Primordial Black Hole Formation from Power Spectrum with Finite-width
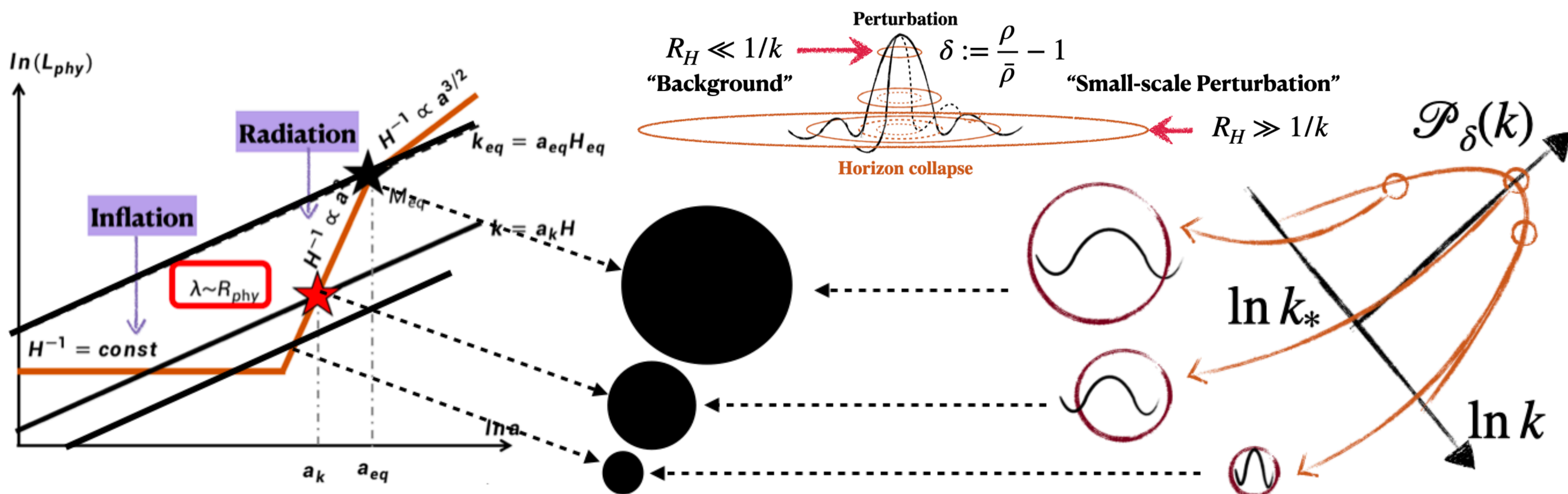## Jianing Wang(ITP.CAS)

KAVLI IPMU

Shi Pi, Misao Sasaki, Volodymyr Takhistov, Jianing Wang (in preparation)

- PBH mass is roughly given by the smoothing scale (horizon scale) according to Hoop conjecture $\mathscr{C} := \dfrac{2\delta M}{R(r)} > 1$

- Smoothing process needs to ensure a healthy defined volume $\propto R_s^3$

- As long wavelength components gradually enter the horizon, the peak gradually widens and the over-density region becomes larger
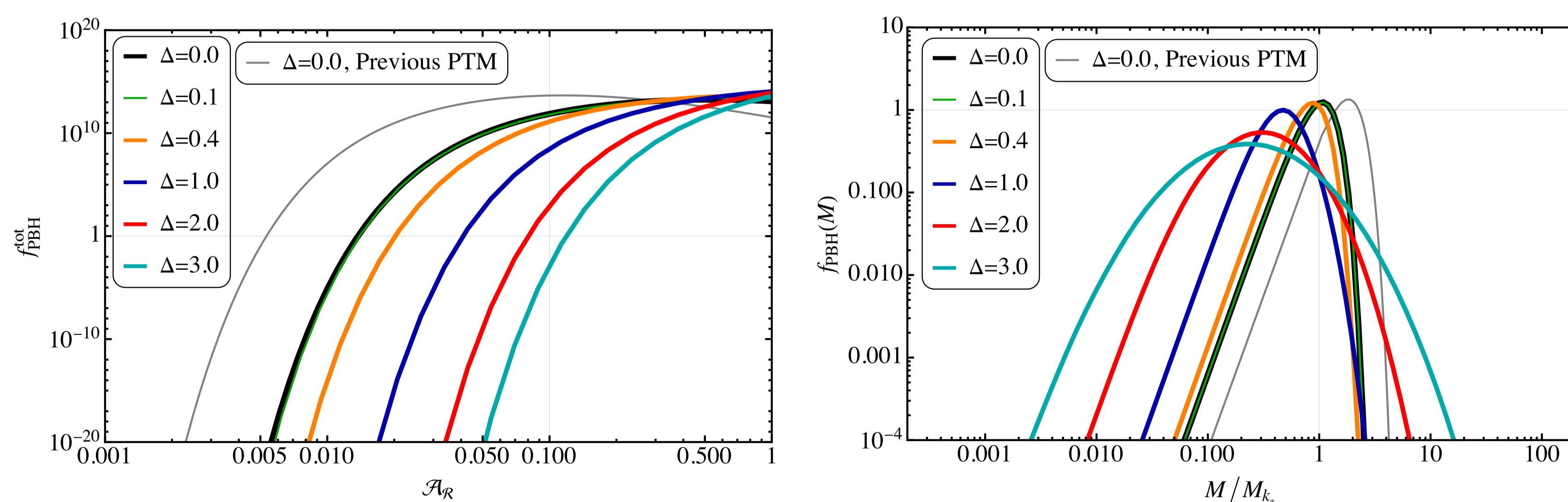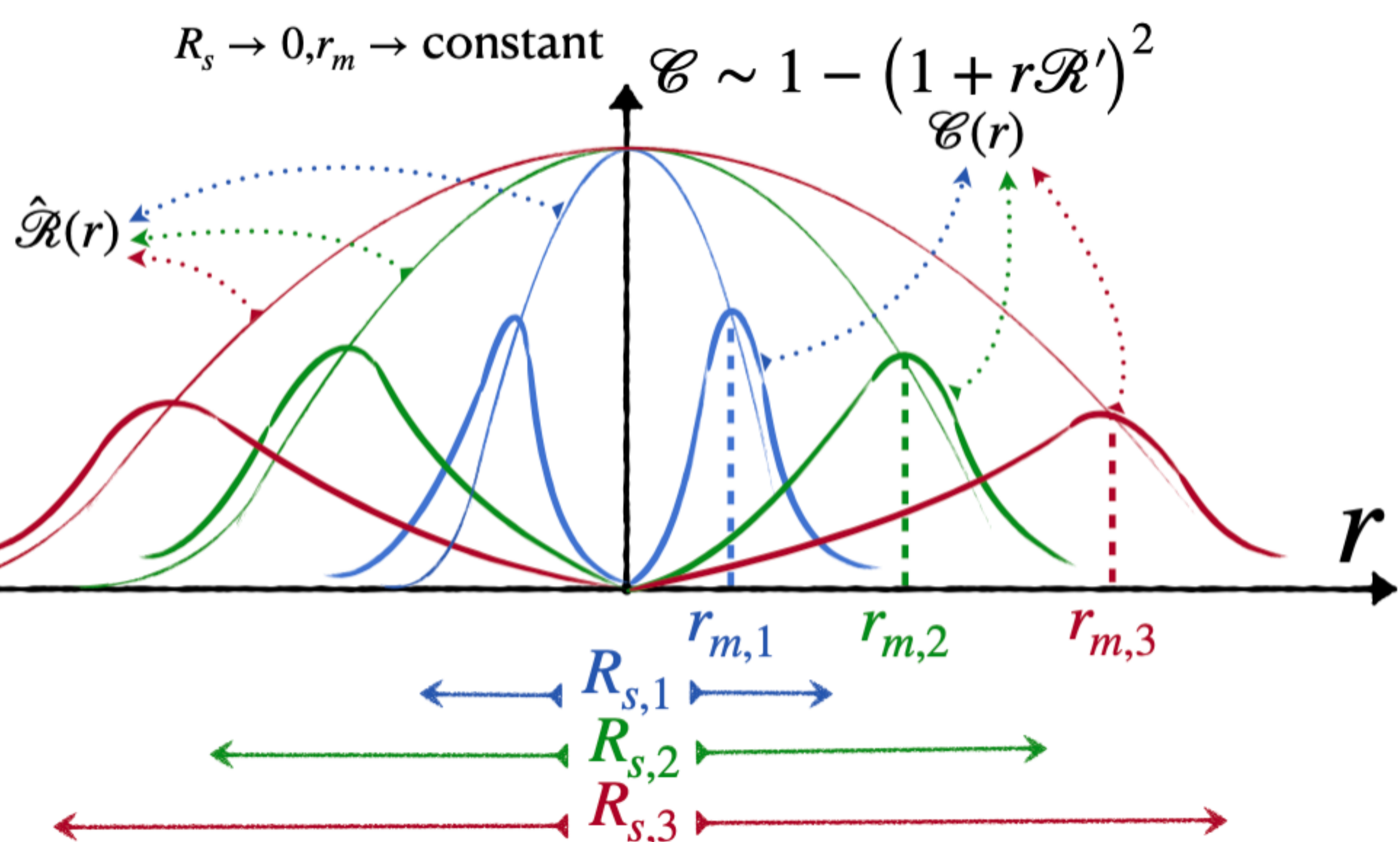

- Smoothing scale should always be larger than the over-density scale $r_m/R_s \lesssim \mathcal{O}(1)$

- Picking up PBHs of different masses with corresponding smoothing scales

$$f_{\text{PBH}}(M_\bullet) \sim \int \frac{dR_s}{R_s} \int dK \int d\mu$$
$$\cdot \, \delta_{\text{D}}\left(\ln \frac{M_\bullet}{M(R_s, K, \mu)}\right) \frac{M(R_s, K, \mu)\, N_{\text{PBH}}(R_s, K, \mu)}{\Omega_{\text{DM}} h^2}$$

▶ Peak's theory method can enhance the formation of PBH, but not in a huge amount!!!

*Comparison of different methods for monochromatic power

Method	$\mathscr{A}_{\mathscr{R}}(f_{\text{PBH}}^{\text{tot}} = 1)$
Previous Peak's theory method [N.Kitajima, et al, JCAP, (2021)]	5.33×10^{-3}
Extended Press-Schechter method	6.31×10^{-3}
Peak's theory method	1.55×10^{-2}
Press-Schechter method	2.78×10^{-2}

▶ Broad power spectrum can suppress the PBH formation.

▶ Broader power spectrum produces a broader PBH mass spectrum.