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The X-Ray Fundamental Plane of the Platinum Sample, the Kilonovae, and the SNe Ib/c Associated with GRBs

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A large fraction of gamma-ray Bursts (GRBs) lightcurves (LCs) show X-ray plateaus. We analyze all GRBs with known redshifts presenting plateaus observed by The Neil Gehrels Swift Observatory from its launch until 2019 August. The fundamental plane relation between the rest-frame time and X-ray luminosity at the end of the plateau emission and the peak prompt luminosity holds for all the GRB classes when selection biases and cosmological evolutions are applied.
We have discovered two important findings: (1) a new class of long GRBs with good data coverage: the platinum sample; and (2) the platinum, the SNe-LGRB and the KN-SGRB samples, yield the smallest intrinsic scatter with $\sigma_{platinum,GRB-SNe} = 0.22 \pm 0.10$ and $\sigma_{KN-SGRB} = 0.24 \pm 0.12$.
The SNe-LGRBs are composed of GRBs associated spectroscopically with the SNe Ib,c, the KN-SGRBs are composed by 8 GRBs associated with kilonovae or where there could have been such an association.
The highest correlation coefficients are yielded for the SN-LGRB-ABC sample, which includes GRBs spectroscopically associated with SNe Ib/c or with a clear optical bump in the LC resembling the SNe Ib/c, ($R^2_{SN-LGRB-ABC} = 0.95$), for the SN-LGRBs ($R^2_{SN-LGRB} = 0.91$), and the KN-SGRBs ($R^2_{KN-SGRB} = 0.90$) when the redshift evolution is considered. These category planes are reliable candidates to use as cosmological tools. Furthermore, the distance from the gold fundamental plane is a crucial discriminant among classes. In fact, we find that the distributions of the distances of the SNe-LGRB, SNe-LGRB-ABC, KN-SGRB and SGRB samples from the gold fundamental plane are statistically different from the distribution of the gold GRBs' distances from the gold fundamental plane with and without considering evolution cases.

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