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Measuring Gamma-Ray Transients Polarization with the POLAR-2 Compton polarimeter

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Gamma-Ray Bursts (GRBs) are among the most powerful and violent events in the Universe. Despite 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 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 has been sent to space as part of the Tiangong-2 Chinese space lab for 6 months of operations starting September 2016. Developed by a Swiss, Chinese, and Polish collaboration, the instrument detected 55 GRBs as well as several pulsars. Time integrated polarization analysis of the POLAR GRB catalog 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.

Based on the success of the POLAR mission, a larger scale instrument, approved for launch to the China Space Station (CSS) in 2024, is currently developed by a Swiss, Chinese, Polish, and German collaboration. 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, allowing for good quality time and energy resolved analysis. Furthermore, thanks to its large effective area which exceeds 2000 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.

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