Measuring Void dynamics through redshift space distortions in the SDSS galaxy distribution.

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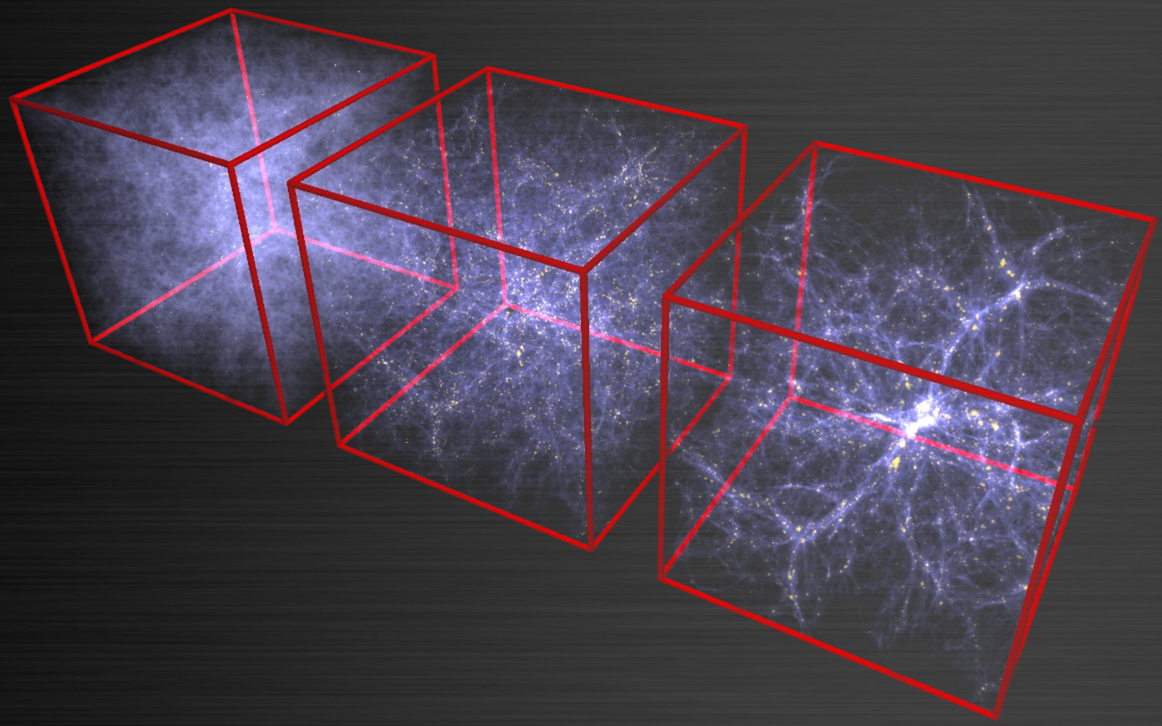

"In so far as one denies what is
one is possessed by what is not
the compulsions
the fantasies
the terrors
that flock to fill the void".
— Ursula Le Guin

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Basic Framework

-The void hierarchy arises by matter assembly.

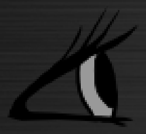
-The void dynamics exhibits two distinct behaviours:
collapse and expansion.

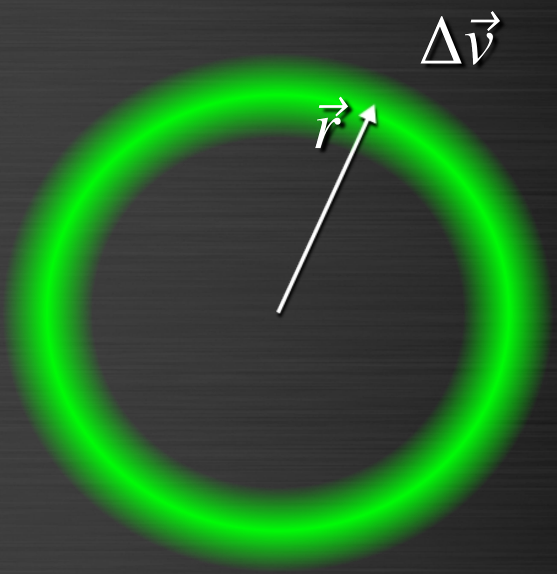
-The phenomenon is well understood in theory:
A PS formalism with two barriers describes well the VPF in simulations.

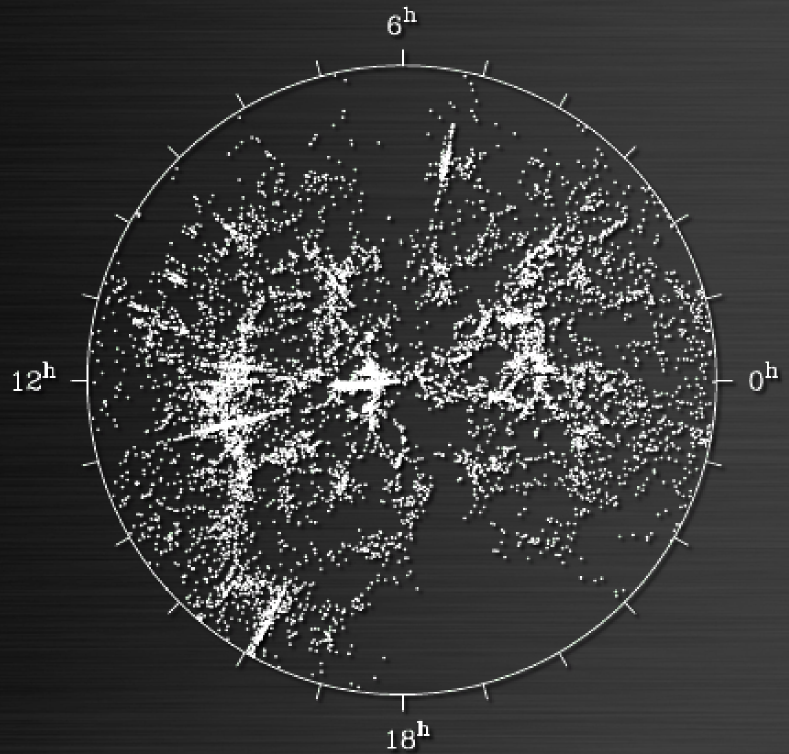
-There is very few studies of void expansion on real data.

-Voids have been used to constraint cosmological models.

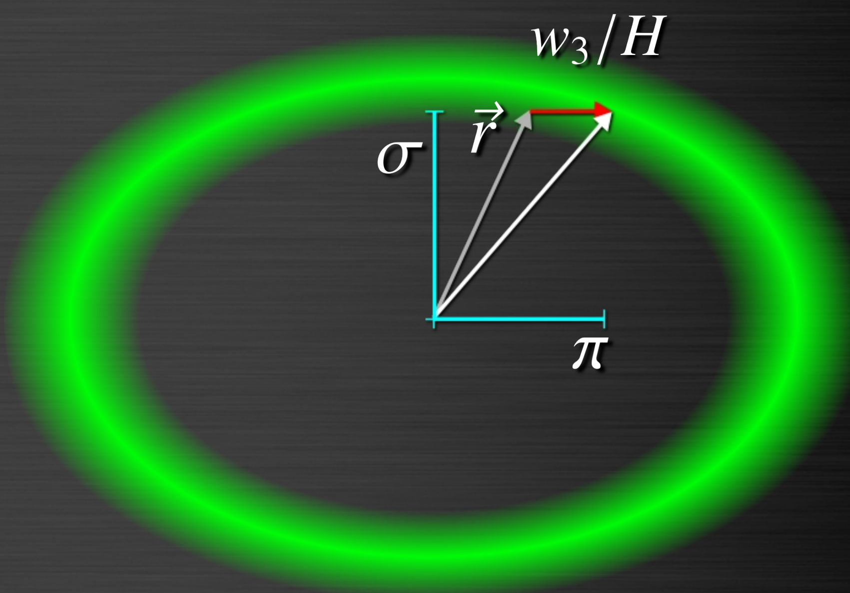
Redshift space distortions







Redshift space distortions



$$\vec{r} \equiv (r_1, r_2, r_3)$$

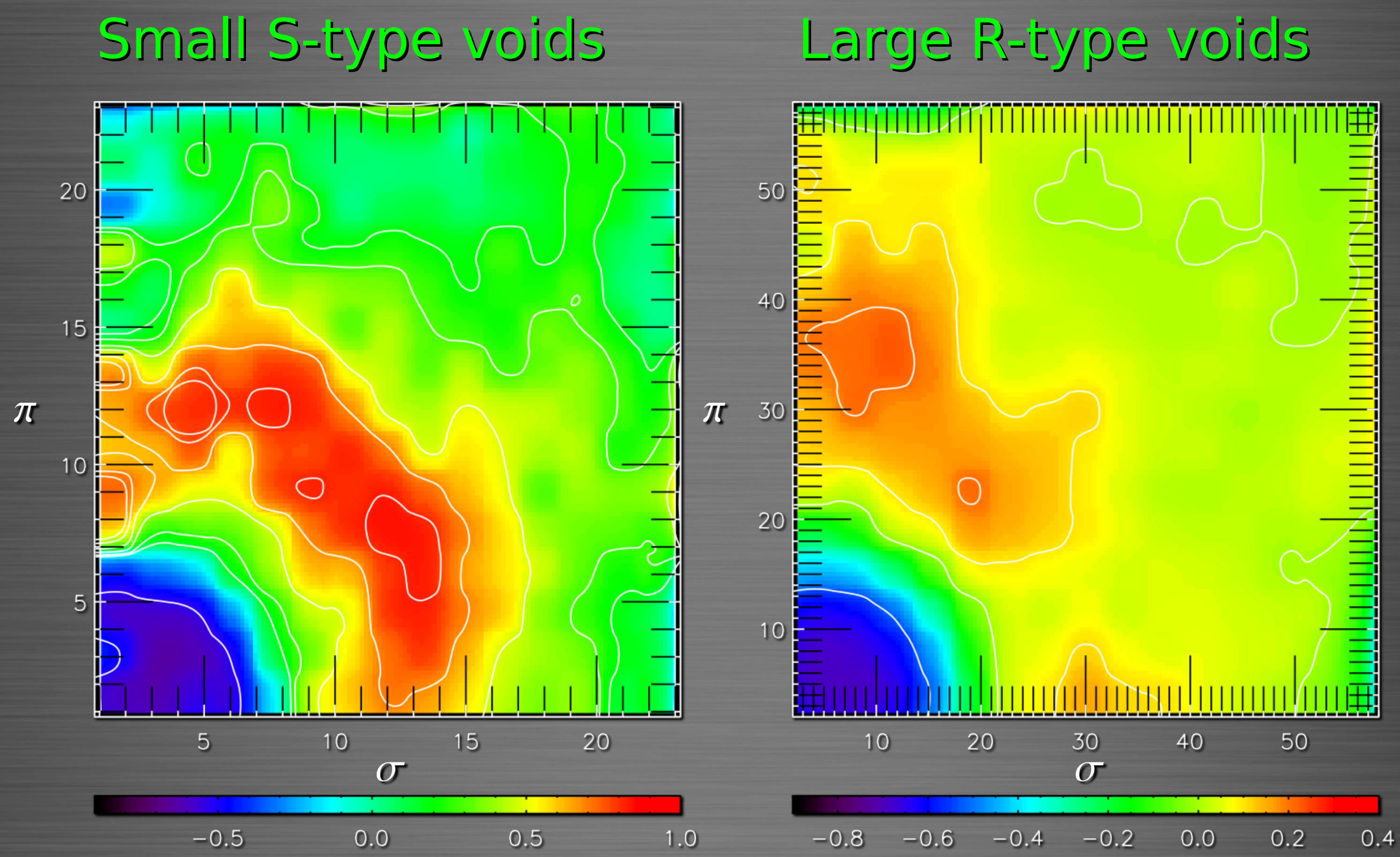
$$\vec{w} = \Delta\vec{v}$$

$$\sigma = \sqrt{r_1^2 + r_2^2}$$

$$\pi = r_3 + w_3/H$$

$$r^2 = \sigma^2 + \left(\pi^2 - \frac{w_3}{H}\right)^2$$

SDSS void-galaxy correlations



Anisotropies arise from line-of-sight velocities

→ Void-finder Ceccarelli – Padilla

→ SDSS – DR7 volume limited samples

$$\xi(\sigma, \pi)$$

Model for redshift space distortions

Classic treatment

$$1 + \xi(\sigma, \pi) = \int d^3w \, g(\vec{r}, \vec{w}) \, [1 + \xi(r)]$$

(Peebles 1980).

Velocity distribution

(Maxwell-Boltzmann on a bulk flow).

$$g \to g\left(\vec{w} - \tfrac{\vec{r}}{r} v(r)\right)$$

$$f\left(w_3 - \frac{r_3}{r} v(r)\right) = \iint dw_1 \, dw_2 \, g\left(\vec{w} - \frac{\vec{r}}{r} v(r)\right)$$

$$f\left(w_3 - \frac{r_3}{r} v(r)\right) = \frac{1}{\sqrt{2\pi}\sigma_v} e^{\frac{-\left(w_3 - r_3/v(r)\right)^2}{2\sigma_v}}$$

$$1 + \xi(\sigma, \pi) = \int dw_3 \frac{1}{\sqrt{2\pi}\sigma_v} e^{\frac{-\left(w_3 - r_3/v(r)\right)^2}{2\sigma_v}} \, [1 + \xi(r)]$$

Model for redshift space distortions

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$$1 + \xi(\sigma, \pi) = \int d^3w\, g(\vec{r}, \vec{w})\, [1 + \xi(r)]$$

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$$r_3 = \pi - w_3/H$$
$$r^2 = \sigma^2 + \left(\pi^2 - \frac{w_3}{H}\right)^2$$

Linear theory relates v with the overdensity inside of a sphere (Δ)

(Yahil 1985)

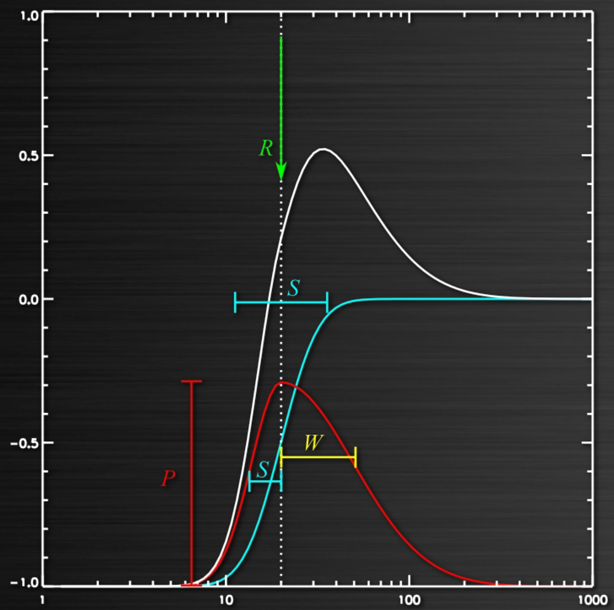
$$v_3(r) = \frac{r_3}{r} v(r) \approx -100\, r_3 \Delta(r) \frac{\Omega_m^{0.6}}{3}$$

$$\xi(r) = \frac{1}{3r^2} \frac{\mathrm{d}\Delta(r)}{\mathrm{d}r}$$

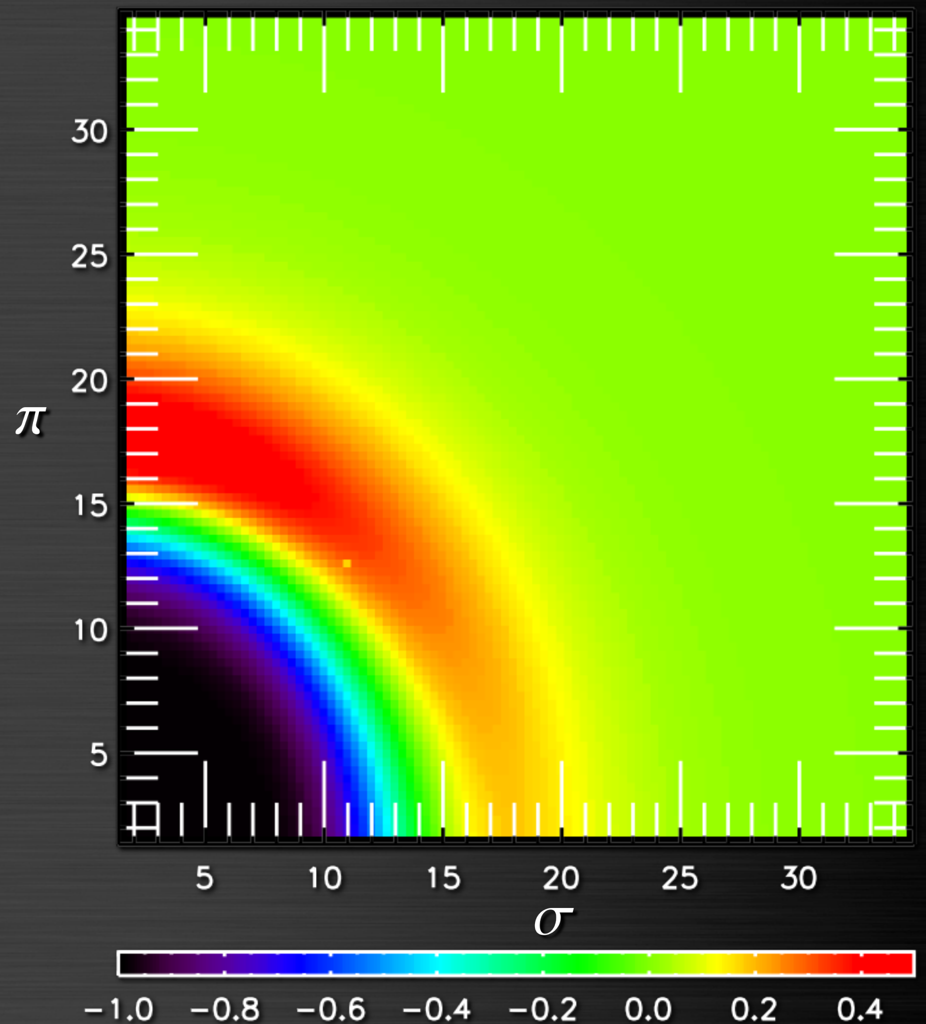
$$\begin{matrix} \xi(r) \\ v(r) \end{matrix} \longleftrightarrow \Delta(r)$$

Disentangling the velocity and the density field

Erf-Gauss 4 (2) parameter model for S-type (R-type) Voids



$$\begin{matrix}\xi(r)\\ v(r)\end{matrix} \longleftrightarrow \Delta(r)$$



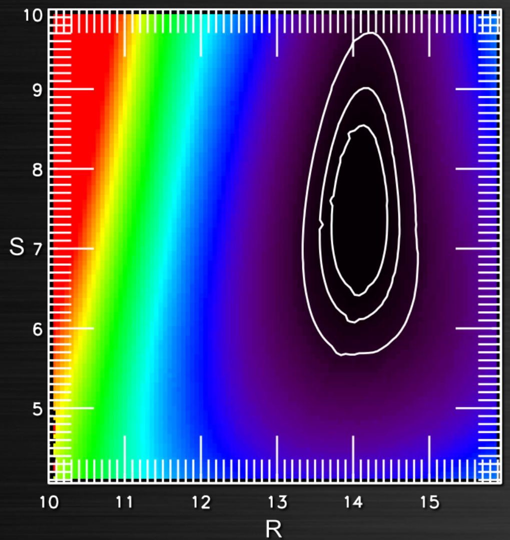
Redshift correlation (RK6 int)

$$1+\xi(\sigma,\pi)=\int dw_3 \frac{1}{\sqrt{2\pi}\sigma_v} e^{\frac{-\left(w_3-r_3/v(r)\right)^2}{2\sigma_v}} \left[1+\xi(r)\right]$$

Metropolis Hastings on SDSS data (MCMC)

Disentangling the velocity and the density field

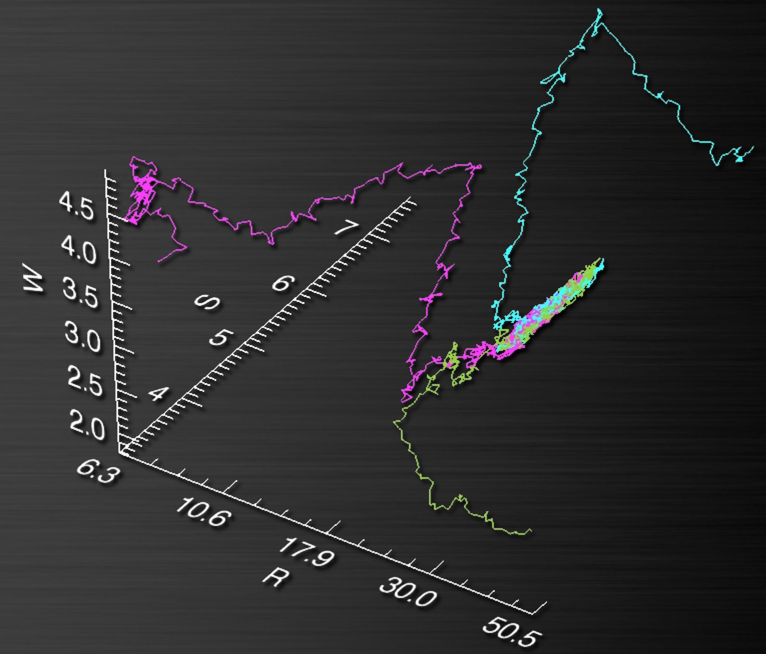
Metropolis Hastings on redshift data

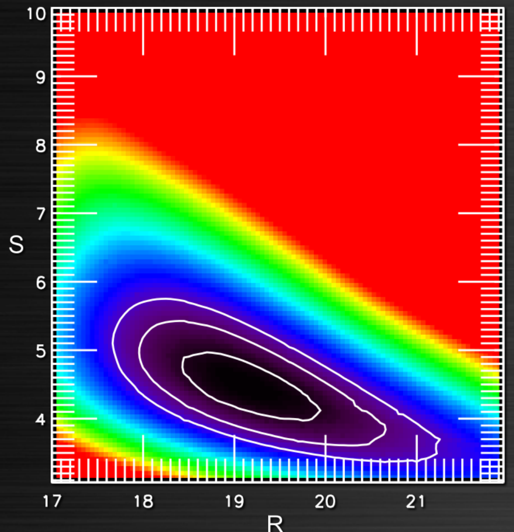


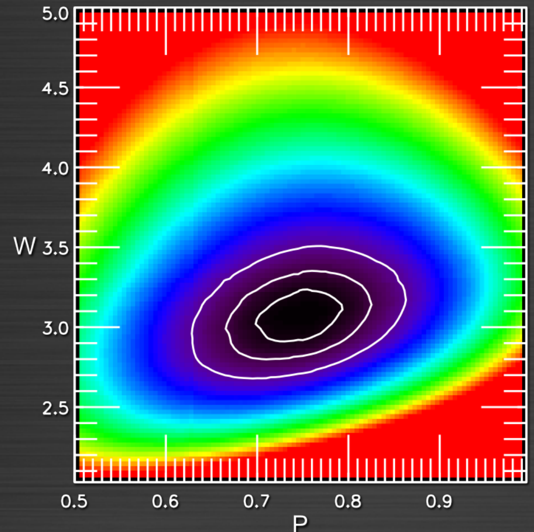
Intermediate size sample

(10Mpc < Rvoid <12Mpc)

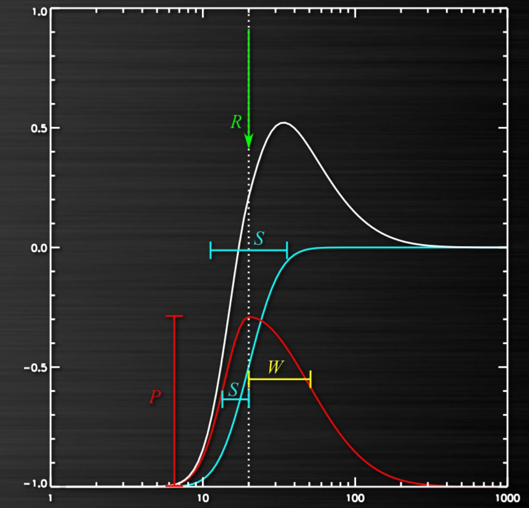
R-type (2 par)



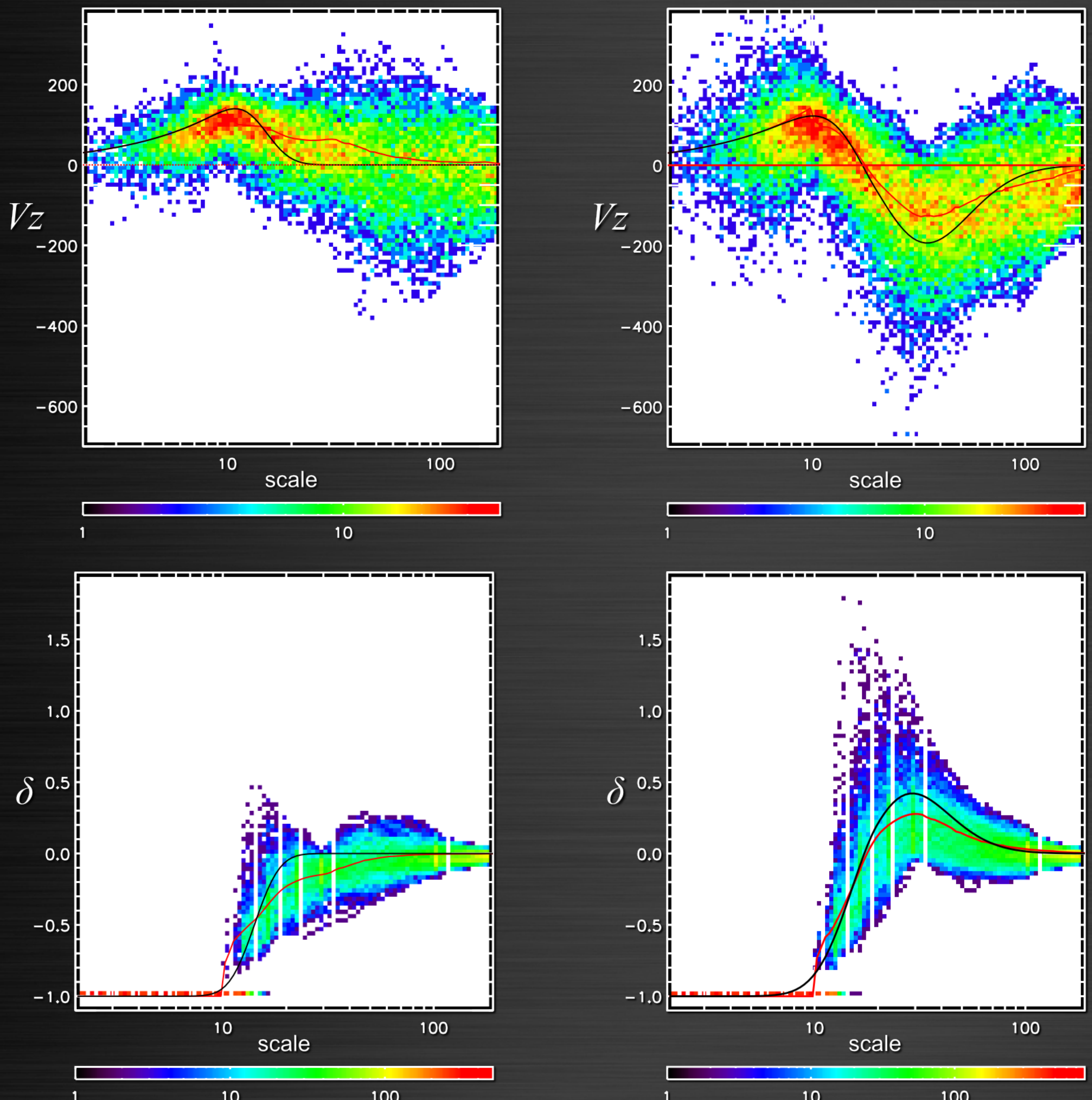




S-type (4 par)



Testing the method on simulations



Intermediate size sample

(10Mpc < Rvoid <12Mpc)

Mock MCMC results over

3D Box distributions

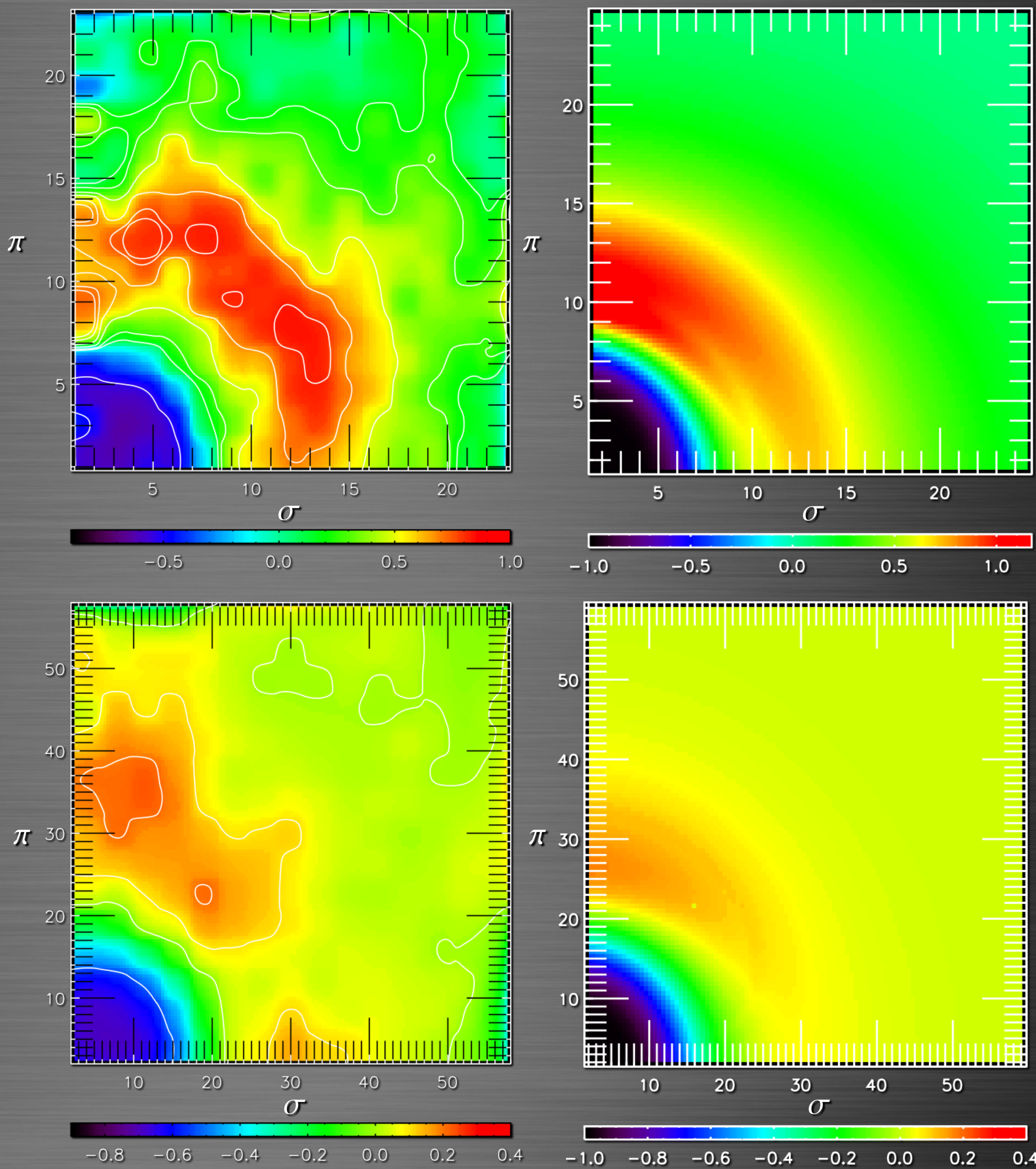
Black line: Mock SDSS measurement

Red line: 3D-simulation sample median

SDSS void-galaxy correlations

Small S-voids

Large R-voids



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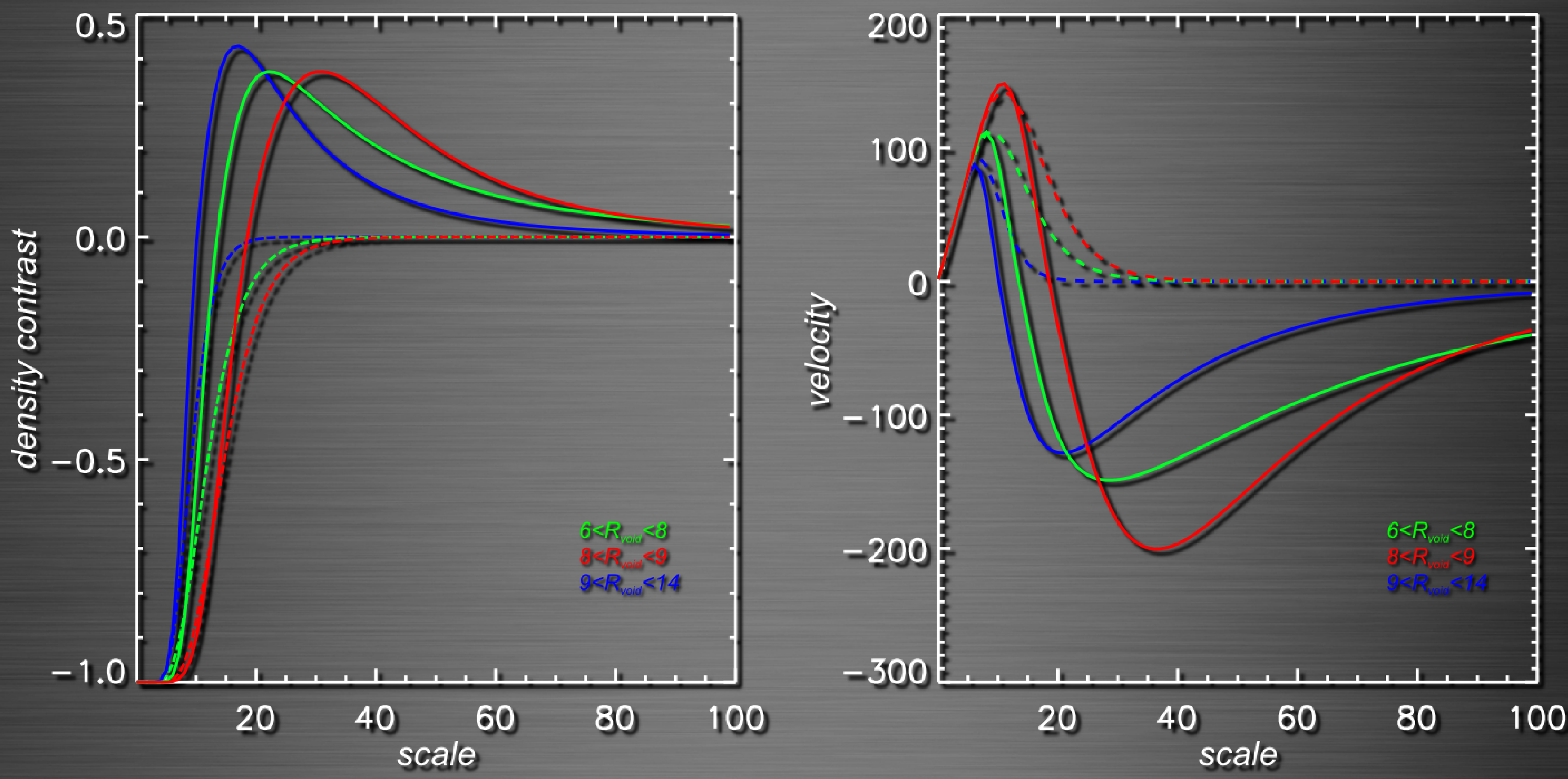

Conclusions

-We have developed a model for recover velocity and density profiles of voids from redshift space distortions.

-The model was successfully tested in LCDM simulations and SDSS mock catalogs.

-The SDSS results are in agreement with mock catalogs and simulations.

-The void environment plays a fundamental role in determining its dynamics.

GRACIAS!