gdzie znaleźć ten plik pdf

http://cosmo.torun.pl/∼boud/wyklad041025.pdf

Mirror matter + 7 yr DAMA NaI: DM detection?

http://de.arXiv.org/abs/astro-ph/0405282

http://de.arXiv.org/abs/astro-ph/0211067

http://de.arXiv.org/abs/astro-ph/0403043

http://de.arXiv.org/abs/hep-ph/0402267

CPT symmetries

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2} \tag{1}$$

CPT symmetries

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2} \quad (1)$$

$$\equiv \frac{1}{4\pi\epsilon_0}\frac{(-q_1)(-q_2)}{r^2} \quad (2)$$

$\Rightarrow$ C-symmetry

• However, domination of matter over anti-matter suggests that C-symmetry is broken

CPT symmetries

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2} \tag{1}$$

$$\equiv \frac{1}{4\pi\epsilon_0}\frac{(-q_1)(-q_2)}{r^2} \tag{2}$$

$\Rightarrow$ C-symmetry

• However, domination of matter over anti-matter suggests that C-symmetry is broken

- T-symmetry: $t \longrightarrow -t$

- T-symmetry: $t \longrightarrow -t$

- P-symmetry: orientation reversal — e.g. $(x, y, z) \longrightarrow (-x, y, z)$

P-symmetry $\longrightarrow$ mirror matter

- Lee & Yang 1956 — P-symmetry violated, mirror matter hypothesised

- something like supersymmetry, but less ambitious ?

simplest mirror matter model

• : ∃ mirror partners to quarks and leptons

among mirror particles: strong, weak, EM interactions

normal ↔ mirror:

• gravity

• photon ↔ mirror-photon kinetic mixing:

$$\mathcal{L} = \frac{\epsilon}{2} F^{\mu\nu} F'_{\mu\nu} \tag{3}$$

- Higgs-boson $\leftrightarrow$ mirror-Higgs-boson coupling

hep-ph/0402267

various operators (5D) lepton-Higgs-lepton'-Higgs' studied

baryon-to-mirror-baryon ratio $= \frac{\Omega_b}{\Omega'_b}$

6 cases yield:

- $\Omega_b/\Omega'_b = 0.20$ (cases 1, 2)
- $\Omega_b/\Omega'_b = 0.21$ (cases 3)
- $\Omega_b/\Omega'_b = 0.46$ (cases 4, 5)
- $\Omega_b/\Omega'_b = 0.54$ (cases 6)

Cf nucleosynthesis, cluster dynamics, WMAP + SNe Ia, grav lensing, ... :

$\Omega_b \approx 0.05, \Omega_{\mathrm{DM}} \approx 0.25.$

astro-ph/0211067

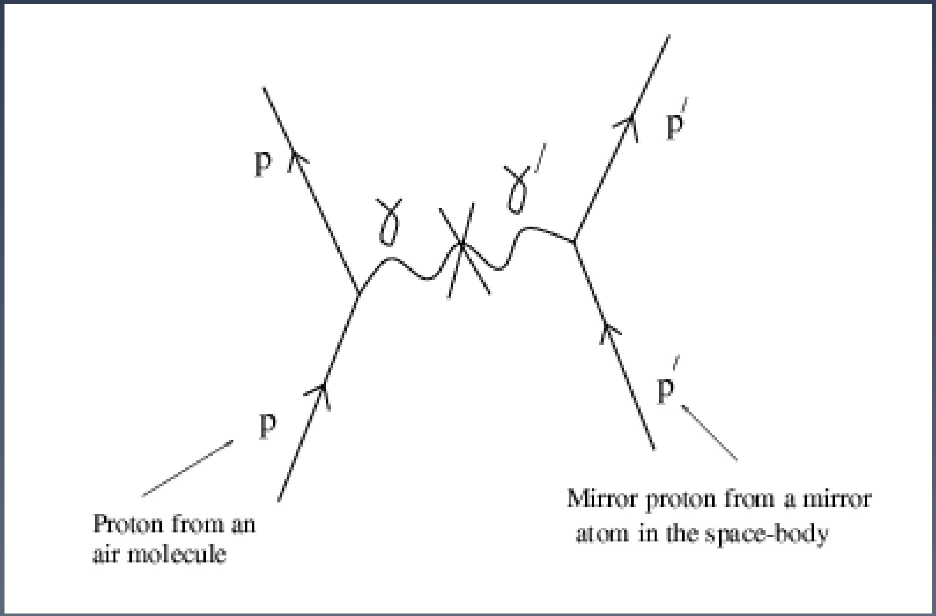


Fig. 1 Foot & Mitra 2002

anomalous impact events

• normal meteorite starts bright and becomes dimmer as it falls through the Earth's atmosphere

• mirror-matter meteorite heats up internally from air molecules penetrating it (no EM friction) and heating via $\gamma - \gamma'$ kinetic mixing

• normal meteorite — matter fragments at impact site

• mirror-matter meteorite — mirror matter fragments only — difficult to detect, but depending on parameters could provide experimental confirmation

mirror SB's (space-bodies) in general

• mirror SB of diameter D_{SB} sinks into the surface of a target (planet, moon, asteroid) after some stopping length L

• if $L < D_{SB}$, then a crater forms, since energy is dissipated at surface

• if $L \gg D_{SB}$, then there is **no** crater

$\Rightarrow \exists$ minimum crater size

observations: NEAR-Shoemaker on 433 Eros (2001):

sharp drop in crater size below about 30-70m

DAMA/NaI 7yr — astro-ph/0405282

Authors state detection of dark matter at 6.3σ confidence

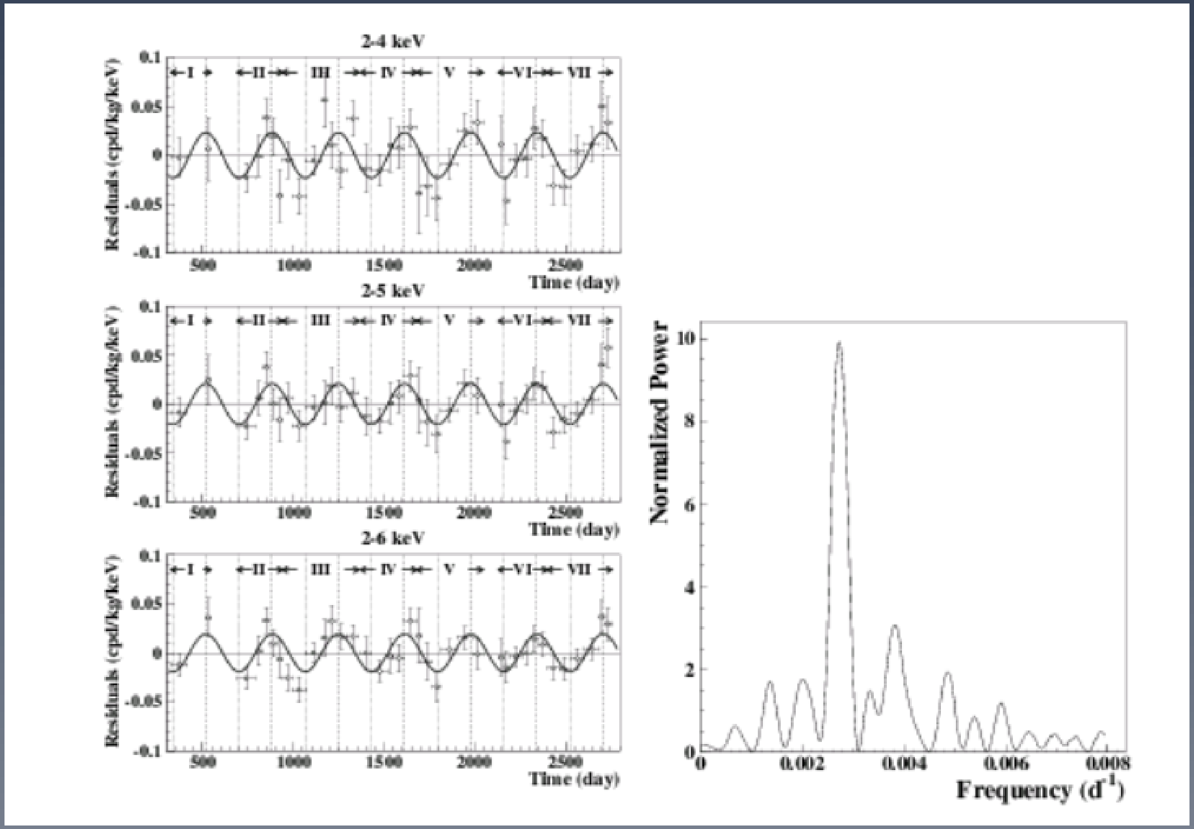


Fig. 1 Bernabei et al. 2004

sinusoid drawn with $T = 1$ yr, phase maximum = "2nd June" = max($v_{\text{Earth-Galaxy}}$)

dominant mode = 2.737 10^{-3} d^{-1}

same hardware, same software: multi-hit detection

a WIMP interacts weakly — it should only hit once (not scatter off multiple detectors); a background baryonic matter event can cause multiple hits

years 6 and 7 — multiple event detection, same hardware, same software

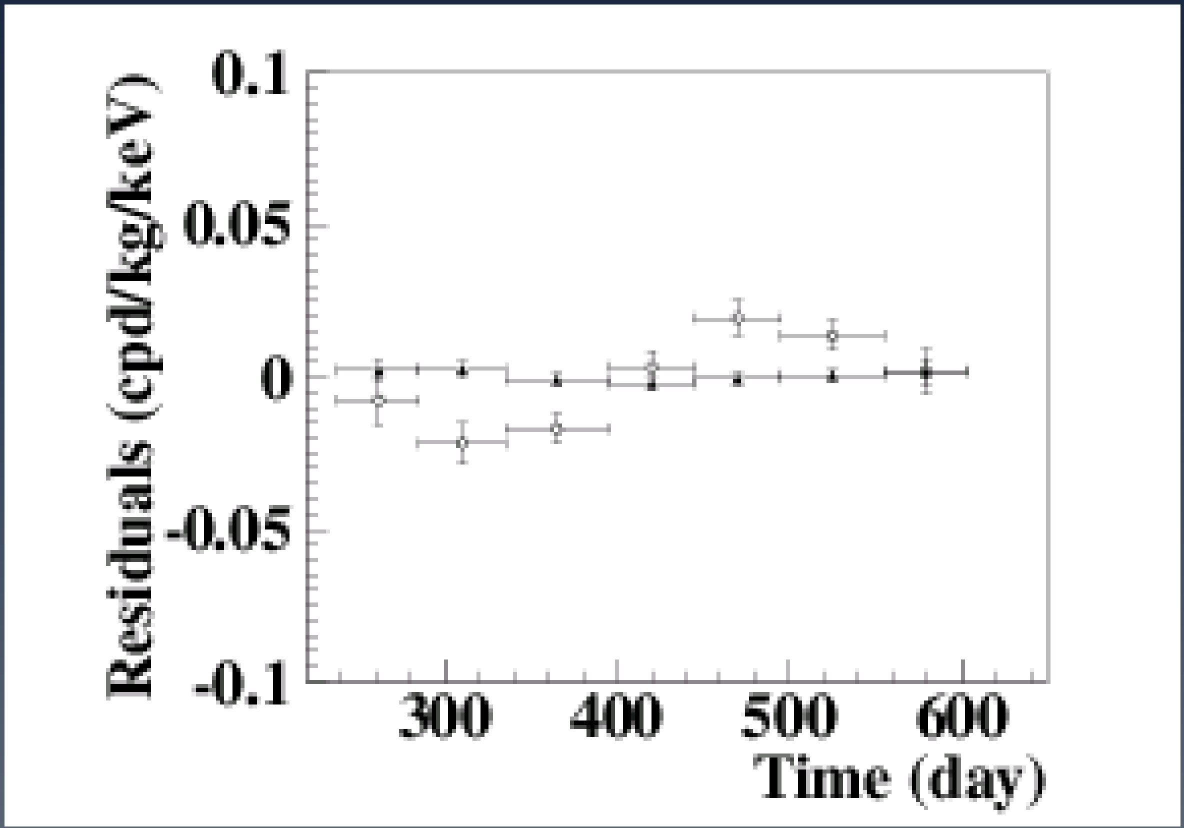


Fig. 2 Bernabei et al. 2004

astro-ph/0403043

DAMA not expected to be sensitive to H' and He' because they are not heavy enough

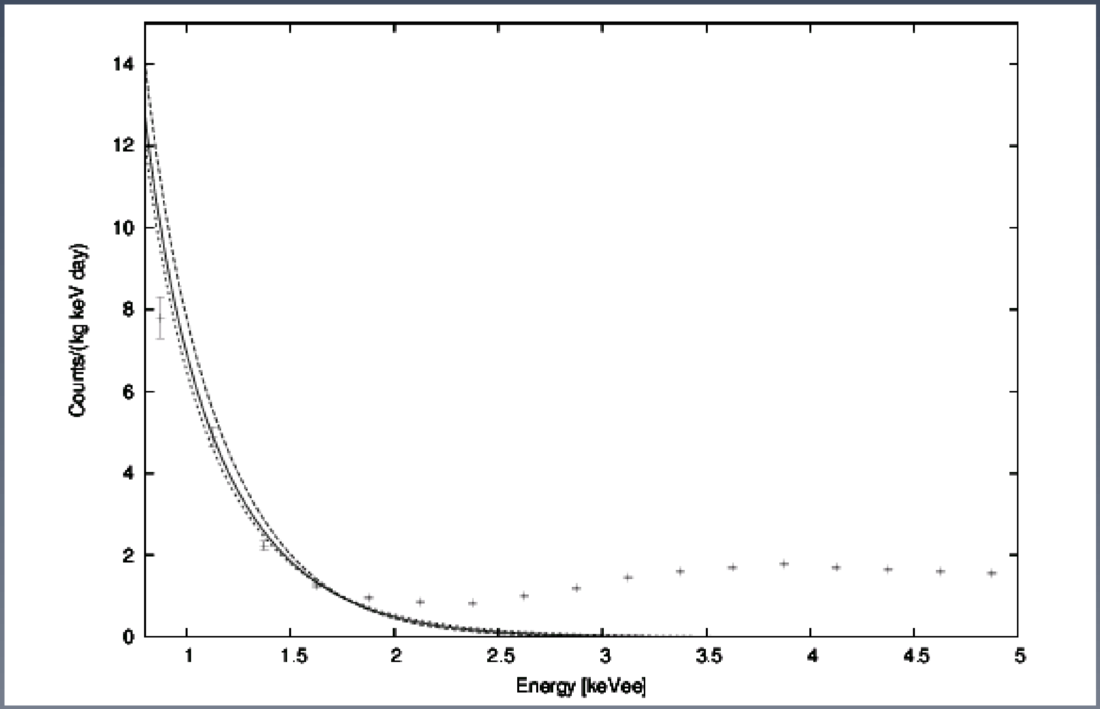


Fig. 3 Foot 2004b - He' + O' dominated halo

spin-independent WIMPs

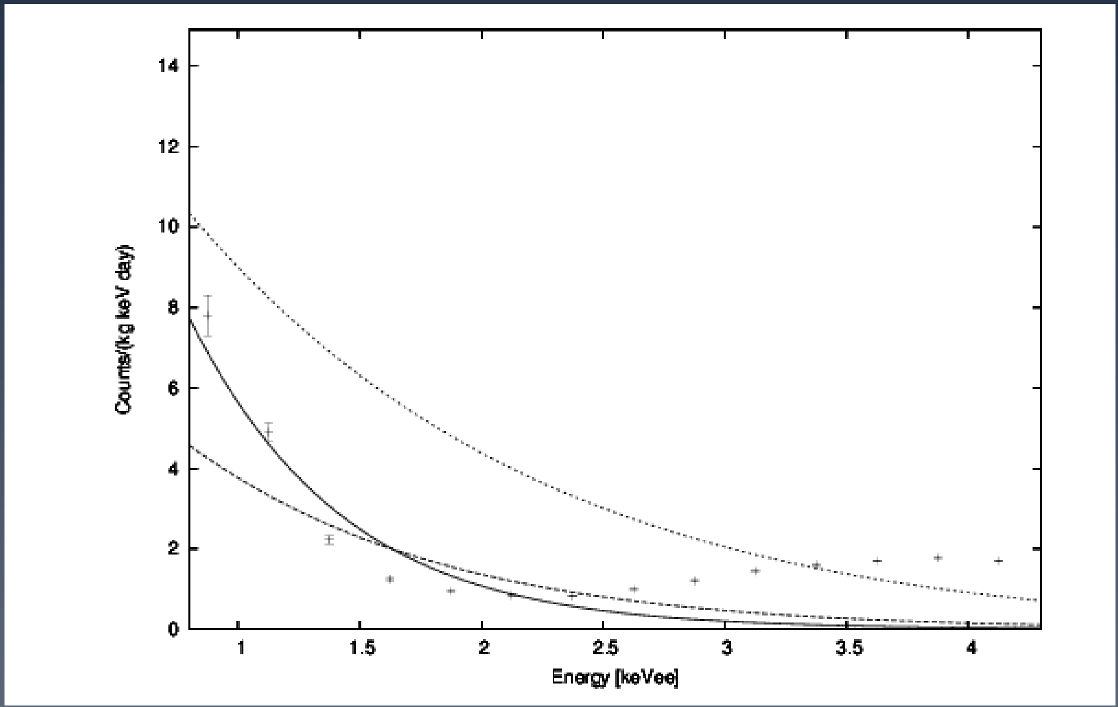


Fig. 6 Foot 2004b - solid line is 30GeV standard (spin-independent) WIMPs, dashed 50GeV, dotted 100 GeV

hep-ph/0308254

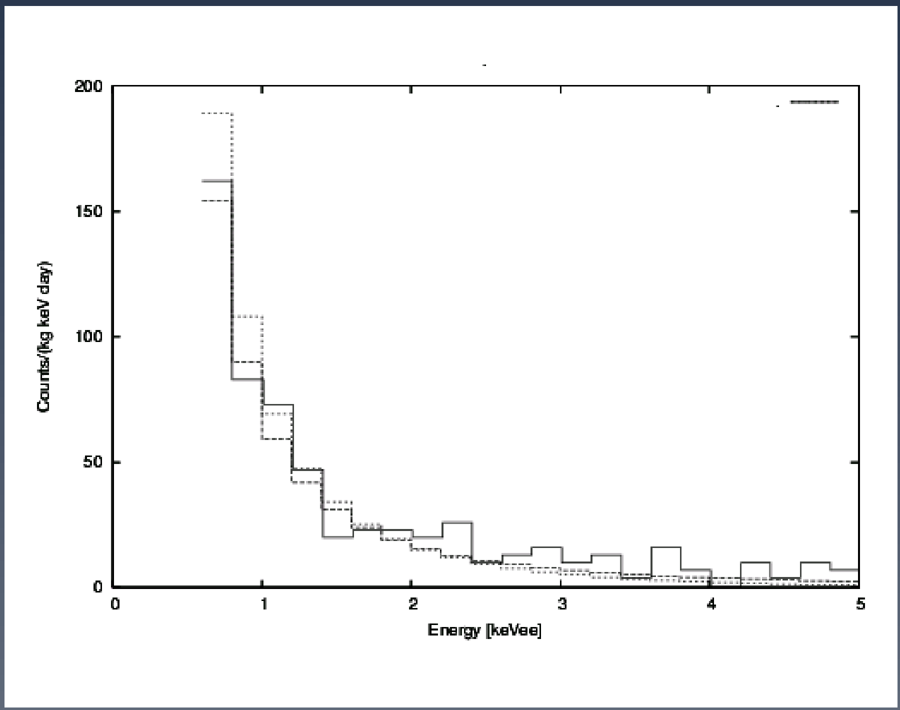


Fig. 4 Foot 2004a

observations: CRESST/Sapphire (sapphire = Al_2O_3),
model: mirror matter

Conclusion

Obvious versions of mirror matter give $\Omega_b/\Omega'_b \approx 0.2$

The two experiments most sensitive to mirror matter — DAMA NaI and CRESST/Sapphire — both detect something consistent with mirror matter.

The DAMA results are difficult to explain by “ordinary” WIMPs, but are also hard to explain as experimental error or background.

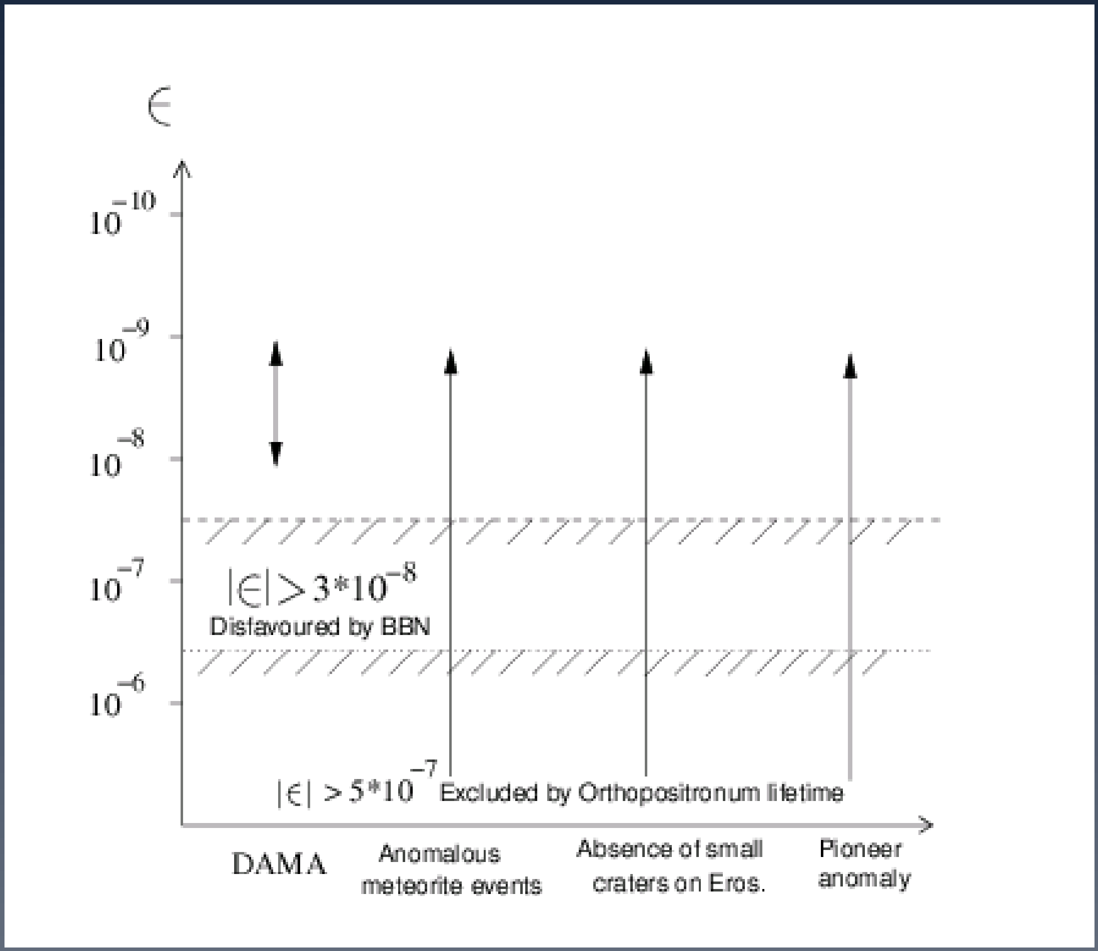


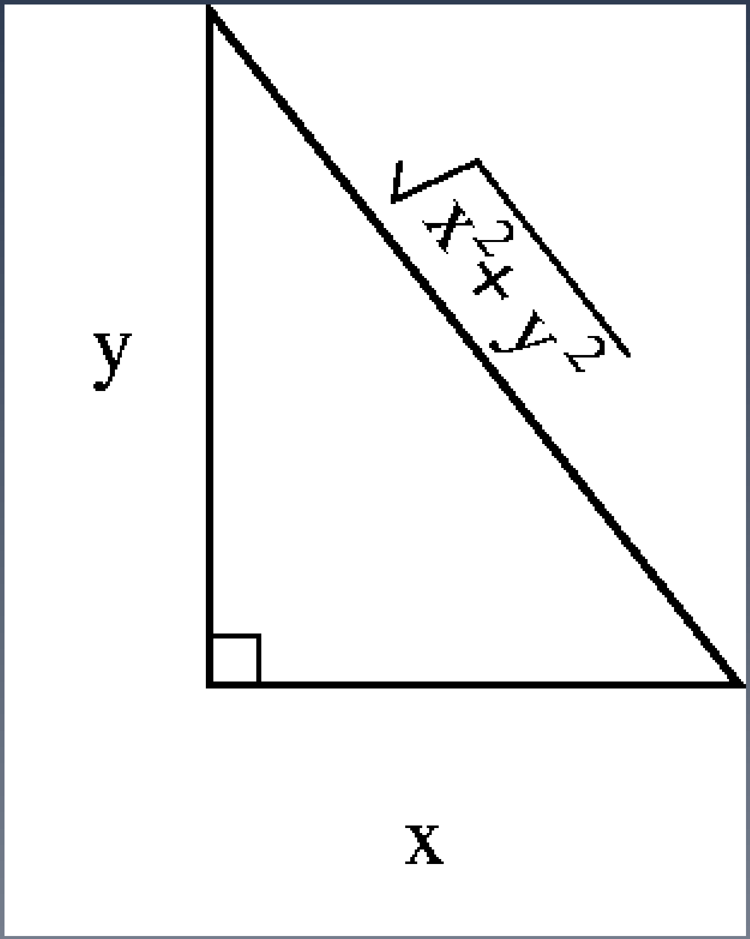
Fig. 5 Foot 2004a

Testy obserwacyjne topologii Wszechświata

Boud Roukema

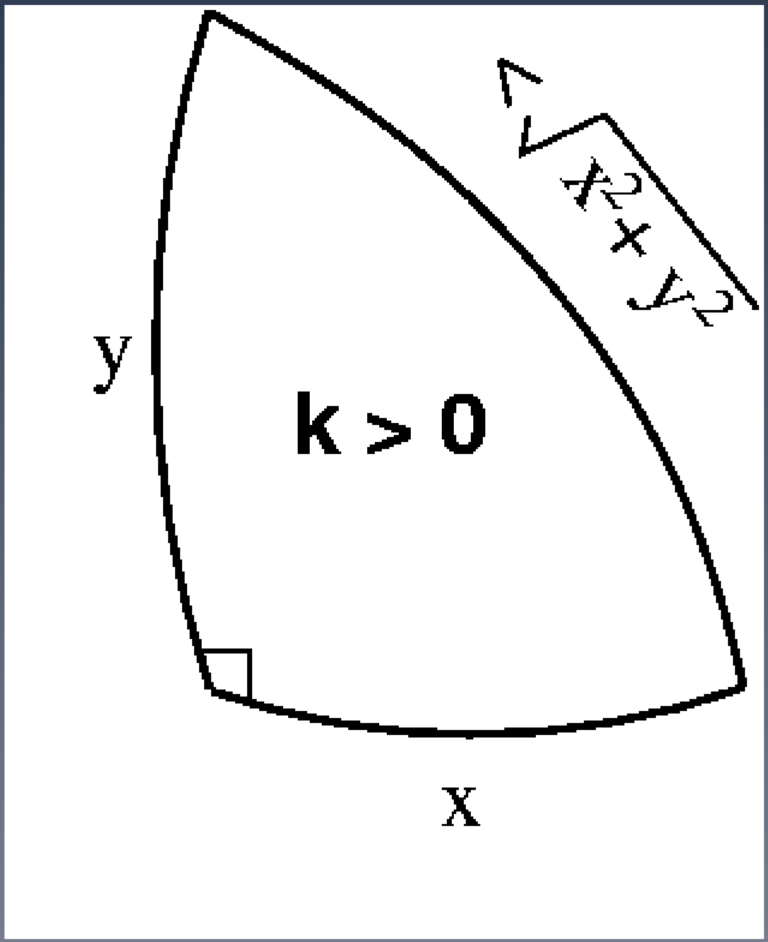
Centrum Astronomii UMK

geometria: krzywizna + topologia



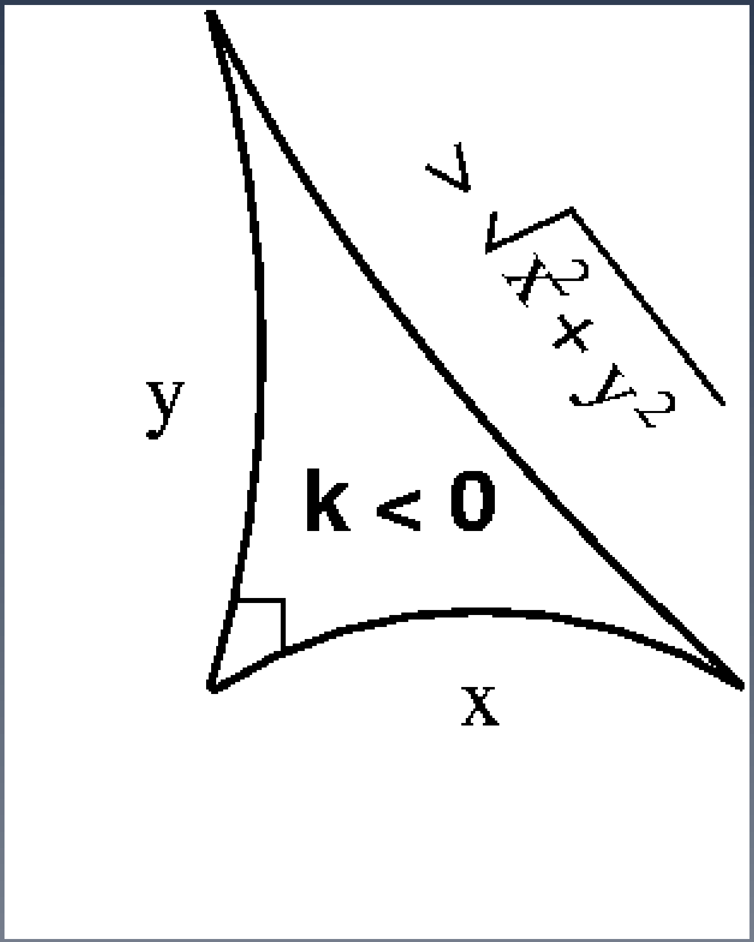
0 + - multi-connected

geometria: krzywizna + topologia



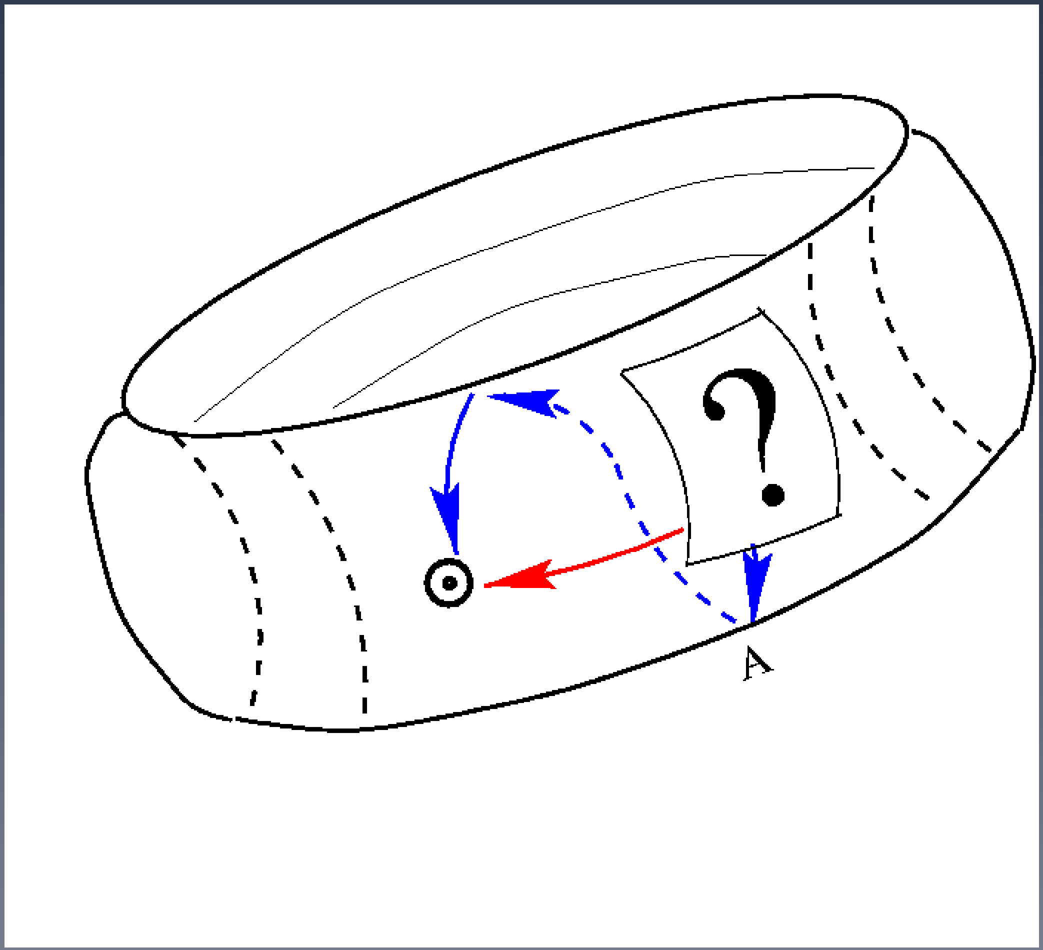
0 + - multi-connected

geometria: krzywizna + topologia



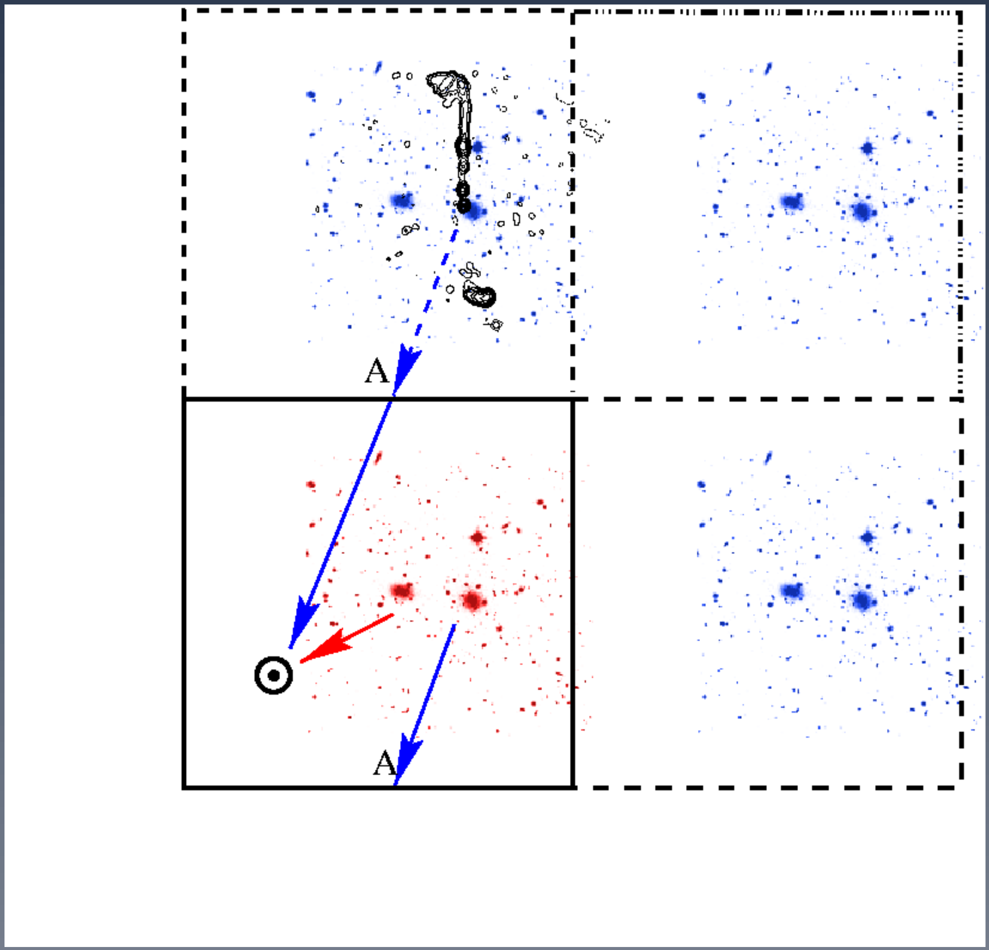
0 + - multi-connected

geometria: krzywizna + topologia



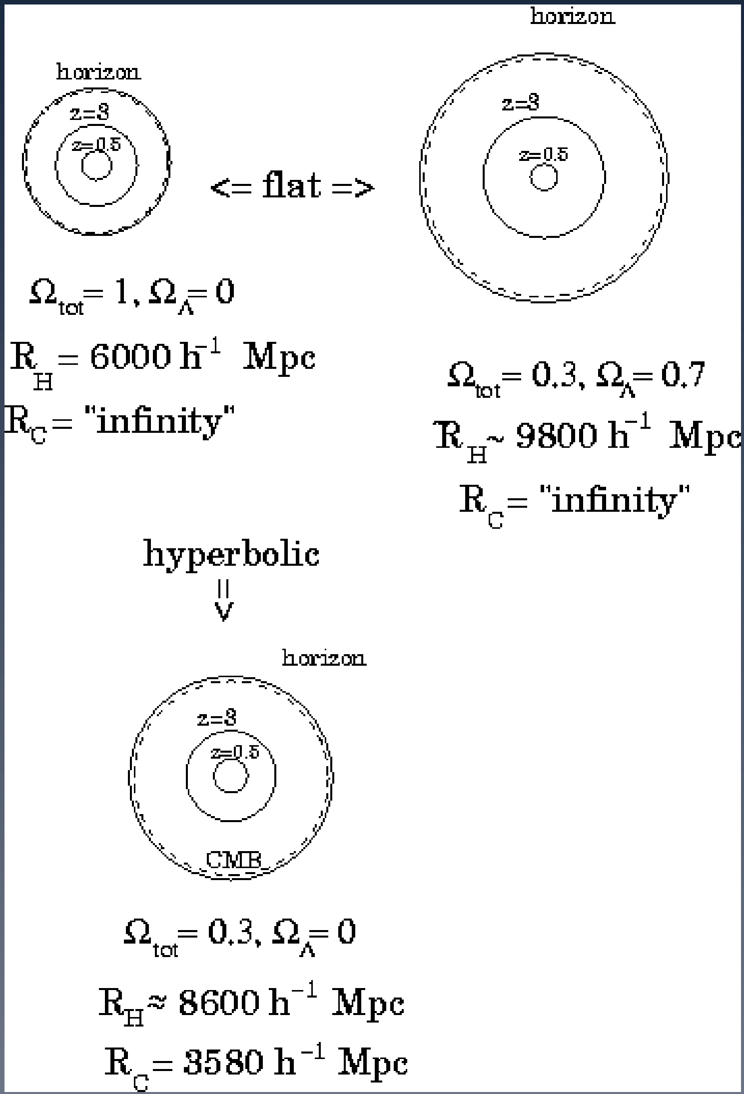
0 + - multi-connected

geometria: krzywizna + topologia



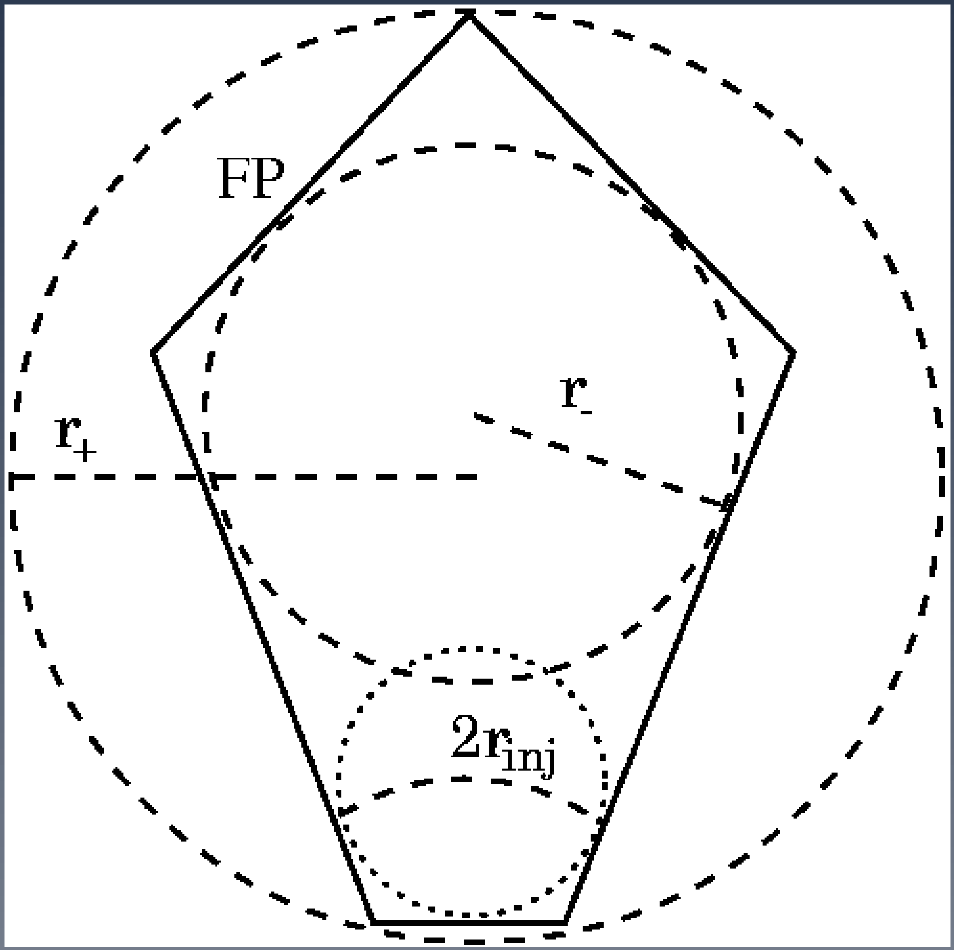
0 + - multi-connected

geometria: krzywizna + topologia



0 + - multi-connected

geometria: krzywizna + topologia



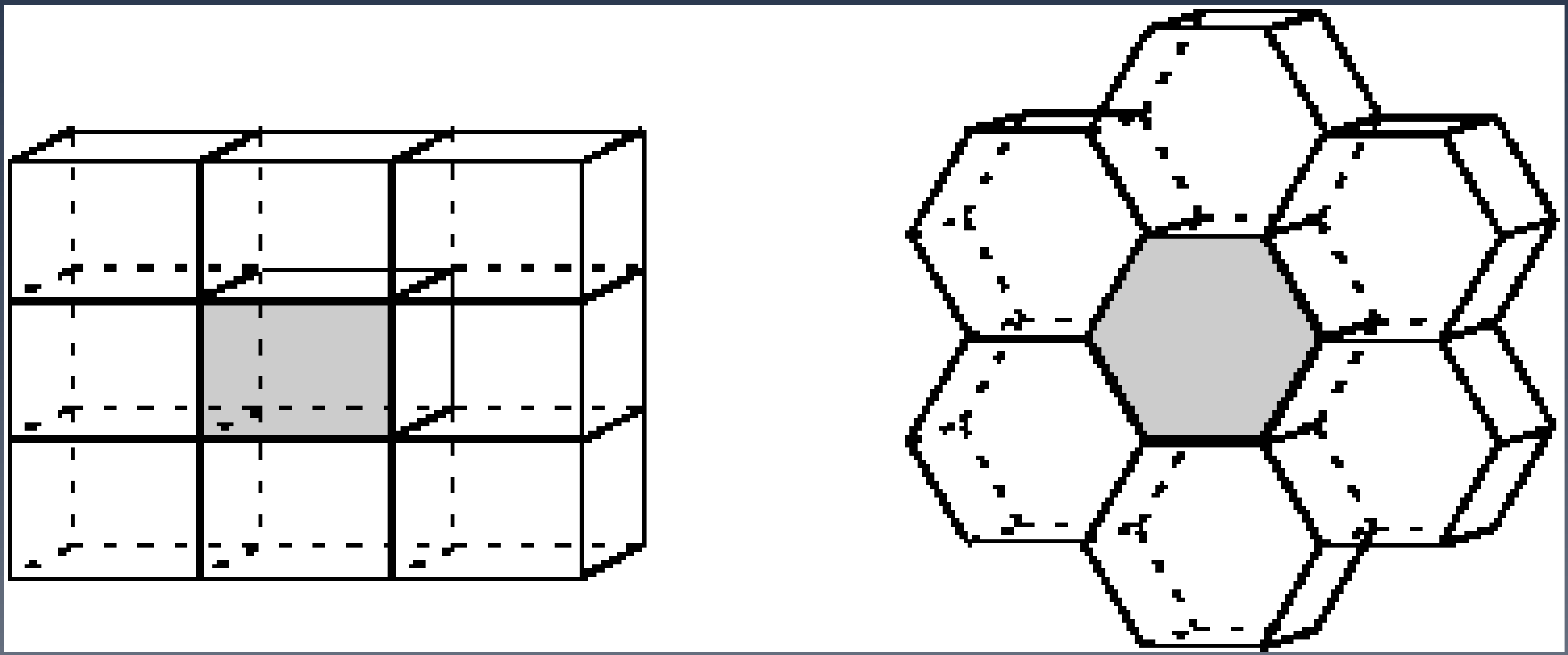
r_- : biggest sphere *inside* FD

r_+ : smallest sphere *containing* FD

$2r_{\rm inj}$: smallest closed spatial geodesic

0 + - multi-connected

Geometry: Curvature + Topology



0

+ - multi-connected (Luminet & Roukema 1999: http://arXiv.org/abs/astro-ph/9901364)

Strategies - 3D

http://arXiv.org/abs/astro-ph/0010189

A. multiple topological images:

A.i 3D (grav collapsed objects):

A.i.1 local isometries - many "type I pairs" or "local pairs"

A.i.2 cosmic crystallography - many "type II pairs" or "generator pairs",

A.i.3 characteristics of individual objects

Strategies - 2D and non-multiple-imaging

A.ii 2D (microwave background, CMB):

A.ii.1 identified circles principle:

A.ii.2 patterns of spots

A.ii.3 perturbation statistics assumptions

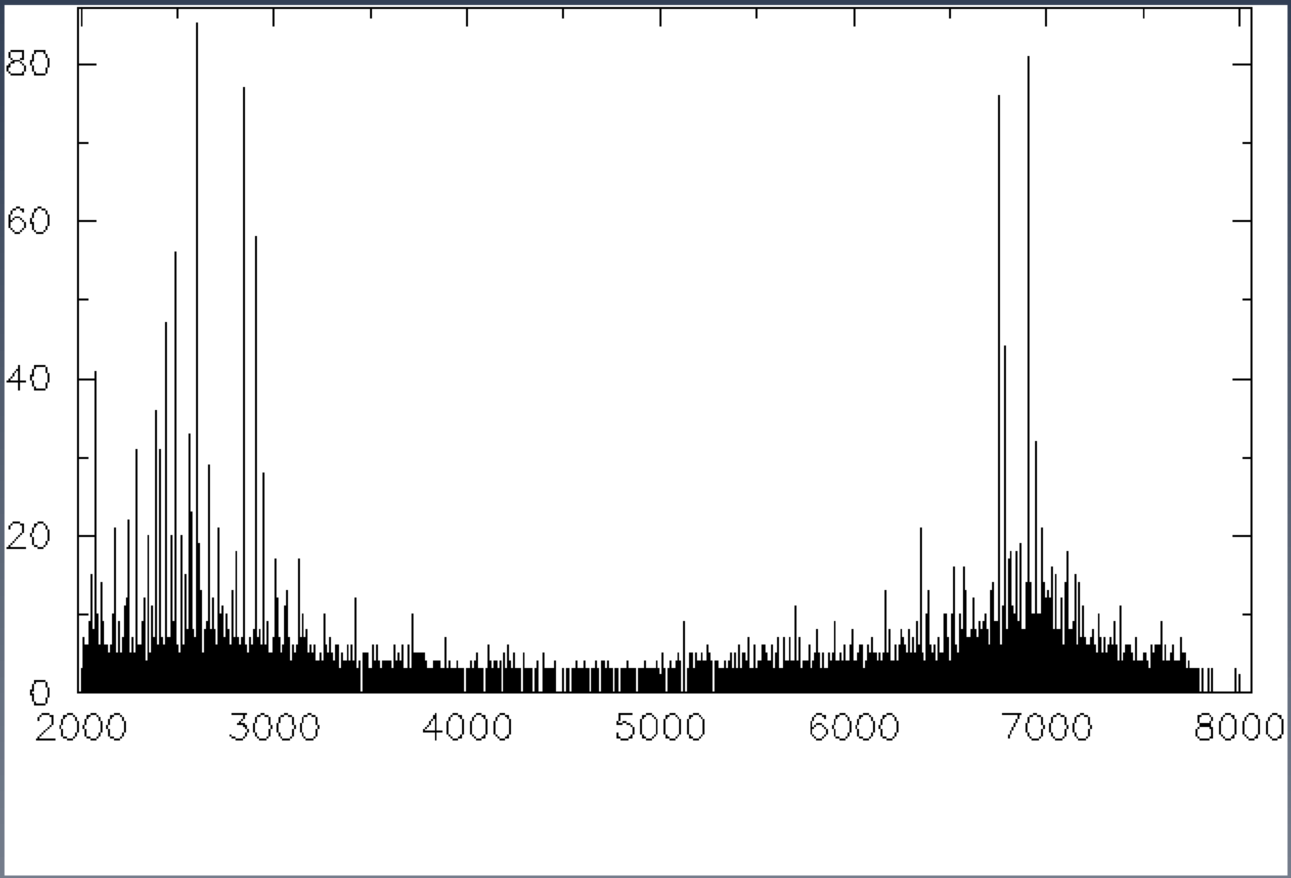
B. other:

B.i cosmic strings

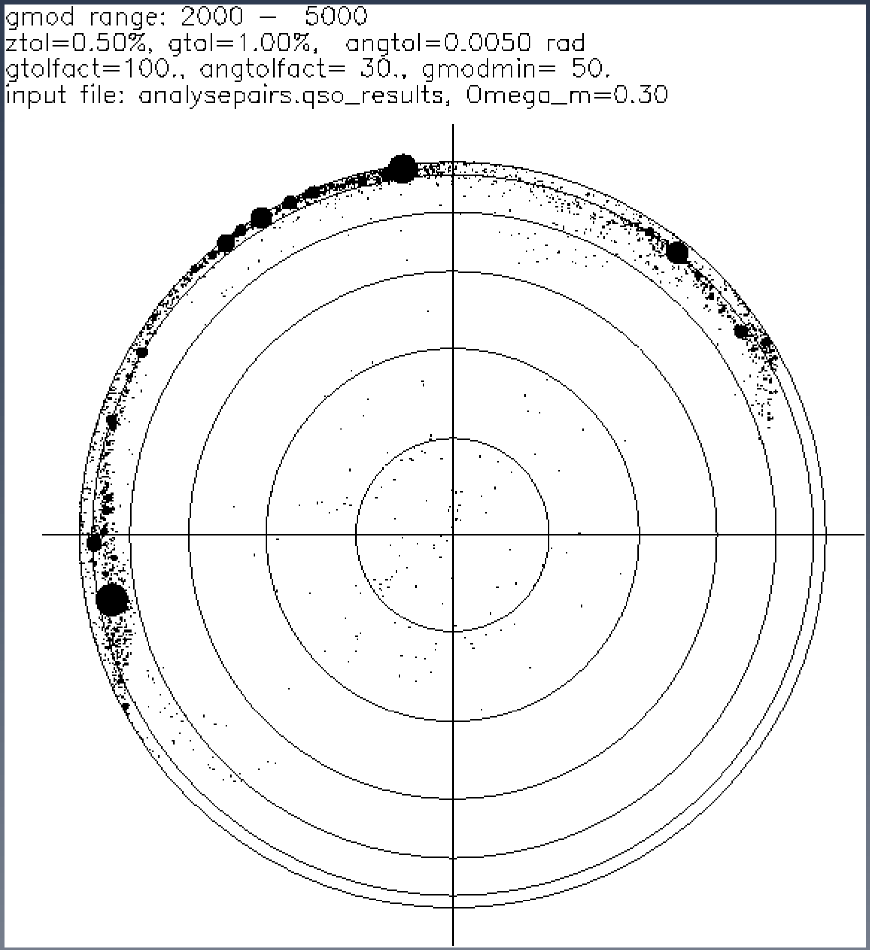
B.ii nested crystallography

AGN Catalogues

Marecki, Roukema, Bajtlik

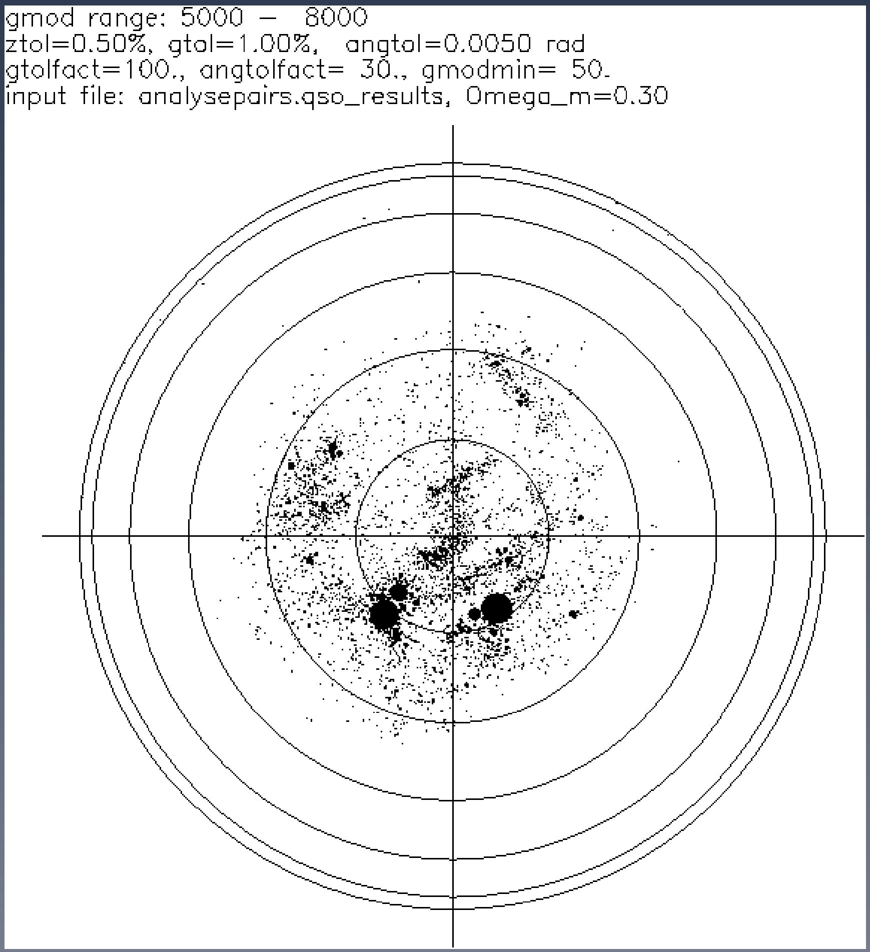


AGN Catalogues



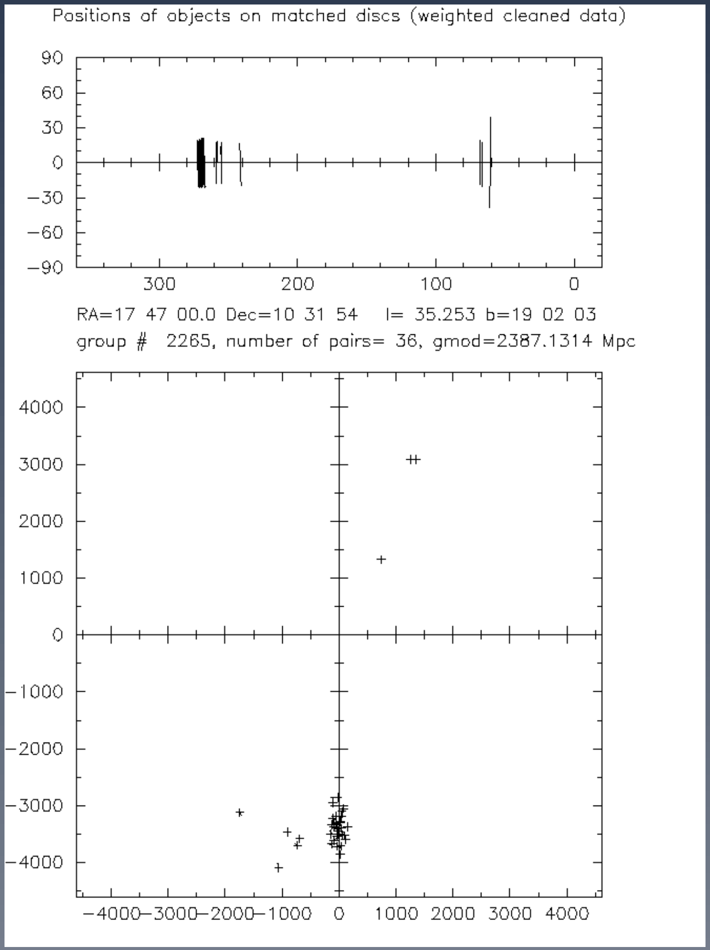
0 + - multi-connected

AGN Catalogues



0 + - multi-connected

AGN Catalogues



0 + - multi-connected

AGN: Conclusion

- AGN short lifetimes implies redshift filter to improve S/N
- application to large AGN catalogue compilation reveals apparent signals
- closer analysis ⇒ these are selection effects
- no signal found in compilation of radio-loud AGNs (RLAGNs)

Marecki, Roukema, Bajtlik (in preparation)

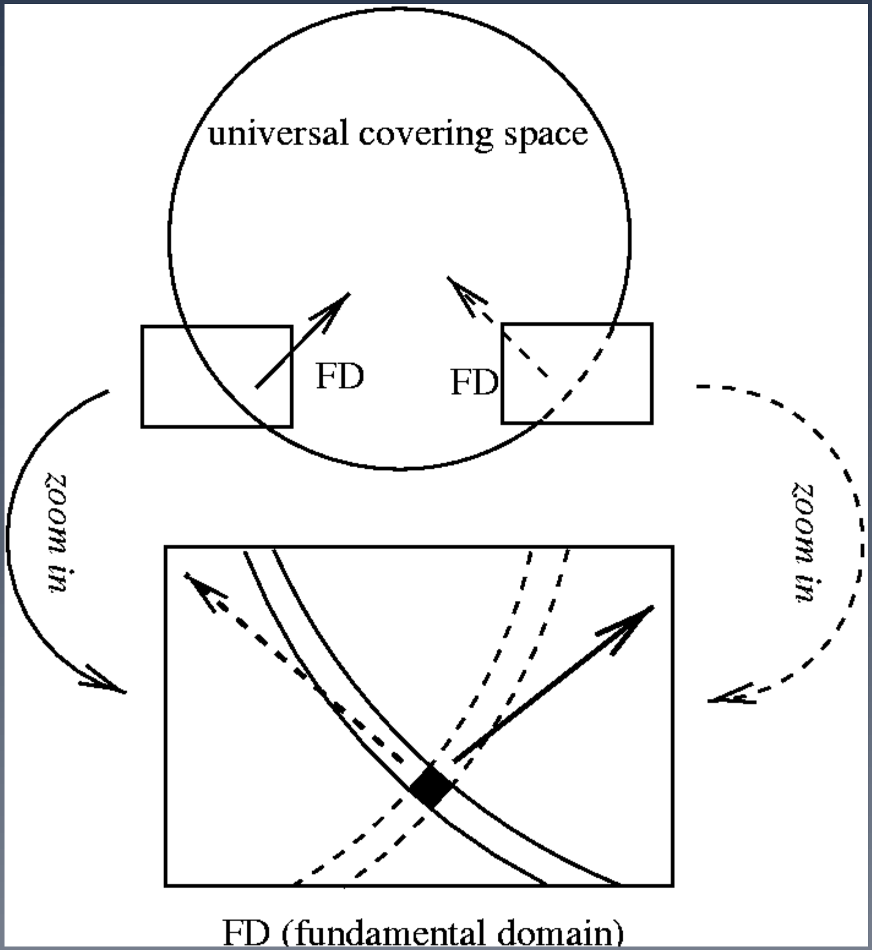
The Identified Circles Principle

Discovery of principle: Cornish, Spergel & Starkman (1996)

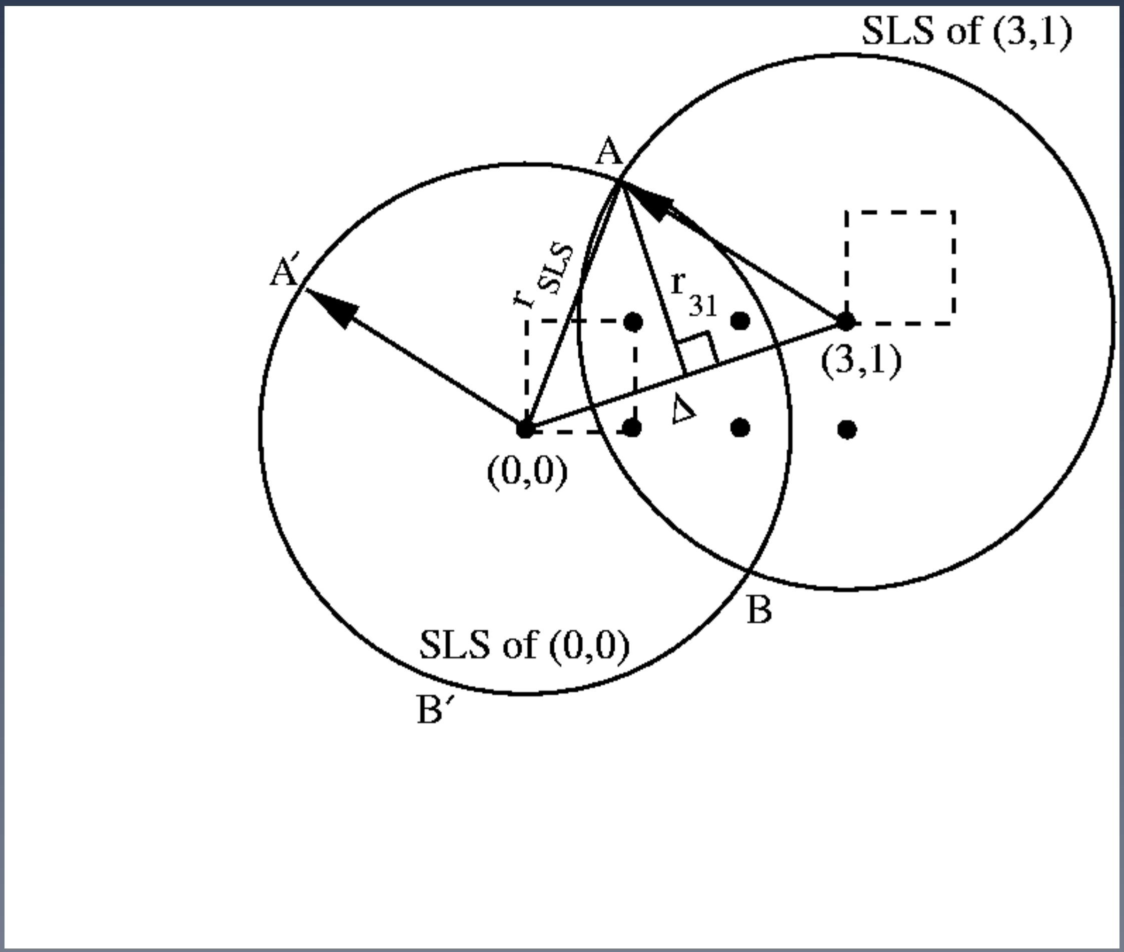
http://arXiv.org/abs/astro-ph/9602039

CQG, 15, 2657 (1998)

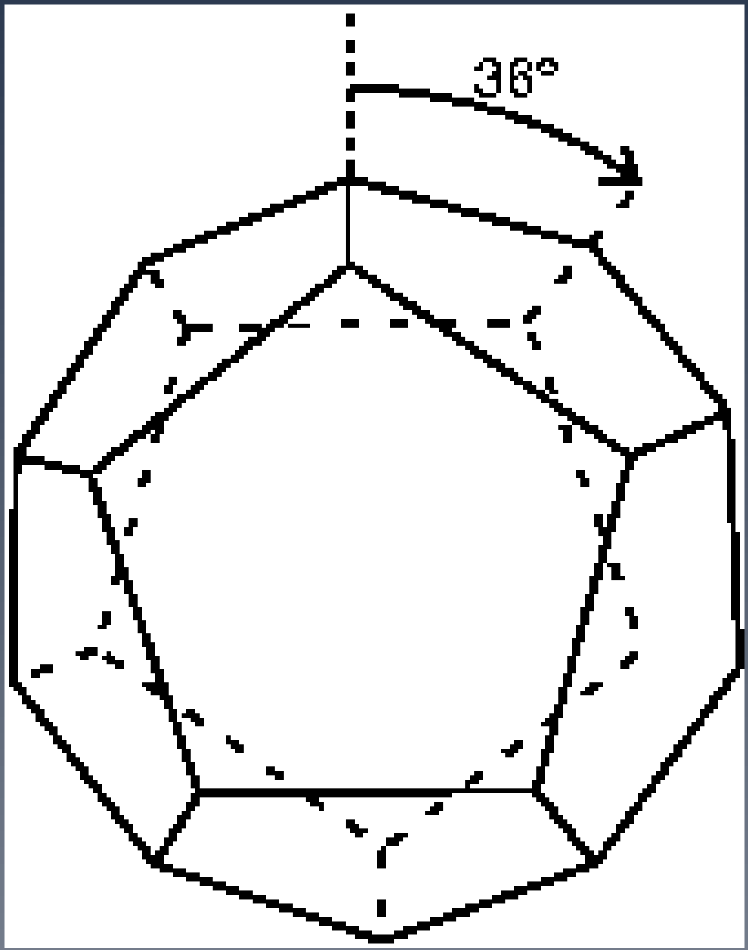
The Identified Circles Principle



The Identified Circles Principle



The Poincaré Dodecahedral 3-Manifold



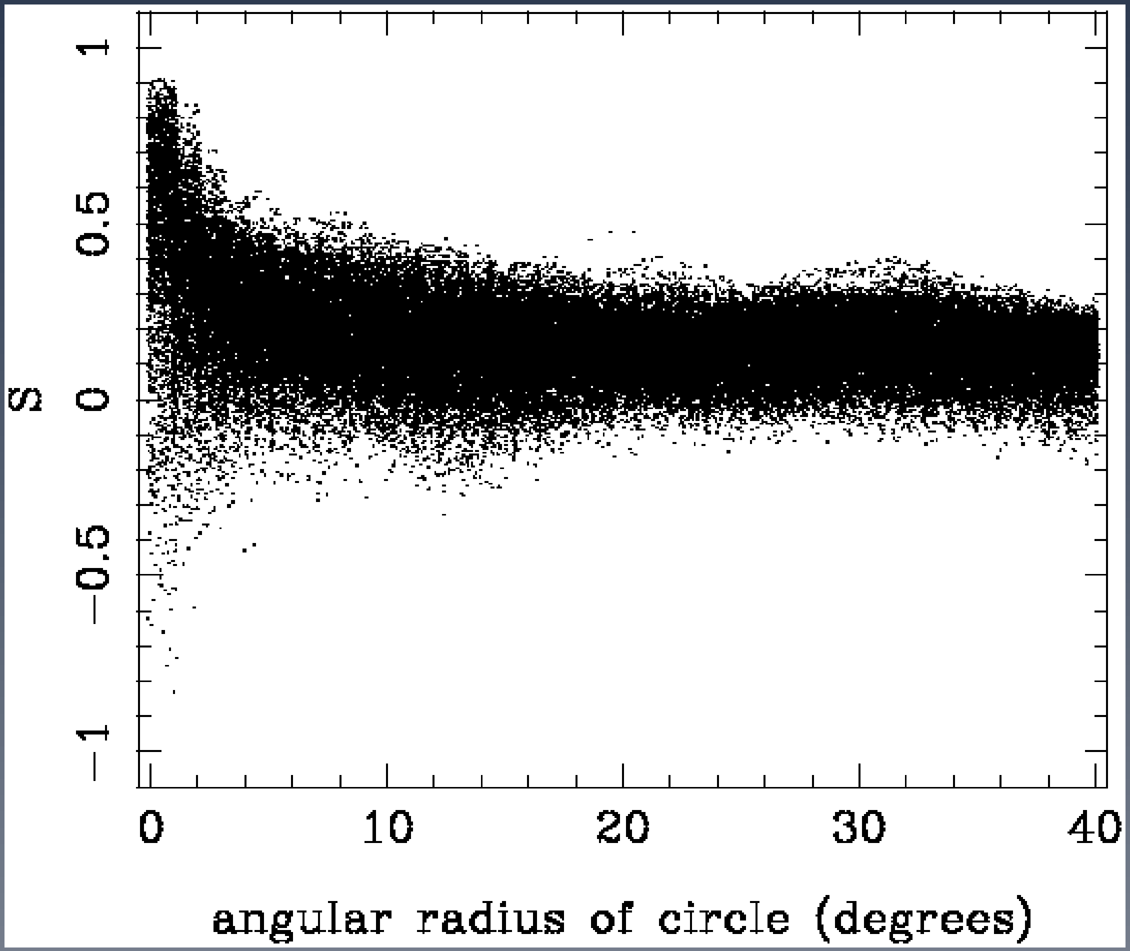
- FD = positively curved dodecahedron covering space is S^3 (hypersphere)
- 120 copies of FD tile S^3
- Luminet et al. (2003) find this favoured by WMAP statistics

The Poincaré Dodecahedral 3-Manifold

Correlation statistic to detect best circle matches:

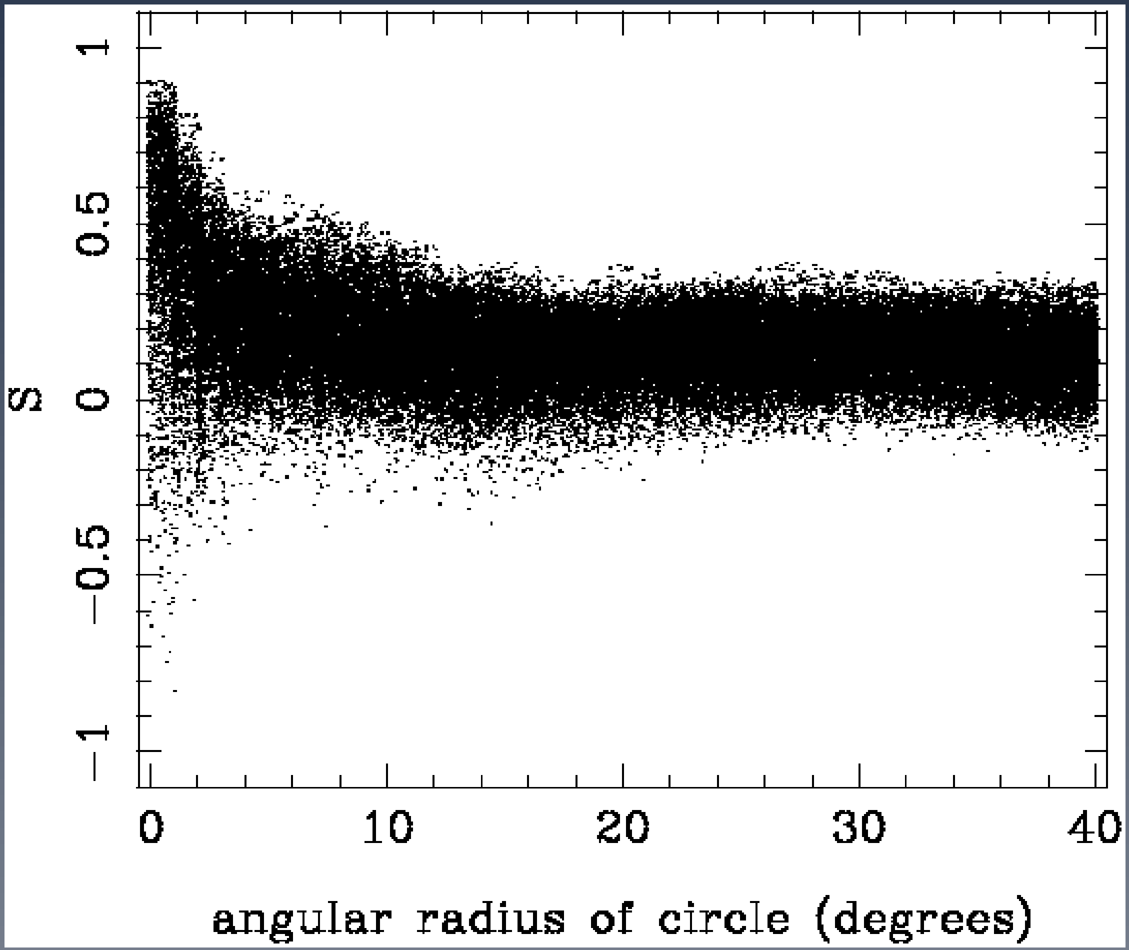
$$S \equiv \frac{\left\langle 2 \left(\frac{\delta T}{T}\right)_i \left(\frac{\delta T}{T}\right)_j \right\rangle}{\left\langle \left(\frac{\delta T}{T}\right)_i^2 + \left(\frac{\delta T}{T}\right)_j^2 \right\rangle} \quad (4)$$

The Poincaré Dodecahedral 3-Manifold



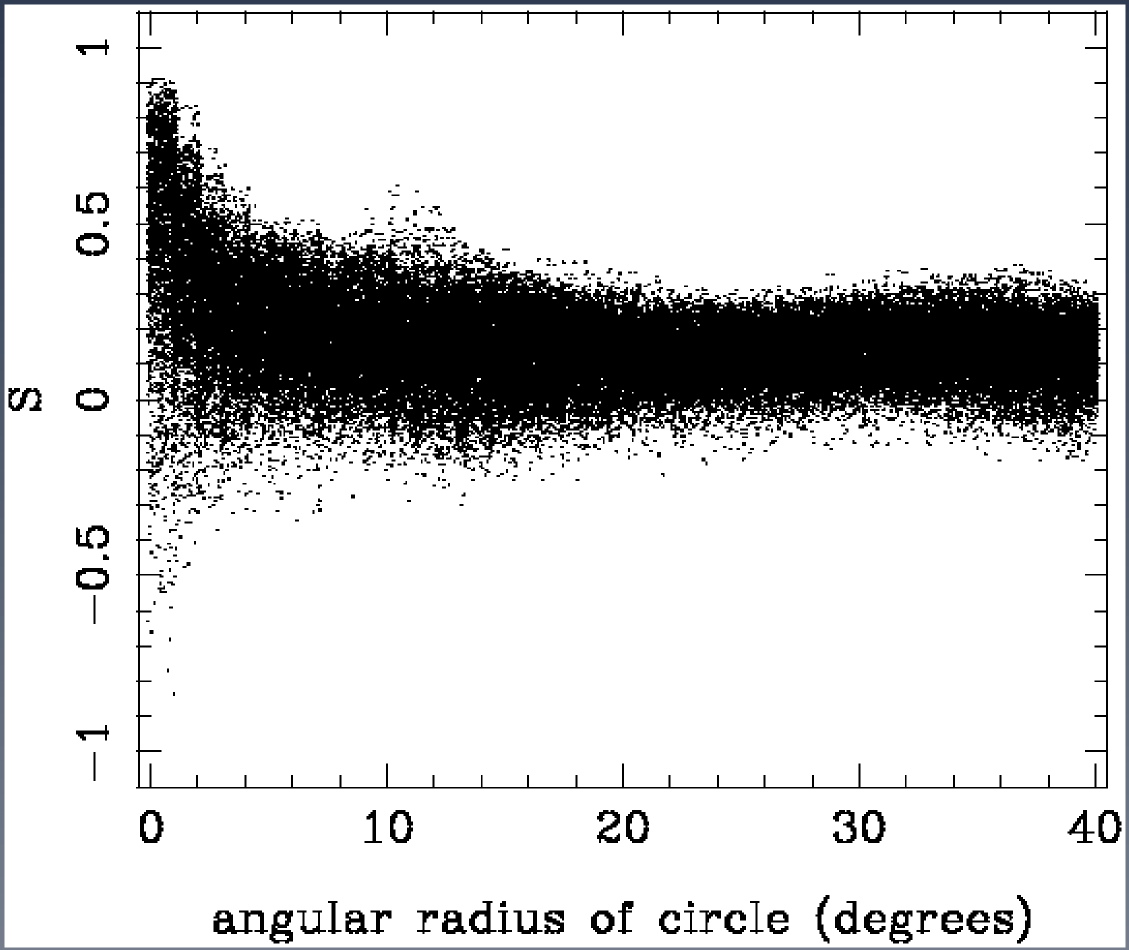
zero rotation

The Poincaré Dodecahedral 3-Manifold



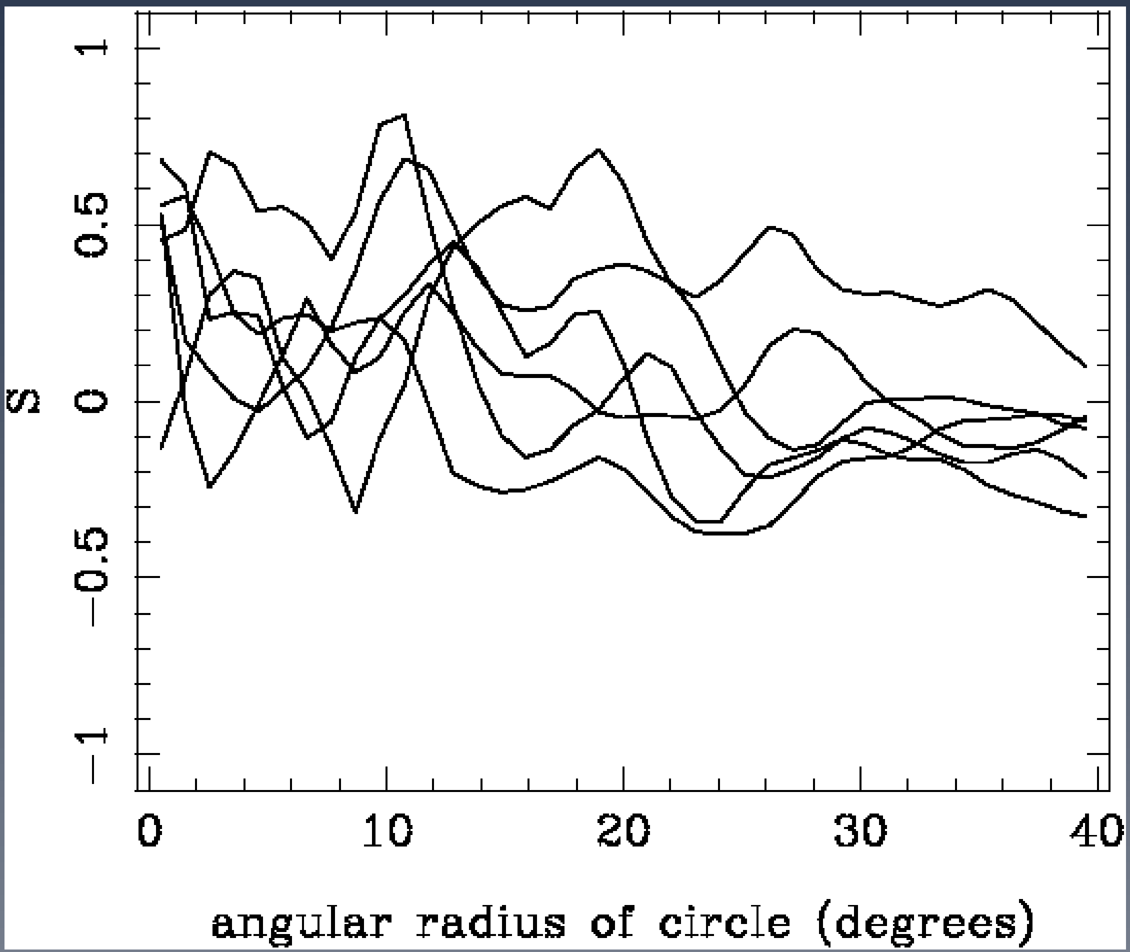
+36° rotation

The Poincaré Dodecahedral 3-Manifold



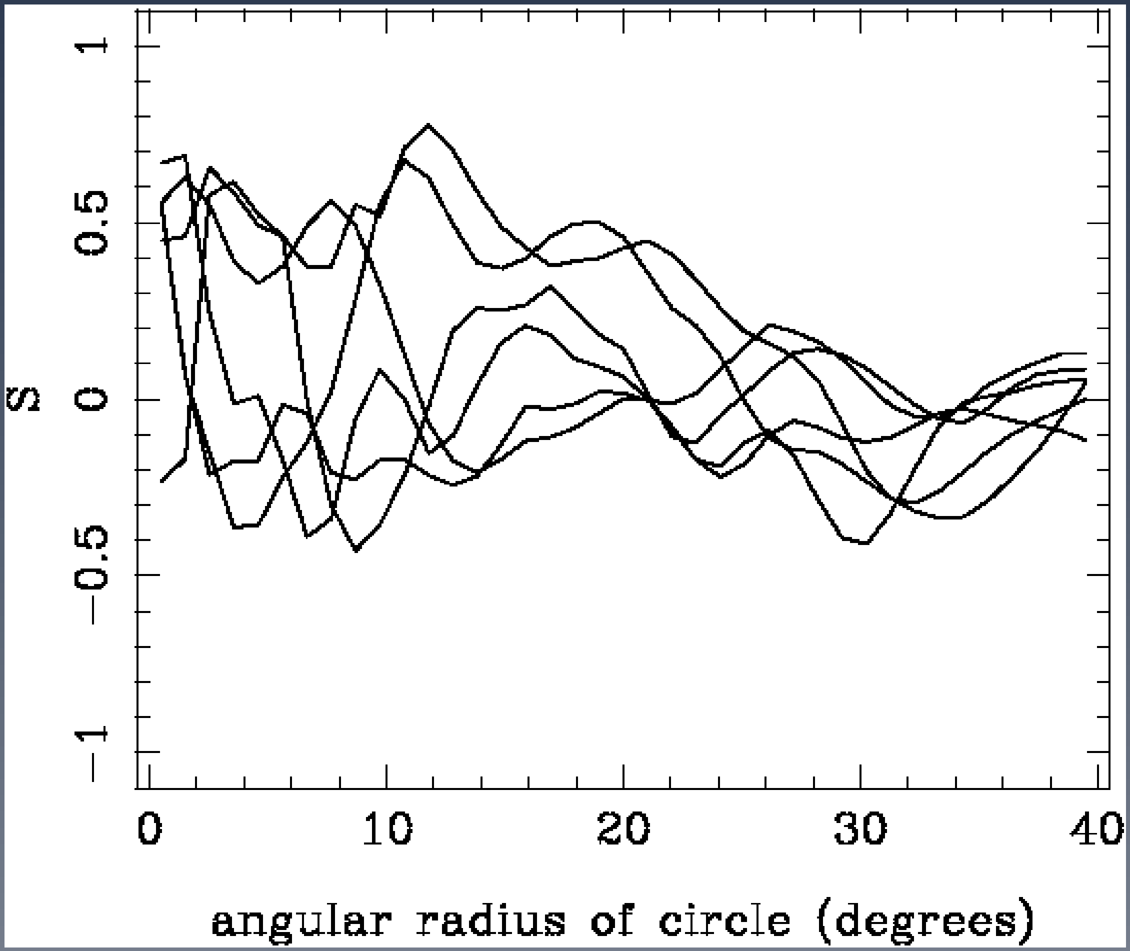
-36° rotation

The Poincaré Dodecahedral 3-Manifold



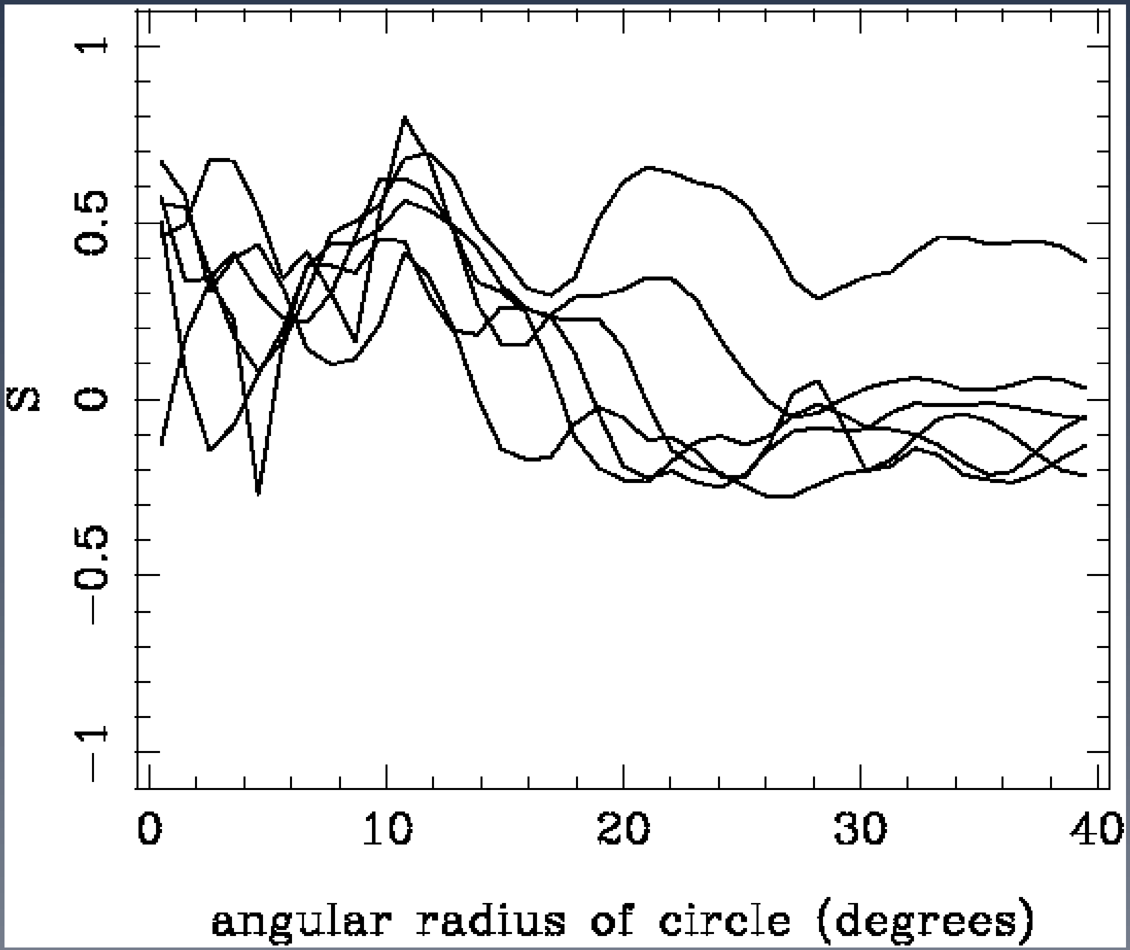
zero rotation

The Poincaré Dodecahedral 3-Manifold



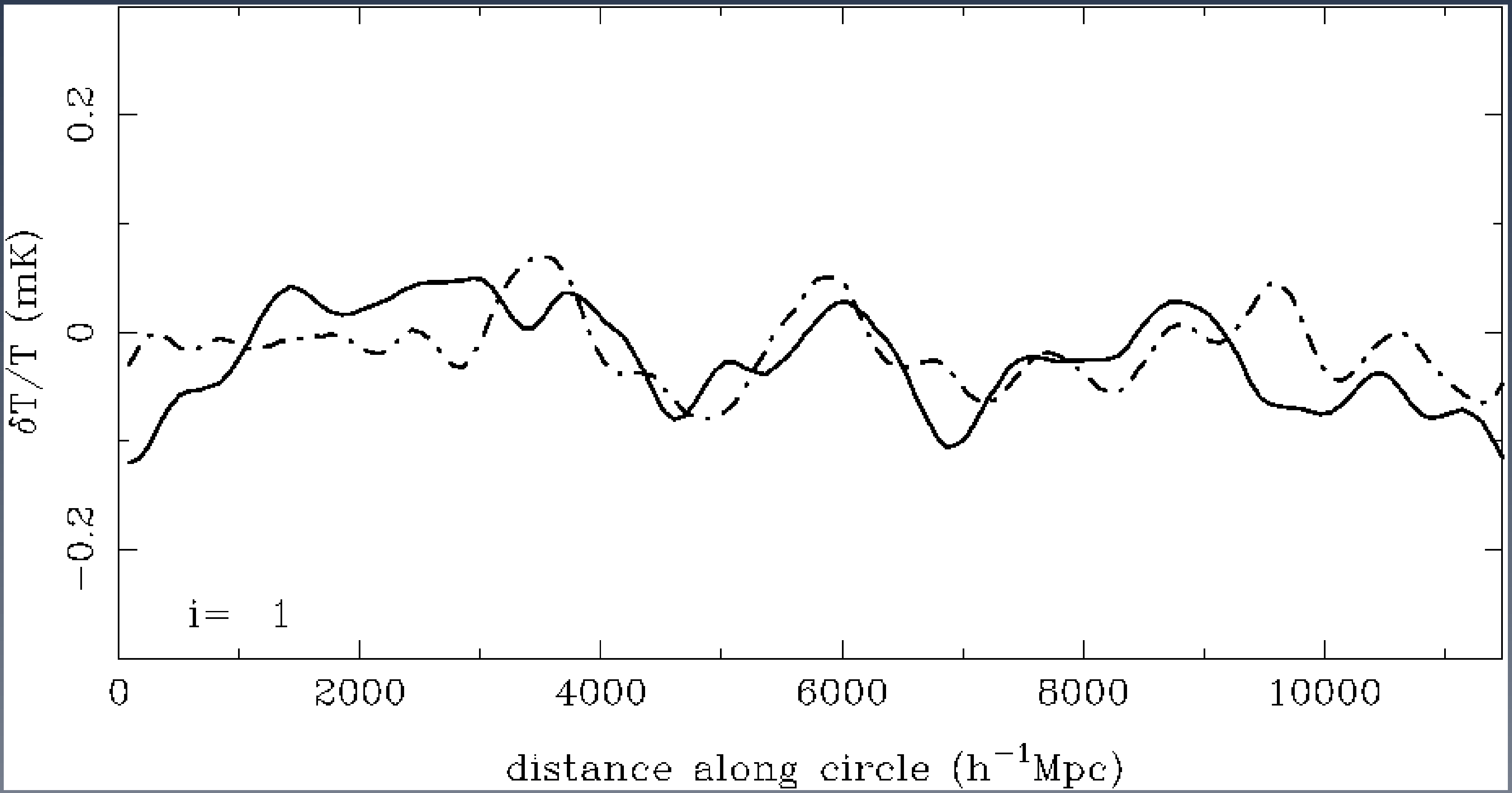
+36° rotation

The Poincaré Dodecahedral 3-Manifold

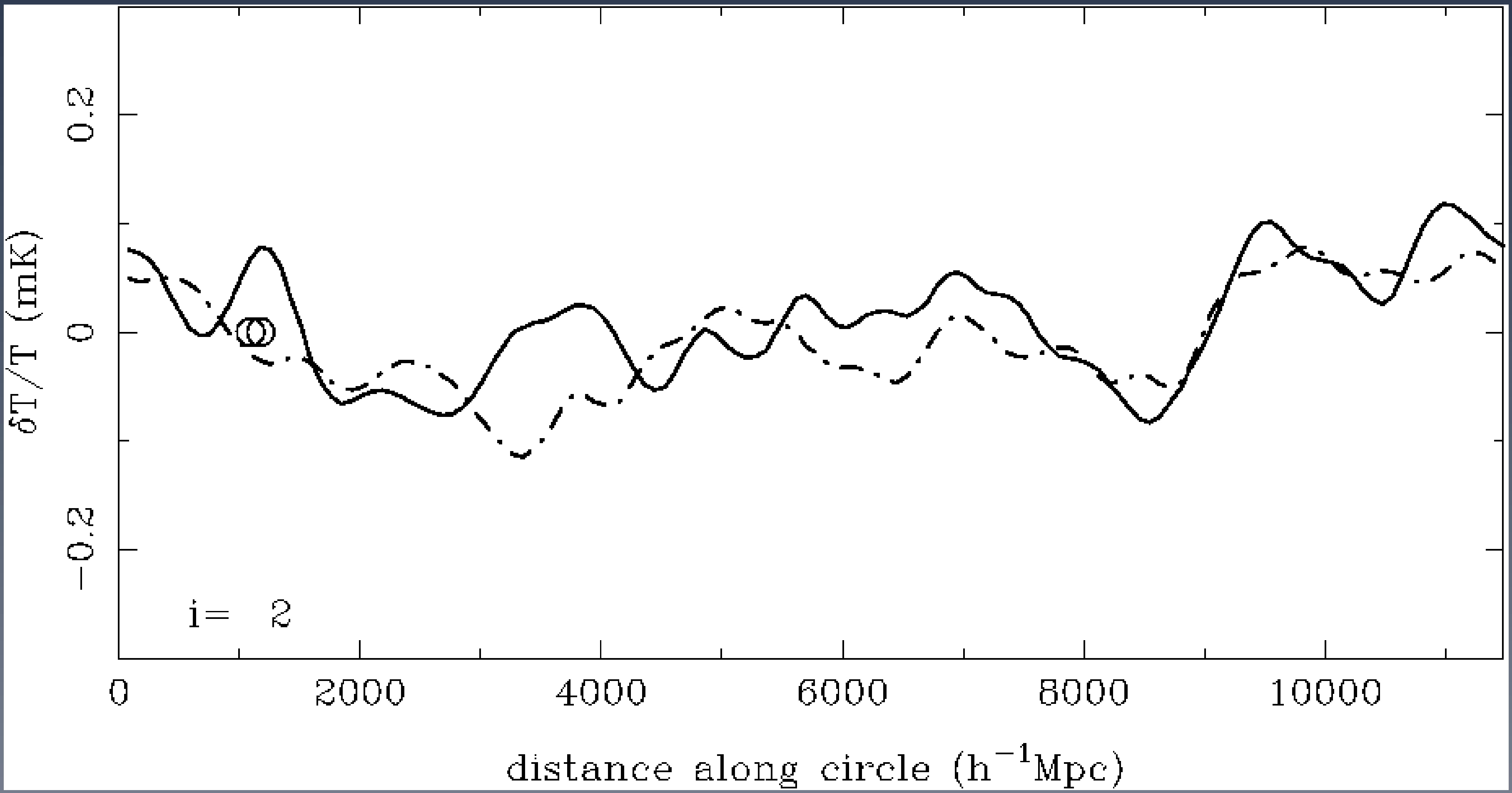


-36° rotation

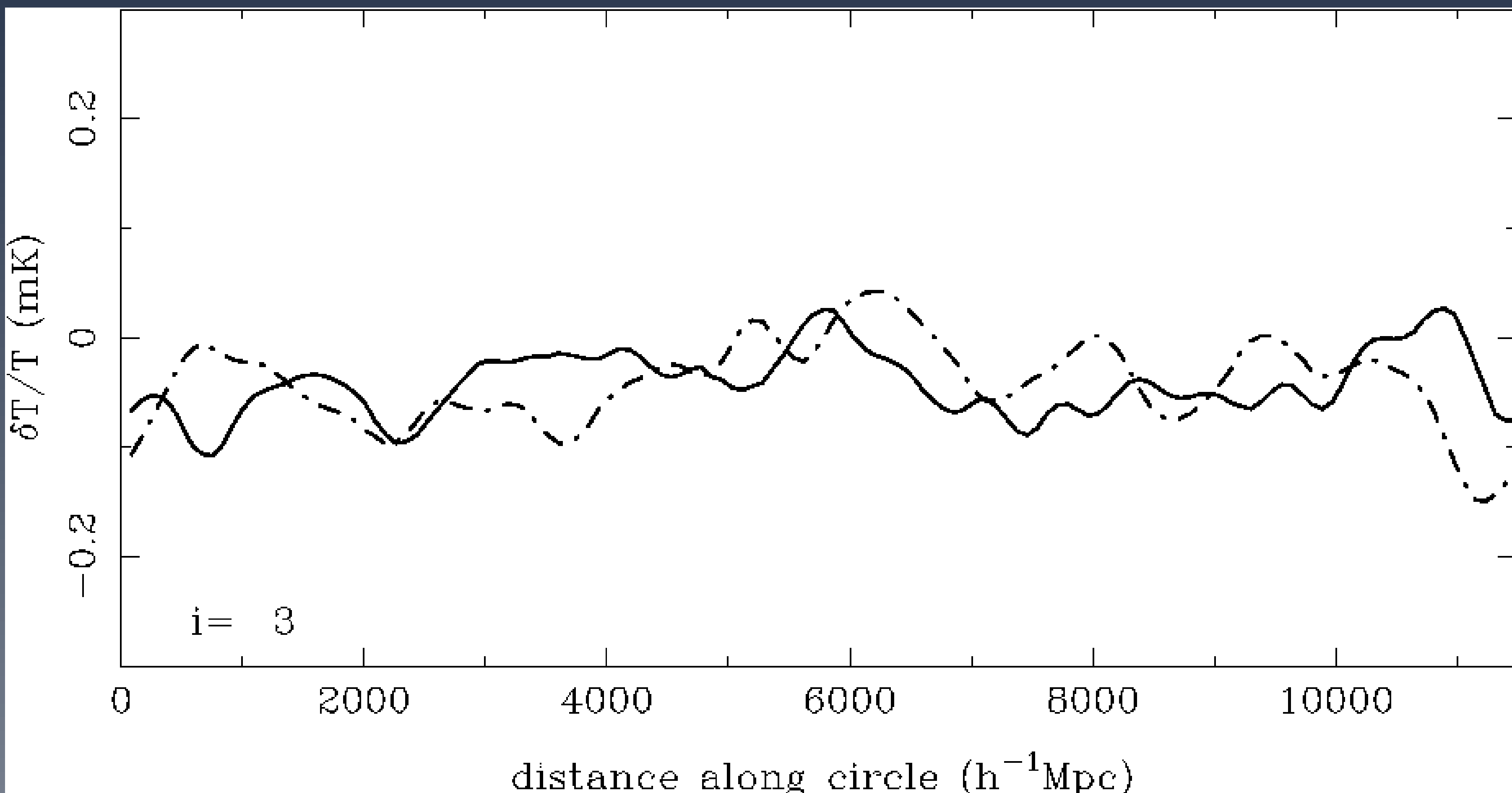
The Poincaré Dodecahedral 3-Manifold



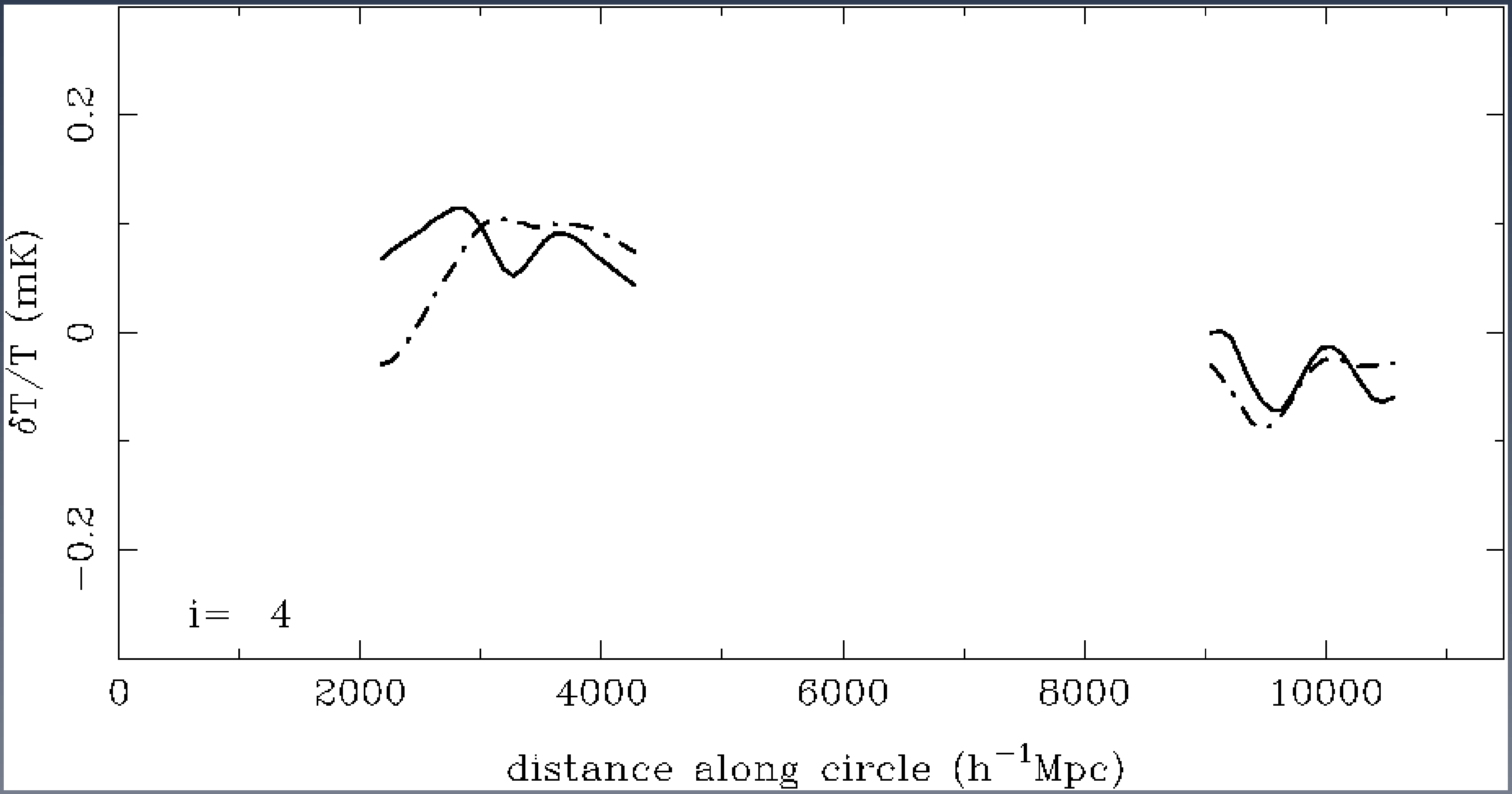
The Poincaré Dodecahedral 3-Manifold



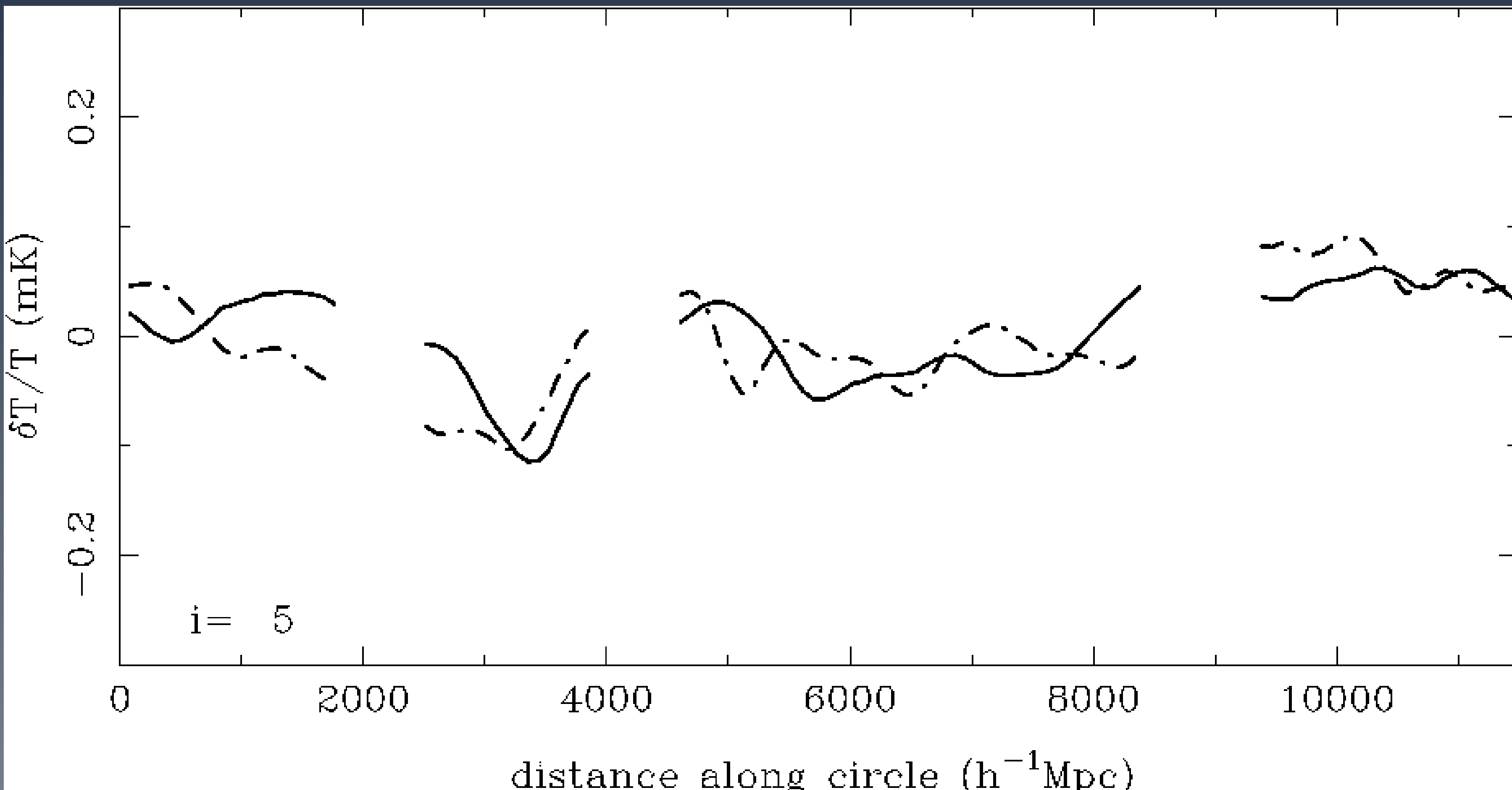
The Poincaré Dodecahedral 3-Manifold



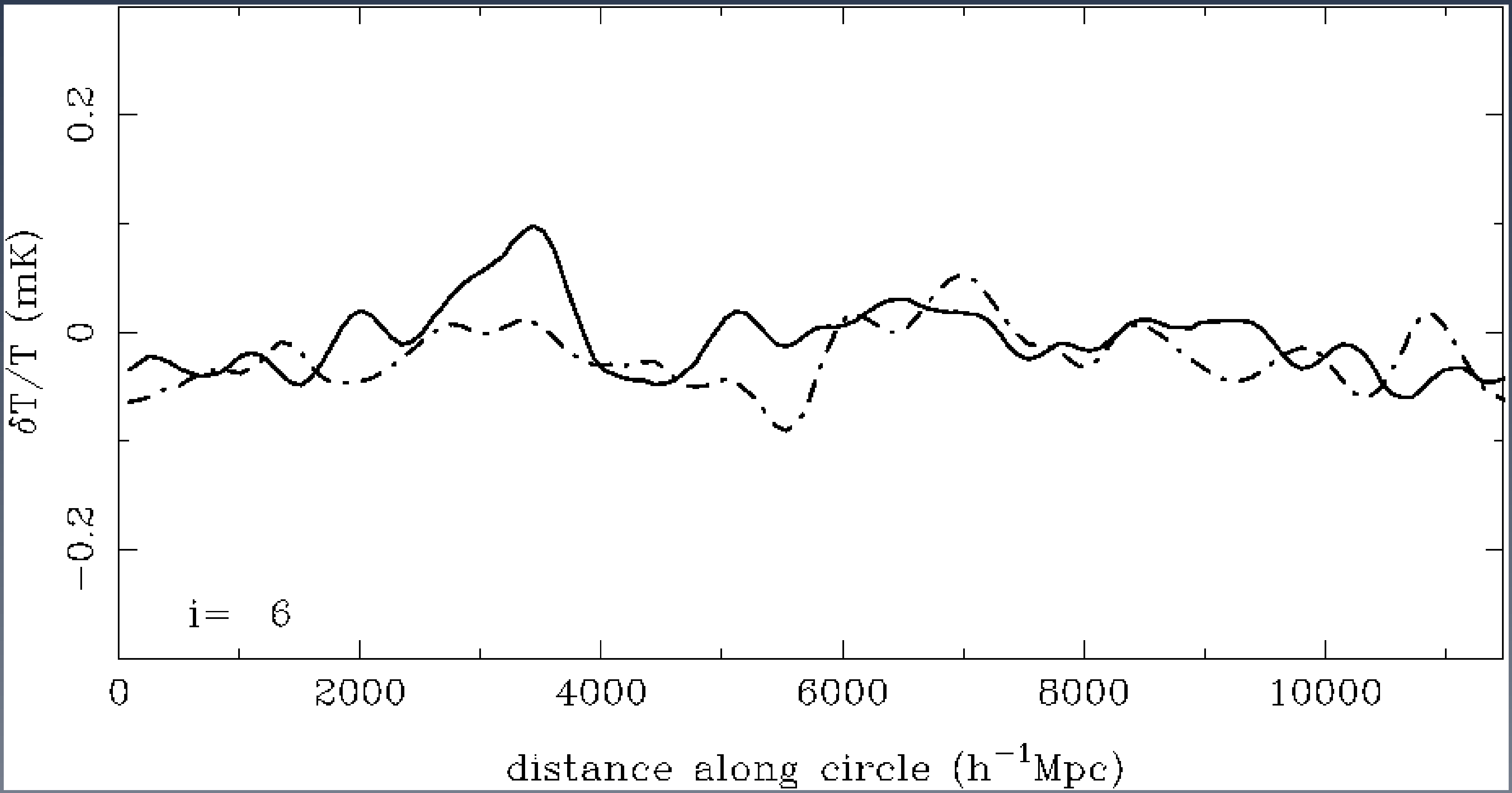
The Poincaré Dodecahedral 3-Manifold



The Poincaré Dodecahedral 3-Manifold



The Poincaré Dodecahedral 3-Manifold



Dodecahedral Hypothesis: Conclusions

- best Poincaré dodecahedral solution has $11 \pm 1^\circ$ matched circles
- the six circle pairs independently have high correlations

Dodecahedral Hypothesis: Conclusions

i	l^{II} in °	b^{II} in °	α in °
1	252.4	64.7	9.8
2	50.6	50.8	10.7
3	143.8	37.8	10.7
4	207.5	9.5	10.7
5	271.0	2.7	11.8
6	332.8	25.0	10.7

Roukema, Lew, Cechowska, Marecki, Bajtlik, A&A in press (2004)

http://arXiv.org/abs/astro-ph/0402608

Quasars

Roukema B. F.
1996, Monthly Notices of the Royal Astronomical Society, 283, 1147
On Determining the Topology of the Observable Universe via 3-D Quasar Positions

Clusters of Galaxies Candidate

Roukema B. F., Edge A. C. (X-ray)

1997, Monthly Notices of the Royal Astronomical Society, 292, 105

Constraining Cosmological Topology via Highly Luminous X-ray Clusters

Clusters of Galaxies Candidate

Roukema B. F., Edge A. C. (X-ray)
1997, Monthly Notices of the Royal Astronomical Society, 292, 105
Constraining Cosmological Topology via Highly Luminous X-ray Clusters

Roukema B. F., Bajtlik, S. (optical)
1999, Monthly Notices of the Royal Astronomical Society, 308, 309
Transverse Galaxy Velocities from Multiple Topological Images

Clusters of Galaxies Candidate

Roukema B. F. (microwave background)
2000a, Monthly Notices of the Royal Astronomical Society, 312, 712 *COBE and Global Topology: An Example of the Application of the Circles Principle*

Application: Constraints on Curvature

Roukema B. F., Luminet, J.–P.

1999, Astronomy & Astrophysics, 348, 8

Constraining Curvature Parameters via Topology

Cosmic Microwave Background (COBE)

Roukema B. F.

2000b, Classical & Quantum Gravity, 17, 3951

A Counterexample to Claimed COBE Constraints on Compact Toroidal Models

Radio-Loud Active Galactic Nuclei (RLAGNs) + Cosmic Microwave Background (WMAP)

work under progress at Toruń Centre for Astronomy, UMK

Radio-Loud Active Galactic Nuclei (RLAGNs) + Cosmic Microwave Background (WMAP)

work under progress at Toruń Centre for Astronomy, UMK

- Marcin Gawroński, Magdalena Kunert, Andrzej Marecki, Sebastian Soberski (RLAGNs)

Radio-Loud Active Galactic Nuclei (RLAGNs) + Cosmic Microwave Background (WMAP)

work under progress at Toruń Centre for Astronomy, UMK

- Marcin Gawroński, Magdalena Kunert, Andrzej Marecki, Sebastian Soberski (RLAGNs)
- Magdalena Cechowska, Bartosz Lew (WMAP)

Radio-Loud Active Galactic Nuclei (RLAGNs) + Cosmic Microwave Background (WMAP)

work under progress at Toruń Centre for Astronomy, UMK

- Marcin Gawroński, Magdalena Kunert, Andrzej Marecki, Sebastian Soberski (RLAGNs)
- Magdalena Cechowska, Bartosz Lew (WMAP)
- http://adjani.astro.uni.torun.pl/cosmo

Theory: Cosmic Topology vs Inflation

Peaks in the Hartle-Hawking Wave Function from Sums over Topologies
Anderson, Carlip, Ratcliffe, Surya, Tschantz, 2003
http://arXiv.org/abs/gr-qc/0310002

• some topologies are much more probable than others

• spatial metrics of constant (negative) curvature are favoured

• work incomplete, but hints at predictability

Fine-Tuning

- observable $\Omega_\Lambda > 0 \Rightarrow$ fine-tuning of inflation

- observable cosmic topology $\Rightarrow$ fine-tuning of inflation

- both might be the result of the same fine-tuning of inflation, or else of some other mechanism (e.g. peak in Hartle-Hawking wave function from sums over topologies)

ArFus: Galaxy Formation Software for the Ordinary User

(printed transparencies)

Distance calculations in cosmology

- light-travel distance:

$$d_{\mathrm{light\text{-}travel}} = \int_t^{t_0} c \, \mathrm{d}t' \tag{5}$$

proper distance = comoving distance =

$$\chi = \int_t^{t_0} \frac{c\,\mathrm{d}t'}{a(t')}$$

proper distance = comoving distance =

$$\chi = \int_t^{t_0} \frac{c\,\mathrm{d}t'}{a(t')} = \frac{c}{H_0}\int_{1/(1+z)}^{1} \frac{\mathrm{d}a}{a\sqrt{\Omega_\mathrm{m}/a - \Omega_\kappa + \Omega_\Lambda a^2}} \tag{6}$$

http://www.wikipedia.org/wiki/Comoving_coordinates proper motion distance = coordinate distance =

$$d_{\mathrm{pm}} = \begin{cases} R_C \sinh \frac{\chi}{R_C} & k = -1 \\ \chi & k = 0 \\ R_C \sin \frac{\chi}{R_C} & k = +1 \end{cases} \quad (7)$$

proper motion distance = coordinate distance =

$$d_{\rm pm} = \begin{cases} R_C \sinh \frac{\chi}{R_C} & k = -1 \\ \chi & k = 0 \\ R_C \sin \frac{\chi}{R_C} & k = +1 \end{cases} \tag{7}$$

$$d_{\rm L} = (1+z) d_{\rm pm} = (1+z)^2 d_{\rm a} \tag{8}$$

FLRW metric

$$\mathrm{d}s^2 = c^2 \mathrm{d}t^2 - a^2(t) \left[\mathrm{d}\chi^2 + \mathrm{d}d_{\mathrm{pm}}^2 (\mathrm{d}\theta^2 + \cos^2\theta \mathrm{d}\phi^2) \right] \quad (9)$$

Non-radial spatial geodesics

What is the comoving distance between two objects at different celestial positions and different redshifts, for an arbitrary curvature 0 + - ?

Distances on the 2-sphere

$$
\begin{aligned}
x_i &= R \cos \delta_i \cos \alpha_i \\
y_i &= R \cos \delta_i \sin \alpha_i \\
w_i &= R \sin \delta_i
\end{aligned}
\tag{10}
$$

Distances on the 2-sphere

$$
\begin{aligned}
x_i &= R \cos \delta_i \cos \alpha_i \\
y_i &= R \cos \delta_i \sin \alpha_i \\
w_i &= R \sin \delta_i
\end{aligned}
\tag{10}
$$

$$
\langle a_1, a_1 \rangle = x_1 x_2 + y_1 y_2 + w_1 w_2 \tag{11}
$$

(cf 15, 17)

but also:

$$\langle a_1, a_1 \rangle = R^2 \cos \theta_{12}. \tag{12}$$

but also:

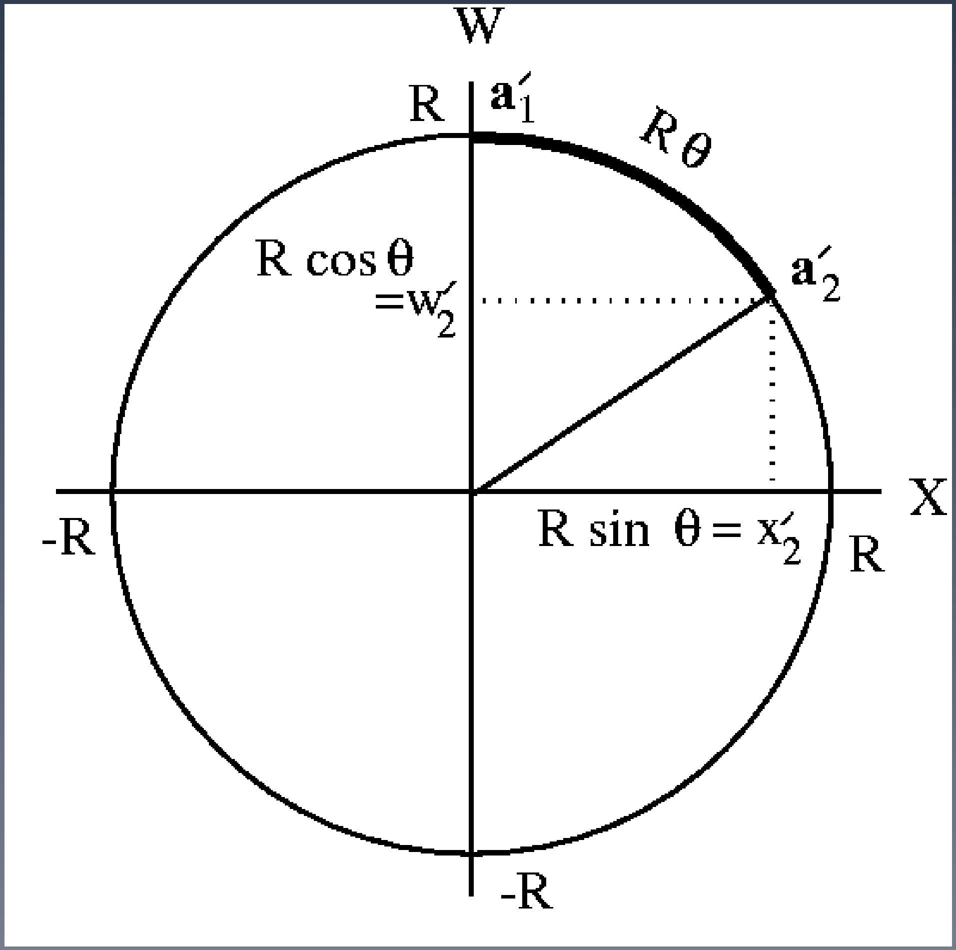
$$\langle a_1, a_1 \rangle = R^2 \cos \theta_{12}. \tag{12}$$

a distance in $\mathcal{S}^2$ = arc-length in $\mathcal{R}^3$:

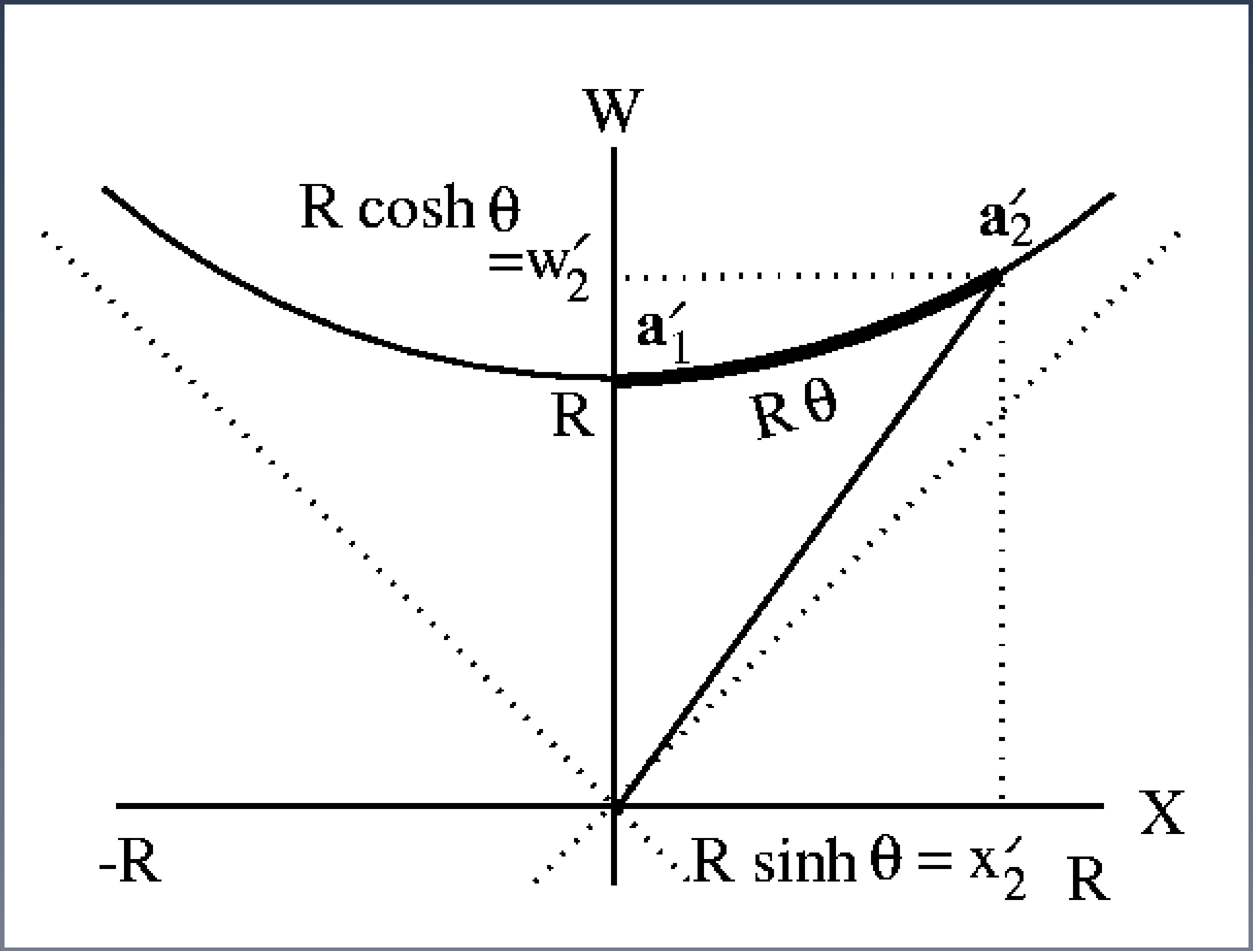
$$\chi_{12} = R\, \theta_{12} = R\ \cos^{-1} \left[\langle a_1, a_2 \rangle / R^2 \right]. \tag{13}$$

(cf 18)

positive curvature



negative curvature



Distances on the 3-sphere (3-hyperboloid)

$$\Sigma(\chi_i) \equiv \begin{cases} R \ \sinh(\chi_i/R) & k \equiv -1 \\ \chi_i & k \equiv 0 \\ R \ \sin(\chi_i/R) & k \equiv +1 \end{cases} \tag{14}$$

$$\begin{aligned} x_i &= \Sigma(\chi_i)\cos\delta_i\cos\alpha_i \\ y_i &= \Sigma(\chi_i)\cos\delta_i\sin\alpha_i \\ z_i &= \Sigma(\chi_i)\sin\delta_i \\ w_i &= \begin{cases} R \ \cosh(\chi_i/R) & k = -1 \\ 0 & k = 0 \quad \text{(cf eq. (10))} \\ R \ \cos(\chi_i/R) & k = +1 \end{cases} \end{aligned} \tag{15}$$

metric on $\mathcal{S}^3$ (or $\mathcal{R}^3$ or $\mathcal{H}^3$):

$$\mathrm{d}s^2 = \begin{cases} k\,(\mathrm{d}x^2 + \mathrm{d}y^2 + \mathrm{d}z^2) + \mathrm{d}w^2 & k = \pm 1 \\ \mathrm{d}x^2 + \mathrm{d}y^2 + \mathrm{d}z^2 & k = 0. \end{cases} \tag{16}$$

inner product (cf 11):

$$\langle a_1, a_2 \rangle \equiv \begin{cases} k\,(x_1 x_2 + y_1 y_2 + z_1 z_2) + w_1 w_2 & k = \pm 1 \\ x_1 x_2 + y_1 y_2 + z_1 z_2 & k = 0. \end{cases} \tag{17}$$

generalisation of eq. (13):

$$\chi_{12} = \begin{cases} R \cosh^{-1}\left[\langle a_1, a_2\rangle / R^2\right] & k = -1 \\ \sqrt{\langle a_1 - a_2, a_1 - a_2\rangle} & k = 0 \\ R \cos^{-1}\left[\langle a_1, a_2\rangle / R^2\right] & k = +1. \end{cases} \quad (18)$$

a distance in $\mathcal{S}^3$ is an arc-length in $\mathcal{R}^4$

generalisation of eq. (13):

$$\chi_{12} = \begin{cases} R\cosh^{-1}\left[\langle a_1, a_2\rangle / R^2\right] & k = -1 \\ \sqrt{\langle a_1 - a_2, a_1 - a_2\rangle} & k = 0 \\ R\cos^{-1}\left[\langle a_1, a_2\rangle / R^2\right] & k = +1. \end{cases} \quad (18)$$

a distance in $\mathcal{S}^3$ is an arc-length in $\mathcal{R}^4$

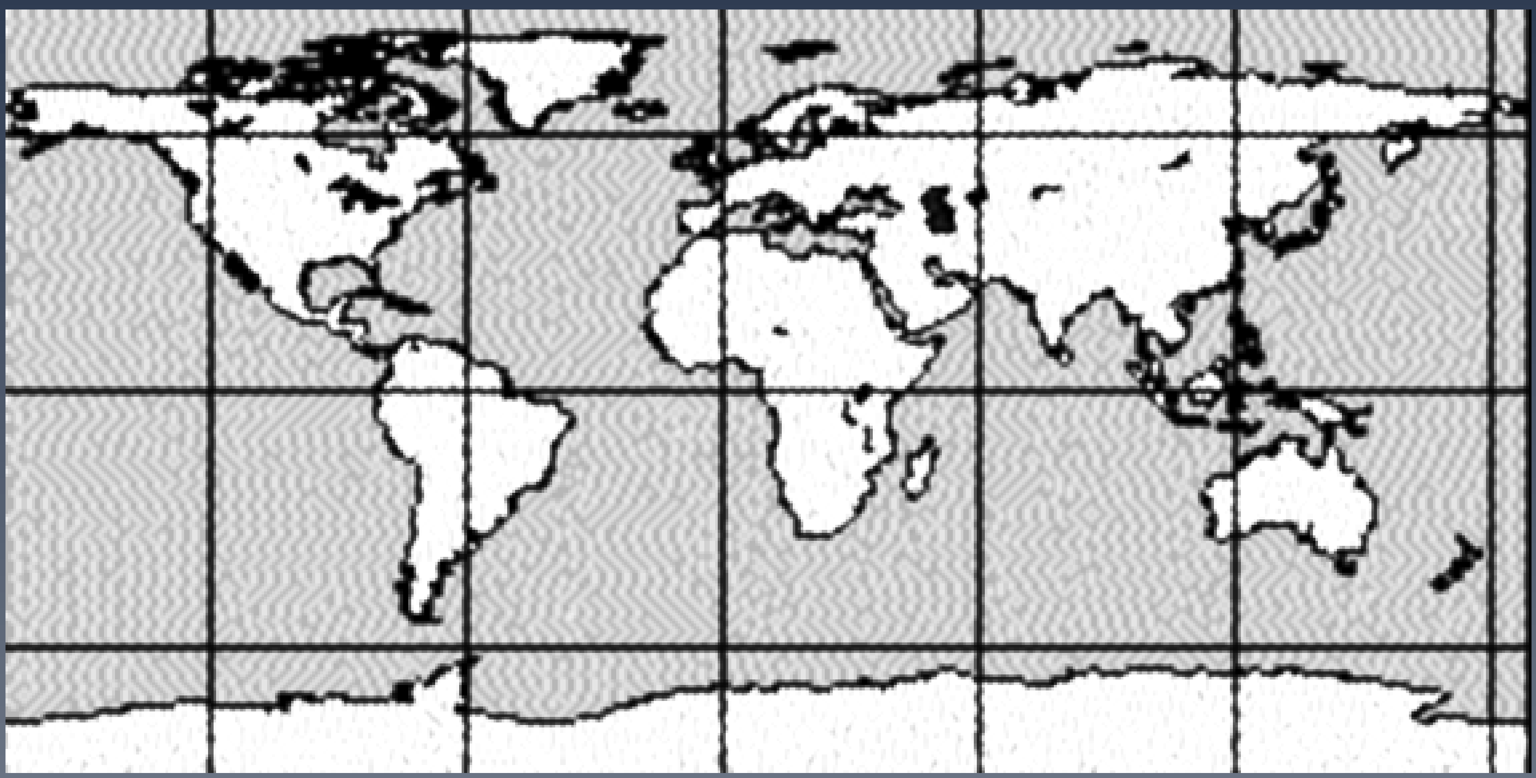
a distance in $\mathcal{H}^3$ is an arc-length in $\mathcal{M}^4$

http://arXiv.org/abs/astro-ph/0102099

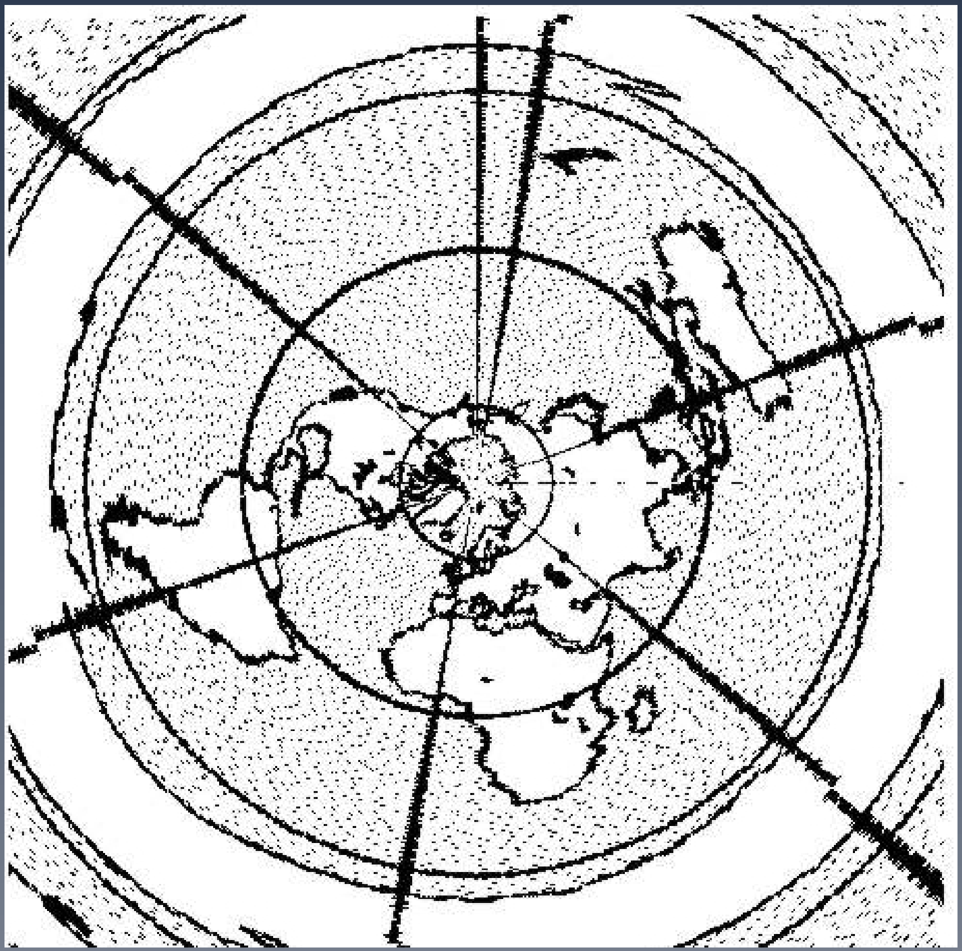
Czy Wszechświat jest krzywizony jak sfery?

- How can we think of curvature?
- How can we measure curvature?
- Finding a standard ruler
- Using a standard ruler - LSS
- 2dF Quasar redshift survey - 2QZ

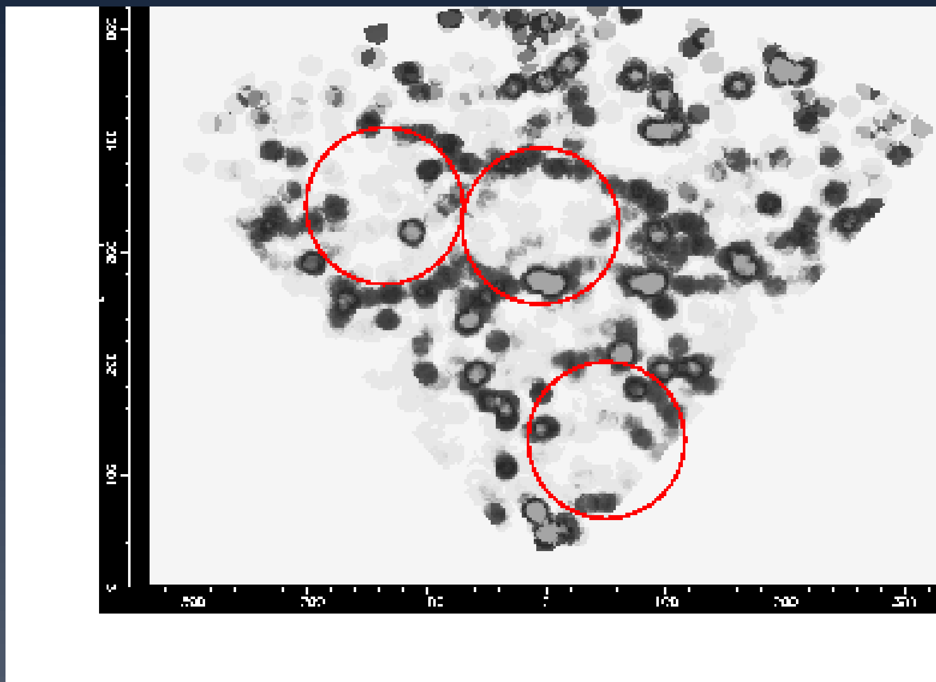
Płaska Ziemia?



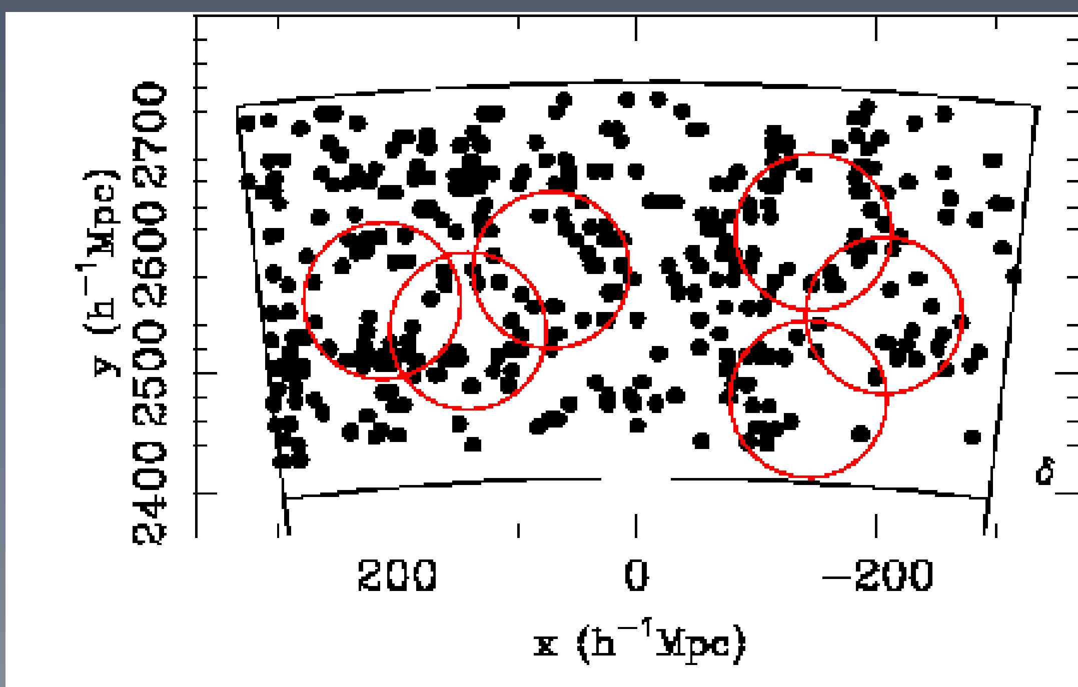
Druga płaska Ziemia?



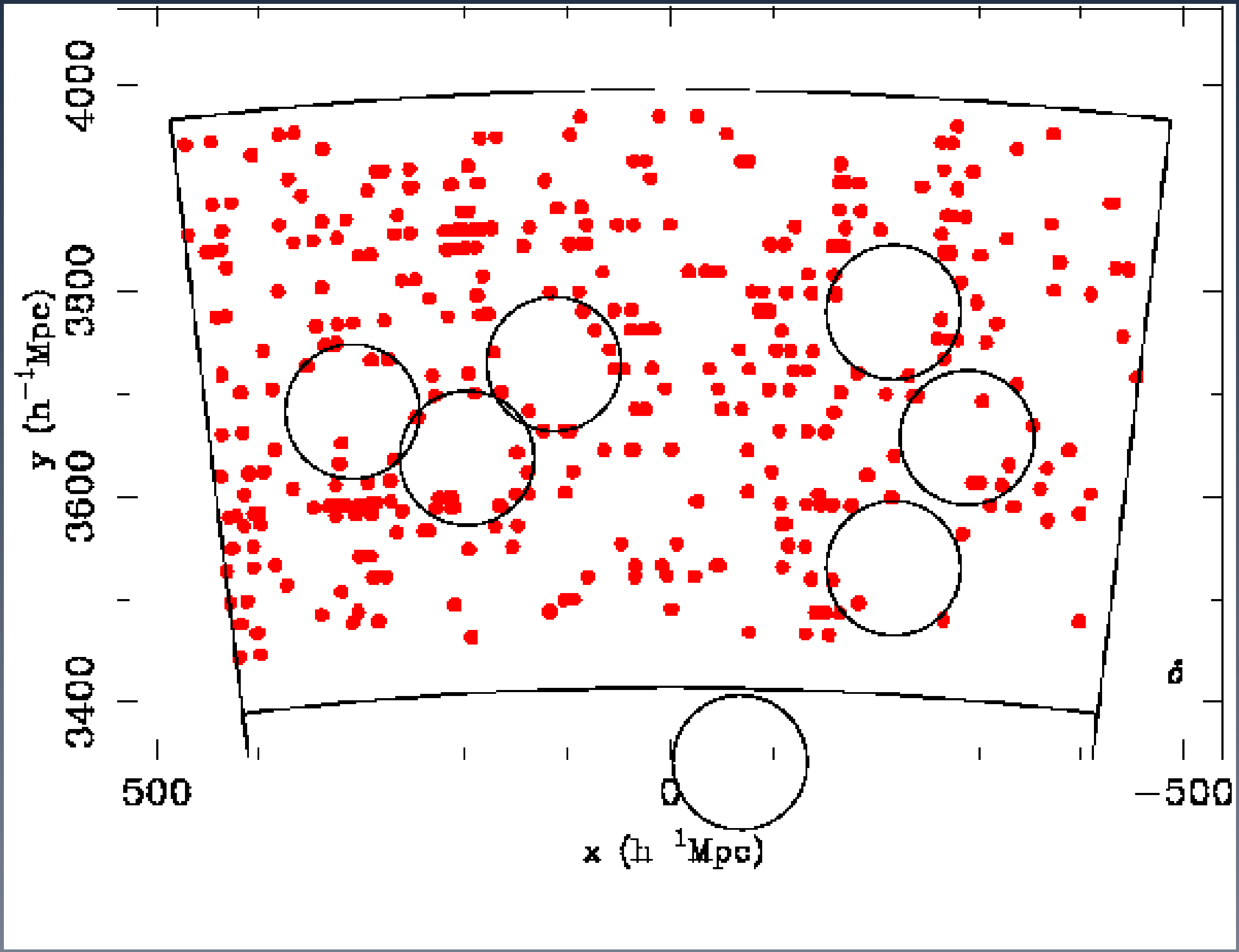
A Standard Ruler: LS Structure Bubbles



$z0$ $\Lambda0$ Λ



Distant quasars: flat WITH cosm constant



$z0$ $\Lambda 0$ Λ

Standard Ruler Constraints on Ω_Λ and Ω_m from the 2dF QSO z Survey – 2QZ-10K

Collaborators :

- Gary Mamon (IAP; ObsParis–Meudon)
- Stanislaw Bajtlik (CAMK)
- results from the Iovino, Clowes & Shaver (1996) catalogue:

tangential: Roukema & Mamon (2000, A&A, 358, 395)

3-D: Roukema & Mamon (2001, A&A, 366, 1)

- results from the 2dF Quasar z survey early release (2QZ-10K):

Roukema, Mamon & Bajtlik (2001, A&A submitted, arXiv:astro-ph/0106135)

Local Cosmological Geometry

- cosmological constant: $\mathbf{\Omega_\Lambda}$
- density parameter: $\mathbf{\Omega_m}$
- curvature (−,0 or +): $\mathbf{\Omega_\kappa \equiv \Omega_m + \Omega_\Lambda - 1}$
- comoving "proper" distance: $\mathbf{d(z) = d(\Omega_m, \Omega_\Lambda, z)}$

A Good Standard Cosmological Ruler

- should be fixed in "physical" coordinates or in comoving coordinates
- should be on scale too large to evolve in a Hubble time
- $\Rightarrow$ comoving ruler best
- $\Rightarrow$ fine feature in $\mathbf{P}(\mathbf{k})$ or the 2-point spatial correlation function $\xi(\mathbf{r})$ of density perturbations

Observational data sets Iovino, Clowes & Shaver (1996): RM00, RM01

- $\mathbf{N = 812}$ high-quality quasar candidates

2QZ-10K: RMB01

- 11000 quasars in initial "10K" release

http://www.2dFquasar.org/ – includes spectra!!

- 10K release: $> \mathbf{85\%}$ "spectroscopic" completeness

- $\mathbf{N = 2378}$ of these fall in regions above 80% "coverage" completeness

- 6 fields $\Rightarrow$ 6 independent measurements of $\xi(\mathbf{r})$ for any given redshift interval

- three redshift intervals:

$$\mathbf{0.6 < z < 1.1,\ 1.1 < z < 1.6,\ 1.6 < z < 2.2}$$

Analysis method

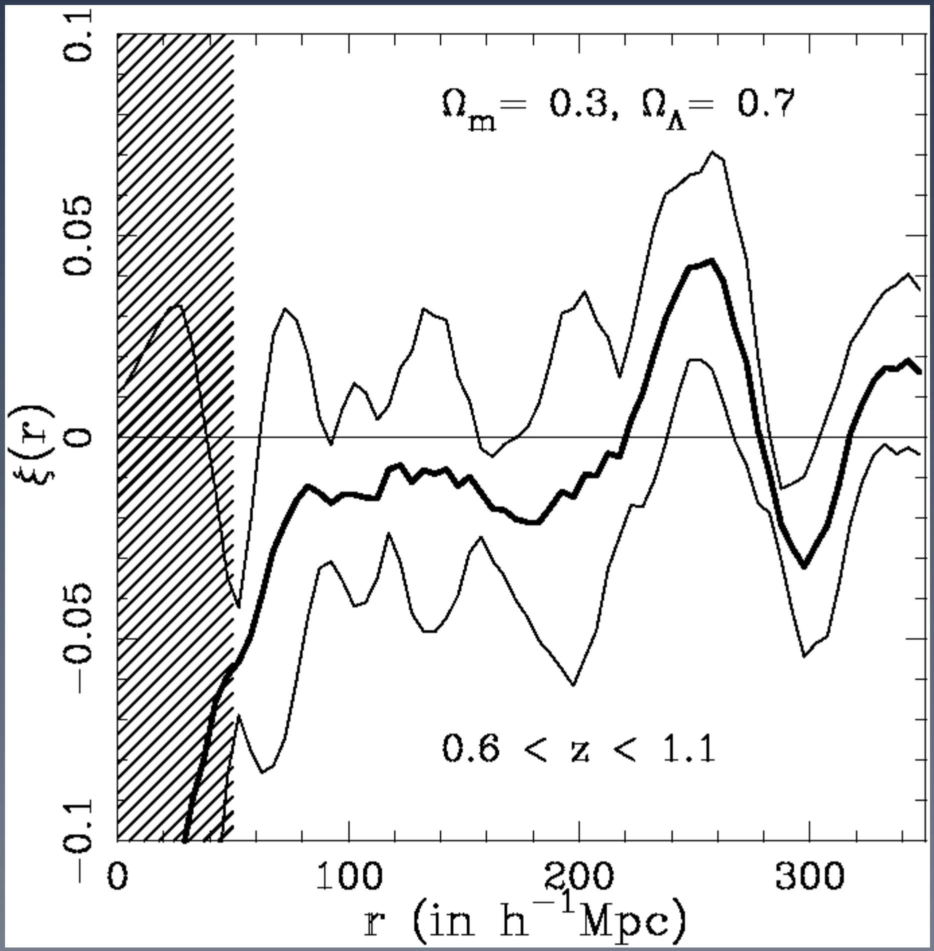
$$\xi(\mathbf{r}) = (\mathbf{DD} - \mathbf{2DR}/\mathbf{n} + \mathbf{RR}/\mathbf{n^2})/(\mathbf{RR}/\mathbf{n^2})$$

- $\mathbf{DD} =$ number of Data-Data pairs in the $\mathbf{i^{th}}$ bin
$\mathbf{r_1 + (i-1)\Delta r < r < r_1 + i\Delta r}$
- $\mathbf{DR} =$ number of Data-Random pairs in $\mathbf{i^{th}}$ bin
- $\mathbf{RR} =$ number of Random-Random pairs in $\mathbf{i^{th}}$ bin
- $\mathbf{n} = \mathbf{N}$(Random points)$/\mathbf{N}$(Data points)

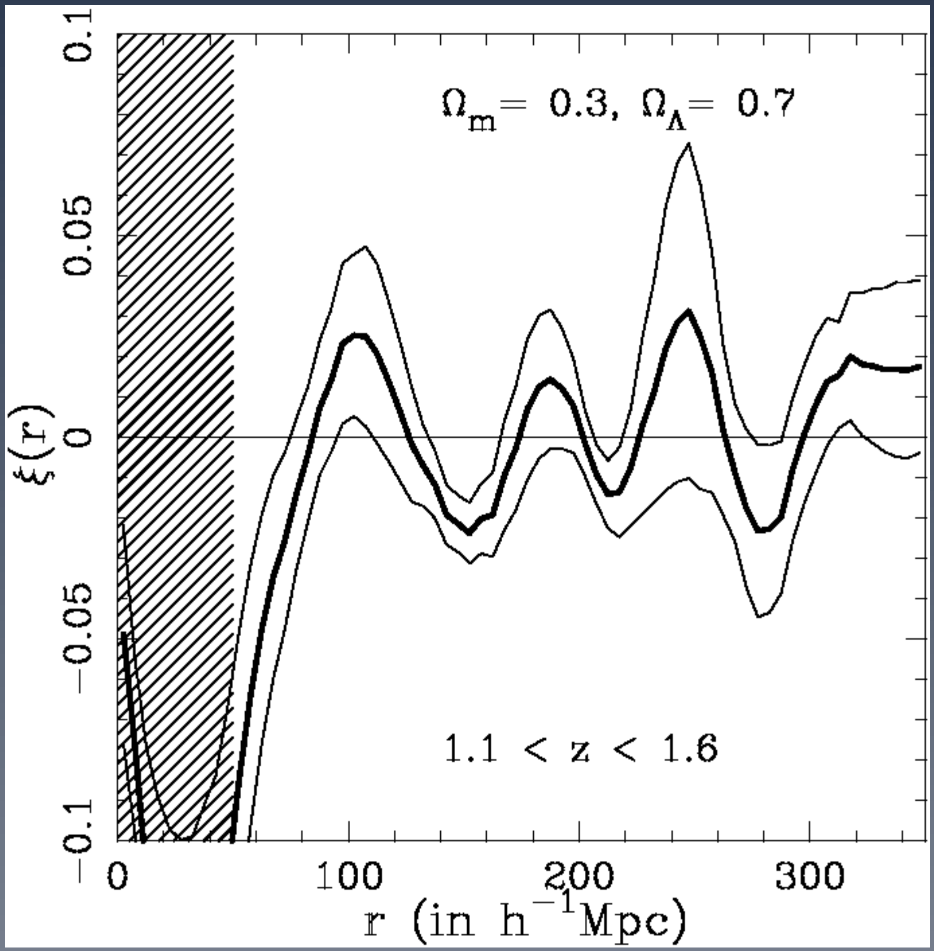
z-scrambling (Osmer 1981):

- angular positions of random data sets = those of the observations
- redshifts of random data sets = those of the observations, but in a randomised order
- $\Rightarrow$ selection effects in z and angle are cancelled
- $\Rightarrow$ conservative results – the real correlations might partly be cancelled along with selection effects

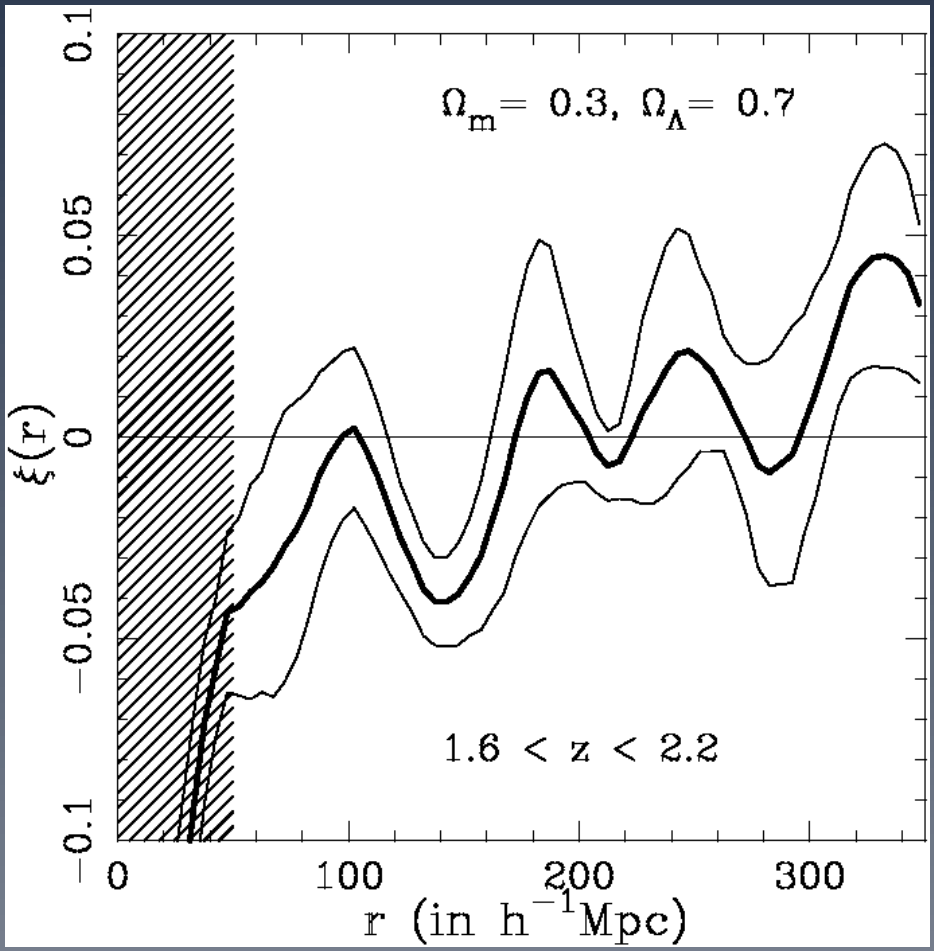
$0.6 < z < 1.1, \Omega_{\rm m} = 0.3, \Omega_\Lambda = 0.7$



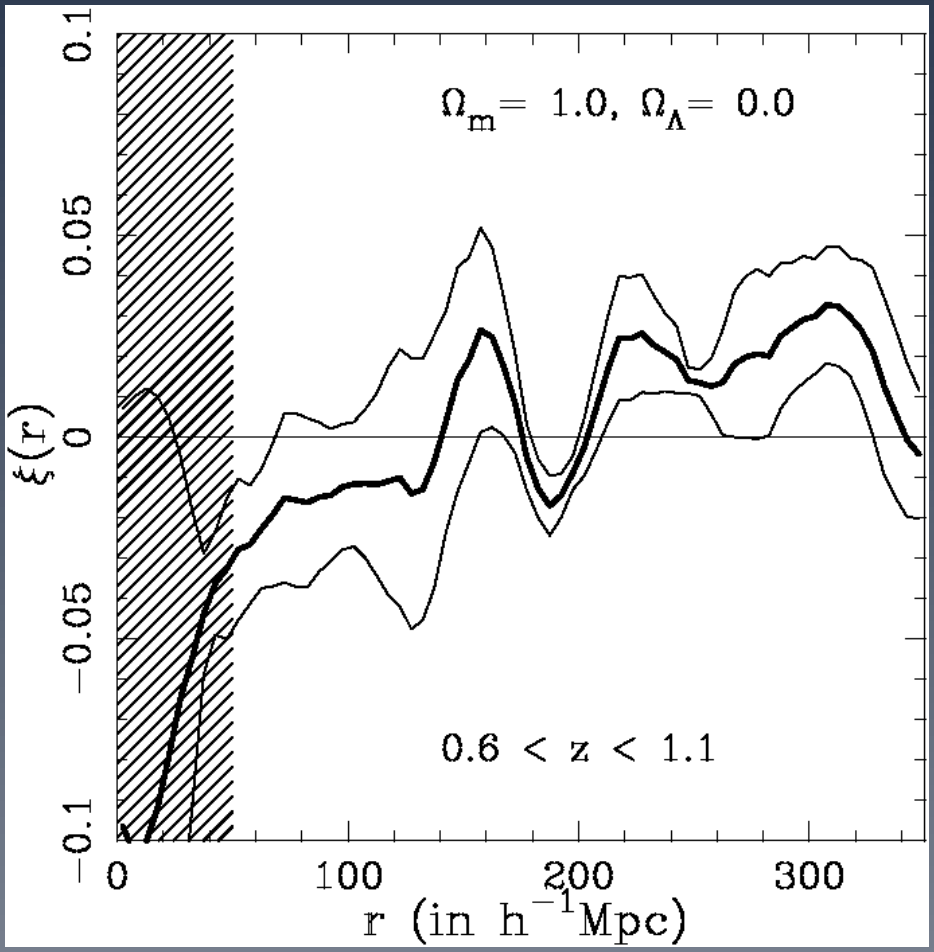
$1.1 < z < 1.6, \Omega_m = 0.3, \Omega_\Lambda = 0.7$



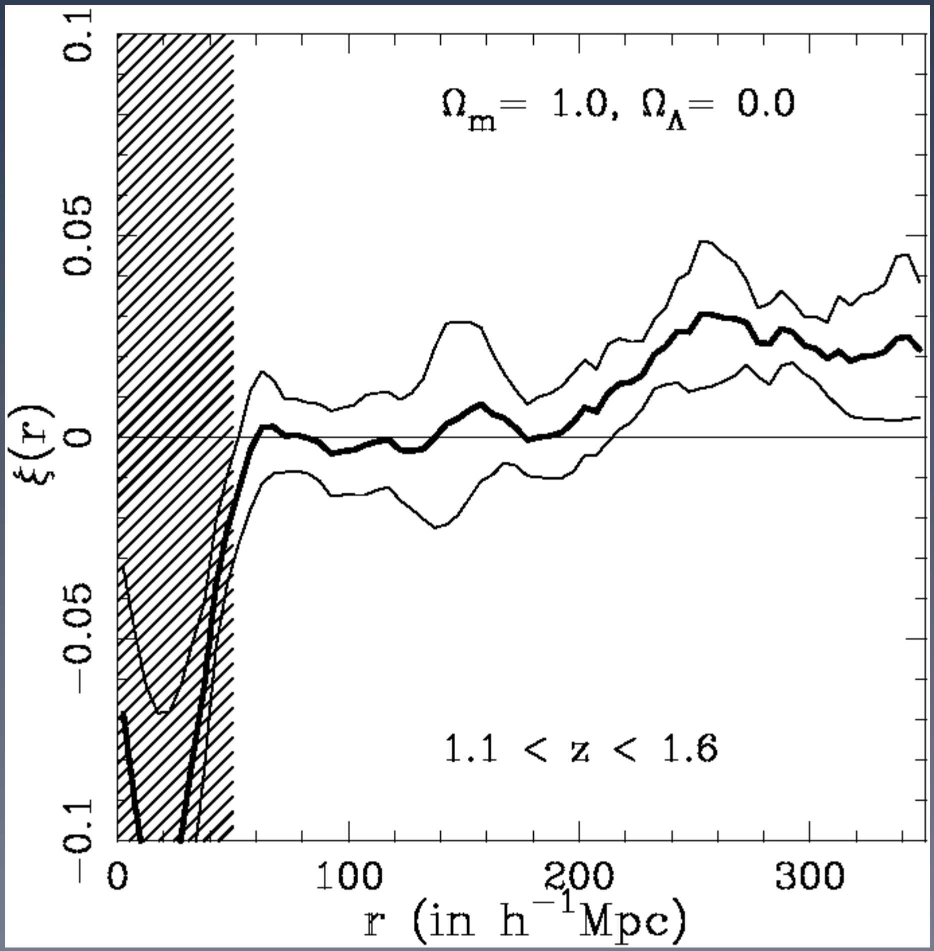
$1.6 < z < 2.2, \Omega_{\rm m} = 0.3, \Omega_\Lambda = 0.7$



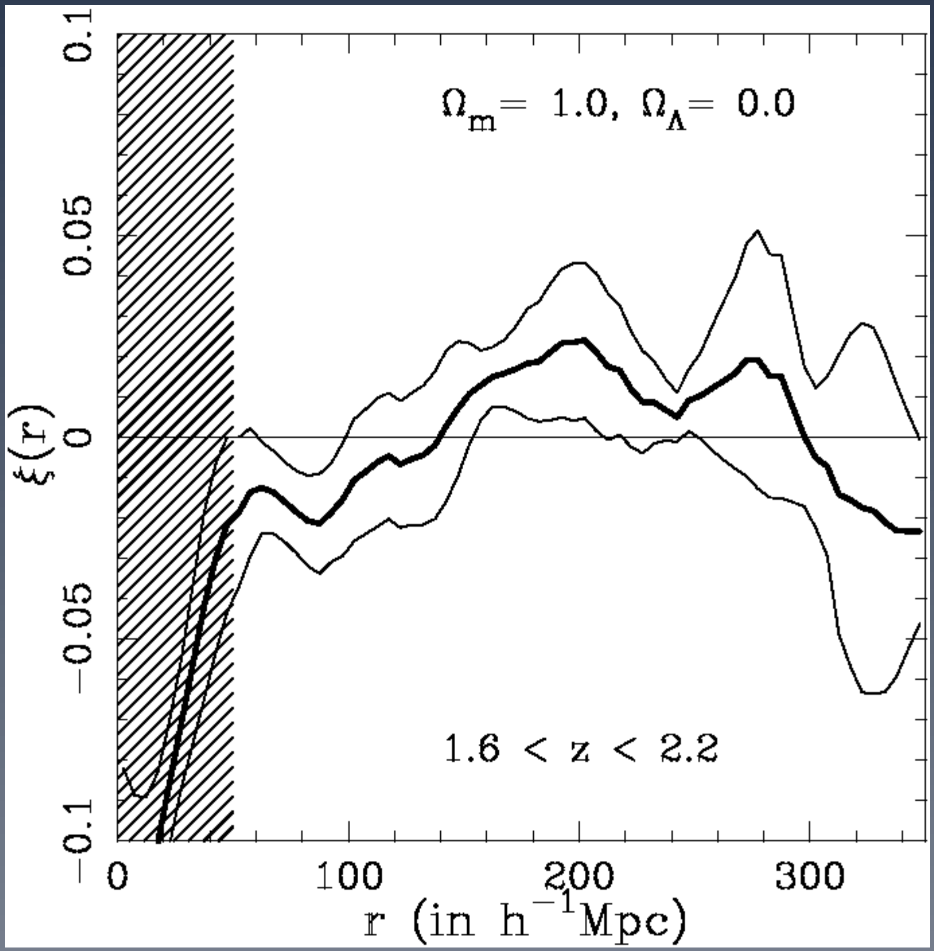
$0.6 < z < 1.1, \Omega_\mathrm{m} = 1.0, \Omega_\Lambda = 0.0$



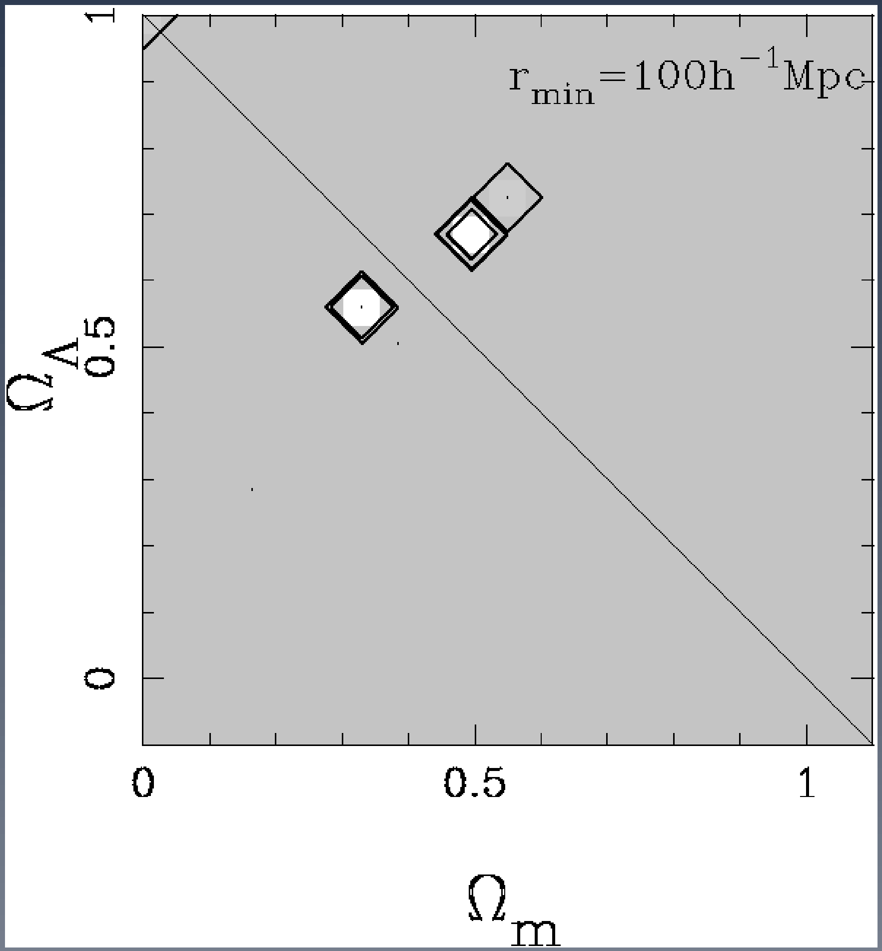
$1.1 < z < 1.6, \Omega_m = 1.0, \Omega_\Lambda = 0.0$



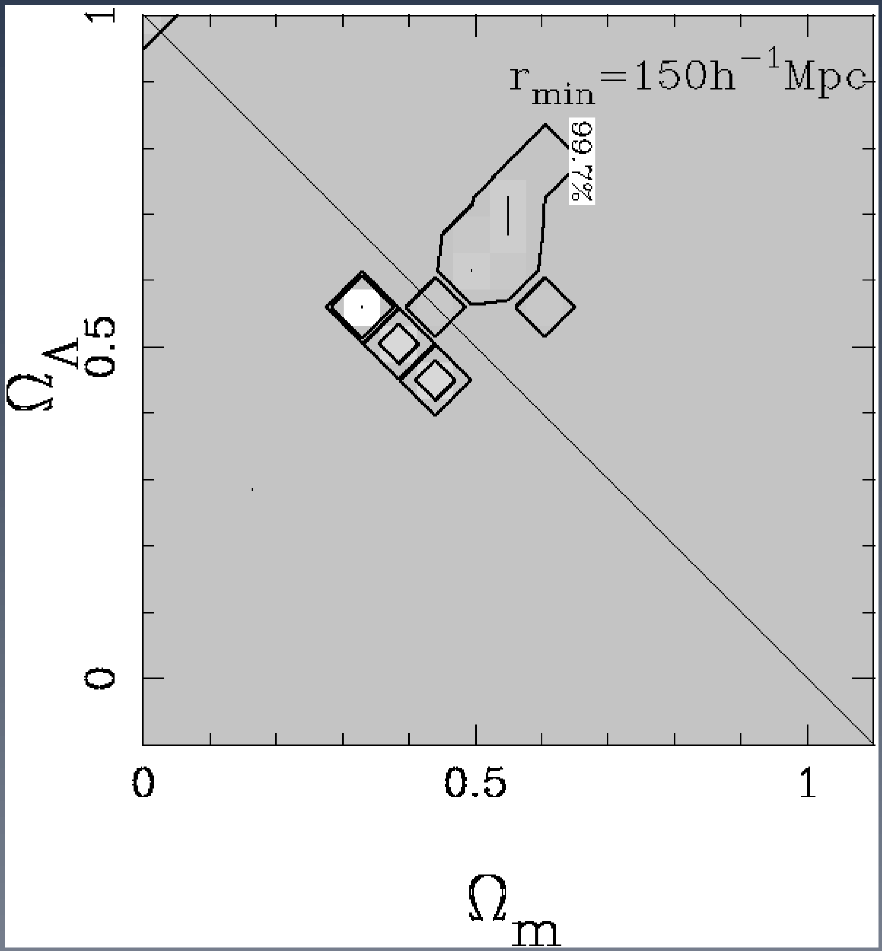
$1.6 < z < 2.2, \Omega_m = 1.0, \Omega_\Lambda = 0.0$



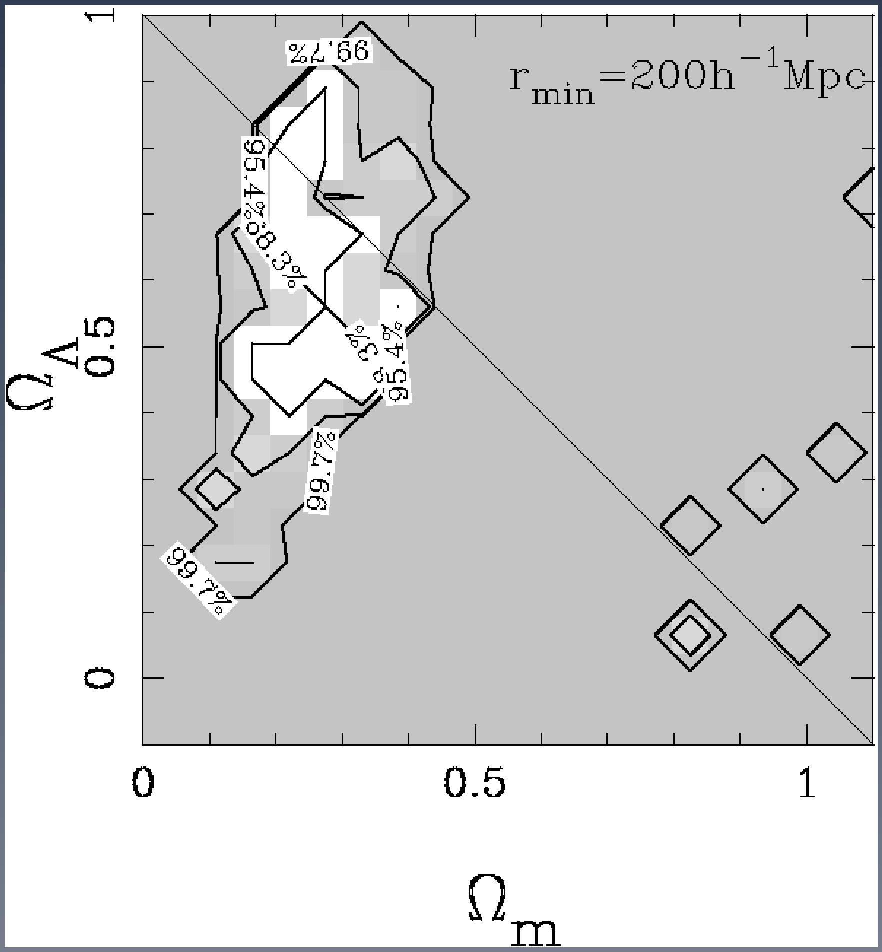
$\Omega_{\rm m}, \Omega_\Lambda$ plane



$\Omega_\mathrm{m}, \Omega_\Lambda$ plane



$\Omega_{\rm m}, \Omega_\Lambda$ plane



Conclusions

- a local maximum in $\xi(\mathbf{r})$ is present in all three redshift ranges of the 2QZ-10K in only one region of the $\mathbf{\Omega_m}, \mathbf{\Omega_\Lambda}$ plane, its scale is:

$\mathbf{2L = 244 \pm 17}\mathrm{h}^{-1}$ Mpc

Conclusions

- a local maximum in $\xi(\mathbf{r})$ is present in all three redshift ranges of the 2QZ-10K in only one region of the $\mathbf{\Omega_m}, \mathbf{\Omega_\Lambda}$ plane, its scale is:
$\mathbf{2L = 244 \pm 17}\mathrm{h}^{-1}$ Mpc

- this region is:
$\mathbf{\Omega}_{\mathrm{m}} = \mathbf{0.25 \pm 0.10}, \mathbf{\Omega_\Lambda} = \mathbf{0.65 \pm 0.25}$ (68% confidence),
$\mathbf{\Omega}_{\mathrm{m}} = \mathbf{0.25 \pm 0.15}, \mathbf{\Omega_\Lambda} = \mathbf{0.60 \pm 0.35}$ (95% confidence)

Conclusions

• a local maximum in $\xi(\mathbf{r})$ is present in all three redshift ranges of the 2QZ-10K in only one region of the $\mathbf{\Omega_m}, \mathbf{\Omega_\Lambda}$ plane, its scale is:
$\mathbf{2L = 244 \pm 17}\mathrm{h}^{-1}$ Mpc

• this region is:
$\mathbf{\Omega_{\mathrm{m}} = 0.25 \pm 0.10, \Omega_\Lambda = 0.65 {\pm} 0.25}$ (68% confidence),
$\mathbf{\Omega_{\mathrm{m}} = 0.25 \pm 0.15, \Omega_\Lambda = 0.60 {\pm} 0.35}$ (95% confidence)

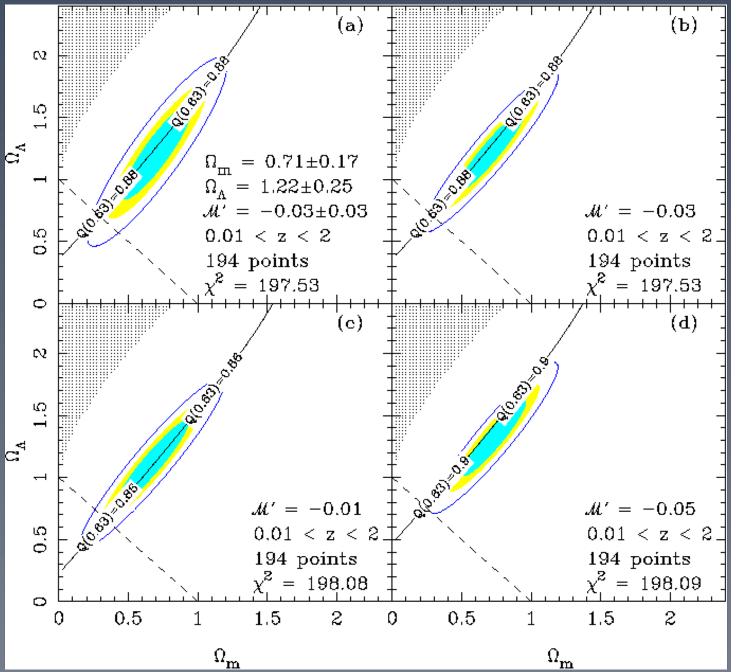
• independently of the SNe Ia data, $\mathbf{\Omega_\Lambda = 0}$ is rejected at 99.7% confidence

In simple words:

Using the large scale structure "bubbles" traced by galaxies and quasars as a standard ruler, distant structures match nearby structures best if the Universe is approximately flat with about 70% of matter-energy density in a cosmological constant.

194 SNe — Roy Choudhury & Padmanabhan (2003)

http://arxiv.org/abs/astro-ph/0311622



quintessence parameters: w_0, w_1