Gregory Horndeski, 'Horndeski Scalar Theory, Past, Present and Future'

Towards Precision Cosmology With Void-Lensing:

I. How To Optimize Void-Lensing Measurements (in Collab With Marie-Claude and Pauline)

II. How To Interpret the Measurement (in Collab With R. Voivodic)

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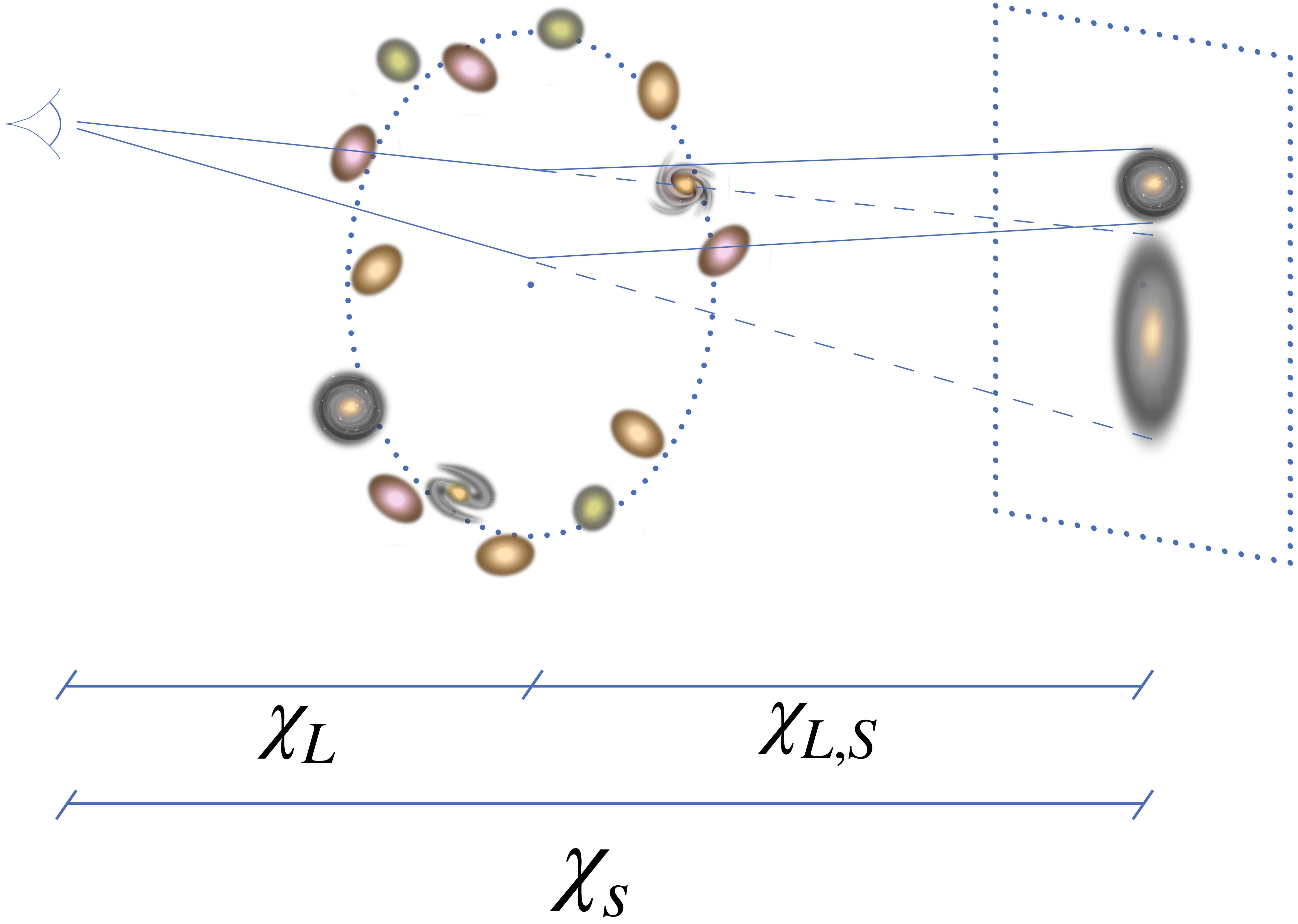
CENTRE DE PHYSIQUE DES PARTICULES DE MARSEILLE CPPM

LAM LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

Voids and Structure Formation

WL Voids



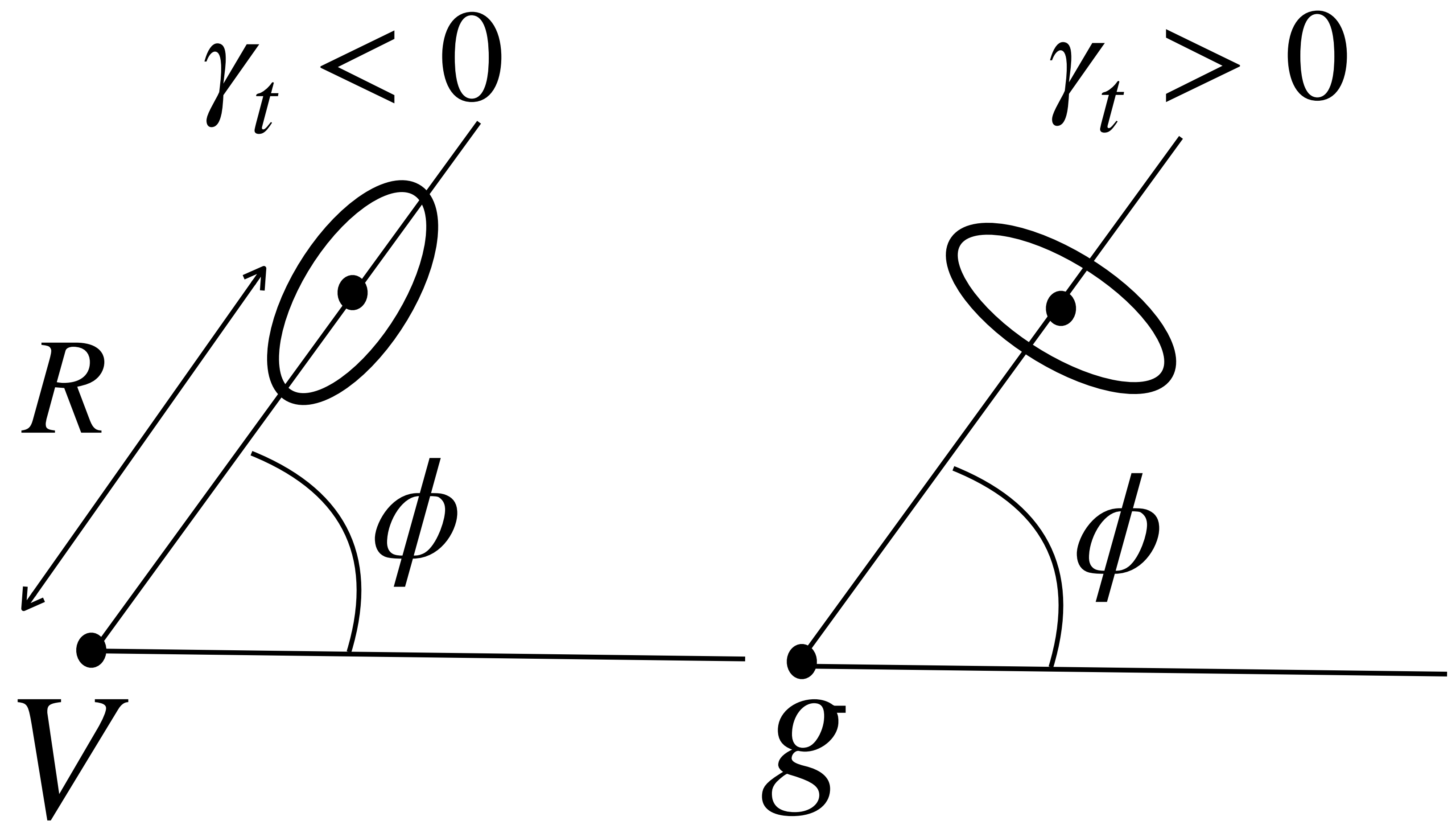
Differential surface mass density:

$$\Delta\Sigma(R, z_L) = \Sigma_{crit}(\bar{\kappa}(< R) - \kappa(R))$$

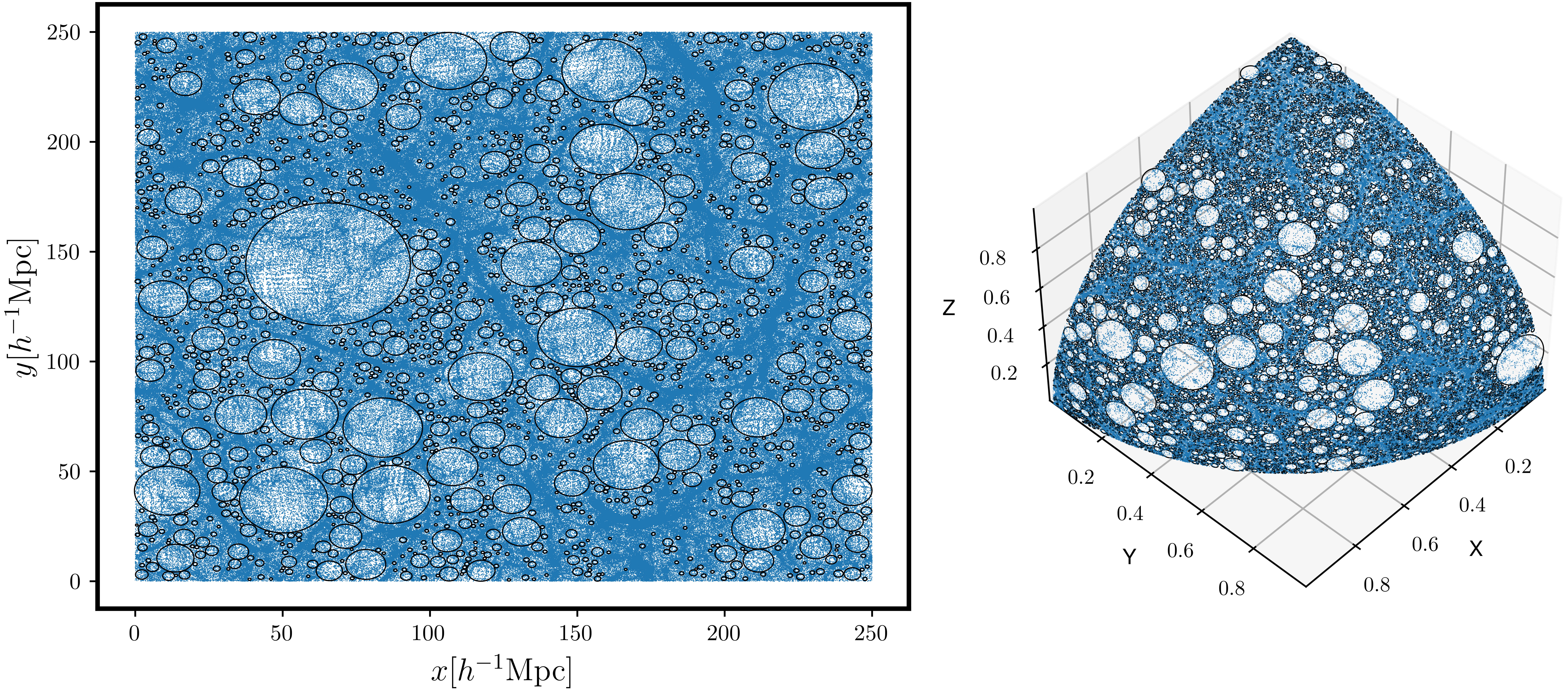
$$= \Sigma_{crit} \times \gamma_t(R)$$

$$\kappa(R) = \int d\chi \Sigma^{-1}_{crit} \bar{\rho} \delta(\chi, R) \equiv \Sigma^{-1}_{crit} \Sigma(R)$$

$$\Rightarrow \Delta\Sigma(R) = \bar{\Sigma}(< R) - \Sigma(R)$$

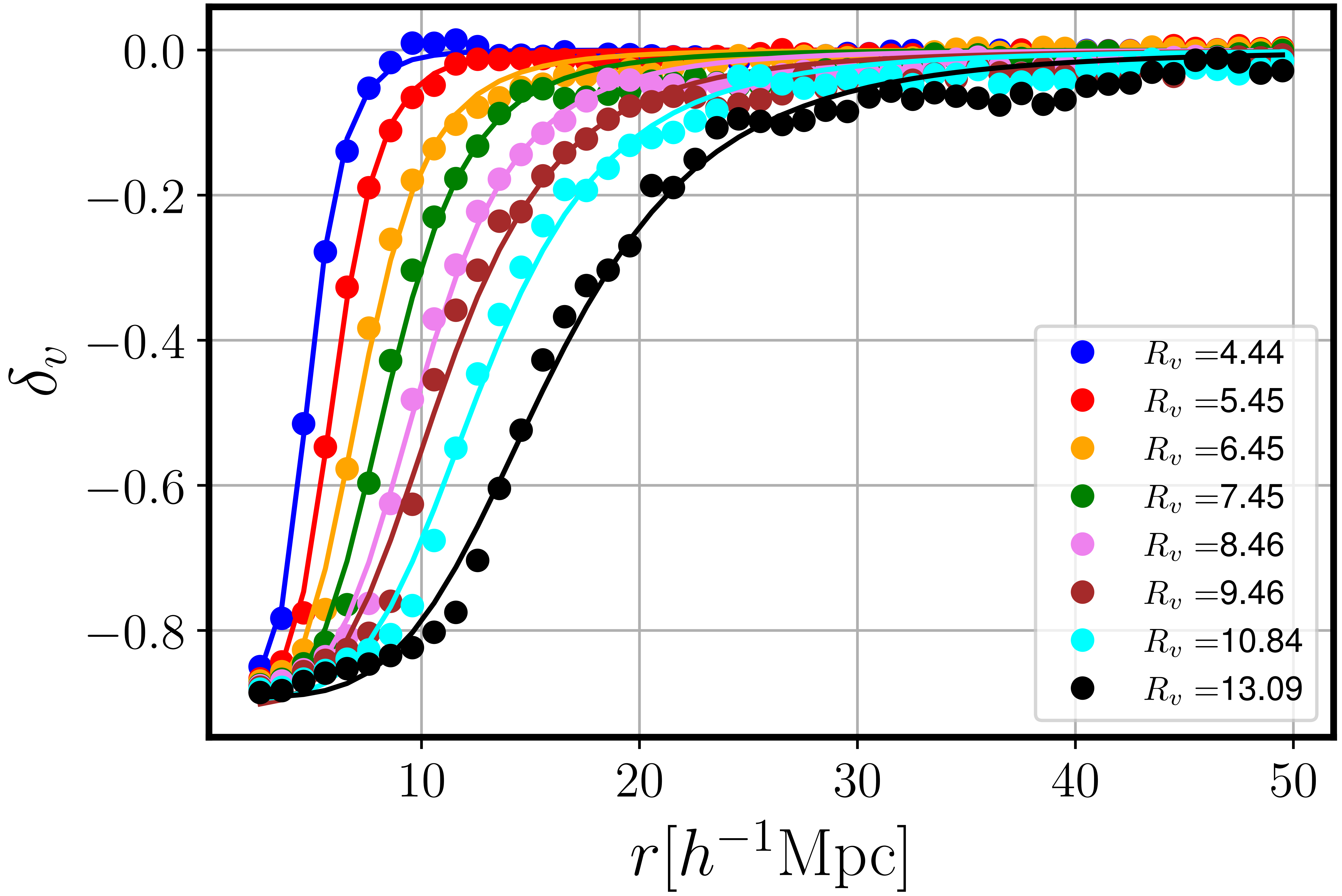


Optimum Centering Void Finder

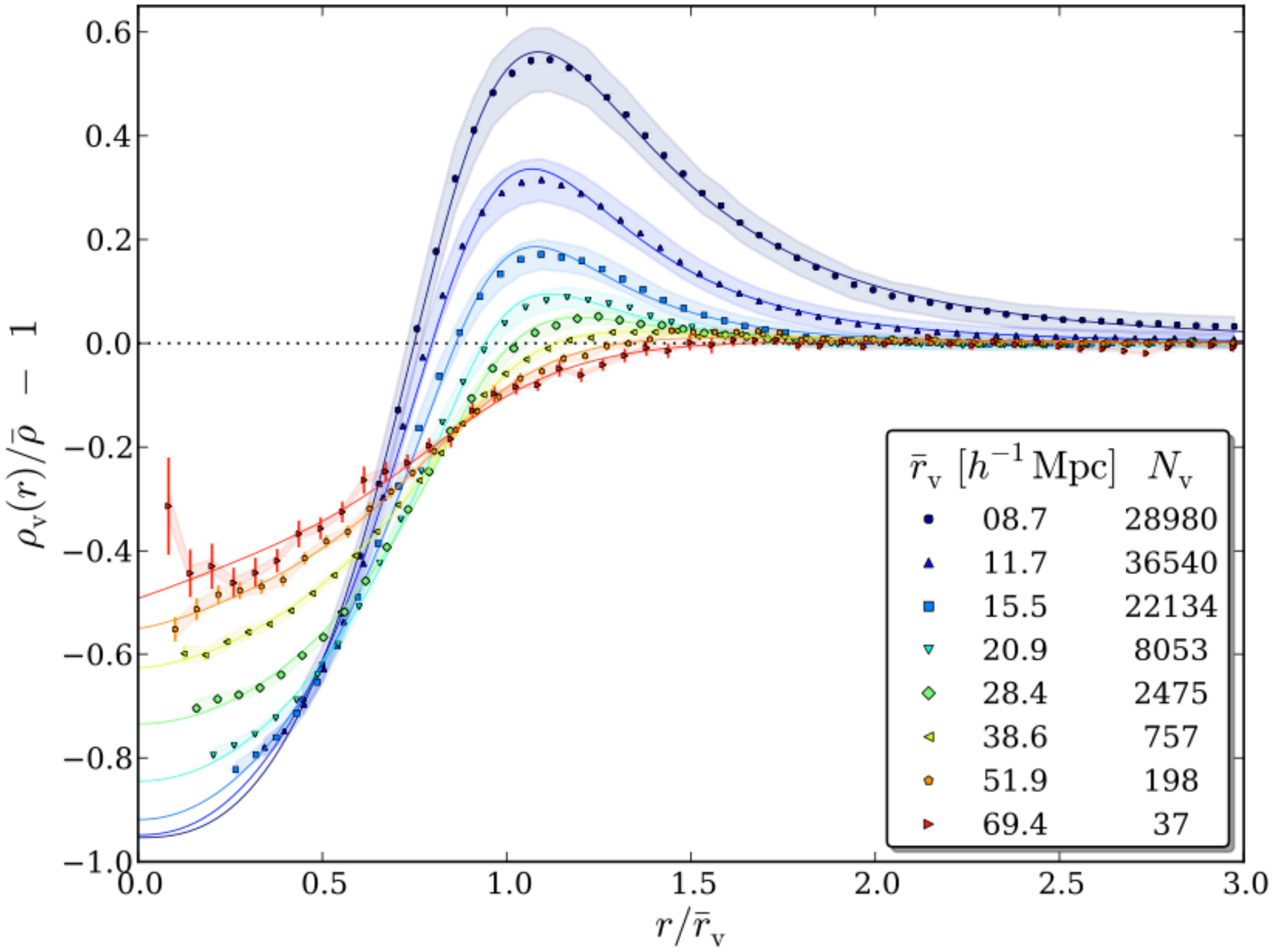


Comparison With Literature

OCVF



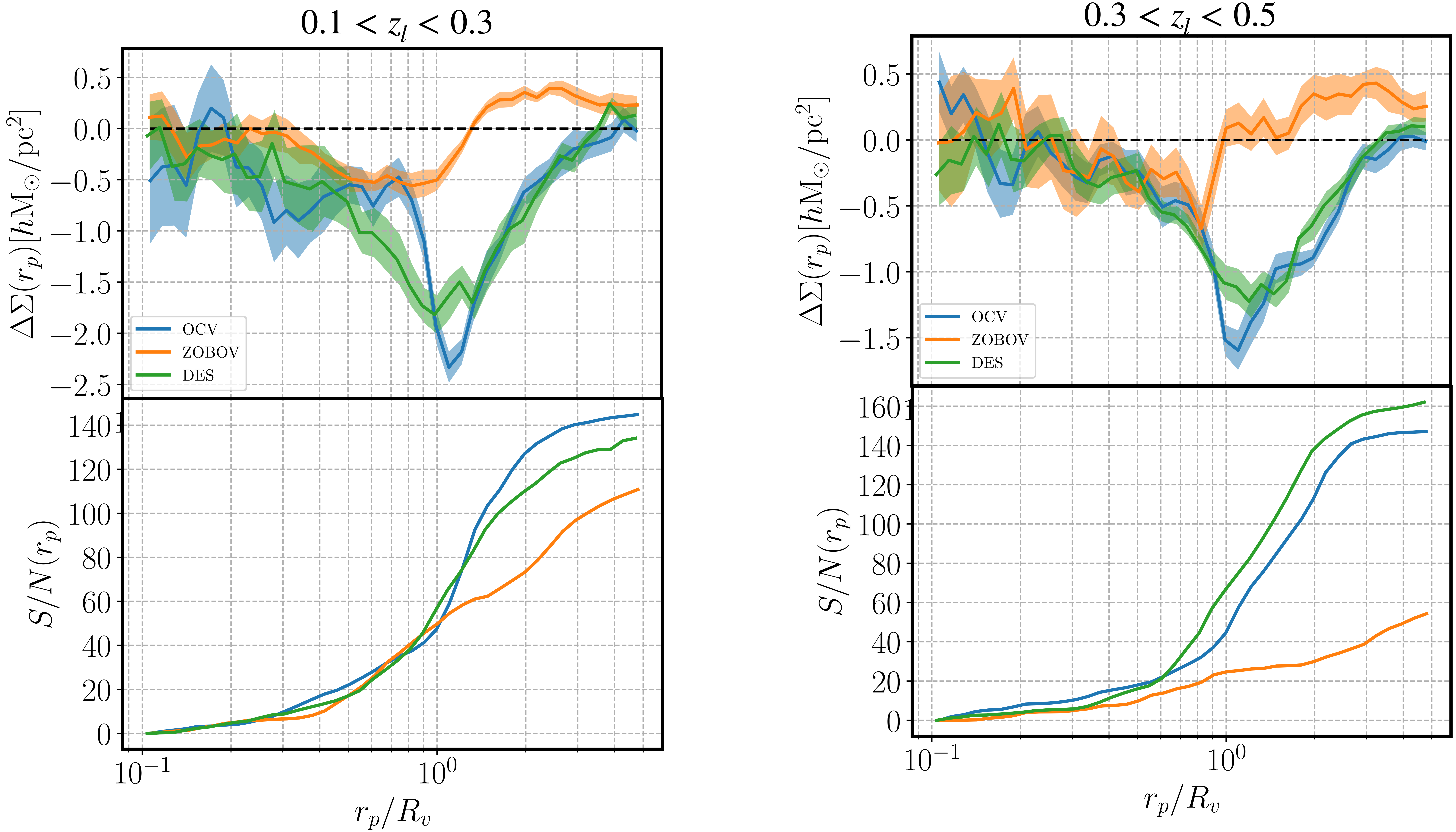
ZOBOV



Hamaus et al (2014)

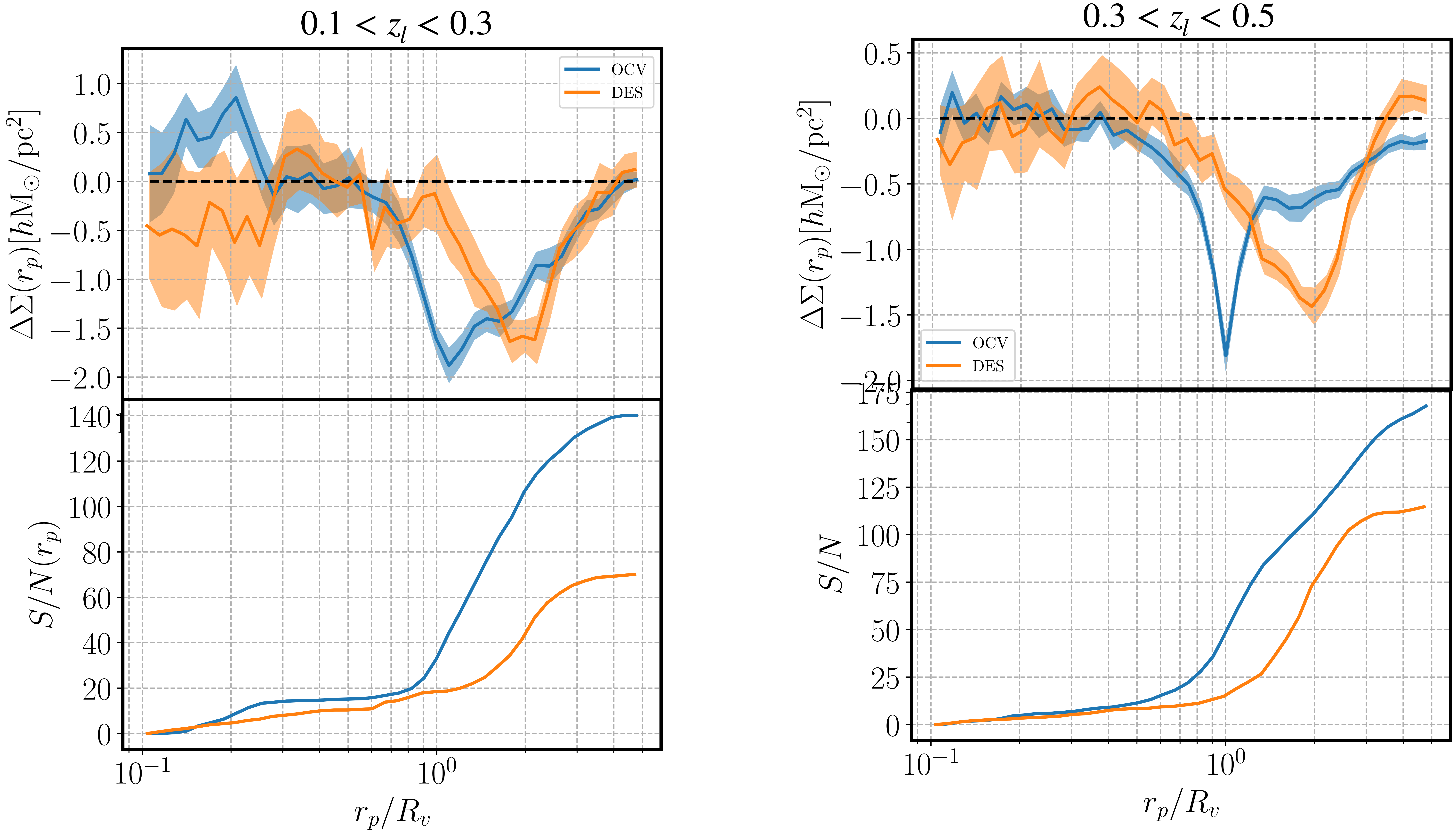
Performance on VL

$10 < R_v < 15[h^{-1}\mathbf{Mpc}]$

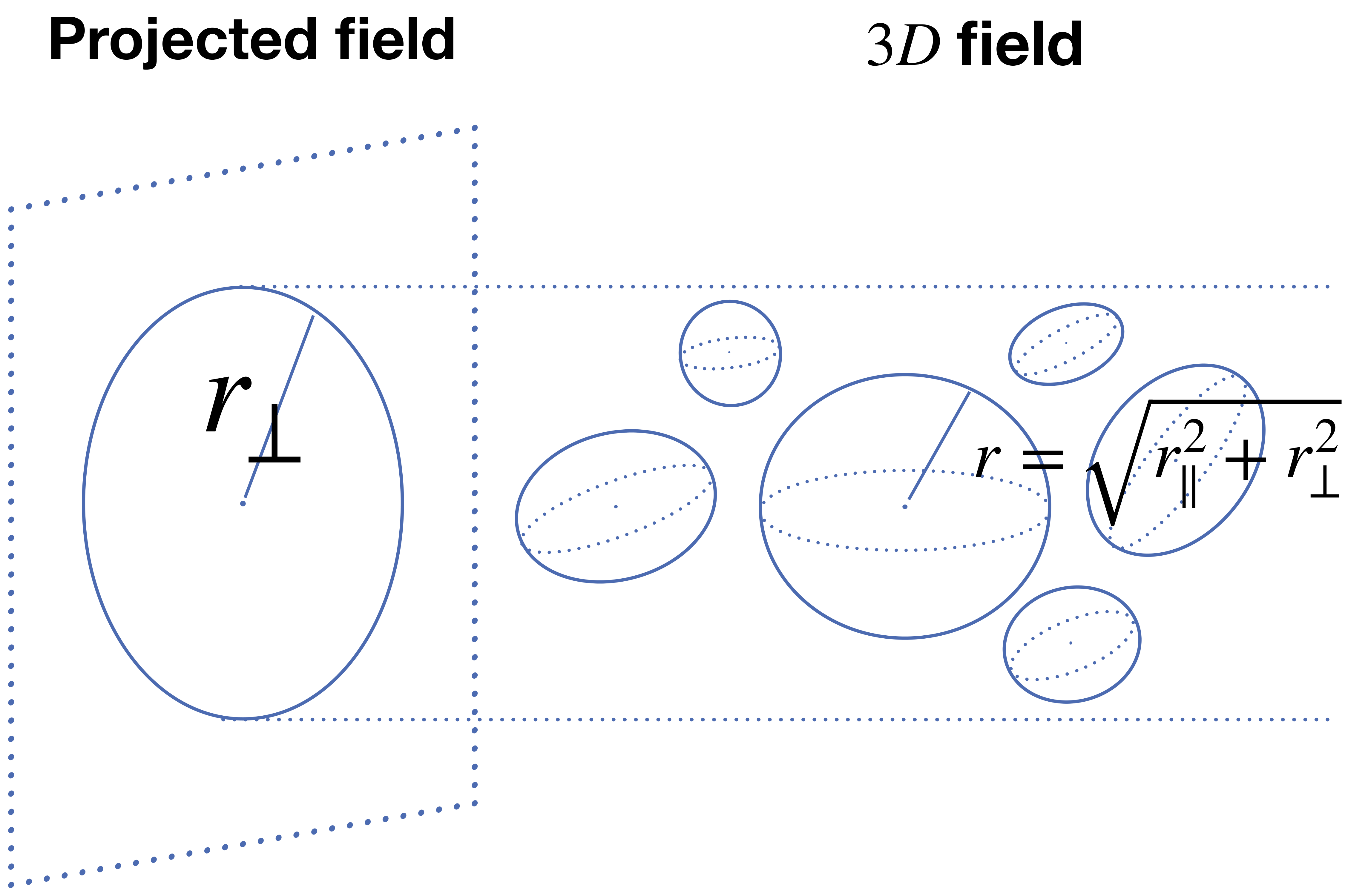


Performance on VL

$5 < R_v < 7[h^{-1}\mathbf{Mpc}]$



The Void-Lensing Model



$$\delta_{2D}(r_\perp \,|\, R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} \,|\, \Delta_{3D}) \int dx_\perp dx_\parallel d\alpha P(x_\perp, x_\parallel, \alpha \,|\, R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\parallel \, \delta_{3D}(r_\perp - x_\perp, r_\parallel - x_\parallel \,|\, \alpha, R_{3D}, \Delta_{3D})$$

The Void-Lensing Model

$$\delta_{2D}(r_\perp | R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} | \Delta_{3D}) \int dx_\perp dx_\parallel d\alpha P(x_\perp, x_\parallel, \alpha | R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\parallel \, \delta_{3D}(r_\perp - x_\perp, r_\parallel - x_\parallel | \alpha, R_{3D}, \Delta_{3D})$$

$$\simeq$$

$$\delta_{2D}(r_\perp | R_{2D}) = \int d \ln R_{3D} \frac{dn_v}{d \ln R_{3D}} \int dx_\perp (1 + \xi(x_\perp)) \int dr_\parallel \, \delta_{3D}(r_\perp, r_\parallel | \alpha, R_{3D})$$

$$= \int dr_\parallel \delta^{eff}(r_\perp, r_\parallel | \alpha, R_{3D})$$

$$\Rightarrow \Delta\Sigma(r_\perp) = \bar{\delta}_{2D}(< r_\perp) - \delta_{2D}(r_\perp)$$

The Void-Lensing Model

$$\delta_{2D}(r_\perp | R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} | \Delta_{3D}) \int dx_\perp dx_\| d\alpha P(x_\perp, x_\|, \alpha | R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\| \, \delta_{3D}(r_\perp - x_\perp, r_\| - x_\| | \alpha, R_{3D}, \Delta_{3D})$$

$$\simeq$$

$$\delta_{2D}(r_\perp | M_{2D}) = \int d\ln R_{3D} \boxed{\frac{dn_v}{d\ln R_{3D}}} \int dx_\perp (1 + \xi(x_\perp)) \int dr_\| \, \delta_{3D}(r_\perp, r_\| | \alpha, R_{3D})$$

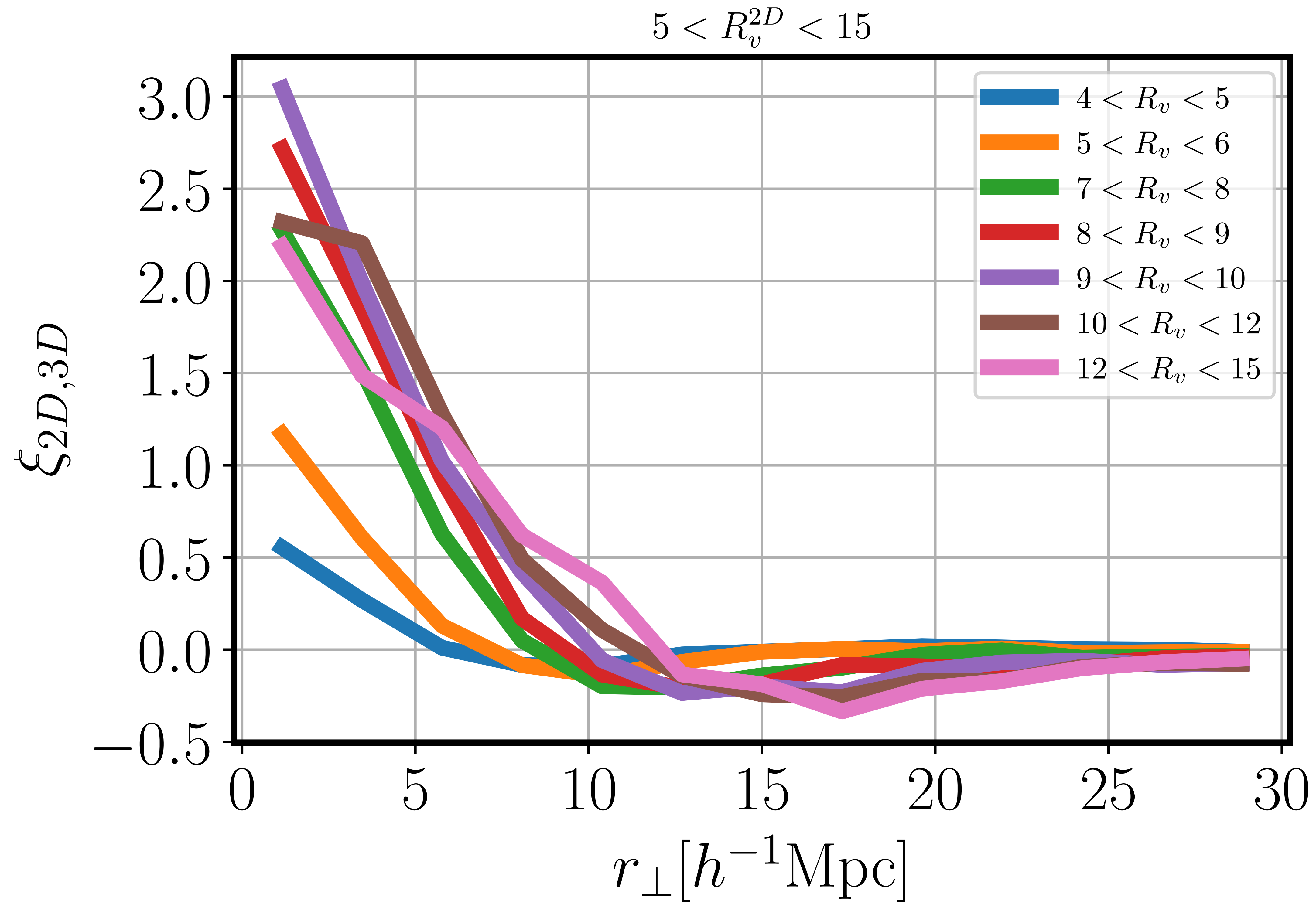
$$\frac{dn_v}{d\ln R} = \frac{f(\sigma)}{V(R)} \frac{d\ln\sigma^{-1}}{d\ln R}$$, **where** $$\sigma^2(R) \equiv \int \frac{dk}{2\pi^2} k^2 P^L_{mm}(k) | \tilde{W}(k \mid R) |^2$$

The Void-Lensing Model

$$\delta_{2D}(r_\perp | R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} | \Delta_{3D}) \int dx_\perp dx_\parallel d\alpha P(x_\perp, x_\parallel, \alpha | R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\parallel \rho_{3D}(r_\perp - x_\perp, r_\parallel - x_\parallel | \alpha, R_{3D}, \Delta_{3D})$$

$$\simeq$$

$$\delta_{2D}(r_\perp | M_{2D}) = \int d\ln R_{3D} \frac{dn_v}{d\ln R_{3D}} \int dx_\perp (1 + \xi(x_\perp)) \int dr_\parallel \delta_{3D}(r_\perp, r_\parallel | \alpha, R_{3D})$$

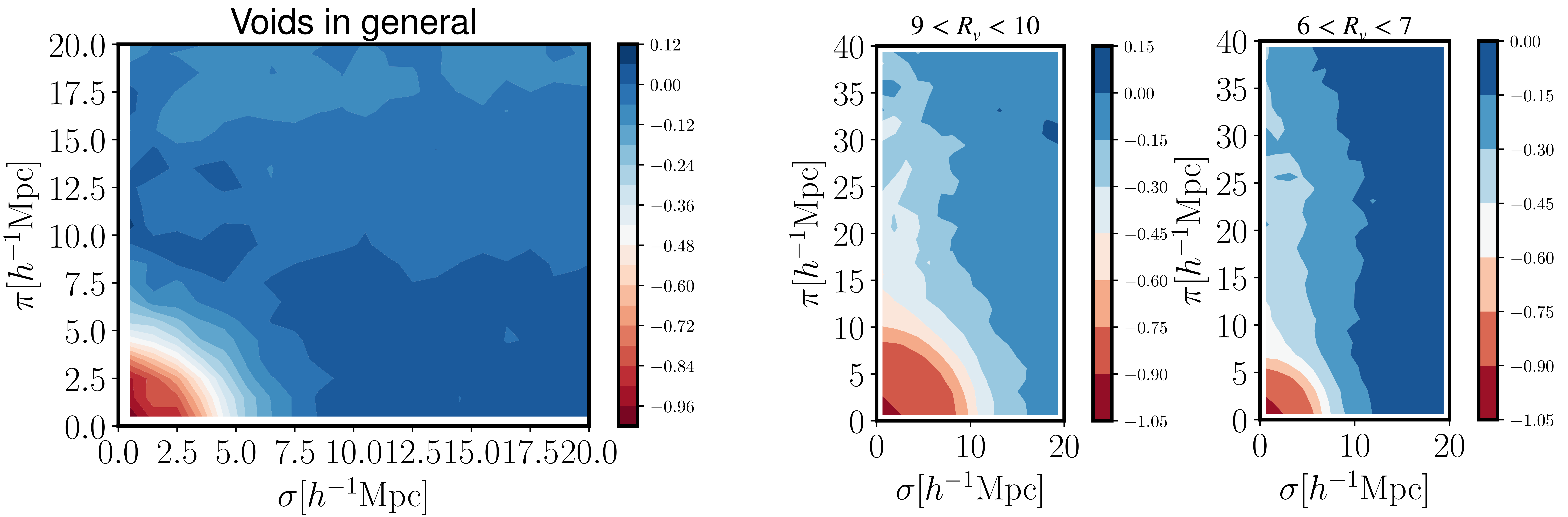


The Void-Lensing Model

$$\delta_{2D}(r_\perp \,|\, R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} \,|\, \Delta_{3D}) \int dx_\perp dx_\parallel d\alpha P(x_\perp, x_\parallel, \alpha \,|\, R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\parallel \, \delta_{3D}(r_\perp - x_\perp, r_\parallel - x_\parallel \,|\, \alpha, R_{3D}, \Delta_{3D})$$

$$\simeq$$

$$\delta_{2D}(r_\perp \,|\, M_{2D}) = \int d\ln R_{3D} \frac{dn_v}{d\ln R_{3D}} \int dx_\perp (1 + \xi(x_\perp)) \int dr_\parallel \boxed{\delta_{3D}(r_\perp, r_\parallel \,|\, \alpha, R_{3D})}$$

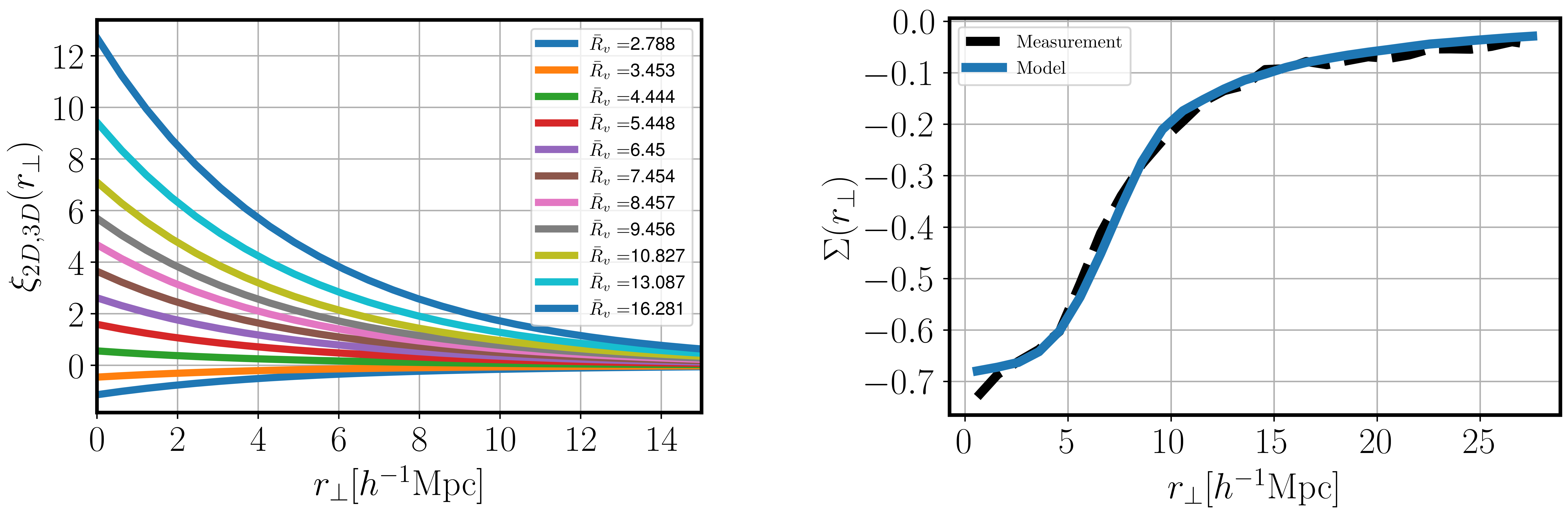


Preliminary Result

$$\delta_{2D}(r_\perp \mid R_{2D}, \Delta_{2D}) = \int dR_{3D} \frac{dn_v}{dR_{3D}}(R_{3D} \mid \Delta_{3D}) \int dx_\perp dx_\parallel d\alpha P(x_\perp, x_\parallel, \alpha \mid R_{3D}, R_{2D}, \Delta_{3D}, \Delta_{2D}) \int dr_\parallel \, \delta_{3D}(r_\perp - x_\perp, r_\parallel - x_\parallel \mid \alpha, R_{3D}, \Delta_{3D})$$

$$\simeq$$

$$\delta_{2D}(r_\perp \mid M_{2D}) = \int d\ln R_{3D} \frac{dn_v}{d\ln R_{3D}} \int dx_\perp (1 + \xi(x_\perp)) \int dr_\parallel \, \delta_{3D}(r_\perp, r_\parallel \mid \alpha, R_{3D})$$



Conclusions and Prospects

- Our method is capable of measuring $\Delta\Sigma$ with high S/N
- Promising results in relating 3D and 2D underdensities
- Open questions: (i) How much we can reconstruct from the DM field using 2D underdensities? (ii) Is the Void intrinsic alignment sensitive to cosmology, modifications to gravity or neutrinos? (iii) How voids found in DM fields relates to voids found in galaxy fields?
- Future: Apply the pipe line to the real data and perform cosmological analysis for the first time