

# Disk heating constraints on PBH clusters

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*EuCAPT Symposium 2024*

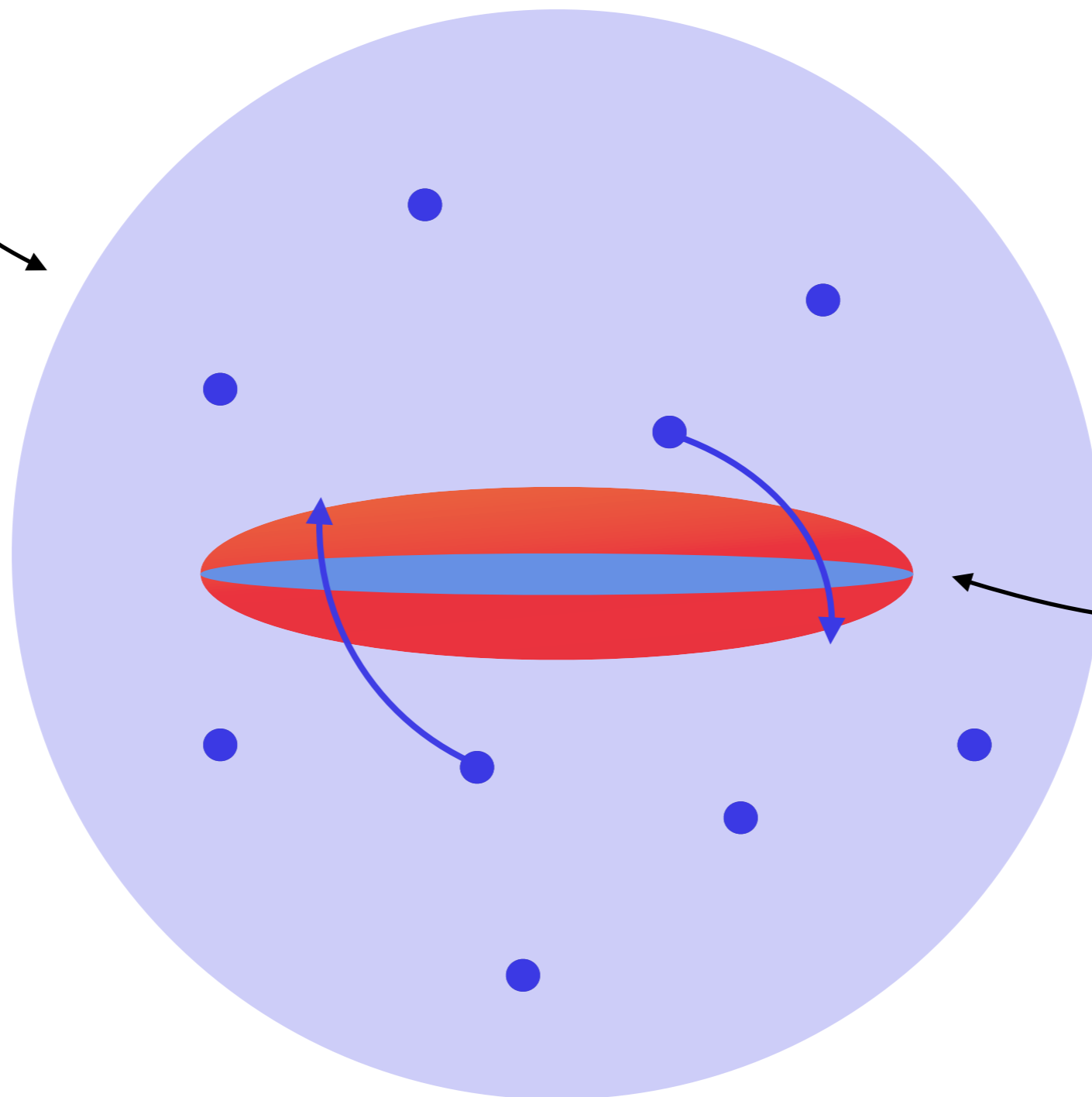
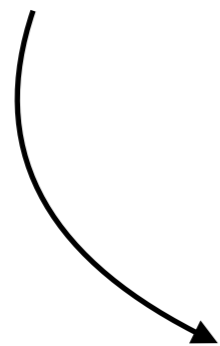
In collaboration with Julien Lavalle



**Francesca Scarcella**



DM halo



stellar  
disk



*“Disk heating”*

*Past work:*

- ▶ MACHOs /  
isolated  
PBHs

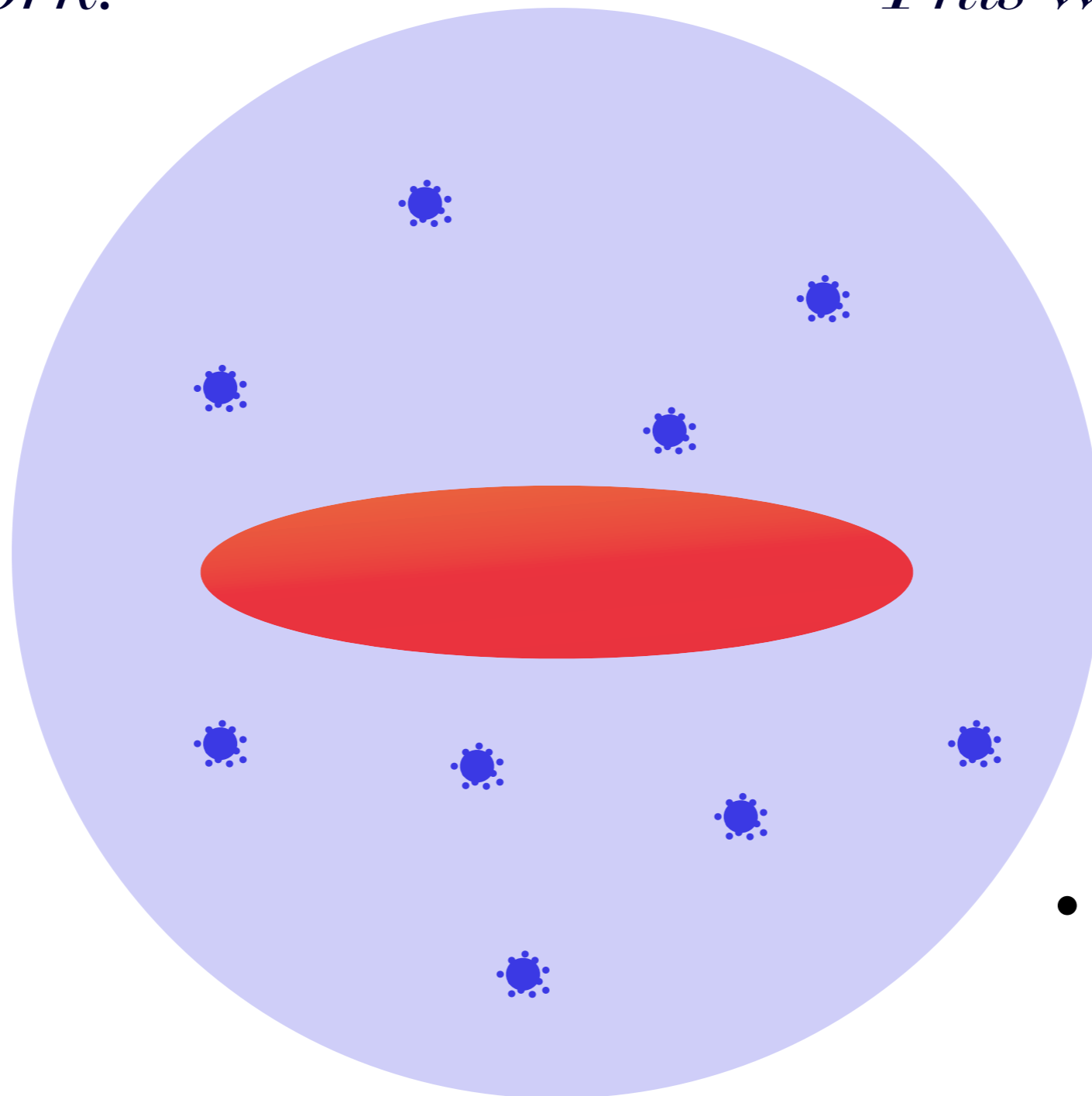
Lacey and  
Ostriker  
1985

*This work:*

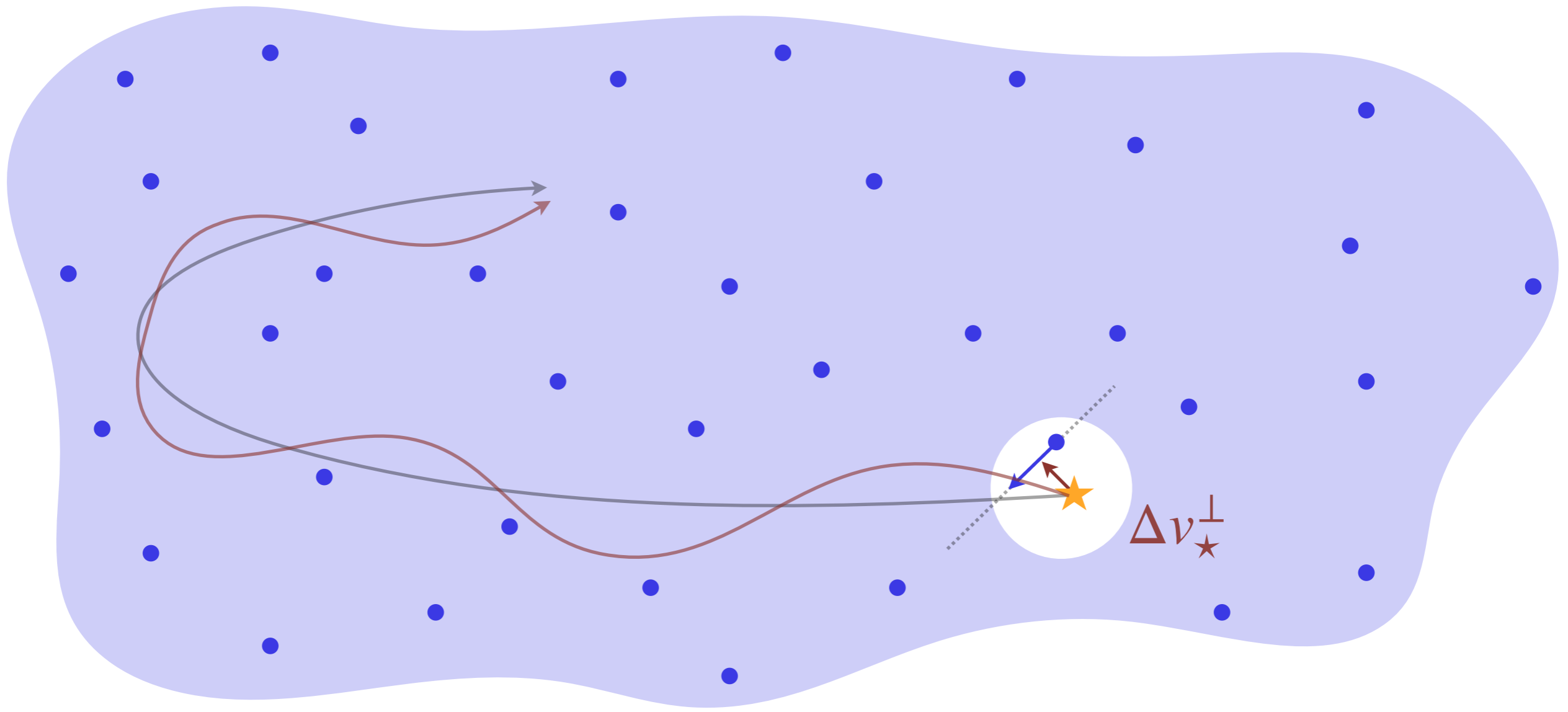
- ▶ PBH clusters

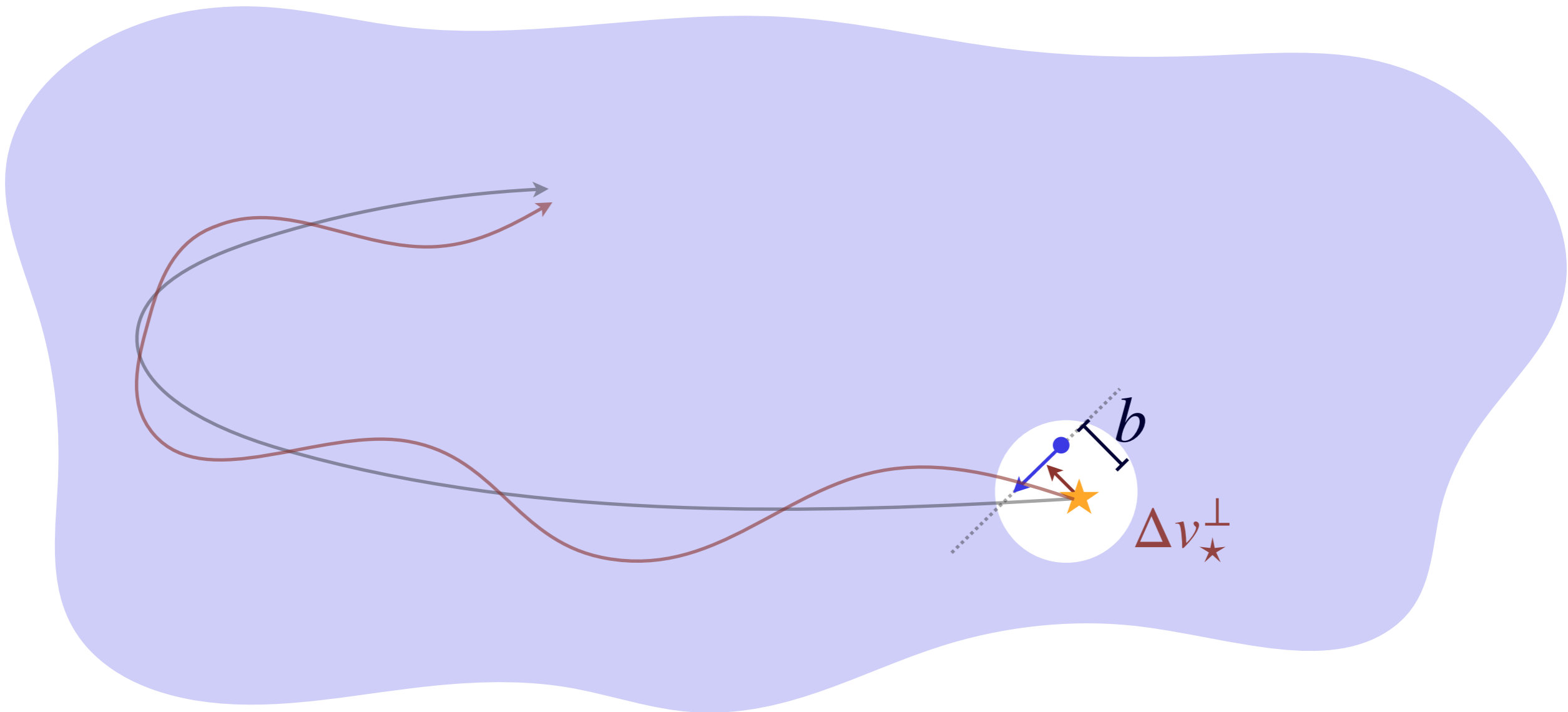
- Late time:  
structure  
formation

- Initial clustering



*Can disk heating constrain PBH clusters ?*





$$\frac{d\sigma_z^2}{dt} = \frac{1}{2} \frac{\langle \Delta v_{\perp}^2 \rangle}{\Delta t} \simeq \frac{1}{2\Delta t} \int db \underbrace{N_{\Delta t}(b)}_{2\pi b n_P v_{\star} \Delta t} \underbrace{(\Delta v_{\star}^{\perp})^2}_{\left(\frac{Gm_P}{v_{\star} b}\right)^2} \simeq \frac{\pi G^2 n_P m_P^2}{v_{\star}} \int \frac{db}{b}$$

► Point-like (MACHOs)

$$\frac{d\sigma_z^2}{dt} \simeq \frac{\pi G^2 n_P m_P^2}{v_\star} \int_{b_{\min}}^{b_{\max}} \frac{db}{b}$$

Lacey and Ostriker 1985

$$M_{\text{PBH}} \lesssim 10^6 M_\odot, f_{\text{PBH}} = 1$$

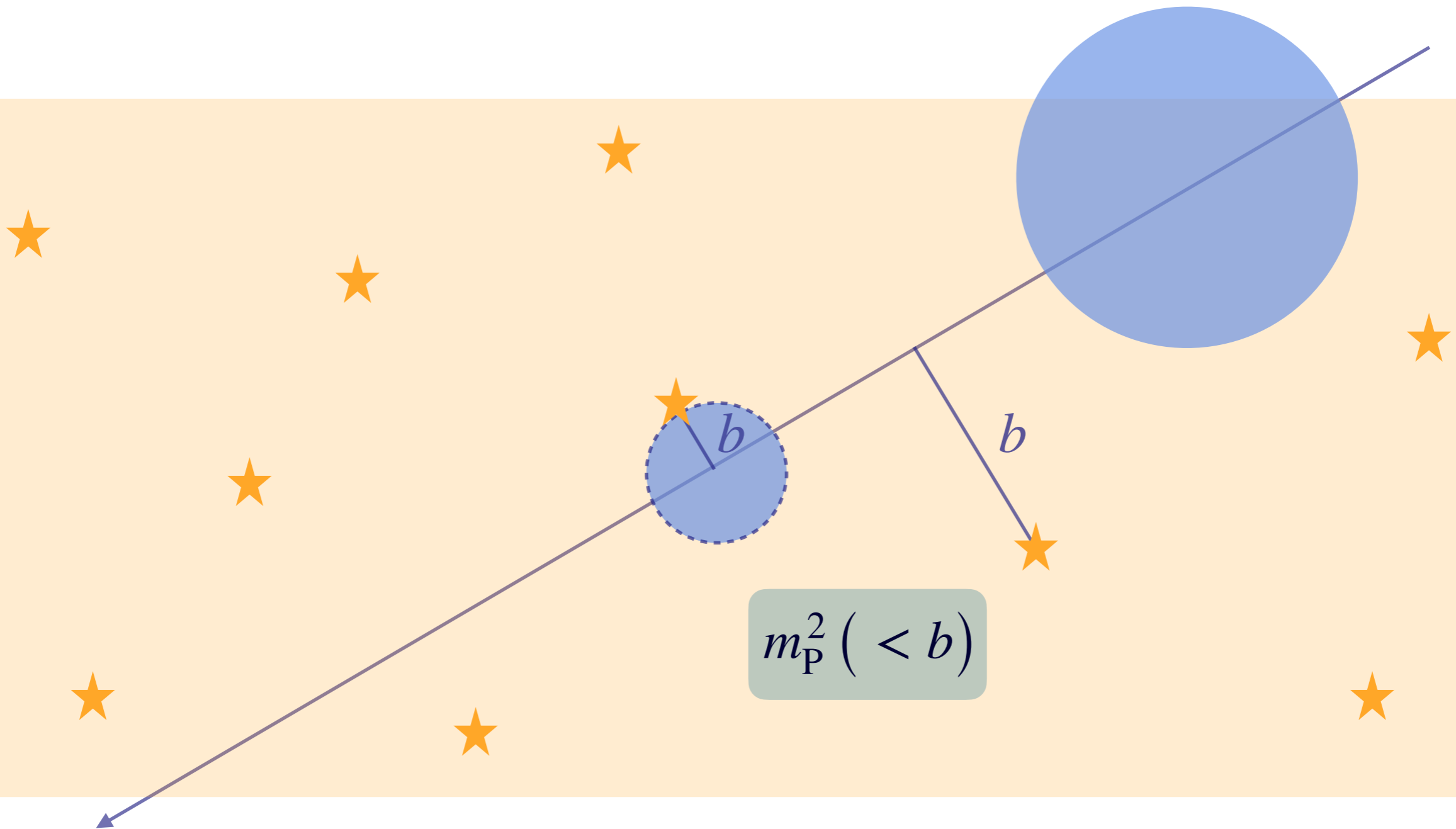
*Can we apply this constraint  
to extended objects?*

► Point-like (MACHOs)

$$\frac{d\sigma_z^2}{dt} \simeq \frac{\pi G^2 n_P m_P^2}{v_\star} \int_{b_{\min}}^{b_{\max}} \frac{db}{b}$$

► Extended

$$\frac{d\sigma_z^2}{dt} \simeq \frac{\pi G^2 n_P m_P^2}{v_\star} \int_{b_{\min}}^{b_{\max}} \frac{db}{b} \frac{m_P^2 (< b)}{m_P^2}$$

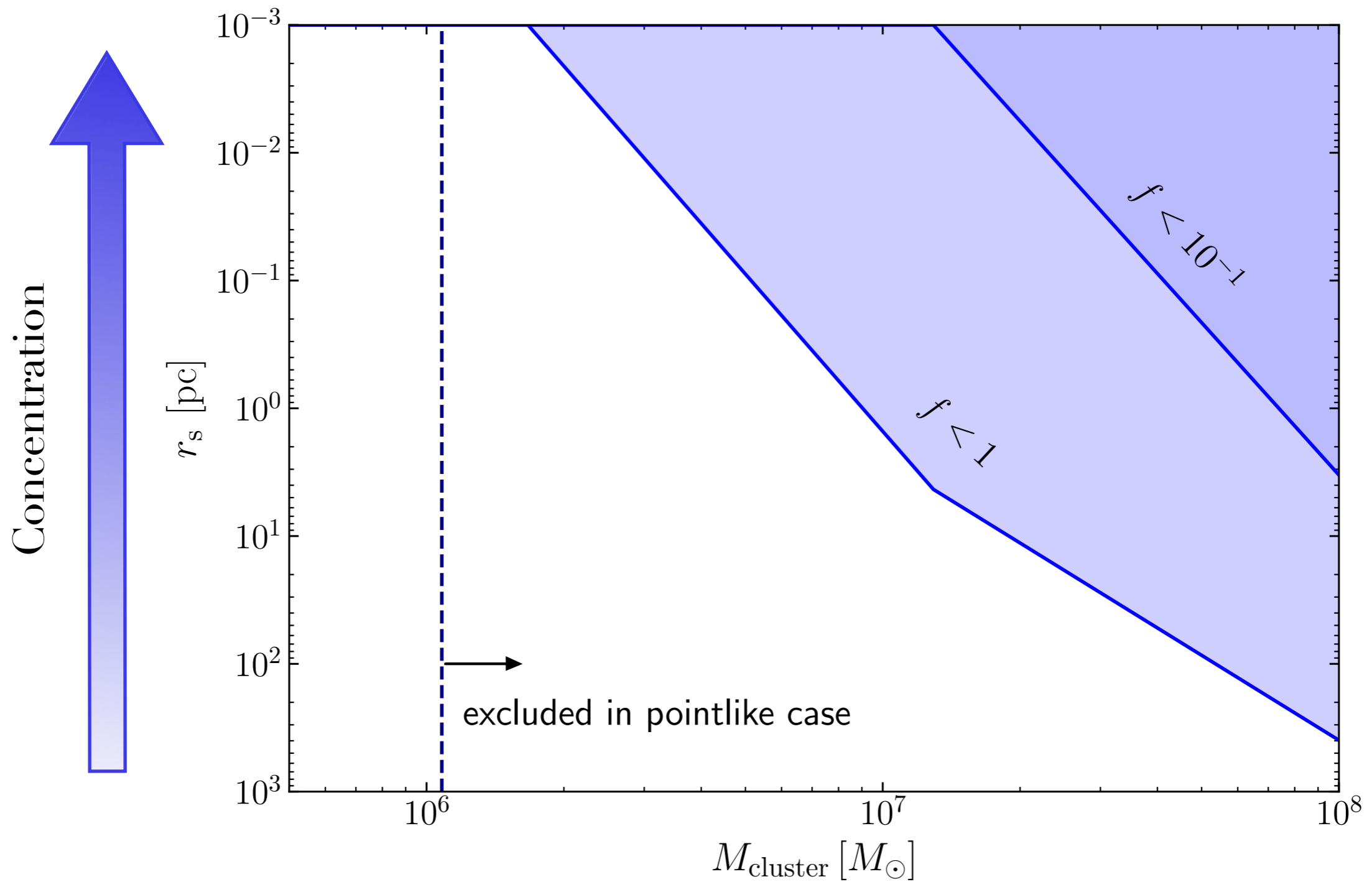


# *The setup*

- ▶ NFW profiles for PBH clusters ( $M, r_s$ )
- ▶ Velocity dispersion at solar radius:  $\sigma_z^2(\text{obs}) \simeq 20 \text{ km/s}$  (Gaia DR2)
- ▶  $\sigma_z^2(t = 0) = 0$
- ▶  $b_{\text{max}} \sim$  average inter-cluster distance
- ▶ Background MW potential from McMillan 2016
- ▶ Jeans equation for DM velocity dispersion



# *Results (preliminary)*



# *Conclusions (preliminary)*

- ▶ “Late-time” PBH clusters unlikely to be strongly constrained
- ▶ Constraints can exclude part of parameter space for initial clustering -> PBH formation scenarios
- ▶ Full analysis coming soon !