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Gamma-Ray Burst Polarimetry with the POLAR and POLAR-2 missions

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Gamma-Ray Bursts (GRBs) are among the most powerful and violent events in the Universe. Despite over half a century of observations of these transient sources, many open questions remain about their nature and the physical emission mechanisms at play. Polarization measurements of the GRB prompt γ -ray emission have long been theorized to be able to answer most of these questions. With the aim of characterizing the polarization of these prompt emissions, a compact Gamma-Ray polarimeter called POLAR has been sent to space as part of the Tiangong-2 Chinese space lab for 6 months of operations starting September 2016. The instrument detected 55 GRBs as well as several pulsars. Time integrated polarization analysis of the 14 brightest detected GRBs has shown that the prompt emission is lowly polarized or fully unpolarized. However, time-resolved analysis depicted strong hints of an evolving polarization angle within single pulses, washing out the polarization degree in time integrated analyses. Energy-resolved polarization analysis has shown no constraining results due to limited statistics. Hence, a more sensitive γ -ray polarimeter is required to perform detailed energy and time resolved polarization analysis of the prompt γ -ray emission of GRBs.

Based on the success of the POLAR mission, a larger scale instrument, approved for launch to the China Space Station (CSS) in 2027, is currently being developed by a Swiss, Chinese, Polish, and German collaboration. Thanks to its large sensitivity in the 20-800 keV range, POLAR-2 will produce polarization measurements of at least 50 GRBs per year with a precision equal to or higher than the best results published by POLAR, allowing for good quality time and energy resolved analysis. Furthermore, thanks to its large effective area which exceeds 2000 cm² 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 the ground within seconds to minutes. POLAR-2 thereby not only aims to make the prompt polarization a standard observable, but it will additionally play an important role in multi-messenger observations.

The scientific results of the POLAR mission will be presented followed by a discussion about the POLAR-2 mission, the future of GRB's prompt emission polarimetry.

Eligibility for "Best presentation for young researcher" or "Best poster for young researcher" prize

Yes

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