Gamma-Ray Polarization Results of the POLAR Mission and Future Prospects

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Summary

Despite over 50 years of Gamma-Ray Burst (GRB) observations many open questions remain about their nature and the environments in which the emission takes place. Polarization measurements of the GRB prompt emission have long been theorized to be able to answer most of these questions. The POLAR detector was a dedicated GRB polarimeter developed by a Swiss, Chinese and Polish collaboration. The instrument was launched, together with the second Chinese Space Lab, the Tiangong-2, in September 2016 after which it took 6 months of scientific data. During this period POLAR detected 55 GRBs as well as several pulsars. From the analysis of the GRB polarization catalog we see that the prompt emission is lowly polarized or fully unpolarized. There is, however, the caveat that within single pulses there are strong hints of an evolving polarization angle which washes out the polarization degree in the time integrated analysis.

The time integrated results of POLAR results appear to rule out models with synchrotron emission from a toroidal magnetic field, whereas the low levels of polarization observed are in agreement with the majority of the other existing models. The observations made using time resolved studies could however change this as they indicate that the polarization could be more complex. In order to really probe the theoretical models a significantly more sensitive detector is required.

Building on the success of the POLAR mission, the POLAR-2 instrument is currently under development. POLAR-2 is a Swiss, Chinese, Polish and German collaboration and was approved for launch in 2024. Thanks to its large sensitivity POLAR-2 will produce polarization measurements of at least 50 GRBs per year with a precision equal or higher than the best results published by POLAR. Furthermore, thanks to its large effective area which exceeds $2000\,\mathrm{cm}^2$ at 100 keV, POLAR-2 will be able to observe faint GRBs such as 170817A and will be capable of sending alerts of such transients, including localization information to ground within seconds to minutes. POLAR-2 thereby not only aims to make the prompt polarization a standard observable it will additionally play an important role in multi-messenger observations.

*https://www.astro.unige.ch/polar/collaboration

†https://www.unige.ch/dpnc/polar-2