectively. Full one body dissipation has been assumed.

Ex≅122 MeV and Lcrit =74 and 81 ħ

The 8πLP setup

LCP

MAX ENERGY Wall:

up to 64 AMeV Ball :

up to 34 AMeV

ENERGY THRESHOLDS

0.5 AMeV for *p* and α

2-3 AMeV for ^{12}C

TRIGGERS

Fission Fragments in ring E/F/G

Evaporation Residues (4 PPAC- PPAC)

CORSET

n: RIPEN or NEDA