OBSERVATIONAL APPROACHES TO THE TOPOLOGY OF THE UNIVERSE

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Many different and complementary strategies for translating the basic principle of multiple topological imaging into observational analysis are now available, both for three-dimensional and two-dimensional catalogues.

1 Introduction

Observational cosmic topology[13,17] shares the fundamental observational problems of curvature estimates (evolution of objects, peculiar velocities, etc., see Section 5.3 of ref.[17]), but since the former concerns global geometry and the latter only local geometry, the former requires additional work in classifying the methods from a purely geometrical point of view. Most work is based on the principle of the existence of multiple topological images of single physical objects.

2 Complementary geometrical strategies

A. multiple topological images:

- A.i three-dimensional (collapsed astrophysical objects):
  - A.i.1 local isometries[18,24,25] - multiple occurrence of "type I pairs" or "local pairs"
  - A.i.2 cosmic crystallography[15,16,8,6,7,9,10,24,25] - multiple occurrence of "type II pairs" or "generator pairs", i.e. of pairs of objects in comoving space separated by a generator
    - for comparison, the uncorrelated pairs from simply connected random simulations could be called "type III pairs" or "random pairs"
  - A.i.3 characteristics of individual objects[11,22,26]
- A.ii two-dimensional (microwave background, CMB):
  - A.ii.1 identified circles principle: discovery of principle[4,5] and its quantitative application to COBE data[19,21]
  - A.ii.2 patterns of spots[14]
  - A.ii.3 perturbation statistics assumptions: see refs listed under (i) in Section 1.2 of ref.[19]; controversy against[2] and in favour of[12,1,3] hyperbolic compact 3-manifolds by applying these assumptions to COBE data remains

B. other:

- B.i cosmic strings[23]
- B.ii nested crystallography[20]

References

1. Aurich R., 1999, ApJ., 524, 497 (arXiv:astro-ph/9903032)
2. Bond J. R., Pogosyan D., Souradeep T., 1998, Class. Quant. Grav., 15, 2573 (arXiv:astro-ph/9804041); arXiv:astro-ph/9912124, arXiv:astro-ph/9912144
3. Cornish N. J., Spergel D. N., 1999, arXiv:astro-ph/9906401
4. Cornish N. J., Spergel D. N., Starkman G. D., 1996, arXiv:gr-qc/9602039
5. Cornish N. J., Spergel D. N., Starkman G. D., 1998, Class. Quant. Grav., 15, 2657 (arXiv:astro-ph/9801212)
6. Fagundes H. & Gausmann E., 1998, PhysLettA, 238, 235 (arXiv:astro-ph/9704259)
7. Fagundes H. & Gausmann E., 1999a, in Proceedings of the XIX Texas Symp. Rel. Astr. Cosmology, CD-ROM version (arXiv:astro-ph/9811368)
8. Gomero G. I., Teixeira A. F. F., Rebouças M. J., Bernui A., 1999a, arXiv:gr-qc/9811038
9. Gomero G. I., Rebouças M. J., Teixeira A. F. F., 2000, PhysLettA, in press, (arXiv:gr-qc/9909078)
10. Gomero G. I., Rebouças M. J., Teixeira A. F. F., 1999c, arXiv:gr-qc/9911049
11. Gott, J.R.I., 1980, MNRAS, 193, 153
12. Inoue K. T., 1999, arXiv:astro-ph/9810034
13. Lachièze–Rey M., Luminet J.–P., 1995, Phys. Rep., 254, 136 (arXiv:gr-qc/9605010)
14. Levin J., Scannapieco E., de Gasperis, G., Silk J., Barrow, J.D., 1999, arXiv:astro-ph/9807206
15. Lehoucq R., Luminet J.–P., Lachièze–Rey M., 1996, A&A, 313, 339 (arXiv:gr-qc/9604050)
16. Lehoucq R., Luminet J.–P., Uzan J.–Ph., 1999, A&A, 344, 735 (arXiv:astro-ph/9811107)
17. Luminet J.–P., Roukema B. F., 1999, 'Topology of the Universe: Theory and Observations', Cargèse summer school 'Theoretical and Observational Cosmology', ed. Lachièze-Rey M., Netherlands: Kluwer, p117 (arXiv:astro-ph/9901364)
18. Roukema B. F., 1996, Month. Not. R. Astron. Soc., 283, 1147
19. Roukema B. F., 2000a, Month. Not. R. Astron. Soc., 312, 712 (arXiv:astro-ph/9910272)
20. Roukema B. F., 2000b, submitted, , *Large Scale Structure Constraints on Cosmic Topology: Nested Crystallography?*
21. Roukema B. F., 2000c, Class. Quant. Grav., 17, 3951 (arXiv:astro-ph/0007140)
22. Roukema B. F., Edge A. C., 1997, Month. Not. R. Astron. Soc., 292, 105 (arXiv:astro-ph/9706166)
23. Uzan J.–Ph., Peter P., 1997, Phys. Lett., B406, 20
24. Uzan J.–Ph., Lehoucq R. & Luminet J–P., 1999, A&A, 351, 766 (arXiv:astro-ph/9903155)
25. Lehoucq R., Uzan J.–Ph. & Luminet J–P., 2000, submitted, , (arXiv:astro-ph/0005515)
26. Wichoski, U., 1999, in CTP98 proceedings, arXiv:astro-ph/0010170