# Exploring the Universe through Gamma-Ray Burst Mapping

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## Overview

The study explores the large-scale cosmic structure using gamma-ray bursts (GRBs) spatial distribution with 542 accurately measured positions and spectroscopic redshifts. The bootstrap point-radius method is used to identify prominent cosmological clusters in both the northern and southern Galactic hemispheres. The northern Galactic hemisphere contains a small (with four GRBs in the redshift range of $0.59 \leq z \leq 0.62$) and a large GRBs' group (the previously identified Hercules-Corona Borealis Great Wall, HCBGW). The Southern Galactic Hemisphere contains the Giant GRB ring and an another possible cluster. The study highlights the potential value of GRB clustering as a probe of large-scale cosmic structure, complementing the clustering of galaxies and quasars. The study emphasizes the importance of continuing optical GRB observations for further spectroscopic redshift measurements.

## Data & Method

Because of the GRBs extreme luminosity, a thorough study of the celestial coordinates and intrinsic properties of GRBs holds promise for shedding light on the largest-scale structures in the Universe.

The study utilized GRB data, including measured celestial sphere positions, optical afterglows, and spectroscopic redshifts, primarily detected by NASA's Swift and Fermi experiments. The dataset, based on the e.g. Horvath et al. (2022) studies, was primarily obtained from the Gamma-Ray Burst Online Index (GRBOX) database, with over five hundred spectroscopic redshifts measured for GRBs.

### References

Horvath I. et al., 2014, A&A, 561, L12

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Balázs L.G. et al., 2015, MNRAS, 452, 2236 Giant Ring paper

Horvath I. et al., 2020, MNRAS, 498, 2544

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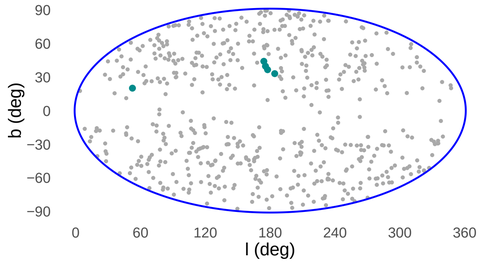
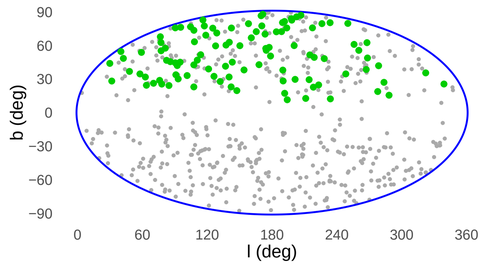
## Bootstrap point-radius method – Results

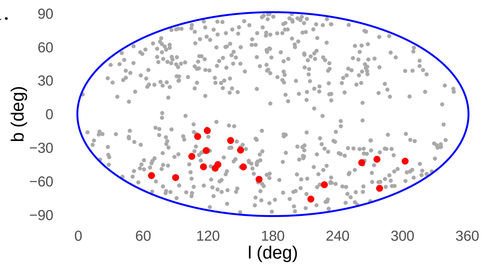
The use point-radius method was also described in Horvath et al. (2020) and (2024). We identify prominent cosmological clusters in both the northern and southern galactic hemispheres (avoiding extinction effects in the Milky Way plane). The northern Galactic hemisphere contains a small significant clusters of GRBs in the redshift range $0.59 \leq z \leq 0.62$ (bootstrap probability 0.012, Fig.1.), as well as the previously identified HCBGW Horvath et al. (2014) and (2015) (in the revised redshift range $0.9 \leq z \leq 2.1$; p=0.017, Fig.2.). The Southern Galactic Hemisphere contains the previously identified Giant GRB ring (p=0.022, Fig.3.), as well as another possible cluster in the $1.17 \leq z \leq 1.444$ range (p=0.031). In addition, both the Hercules-Corona Borealis Great Wall and the Giant GRB ring became more pronounced as the GRB sample size increased.




The 5 GRBs on the northern hemisphere within $0.59 \leq z \leq 0.62$.




The northern hemisphere's (extended) Hercules-Corona Borealis Great Wall. The redshift range is $0.938 \leq z \leq 2.101$.




The figure shows the 19 GRBs in the $0.748 - 0.8595$ redshift range (red dots) in the southern hemisphere. This grouping was previously identified as the Giant GRB Ring.

## Conclusion

**GRB clustering provides valuable insights into the large-scale cosmic structure. To improve this it is important to continue the optical GRB observations, therefore further spectroscopic redshift measurements can be made.**