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The role of the magnetic fields in GRB outflows

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We report multicolor optical imaging and polarimetry observations of the afterglow of the first TeV-detected gamma-ray burst (GRB), GRB 190114C, using the RINGO3 and MASTER II polarimeters. Observations begin 31 s after the onset of the GRB and continue until ~7000 s postburst. The light curves reveal a chromatic break at ~400-500 s, with initial temporal decay $\alpha = 1.669 \pm 0.013$ flattening to $\alpha \sim 1$ postbreak, which we model as a combination of reverse and forward shock components with magnetization parameter RB ~ 70. The observed polarization degree decreases from 7.7% ± 1.1% to 2%-4% 52-109 s postburst and remains steady at this level for the subsequent ~2000 s at a constant position angle. Broadband spectral energy distribution modeling of the afterglow confirms that GRB 190114C is highly obscured (AV,HG = 1.49 ± 0.12 mag; NH HG = (9.0 ± 0.03) × 1022 cm-2). We interpret the measured afterglow polarization as intrinsically low and dominated by dust - in contrast to the P > 10% measured previously for other GRB reverse shocks - with a small contribution from polarized prompt photons in the first minute. We test whether first- and higher-order inverse Compton scattering in a magnetized reverse shock can explain the low optical polarization and subteraelectronvolt emission but conclude that neither is explained in the reverse shock inverse Compton model. Instead, the unexpectedly low intrinsic polarization degree in GRB 190114C can be explained if large-scale jet magnetic fields are distorted on timescales prior to reverse shock emission.

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