



# Lefschetz thimbleの変形による 複素Langevin法の改善

Shoichiro Tsutsui (Kyoto)

In collaboration with  
Takahiro M. Doi (Kyoto)

**arXiv:1508.04231**

# complex Langevin process

## complex Langevin (CL)

$$\frac{dz}{dt} = -\frac{\partial S(z)}{\partial z} + \eta$$

stochastic quantization for  
complex actions

➤ sometimes gives wrong answers

➤ not well understood for  
an action involving a log term

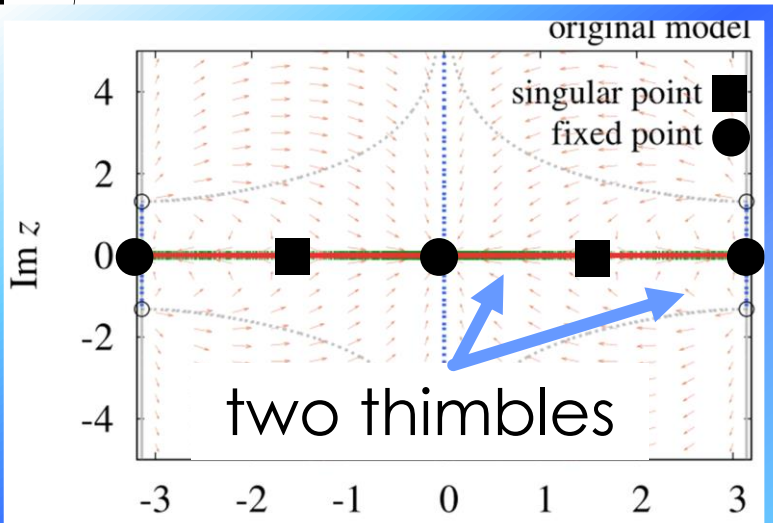
e.g.)

$$S(x) = -\beta \cos x + \log(\cos x)$$

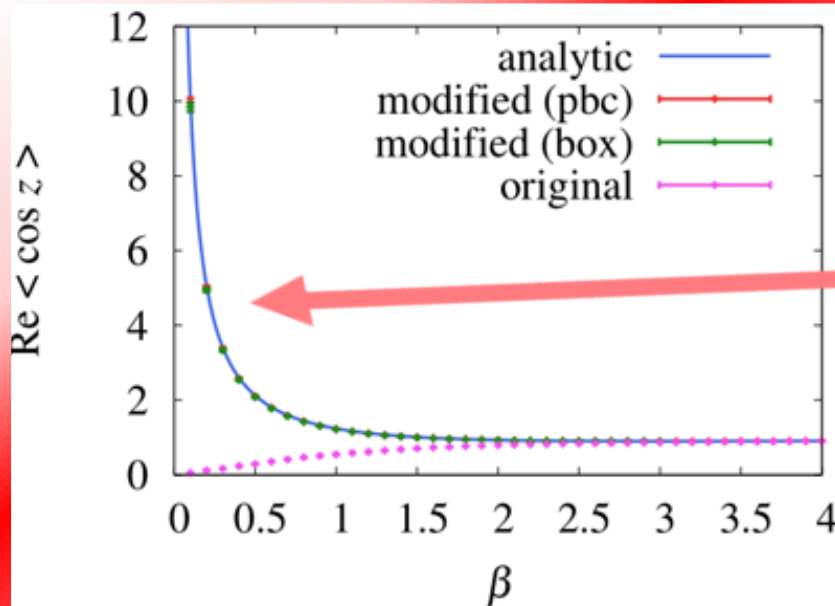
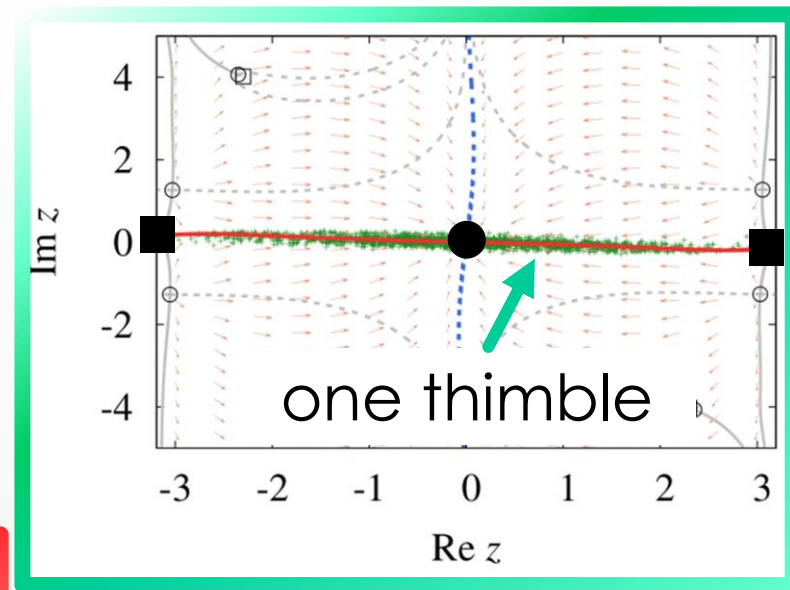
CL  $\sim$

importance sampling on  
**Lefschetz thimbles (steepest descent paths)**

# Improved Langevin dynamics



modify



improved Langevin  
agrees with the  
analytic result