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Orphan GRB Afterglows –Detailed Predictions and Survey Strategies

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A gamma-ray burst (GRB) afterglow is considered an orphan when it is detected without a targeted search triggered by the prompt GRB emission. This can occur when the GRB jet points away from us or if the prompt emission along our line of sight is dim (e.g. a "dirty fireball"). We present a semi-analytic model for the afterglow lightcurves based on and calibrated with numerical simulations. Such an approach better captures the peak time and flux for off-axis observers, as well as the shape of the lightcurves near the peak at different frequencies, which are the most relevant properties for transient surveys or targeted searches triggered by gravitational-wave detections. We use this model to calculate the rates of both single-epoch and multiple-epoch detections of orphan afterglows for different surveys as a function of their wavelength, sensitivity, and cadence. Additionally, we discuss an optimization scheme for observational strategies and potential methods for distinguishing orphan afterglows from other transients.

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