Anisotropy of dark matter annihilation in the Galaxy

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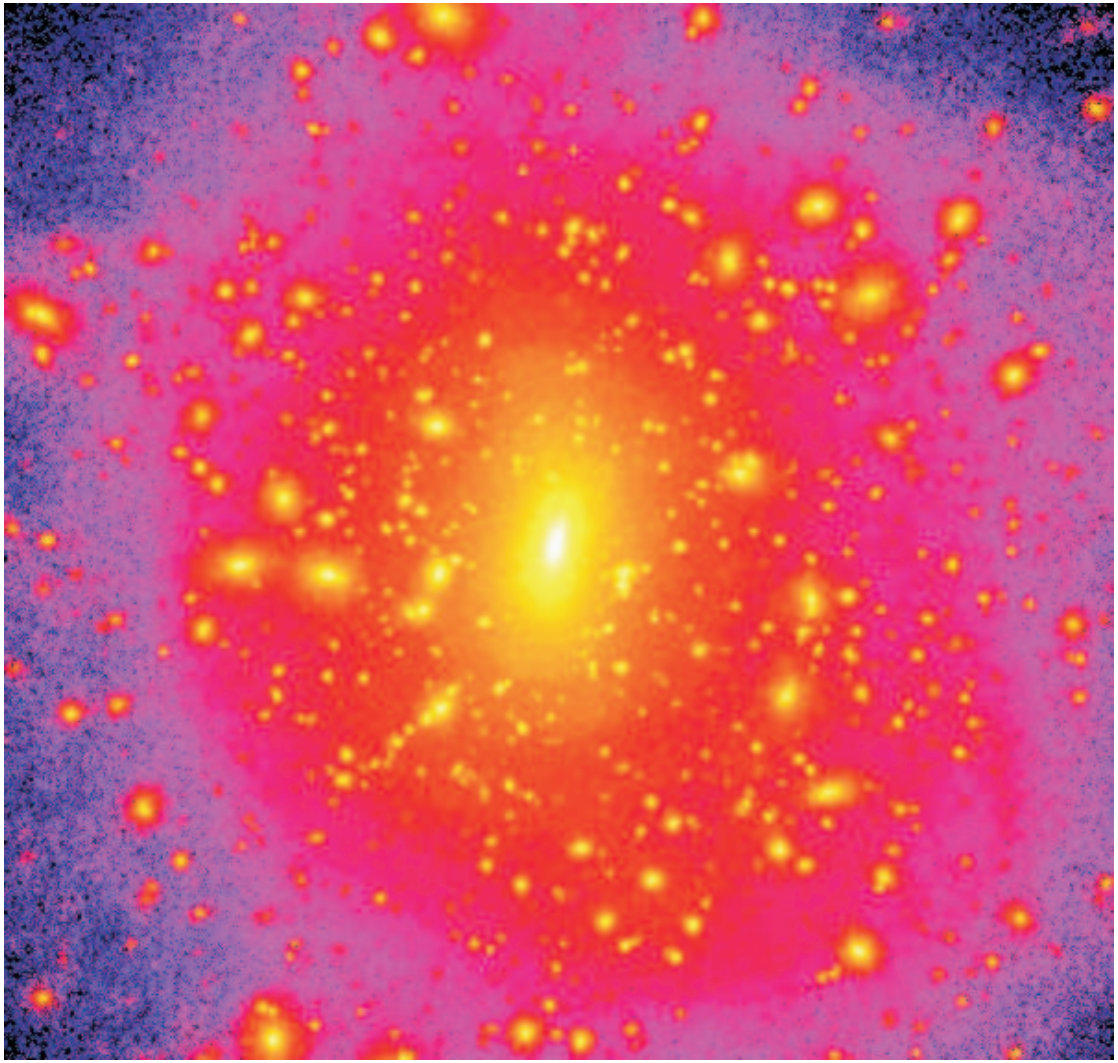
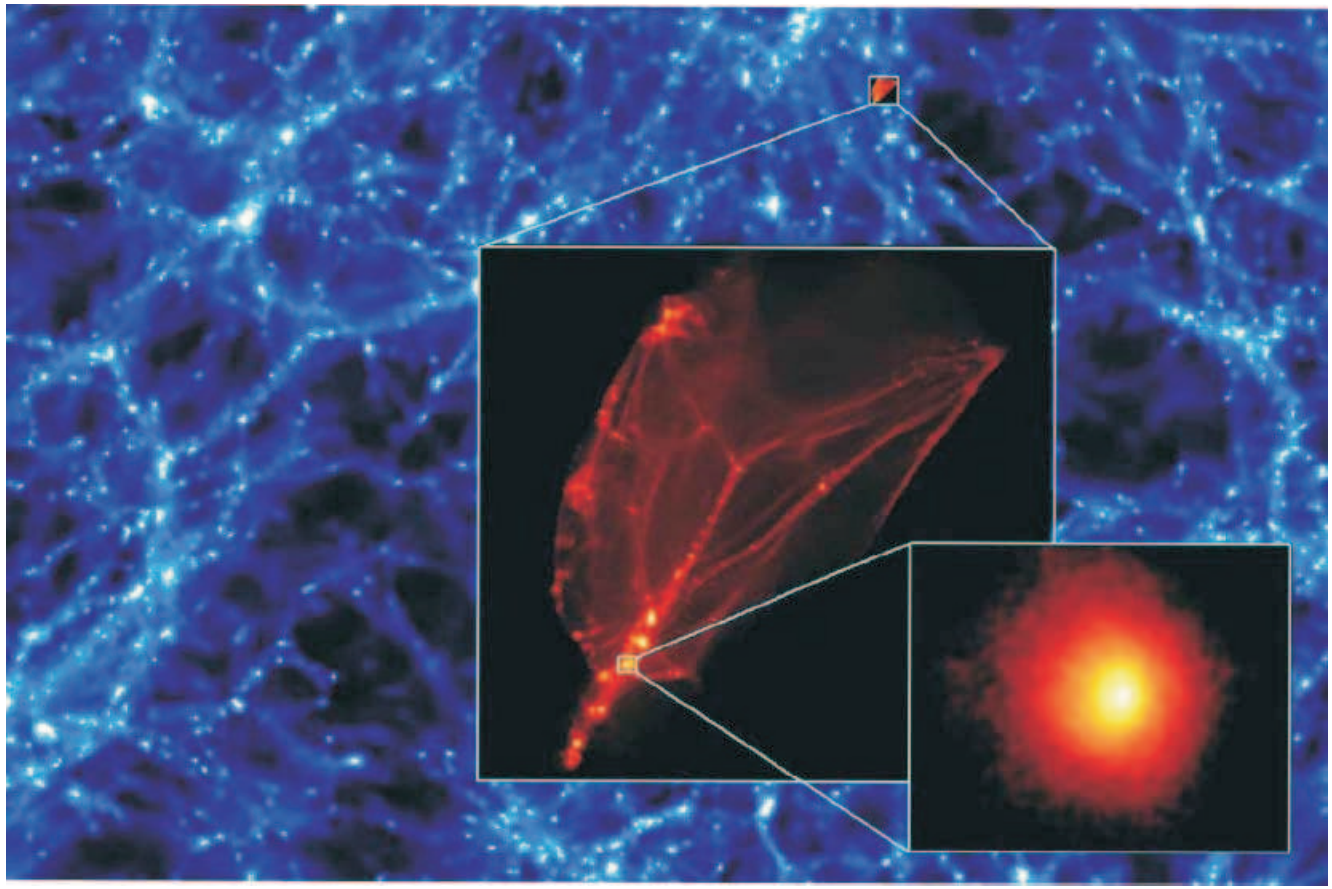
◇ Large-scale DM clumps from simulations



DM halo clumpiness

◇ Small-scale DM clumps from simulations



3 kpc **60 pc** **0.024 pc**

$N = 62 \cdot 10^6, \quad m = 10^{-10} M_\odot, \quad M_{\rm cl} = 10^{-6} M_\odot, \quad z = 350 \to 26$

Diemand, Moore & Stadel '05

◇ Internal density profile of DM clump

$$\rho_{\rm int}(r) \;=\; \begin{cases} \rho_c, & r < R_c; \\ \rho_c \left(\dfrac{r}{R_c}\right)^{-\beta}, & R_c < r < R; \\ 0, & r > R, \end{cases} \qquad \beta \simeq 1.8$$

Analytical theory — Gurevich & Zybin ’90 ’97

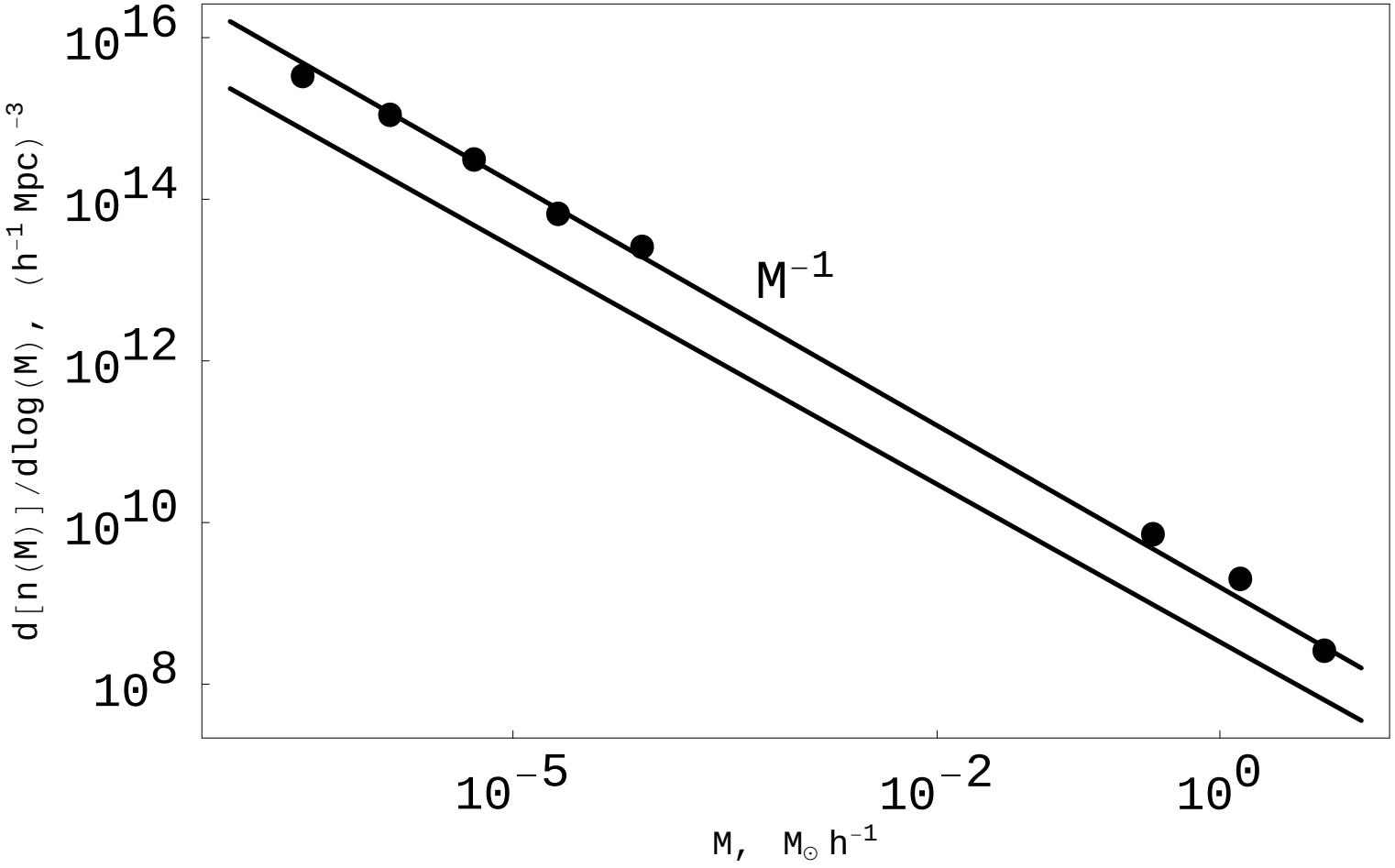
DM clump core radius?

$$\frac{R_c}{R} \leq 0.01$$

Model — Berezinsky, Dokuchaev & Eroshenko ’03, ’06

Simulations — Diemand, Moore & Stadel ’05

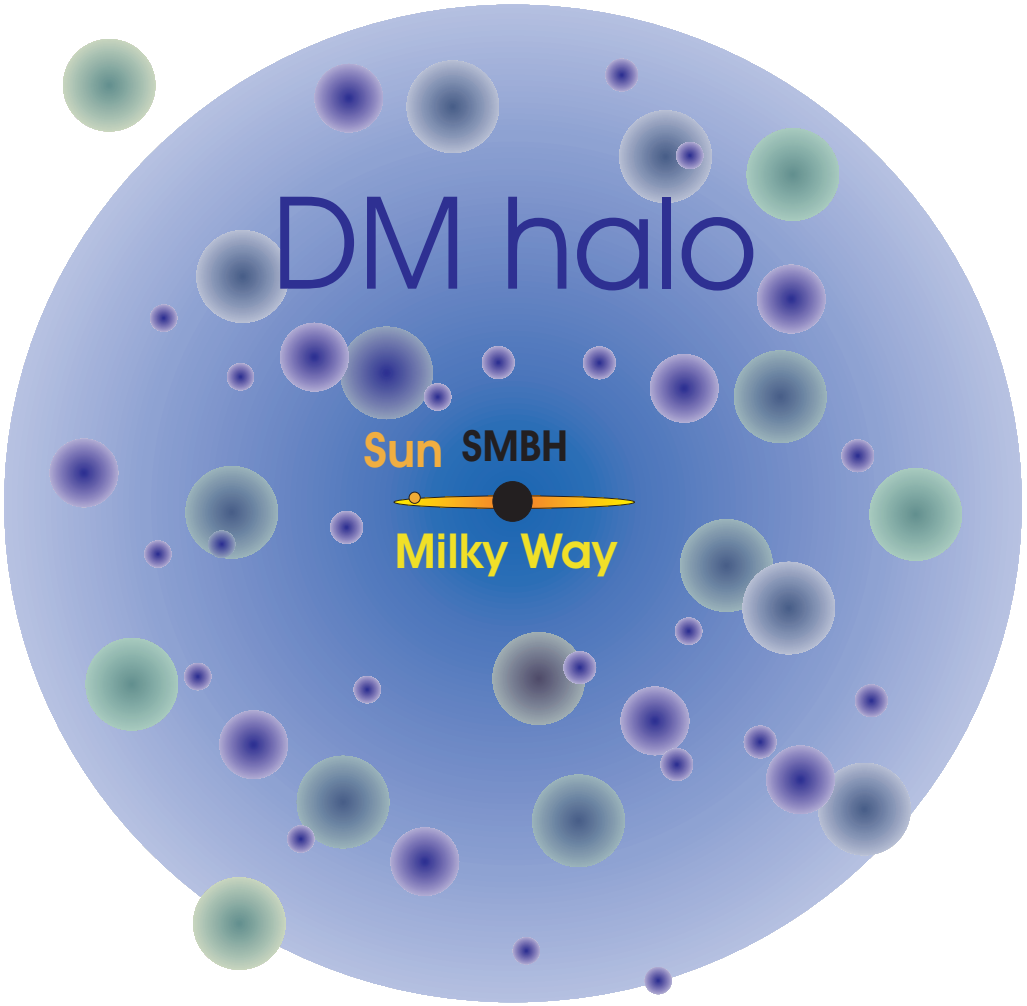
◇ Mass function of small-scale DM clumps



Lower line – model calculation — **Berezinsky, Dokuchaev & Eroshenko ’03**

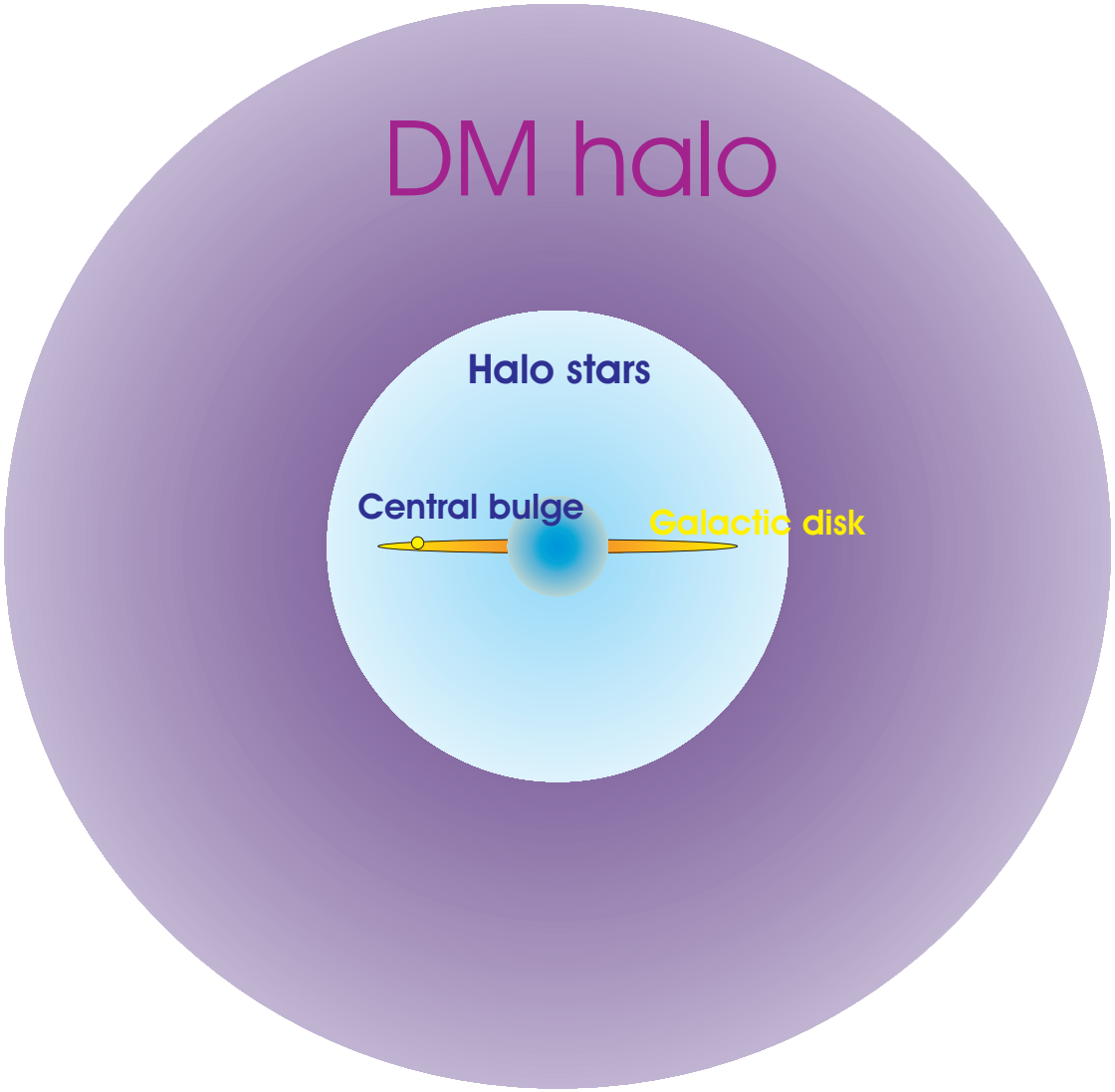
Dots – numerical simulations — **Diemand, Moore & Stadel ’05**

Small-scale DM clumps in the Galactic halo

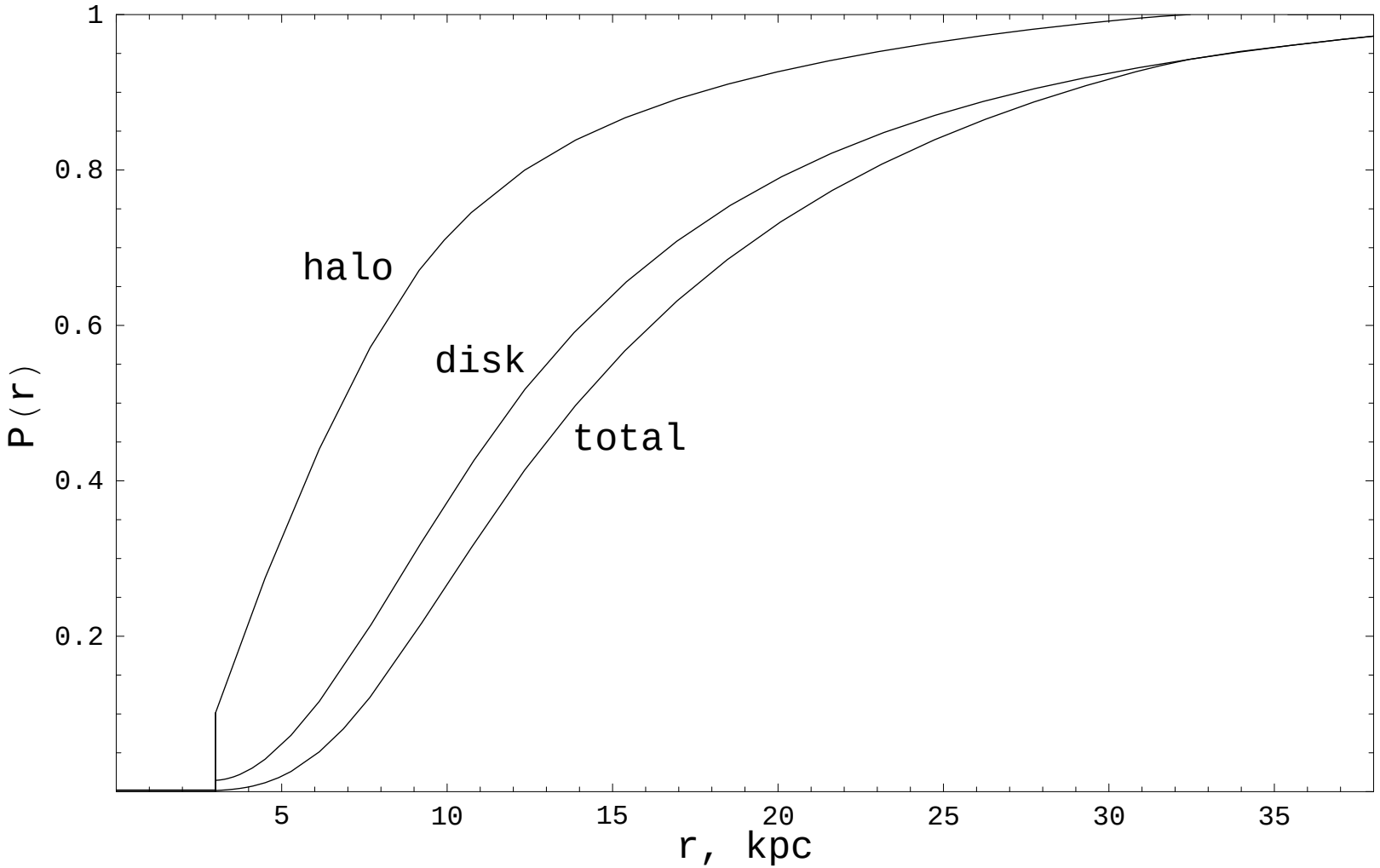


from primordial fluctuations. . .

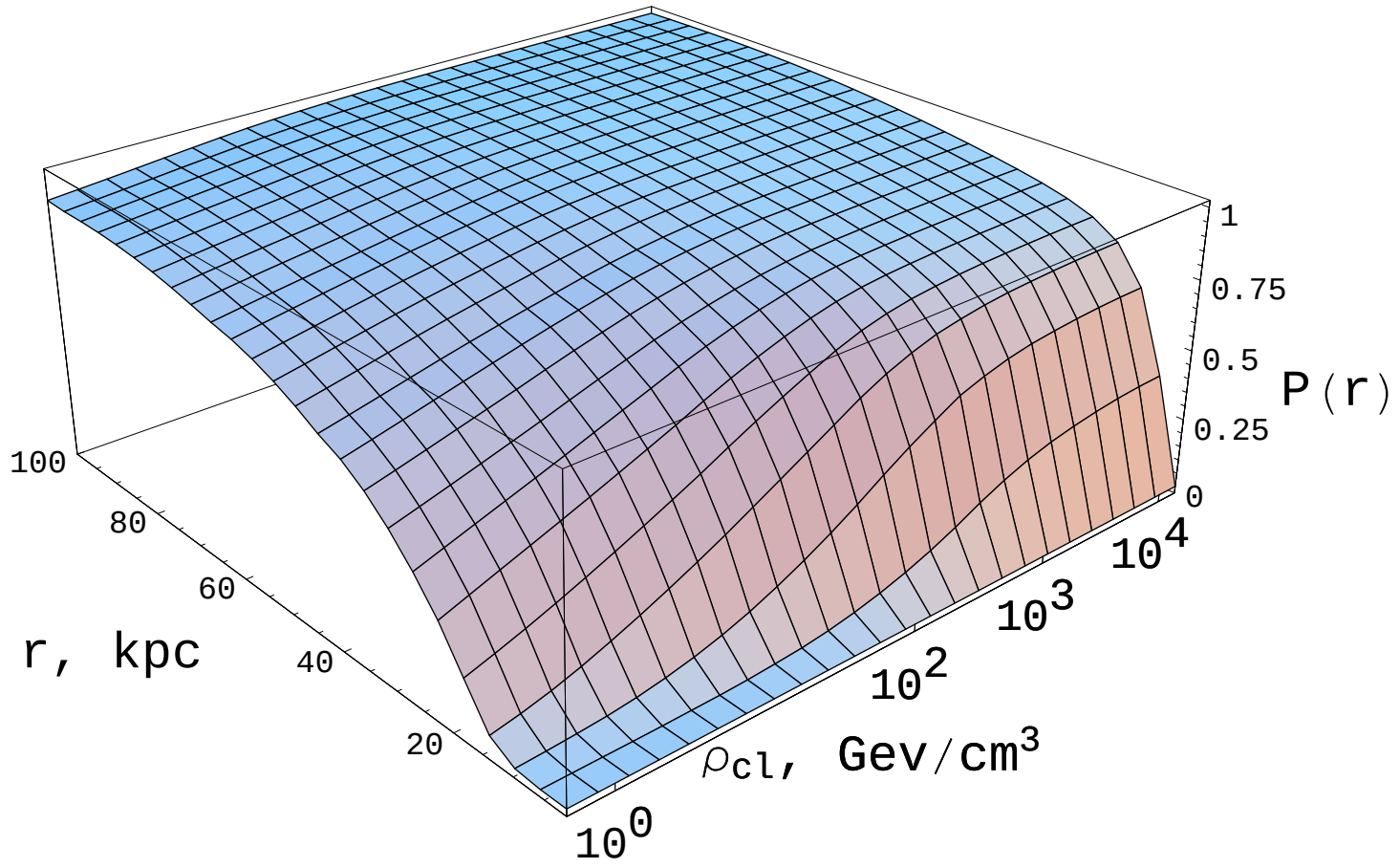
Stellar components of the Milky Way



Tidal destruction of small-scale DM clumps by stars



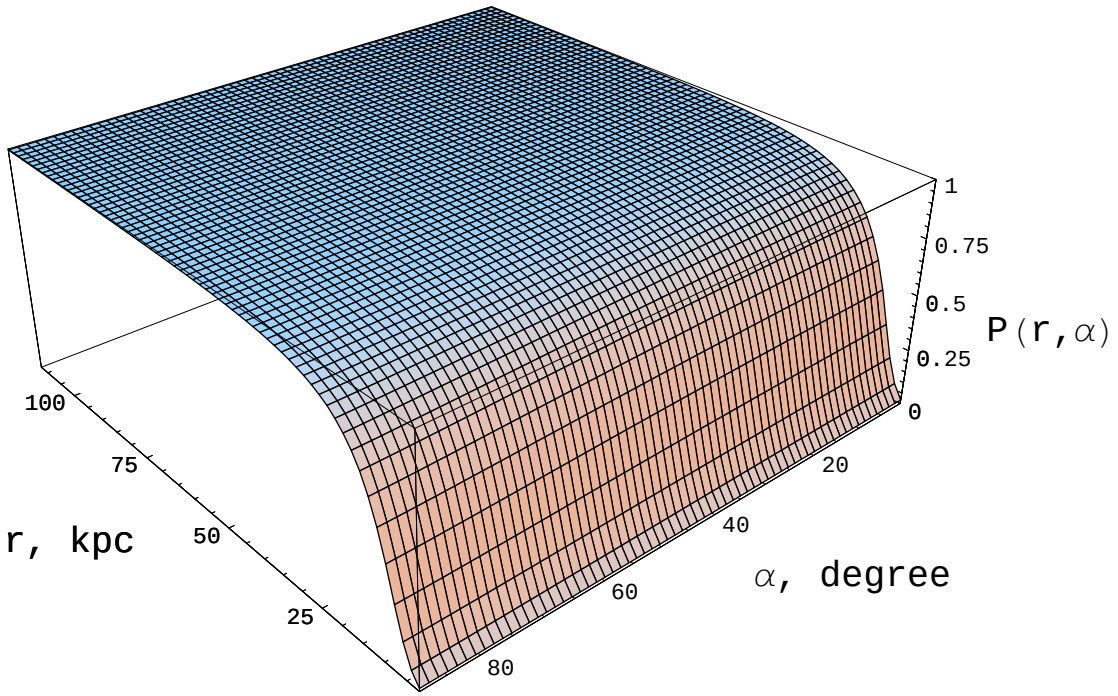
The fraction of clumps with mass $M = 2 \cdot 10^{-6} M_{\odot}$ survived through tidal destruction in the Galactic disc P_{d}, Galactic halo P_{H}, $P_{\mathrm{tot}} = P_{\mathrm{H}} P_d$
Absence of clumps inside the bulge at $r < 3$ kpc.



The survived fraction of clumps $P(r)$ in the Galactic halo

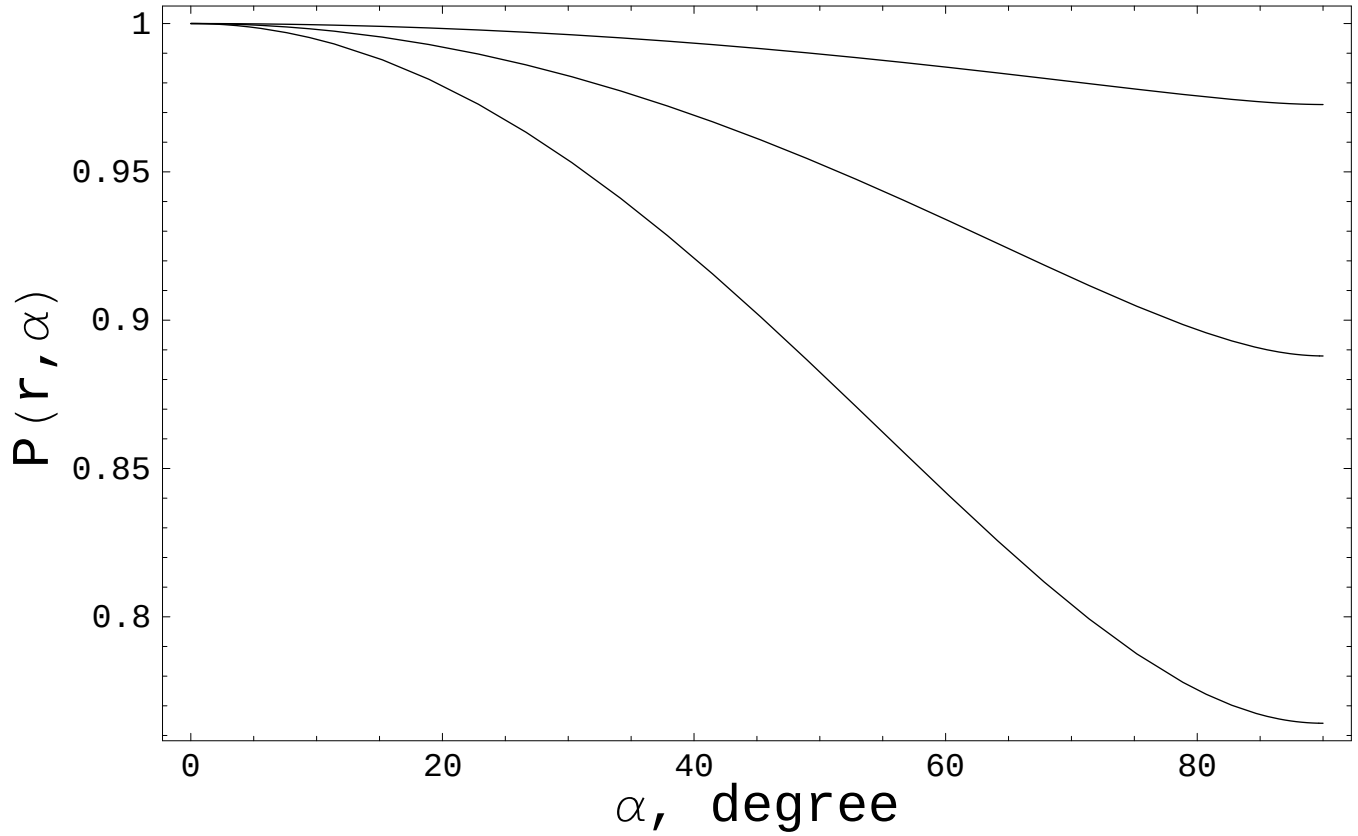
Internal density of clumps ρ_{cl} in GeV cm^{-3}

◇ Anisotropy of DM clump distribution in the Galaxy



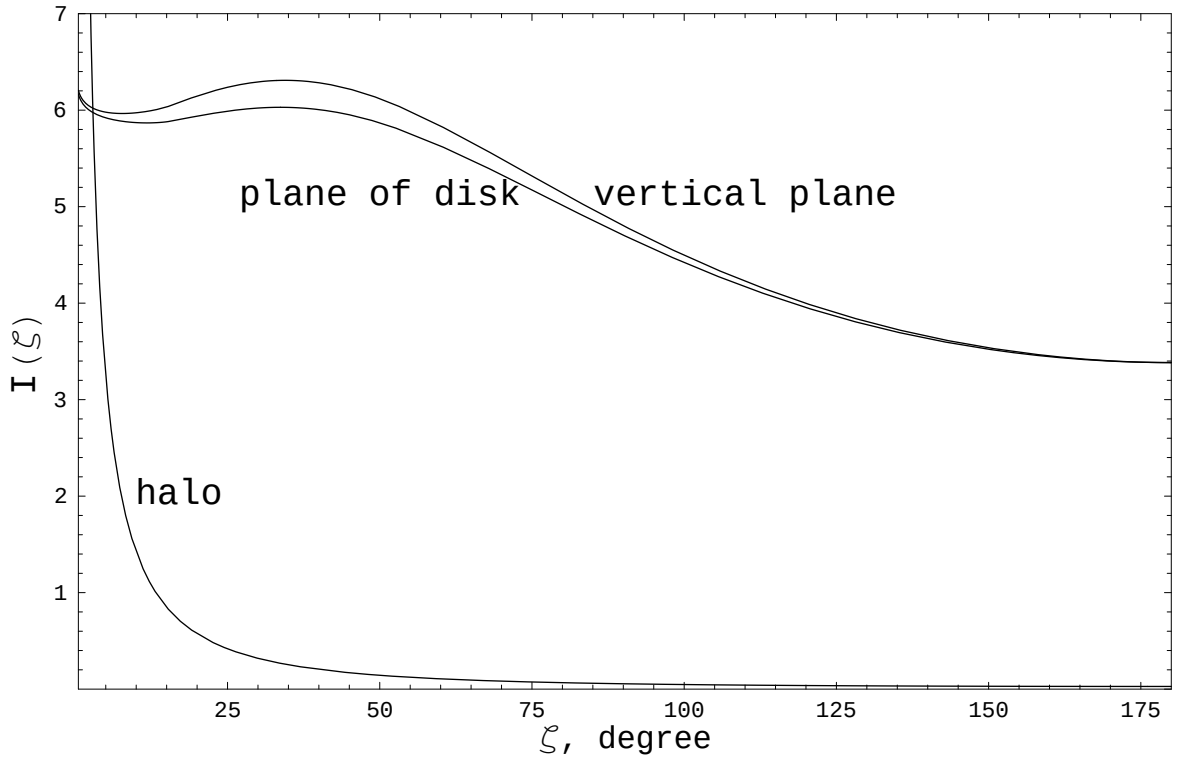
A survival probability $P(r,\alpha)$ of DM clumps in the halo as a function of a radius r and angle α between a radius-vector $\vec{r}$ and the disk polar axis.

◇ Normalized anisotropy of DM clump distribution



The normalized fractions of DM clumps in the halo $P(r,\alpha)$ as a function of an angle α between a radius-vector $\vec{r}$ and the disk polar axis for $r = 3$, 8.5 and 20 kpc (from the bottom to the top)

◇ Annihilation signal from DM clumps



An annihilation signal in the Galactic disk plane and in the vertical plane as a function of angle ξ between the line of observation and the direction to the Galactic center. For comparison it is shown also the signal from the Galactic halo without the DM clumps

◇ Conclusions

- DM annihilation rate in the Galactic halo is dominated by clumps if mass fraction in clumps is above a few percent

- Amplification (boosting) of annihilation signal due to DM clumps is $\sim 10 - 10^3$ and crucially depends on the initial perturbation spectrum

- Tidal destruction of clumps with orbits near the disk plane occurs more efficiently as compared with the near-polar orbits

- Annihilation of DM particles in the small-scale clumps produces anisotropic ($\sim 5\%$) gamma-ray signal with respect to the Galactic disk