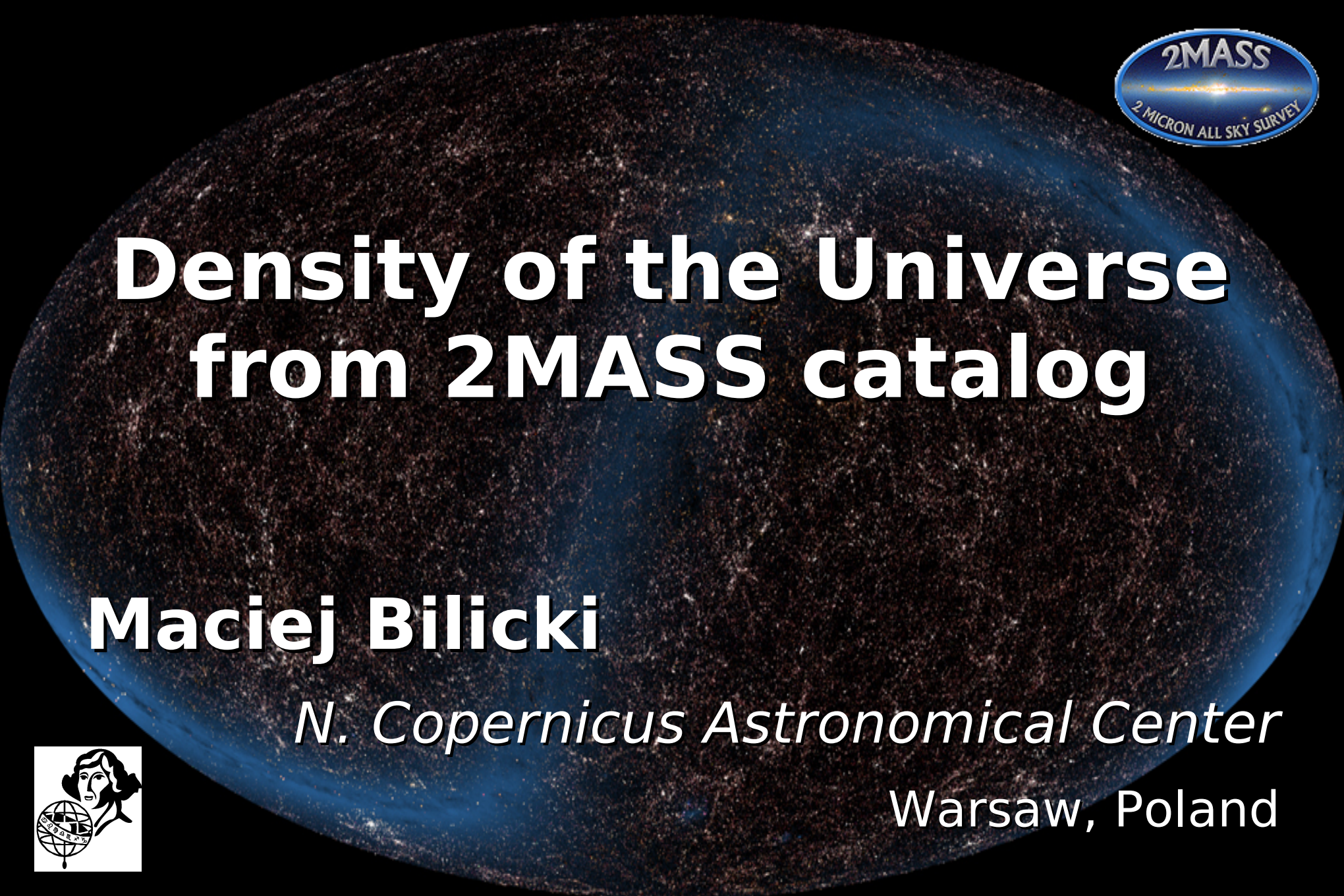


Density of the Universe from 2MASS catalog

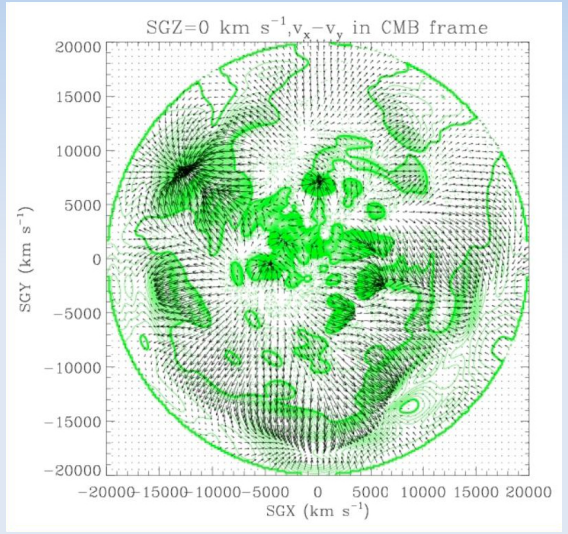
Maciej Bilicki

N. Copernicus Astronomical Center

Warsaw, Poland

Density and velocity fields in cosmology

- Formation of cosmological large-scale structures: gravitational instability



- Relation between peculiar velocities and accelerations (in linear theory):

$$\boldsymbol{v}_{pec} \sim \Omega_m^{0.6}\, \boldsymbol{g}$$

- Accelerations due to matter inhomogeneities:

$$\boldsymbol{g}(\boldsymbol{r}) = \int \frac{\delta(\boldsymbol{r}')}{4\pi} \frac{\boldsymbol{r}'-\boldsymbol{r}}{|\boldsymbol{r}'-\boldsymbol{r}|^3} d^3\boldsymbol{r}',$$

where density contrast $\delta = \delta\rho / \rho$.

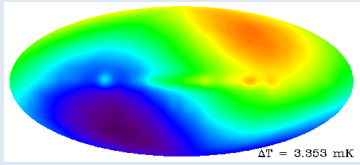
Local Group as a probe

- For the Local Group of we get $\boldsymbol{v}_{LG} = \beta\, \boldsymbol{g}_{LG}$,

  where $\beta = \Omega_m^{5/9} / b$ (linear biasing $\delta_{gal} = b\, \delta_{mat}$)

- The *velocity* of the LG is known from CMB dipole:

  v_{LG}=622 km/s towards (l, b)=(272°, 28°)



- The acceleration

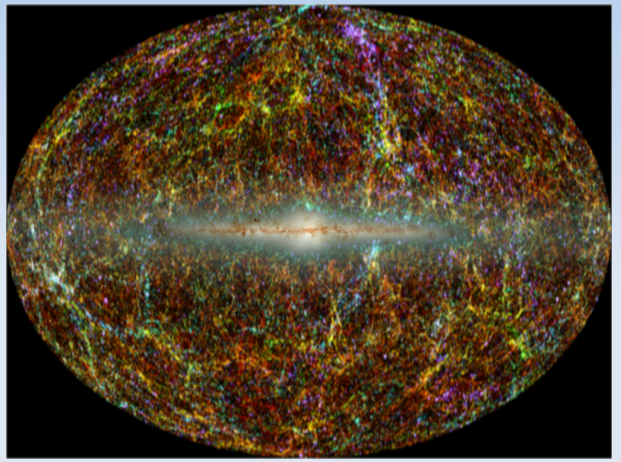
$$\boldsymbol{g}_{LG} = \rho_b^{-1} \sum_i \frac{M_i}{4\pi} \frac{\hat{\boldsymbol{r}}_i}{r_i^2} \sim \rho_L^{-1} \sum_i S_i\, \hat{\boldsymbol{r}}_i$$

can be calculated from an all-sky *photometric* survey

(as both received flux and gravity ~ r^{-2})

Data from 2MASS XSC

- 2MASS eXtended Source Catalog: > 1.600.000 IR objects
- Sample preparation:
  - masking out the Zone of Avoidance
  - elimination of Milky Way sources
  - removal of Local Group galaxies
  - cut-offs for limiting fluxes: faint end (completeness) and bright end (mitigation of non-linear effects)



- *Maximum likelihood method* to *optimally* measure β
  - maximal correlation of $\boldsymbol{v}_{LG}$ and $\boldsymbol{g}_{LG}$ for minimum of $\theta = \sphericalangle(\boldsymbol{v}_{LG}, \boldsymbol{g}_{LG})$

Chodorowski et al. 2008

Preliminary results

- $[\boldsymbol{v}_{LG} = \beta\, \boldsymbol{g}_{LG}]$ + [MLE for β] =>

$$\beta \equiv \Omega_m^{0.55} / b \simeq 0.4$$

- Errors not estimated (yet)
- $b_K \simeq 1.1$ (Maller et al. 2004) $\Rightarrow$ $\Omega_m \simeq 0.2$
- Other recent estimates:
  - $\beta_{2MRS} \simeq 0.4$ (dipole of 2MRS, Erdoğdu et al., 2006)
  - $\beta_{IRAS} \simeq 0.49$ (dipole of PSCz, Basilakos & Plionis, 2006)

Outstanding questions

- Is the *clustering dipole* really convergent?

  (i.e., is the survey deep enough?)

  => Probably not (z_{med}=0.07 only)

- Is the *linear biasing* valid?

- Is the *linear theory* valid?

- What is in the *dark matter sandwich*?

The Dark Matter Sandwich

"I can't tell you what's in the dark matter sandwich.
No one knows what's in the dark matter sandwich."