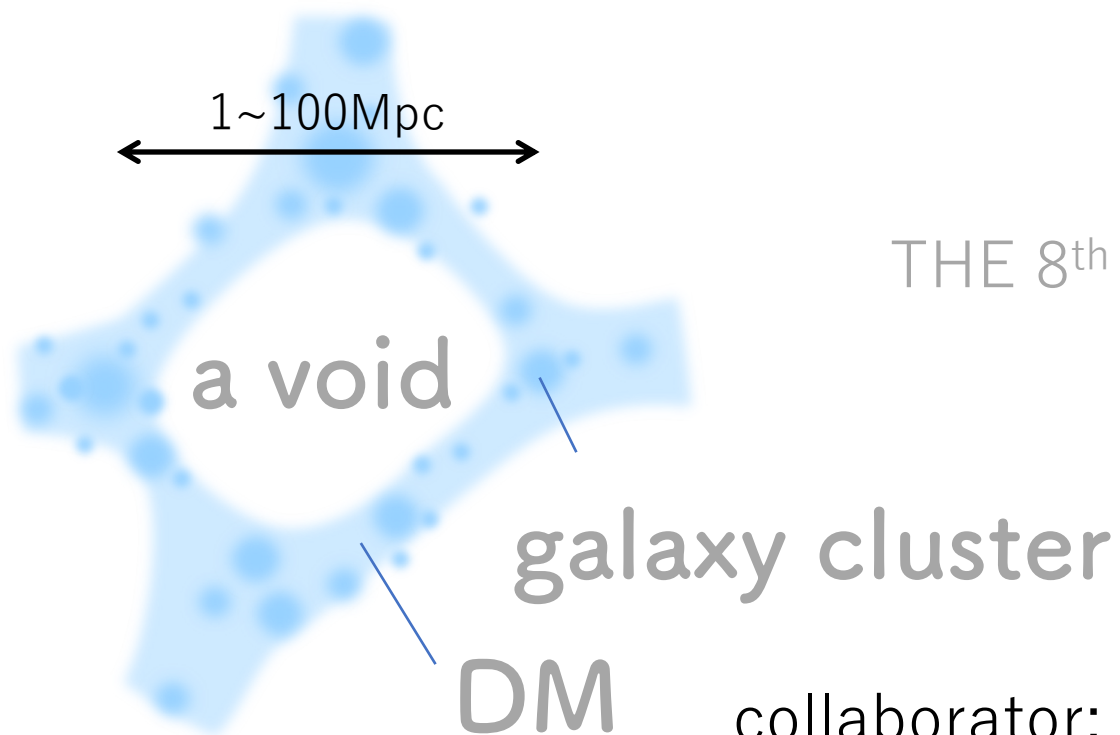


The evolution of cosmic voids



THE 8th KIAS WORKSHOP ON COSMOLOGY AND
STRUCTURE FORMATION

Mutsumi MINOGUCHI

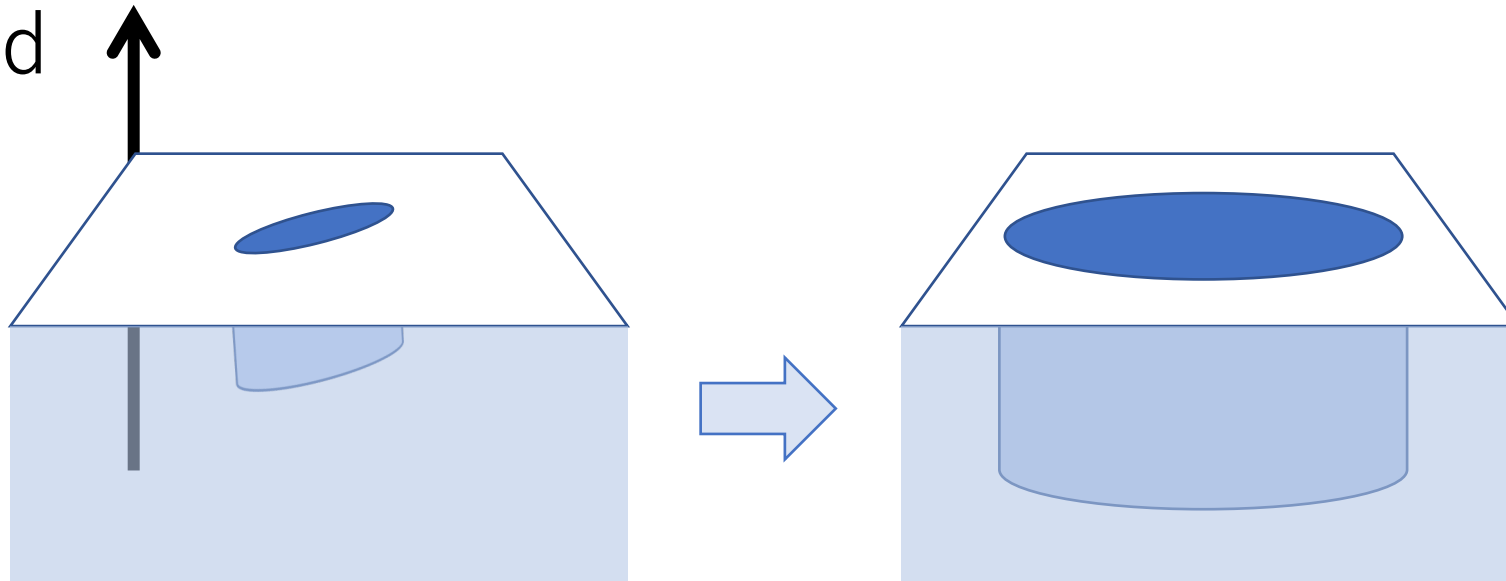
Nagoya University - Cosmology

collaborator: Atsushi J. Nishizawa & Tsutomu Takeuchi

Introduction – the basic behavior of under-dense region

ellipsoidal top-hat model (Icke 1984)

normalized
density



- grows to be more under-densed
- expand
- become spherical

Methods & Setup – the evolution of each voids

N-body simulation

most-most

50-50

“independent”
type voids

“metabolic”
type voids

Δz_{b0}

0

Void finder: VIDE (Sutterl+ 2015)

Radius : $R := \sqrt[3]{V/(4/3\pi)}$

V : volume of a void

ellipticity : $e := 1 - L_{max}/\sqrt{L_{mid}L_{min}}$

L : eig. of inertia tensor

central density : $\delta_c := 1 - \rho_c/\bar{\rho}$

ρ_c : central density
 $\bar{\rho}$: mean density

Void tracing

• most-most

maximize $N_{A \cap B}^2 / N_A N_B$

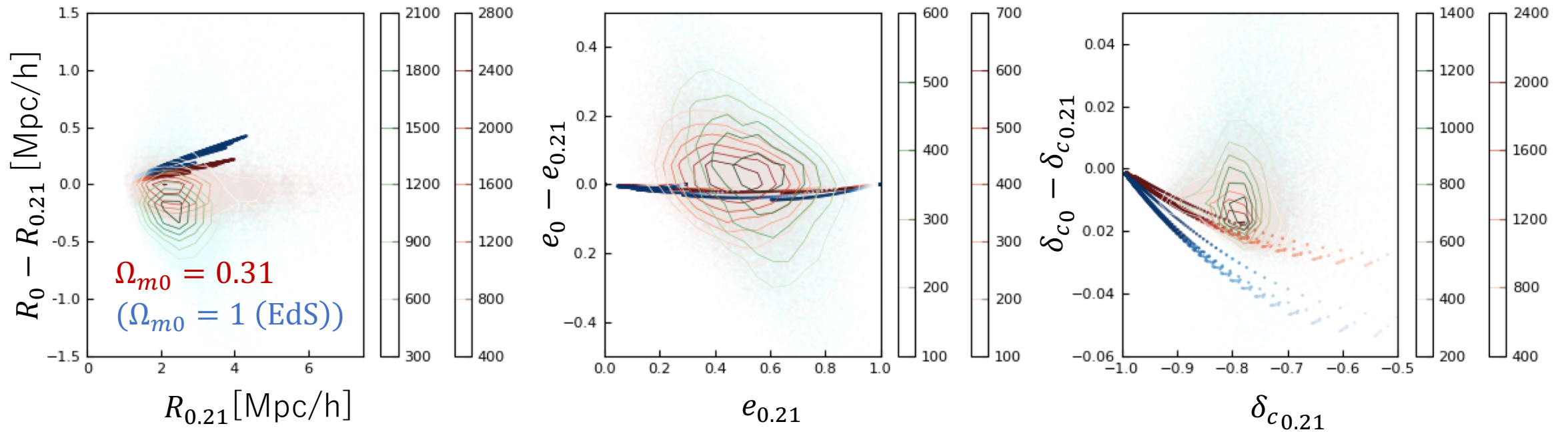
• 50-50

$N_{A \cap B} / N_A \geq 0.5$ and

$N_{A \cap B} / N_B \geq 0.5$

Result – the evolution of each voids

of voids
metabolic
independent

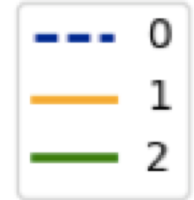
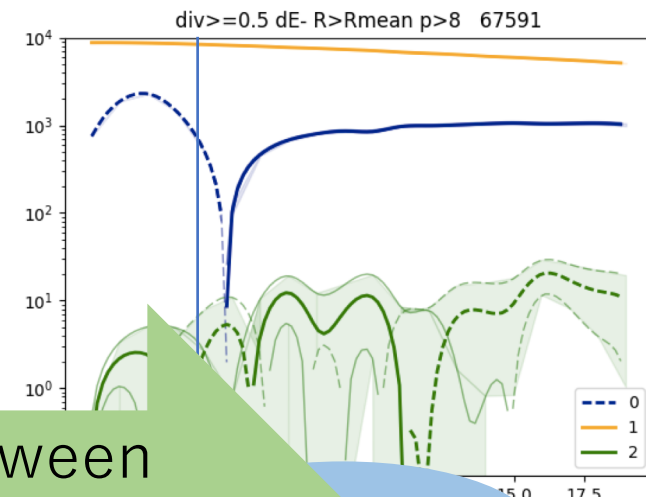
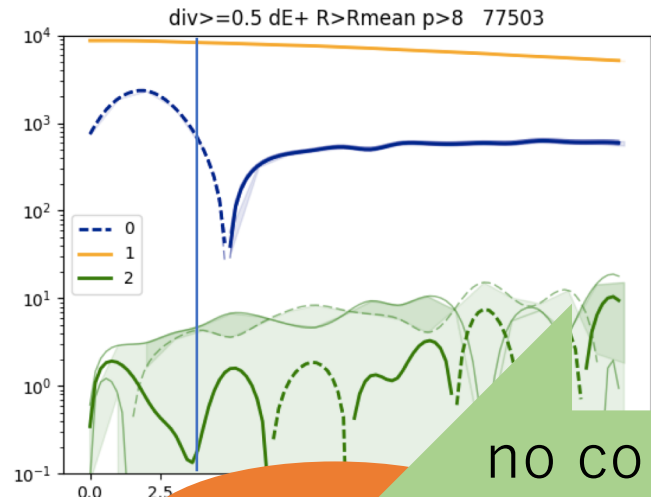


Result – tidal field and voids

Big voids →

$$\int \frac{\partial \Phi}{\partial r} P_l(\cos\theta) d(\cos\theta)$$

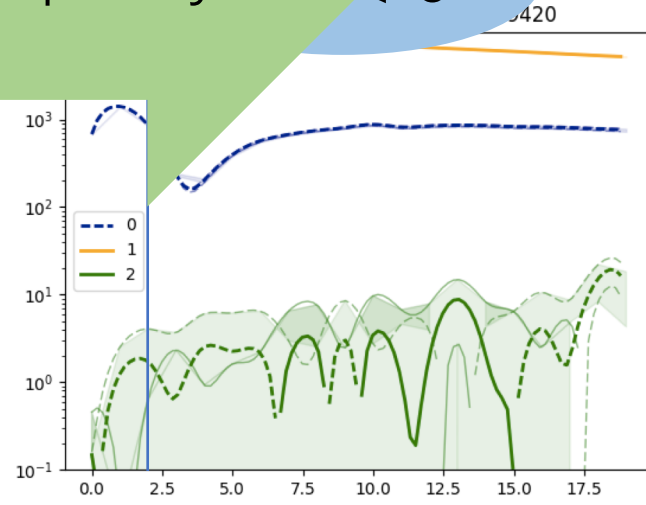
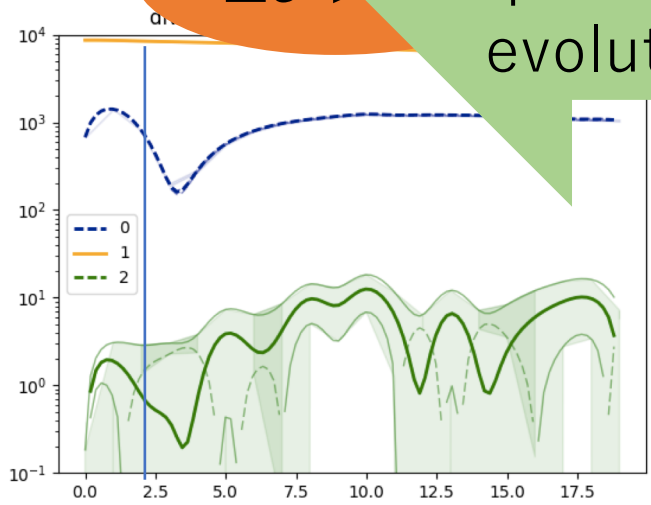
Small voids →



$\Delta e >$

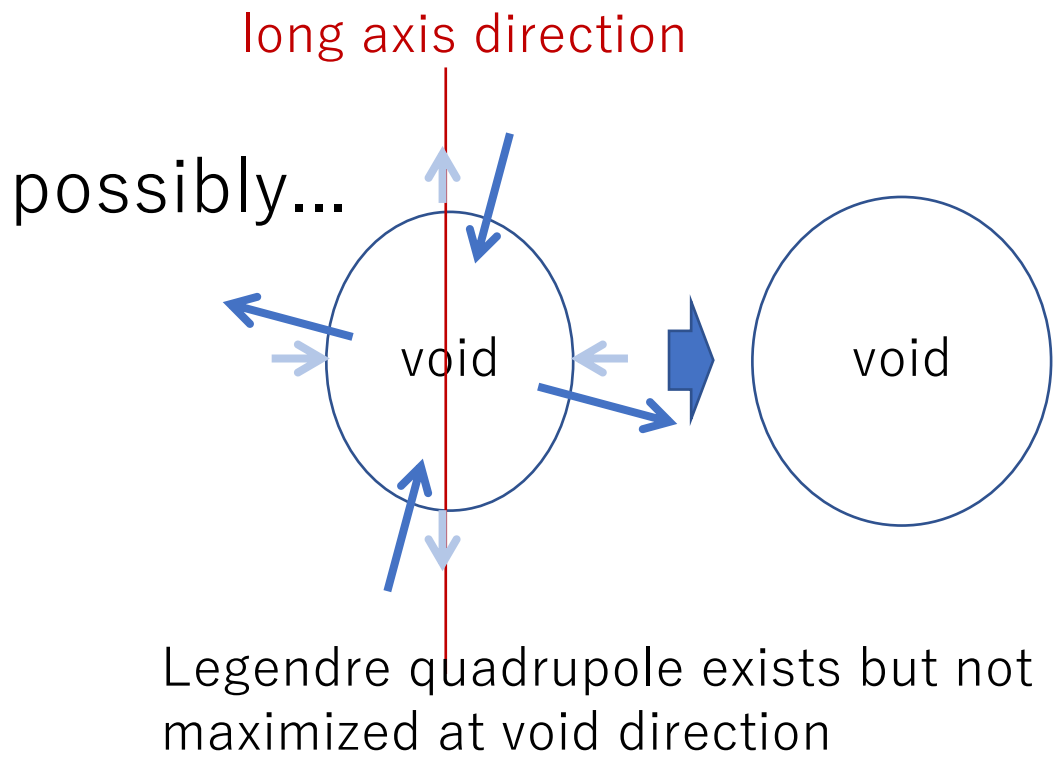
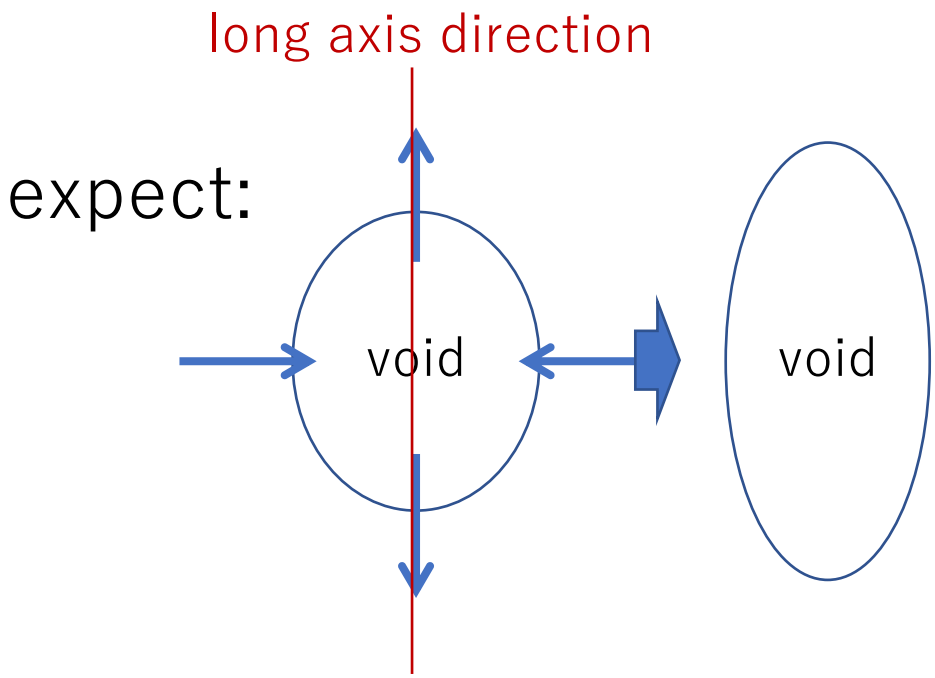
no correlation between quadrupole and ellipticity evolution for 1 σ

< 0

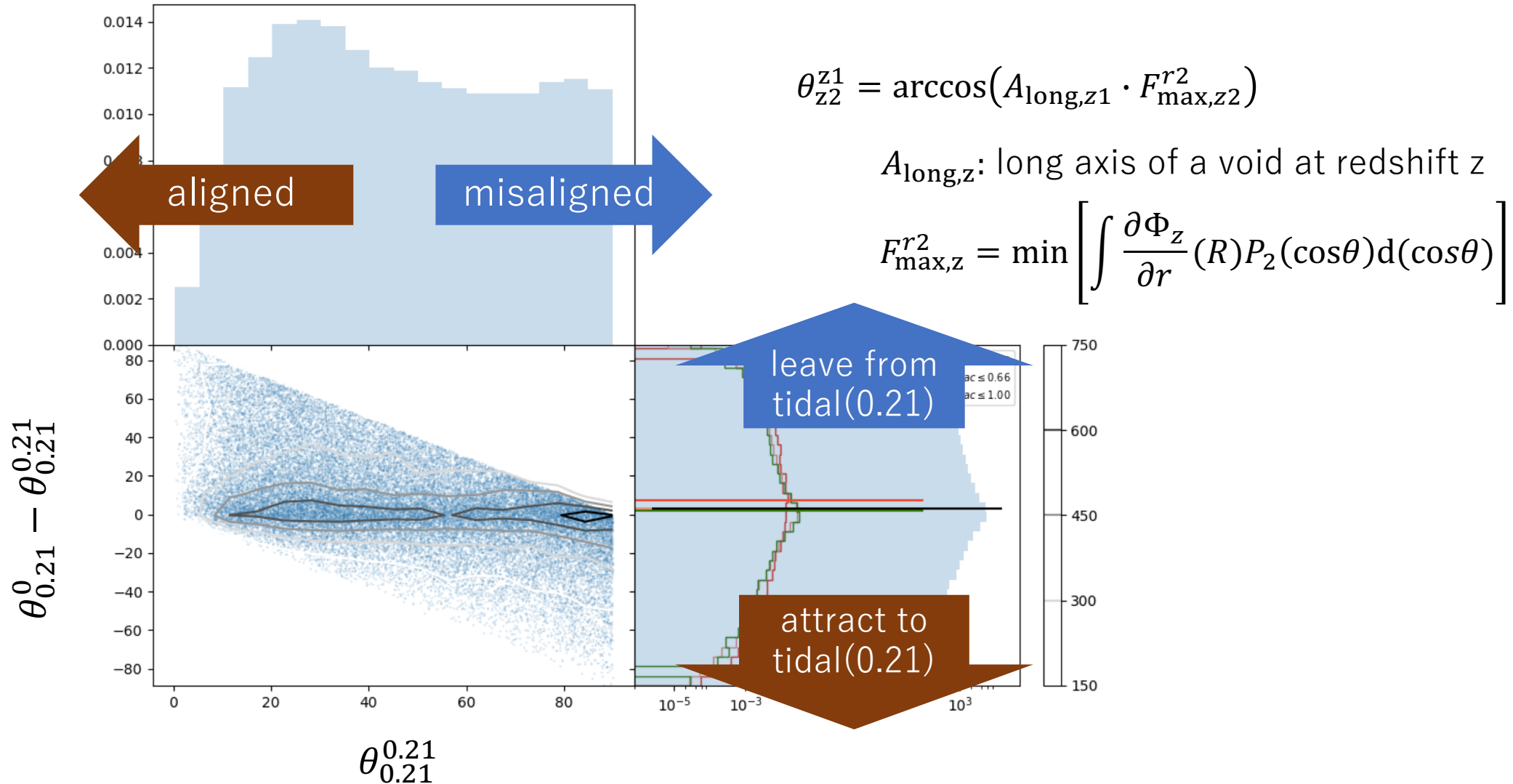


r [Mpc/h]

Do voids and tidal fields really aligned?

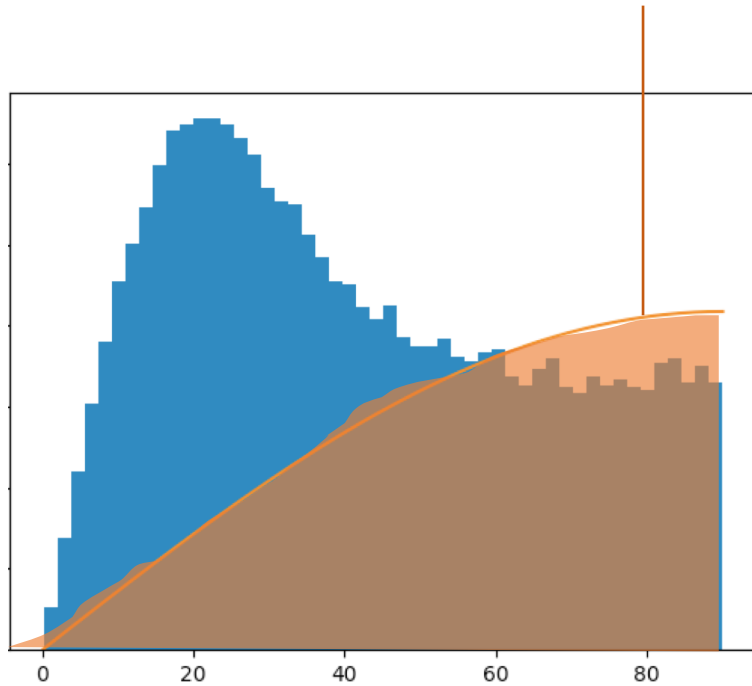


Result – alignment between tidal field and voids

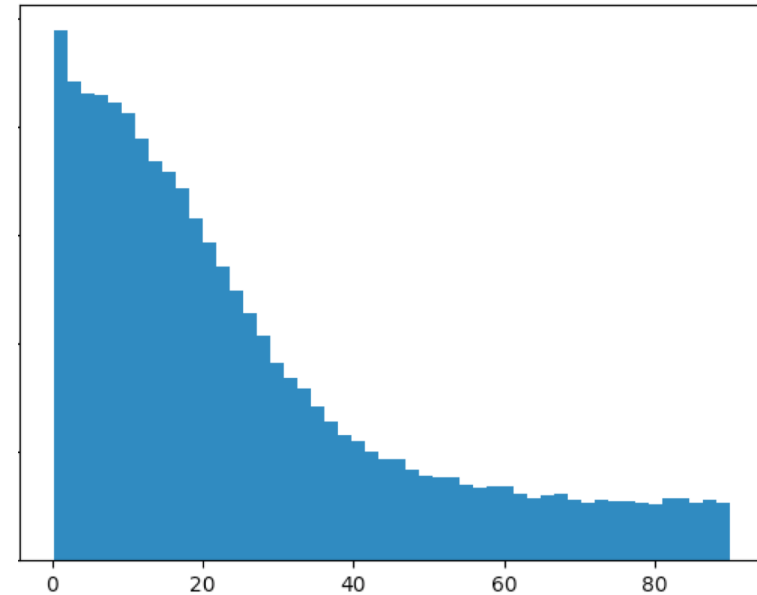


Result – alignment between tidal field and voids

uniform distribution on the surface of sphere

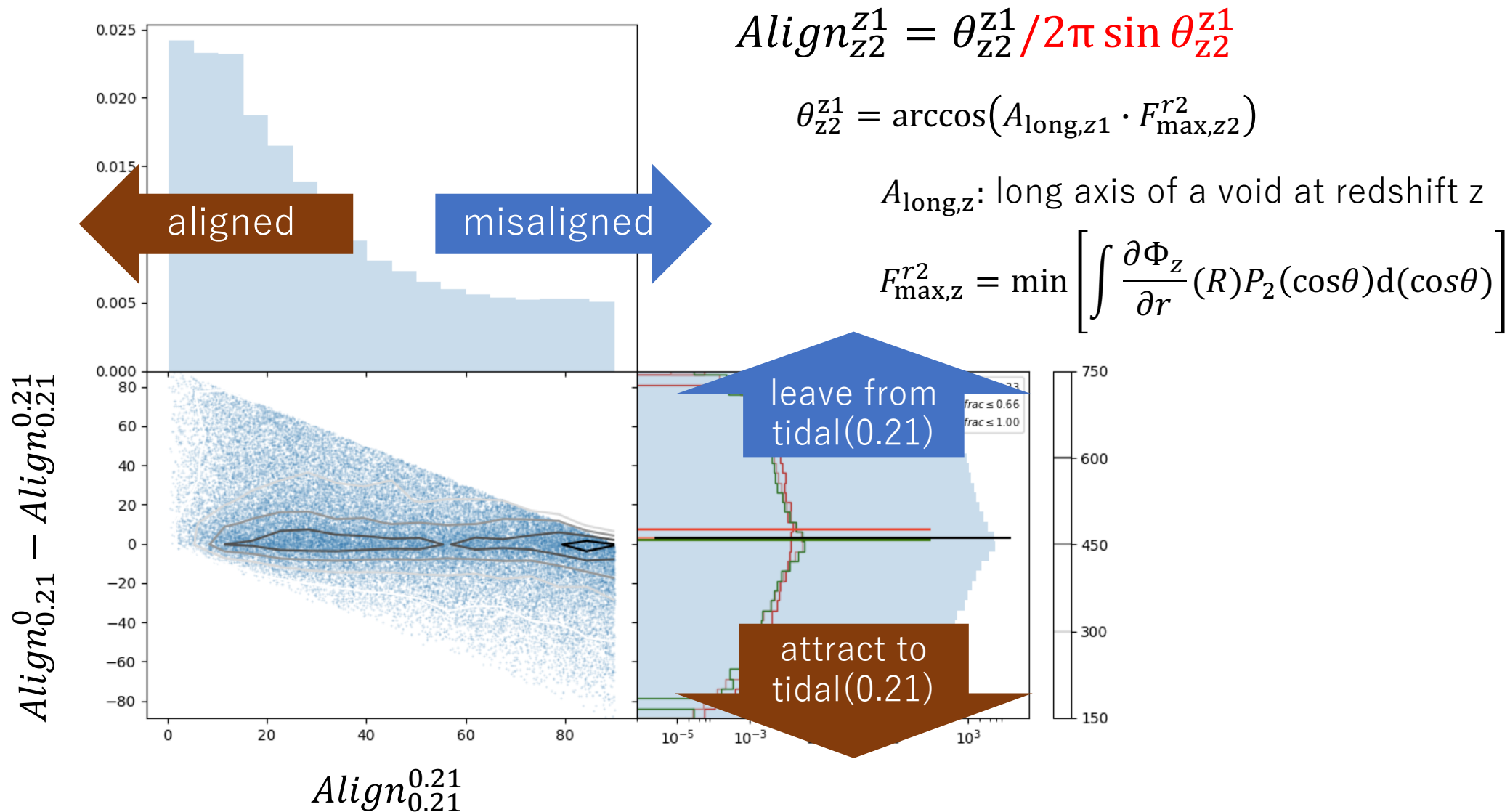


$$\theta_{z2}^{z1}$$



$$\theta_{z2}^{z1} / 2\pi \sin \theta_{z2}^{z1}$$

Result – alignment between tidal field and voids



Summary

Want to understand physical back ground of void evolution

- isolated description

 - failed especially on edge(ellipticity) of void

- tested Legendre quadratic component of radial tidal field

 - no correlation with Δe

 - not perfectly aligned to void

 - void direc. not be attracted to tidal direc.

next step:

- ellipticity vs maximized tidal quadrupole

- remove the tidal field made by void self

 - (→ test for “back ground + void” description)

