New Cosmological Data and the Values of the Fundamental Parameters
IAU Symposium, Vol. 201, 2005
Anthony Lasenby and Althea Wilkinson, eds.

Angular Distribution of Gamma-Ray Bursts: An Observational Probe of Cosmological Principle

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Abstract.

The test of the isotropy in the angular distribution of the gamma-ray bursts collected in BATSE Catalog (Meegan C. A. et al. 2000) is a test of cosmological principle itself, because the gamma-ray bursts are at cosmological distances. Several articles of the authors study this question *(Balázs L. G., Mészáros A., & Horváth I., Astron. Astrophys., 339, 1, 1998; Balázs L. G., Mészáros A., Horváth I., & Vavrek R., Astron. Astrophys. Suppl., 138, 417, 1999; Mészáros A., Bagoly Z., & Vavrek R. Astron. Astrophys., 354, 1, 2000; Mészáros A., Bagoly Z., Horváth I., Balázs L.G. & Vavrek R. Astrophys. J., 539, 98, 2000).* The final conclusion concerning the validity of isotropy is complicated both by instrumental effects and by the fact that there are three subgroups of gamma-ray bursts ("short", "intermediate", "long"; separation is done with respect to the duration of bursts). The long bursts are surely up to $z \simeq 4$ (z is the redshift); for the remaining two subclasses the redshifts are unknown. The done tests of isotropy suggest (after the elimination of instrumental effects) the existence of *anisotropy* for the intermediate subclass on the confidence level $> 95\%$. On the other hand, for the remaining two subclasses the situation is unclear; there is no unambiguous rejection of isotropy for them yet on the higher than 95% confidence level. If the bursts of intermediate subclass are at high z-s (say, at $z > 0.1$), then the validity of cosmological principle would be in serious doubt.

https://doi.org/10.1017/S0074180900216793 Published online by Cambridge University Press

1. Introduction

It is shown independently by different authors (Horváth 1998; Mukherjee et al. 1998) that the gamma-ray bursts - detected by the BATSE instrument of Compton Gamma-Ray Observatory (Meegan et al. 2000) - should be separated into three subclasses with respect to their durations ("short", "intermediate" and "long" ones).

GRBs are surely at cosmological distances. Hence, they can well probe the fulfilment of cosmological principle; if this principle holds, and GRBs are at much bigger redshifts than $z > 0.1$, then they should be distributed isotropically. GRBs of long subclass are surely at these big redshifts; for the remaining two subclasses the redshifts are not known.

2. Results

The authors did several tests of isotropy. The confidence levels of various tests are collected at the Table, when the question "Is the null hypothesis of isotropy rejected?" is answered.

short	intermediate	long	test
No	Yes $> 97\%$	No	Spherical harmonics
No	Yes $> 96.4\%$	No	Counts-in-cells
Yes $> 99.2\%$	Yes $> 99.8\%$	Yes $> 99.8\%$	Two-Point-Correlation

The done tests of isotropy suggest (after the elimination of instrumental effects) the existence of **anisotropy for the intermediate subclass** on the confidence level $> 95\%$. For the remaining two subclasses the situation is unclear; there is no unambiguous rejection of isotropy for them yet.

3. Conclusion

The long bursts are surely up to $z \simeq 4$; for the remaining two subclasses the redshifts are unknown. If the bursts of intermediate subclass are at high z-s (say, at $z > 0.1$), **then the validity of cosmological principle would be at a serious doubt**; if they were dominantly at $z < 0.1$, then the situation would be in accordance with the anisotropies and inhomogeneities of galaxies up to these redshifts.

References

Horváth, I. 1998 Astrophys. J., 508, 757

Meegan, C. A. et al. http://www.batse.msfc.nasa.gov/data, 2000

Mukherjee, S. et al. 1998 Astrophys. J., 508, 314