On the sociology and hierarchy of voids: a study of seven CAVITY nearby galaxy voids and their dynamical CosmicFlows-3 environment

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ABSTRACT

Context. The present study addresses a key question for our understanding of the relation between void galaxies and their environment: the relationship between luminous and dark matter in and around voids.
Aims. To explore how empty of matter local Universe voids are, we study the full (dark+luminous) matter content of seven nearby cosmic voids that are fully contained within the CosmicFlows-3 volume.
Methods. The cosmic voids matter density profiles are independently obtained using two different methods. They are built on one hand from the galaxy redshift space 2 points-correlation function and, on the other hand, using peculiar velocity gradients from the CosmicFlows-3 dataset.
Results. The results are noticeable since when using the redshift survey, all voids show a radial positive gradient of galaxies, while based on the dynamical analysis, only three of these voids display a clear underdensity of matter in their center.
Conclusions. It is the first time such a detailed observational analysis of voids is conducted, showing that void emptiness should be derived from dynamical information. Yet, from this limited study, the Hercules void is the best candidate for a local Universe pure "pristine volume" expanding in 3 directions with no dark matter located in that void.

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Void Galaxy Survey (VGS) (Kreckel et al. 2011, 2012; Beygu et al. 2016, 2017)

CAVITY survey (Pérez & al. 2023) –
the Calar Alto Void Integral-field Treasury surveY:
Включает 15 войдов, в каждом минимум 20 галактик, на красных смещениях 0.005-0.05
-> 3000 галактики. Из них отбираются 200-300 для наблюдений с PMAS на 3.5м телескопе Calar Alto

CosmicFlows-3: 18000 измерений расстояний + скорости

7 войдов CAVITY вошли в CosmicFlows-3

Можно восстановить распределение масс,
сравнить с распределением галактик в войдах

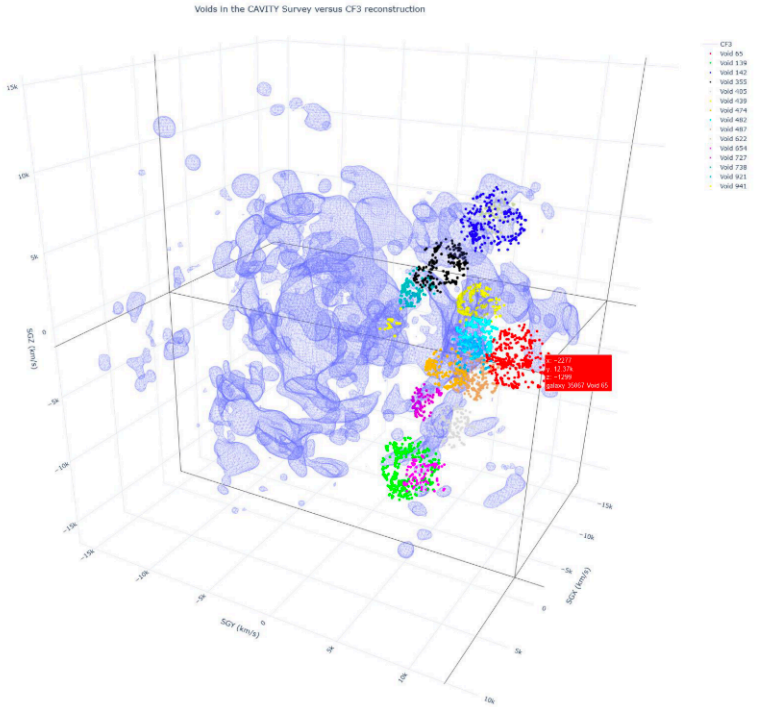

Fig. 1. Interactive 3D visualization of the distribution of nearby voids [Start Interaction]. The positions of the CAVITY survey target galaxies are given using markers colored against their void membership as indicated in the column displayed on the right-hand side. Hover on the galaxy markers to display the galaxy positions, identifiers and void memberships. The wireframe polygon is a high-density ($\delta_m = 1.3$) iso-surface of the reconstructed CosmicFlows-3 overdensity field. Use mouse action to rotate, pan, or zoom in or out. Single-click or double-click on the elements listed on the right-hand side column to hide them or single-them out from the scene.

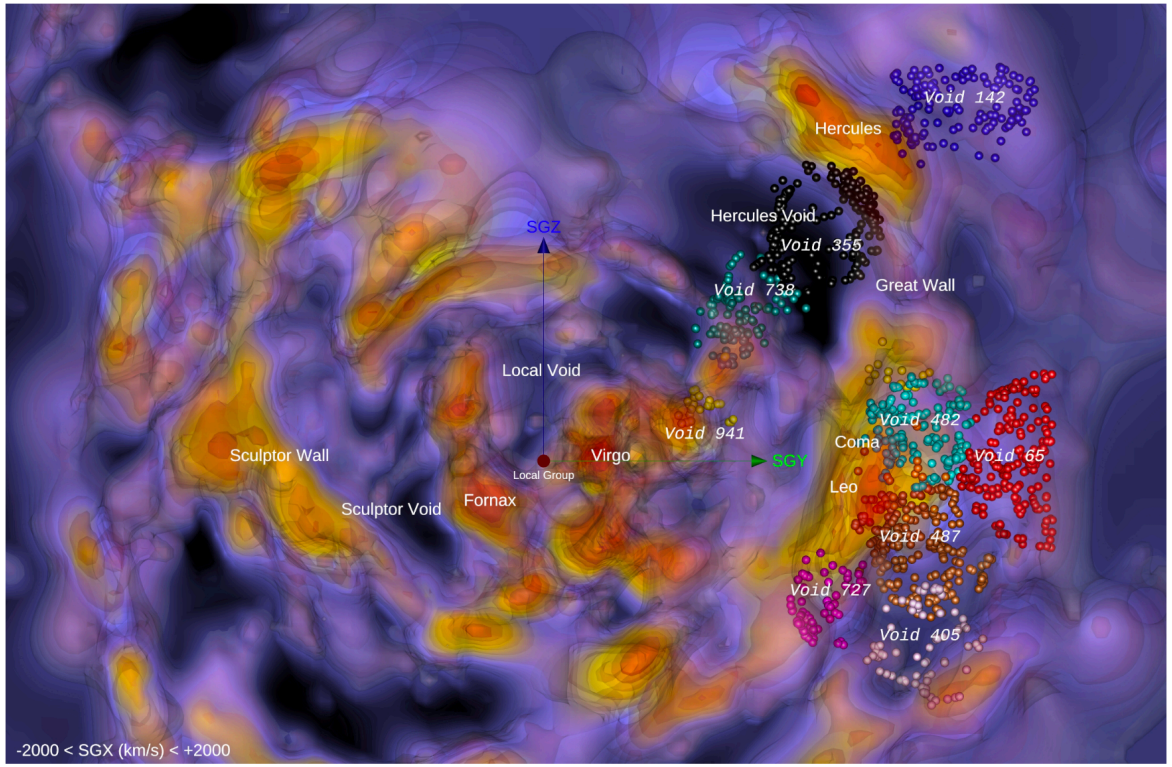

Fig. 2. Map of sample void against reconstructed CosmicFlows-3 density field. Map of galaxy and mass distribution within a slice $-2000 < SGX < 2000$ km/s. Galaxy markers are given distinct colors as a function of their void membership. Scale and orientation are given by the 5000 km/s long green (SGY) and blue (SGZ) arrows emanating from our position, associated with the cardinal axes of the Supergalactic Coordinate System.

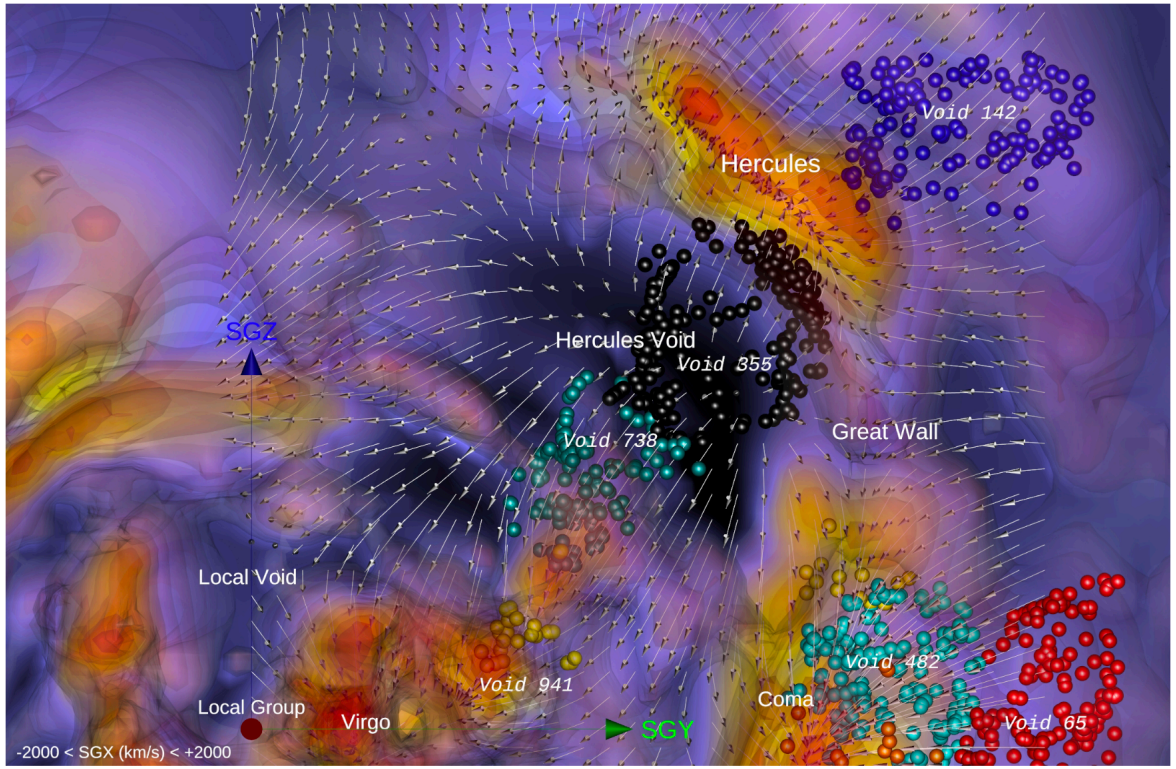

Fig. 3. Voids around the Hercules Void, zoom-in. The positions of galaxies are plotted against the reconstructed CosmicFlows-3 density contrast and velocity field, within a slice $-2000 < SGX < 2000$ km/s. Galaxy markers are given distinct colors as a function of their void membership. Scale and orientation are given by the 5000 km/s long green (SGY) and blue (SGZ) arrows emanating from our position, associated with the cardinal axes of the Supergalactic Coordinate System. The map shows that the galaxies within Void 355 and Void 738 are subject to the evacuation of matter from the Hercules Void, as mapped by the divergent flow at this location.

Войды – не изолированные объекты. Они также могут находиться в регионах с высокой и низкой плотностью.

Void-in-cloud – в окружении высокой плотности войды могут схлопываться

Void-in-void – войды сливаются в войды большего размера

Войды 355 и 738 – рядом со сверхскоплением Hercules, но в регионе низкой плотности.

487 и 727 – рядом со сверхскоплением Coma

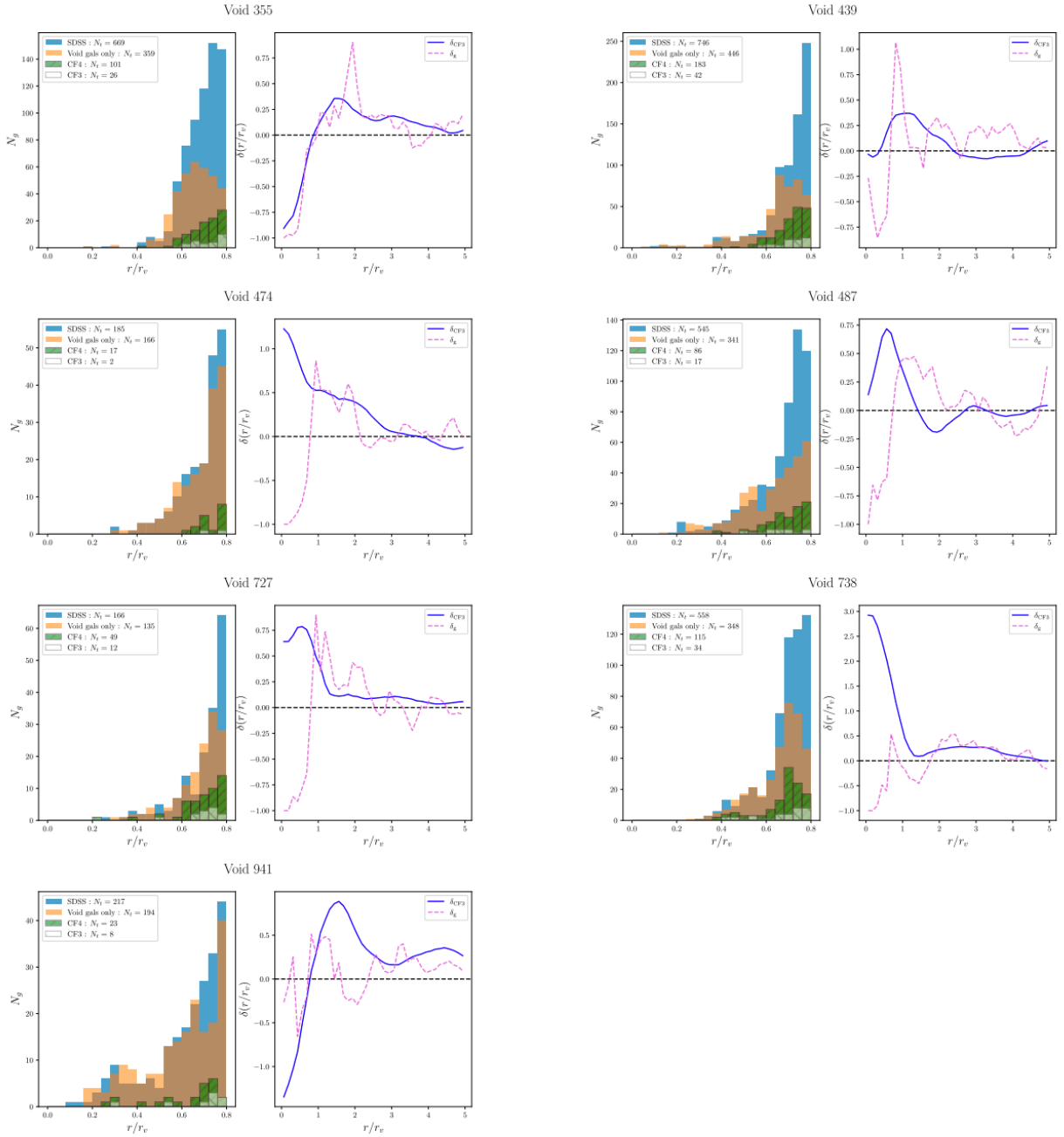

Fig. 5. Void radial density rofiles. For each of the seven SDSS/CAVITY nearby voids that are included in CosmicFlows-3 volume we show on the left panel the radial number of galaxies and on the right panel the matter content computed from CF3 (blue) and from the galaxy number density in SDSS (pink). All seven voids are empty of galaxies near their center and roughly up to their effective radius. However four voids (474, 487, 727 and 738) display CF3 computed overdensities of matter in their center.

Хорошее согласие – только для войда 355,

В половине войдов наблюдается высокая плотность вещества в центре, при малом числе галактик.
При рассмотрении распределения скоростей на оценку масс влияет динамика окружающих областей?

Важно различать разные типы войдов.