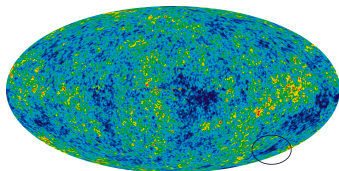


# A CMB Cold Spot szupervoid eredete

**Kovács András**<sup>1</sup>, *Szapudi István*, Ben Granett, Frei Zsolt,  
Joe Silk, Fabio Finelli, Juan García-Bellido, Francesco Paci,  
& Pan-STARRS1 Collaboration

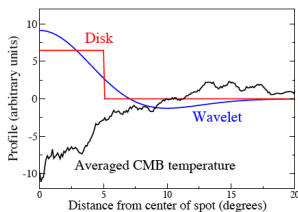
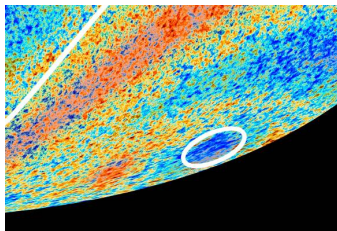
<sup>1</sup>Eötvös University, Budapest; október 6.-tól IFAE Barcelona



September 18, 2014



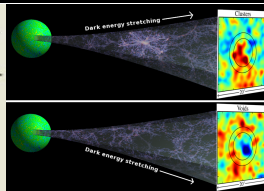
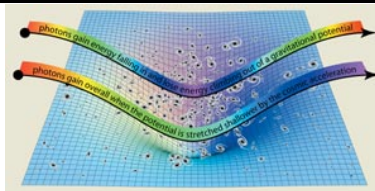
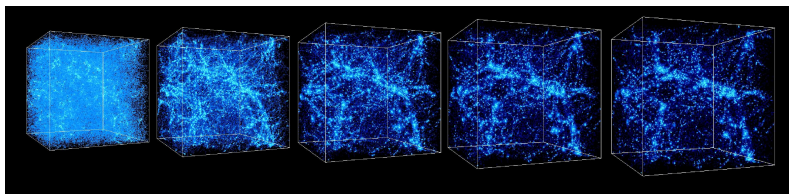
# A CMB Cold Spot



- felfedezés a WMAP adatokban, majd a Planck is látja
- $2 - 3\sigma$  fluktuáció (Cruz et al. 2006),  $\Delta T \simeq -100 \mu K$
- mérete  $5^\circ$ , de meleg gyűrű veszi körül  $15^\circ$  sugárnál
- magyarázatok: szupervoid, párhuzamos Univerzum, szimpla statisztikus fluktuacio, kozmikus textúra

# Szupervoid hipotézis

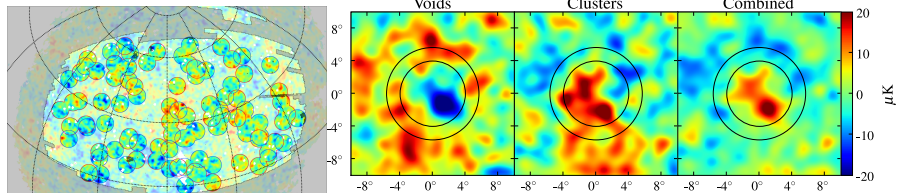
## Dark Energy dinamikai tesztelése



- az  $R > 100h^{-1}\text{Mpc}$  méretű struktúrák lenyomatot hagynak a CMB-n (Integrált Sachs-Wolfe effektus, röviden ISW)

# Szupervoid hipotézis

Imprints of superstructures - Granett et al. (2008)



- Granett, Szapudi és Neyrinck  $4.4\sigma$  korrelációt talált egy 50-50 elemű mintában
- a jel erőssége viszont  $2\sigma$  ellentmondásban áll a  $\Lambda\text{CDM}$  modellel...

# Szupervoid hipotézis

Imprints of superstructures - Granett et al. (2008)

- Inoue & Silk (2007):  $\sim 200h^{-1}\text{Mpc}$  méretű,  $\delta = -0.3$  mélységű szupervoid okozhatja a Cold Spot-ot
- többen, több módon is keresték

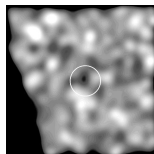
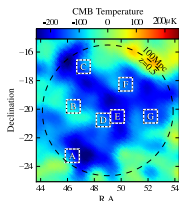
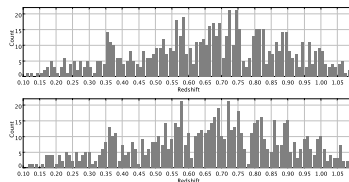
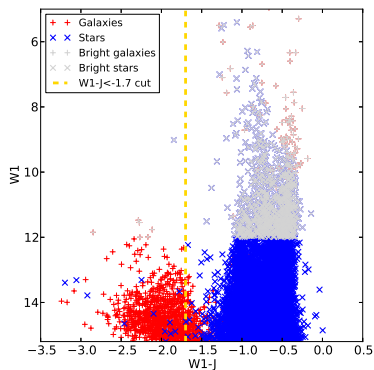
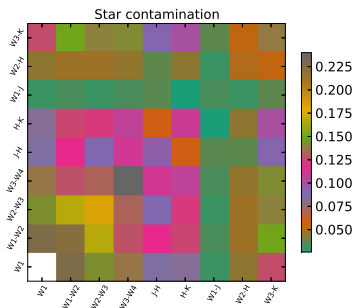


Fig. 1.  $1-20^\circ$  field from smoothed WISE at  $l^\circ$  resolution, centered at  $l = 200^\circ$ ,  $b = -27^\circ$ . Values range from 0.3 mJy beam $^{-2}$  (black) to 21.5 mJy beam $^{-2}$  (white). A  $10^\circ$  diameter circle indicates the position and size of the  $100h^{-1}\text{Mpc}$  cold spot.



# WISE-2MASS galaxisok

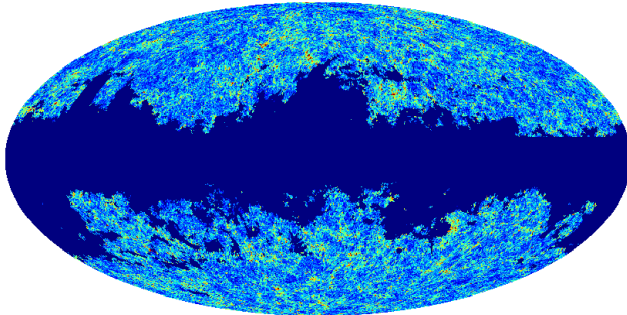
## Machine learning



# WISE-2MASS galaxisok

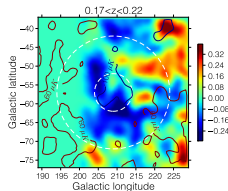
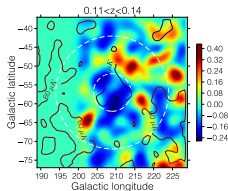
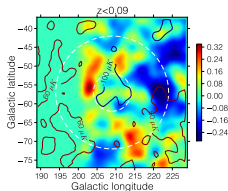
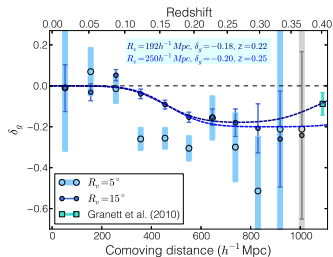
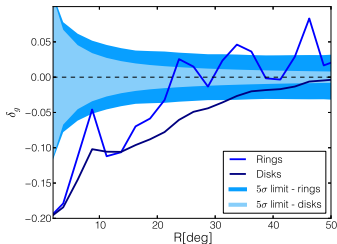
## Galaxis katalógus

WISE-2MASS galaxies -  $J < 16.5$



# A szupervoid felfedezése

Q1: van-e egy szignifikáns szupervoid a Cold Spot régióban?



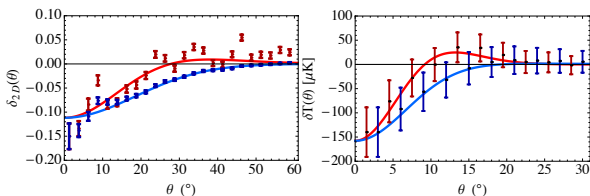


# A Cold Spot magyarázata a szupervoiddal

Q2: milyen fizikai mechanizmus felel az effektusért?

$$\Delta\Phi \approx -\frac{\Omega_m}{2} \left(\frac{r_c}{c/H_0}\right)^3 (1+2z)^{1/2}(1+z)^{-2} \delta \approx \frac{1}{2} \frac{\Delta T}{T}$$

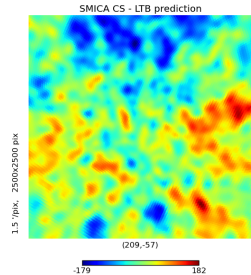
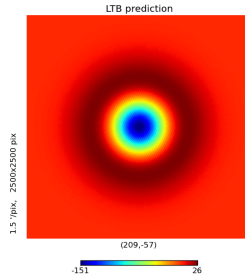
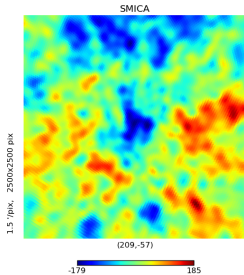
- lineáris ISW modell? Nem.
- nem-lineáris LTB modell? Talán.



- Bal: sűrűség profil vs. nem-lineáris LTB szupervoid modell
- Jobb: a piros profil a modell jóslata a CMB profilra

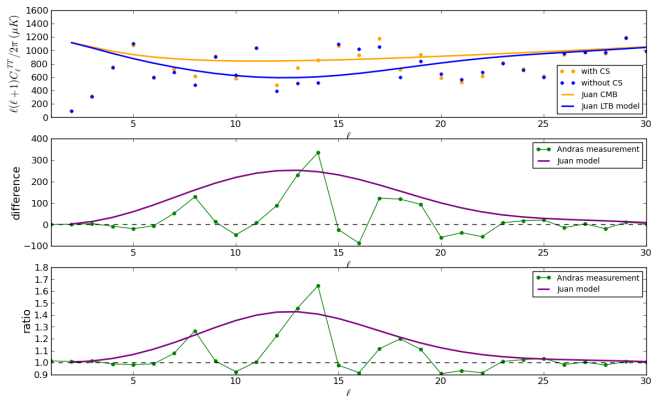
# A Cold Spot magyarázata a szupervoiddal

Q2: milyen fizikai mechanizmus felel az effektusért?



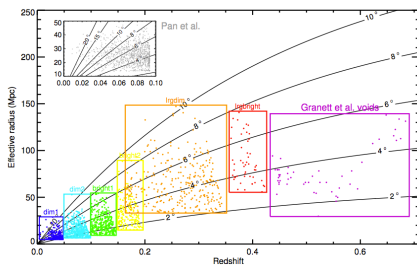
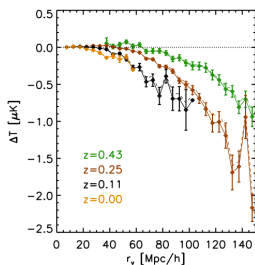
# A Cold Spot magyarázata a szupervoiddal

Q2: milyen fizikai mechanizmus felel az effektusért?



# Szupervoid katalógusok és szimulációk

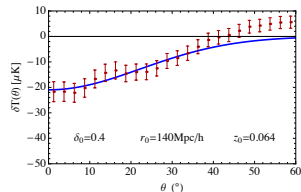
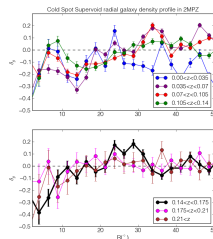
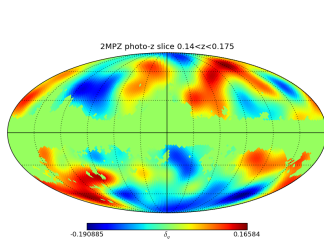
Q3: milyen ritka a felfedezett szupervoid?



- valami még talán hiányzik a szimulációkból...
- a tipikus fluktuáció  $200h^{-1} \text{Mpc}$  skálákon  $\sigma_{200} \approx 0.04$ , azaz a mérésünk  $\geq 3.5\sigma$  egy fluktuációt jelent
- a szupervoid elég ritka, de nem lehetetlenül ritka

# Továbblépési lehetőségek

Vannak-e hasonló objektumok?



- találtunk még egy supervoidot is az adataink közt, és a Cold Spot régiót új adatokkal is megvizsgáltuk
- SuperCOSMOS-WISE-2MASS photo-z minta a teljes elérhető égboltra

# Médiamegjelenés

IFLS, New Scientist, Sky&Telescope

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Ancient water discovery holds clues to our origins

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Giant hole blamed for mysterious cosmic cold spot

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- NASA Assessing Targets for Asteroid Mission
- Groundbreaking for Europe's Giant Telescope
- Smallest Object Yet Measured in Pluto's