Statistical differences between Swift GRB classes based on γ- and X-ray observations

D. Szécsi, L. G. Balázs, Zs. Bagoly, I. Horváth, A. Mészáros, P. Veres

Abstract There are number of evidences that the gamma-ray bursts (GRBs) have a third group beside the short and long ones: the intermediate group. Although at this time, no reasonable physical explanation is known for them. We use discriminant analysis to confirm the former classification and give some further physical properties for the intermediate GRBs.

Keywords: gamma-ray burst – discriminant analysis – Swift satellite

1 Discriminant Analysis: Separation Between Long And Intermediate Groups

We analyse the γ- and X-ray properties observed by the Swift satellite. The variables used in this work are the following: *Fluence* (Fl), *1-sec Peak Photon Flux* (P), *Photon Index* (Pind), *Early X-Flux* (Xfl), *Initial Temporal Decay Index* (Xdec), *Spectral Index* (Xsp) and *HI Column Density* (XNH).

This analysis can confirm the classification of the GRBs based on the hardness-duration joint distribution [1], and also can confirm the separation between the long and the intermediate groups. We can get the discriminant function and the statistical parameters dominating the discriminant function. In our data set, we have 61 intermediate and 123 long GRBs based on the grouping of the hardness-duration joint distribution. We used SPSS[1] in our computations.

Dorottya Szécsi
Eötvös University, H-1117 Budapest, Pázmány P. s. 1/A, Hungary, e-mail: szdpadt@inf.elte.hu

Lajos G. Balázs
Konkoly Observatory, H-1505 Budapest, POB 67, Hungary

Zsolt Bagoly
Eötvös University

István Horváth
Bolyai Military University, H-1581 Budapest, POB 15, Hungary

Attila Mészáros
Charles University, V Holešovičkách 2, CZ 180 00 Prague 8, Czech Republic

Péter Veres
Pennsylvania State University, 525 Davey Lab, University Park, PA 16802, USA

[1] SPSS is a registered trademark (`http://www.spss.com`).

In Table 1, we compared the means of the variables between the groups using F-statistics. Bold faces mark the variables where the differences in the group means are significant.

In our case, we have two classes (long and intermediate bursts) and one discriminant function. The correlation between the variables and the discriminant function is shown in the last column of Table 1. The correlation coefficients marked with bold faces are significant at a very high level. Therefore, the discriminant function is mostly dominated by these variables.

Variable	Wilks' Lambda	F	df1	df2	Sig.	Corr.
Pind	**.838**	**35.055**	**1**	**182**	**.000**	**-.409**
Xdec	.997	.476	1	182	.491	.048
Xsp	**.943**	**10.908**	**1**	**182**	**.001**	**-.228**
log Fl	**.634**	**104.841**	**1**	**182**	**.000**	**.707**
log P	.982	3.258	1	182	.073	.125
log Xfl	**.833**	**36.385**	**1**	**182**	**.000**	**.417**
log XNH	**.960**	**7.660**	**1**	**182**	**.006**	**.191**

Table 1

Test of Function	Wilks' Lambda	Chi-square	df	Sig.
1	.465	136.721	7	**.000**

Table 2

The significance of the differences measured by the discriminant functions is shown in Table 2. As the value in the column Significance is .000, we can state that the two groups differ significantly based on the γ- and X-ray observations.

2 Conclusion

We confirmed the separation between the long and intermediate groups and gave the variables dominating the discriminant function (Fluence, Early X-Flux, Photon Index, Spectral Index and HI Column Density). It is important constructing or developing a model for the intermediate GRBs.

Acknowledgements This work was supported by OTKA grant K077795, by OTKA/NKTH A08-77719 and A08-77815 grants (Z.B.), by the GAČR grant No. P209/10/0734 (A.M.) and by the Research Program MSM0021620860 of the Ministry of Education of the Czech Republic (A.M.).

References

1. Horváth, I. et al.: Detailed Classification of Swift's Gamma-ray Bursts. The Astrophysical Journal **713**, 552 (2010)