

# The Needle in the Hundred-Square-Degree Haystack: from Fermi GRBs to LIGO Discoveries

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## Abstract

Accurate localizations have driven and enriched our understanding of gamma-ray bursts. They could do the same for future gravitational-wave detections with LIGO and Virgo. We report the discovery of the optical afterglow of the gamma-ray burst (GRB) 130702A, identified upon searching 71 square degrees surrounding the Fermi Gamma-ray Burst Monitor (GBM) localization. Discovered and characterized by the intermediate Palomar Transient Factory (iPTF), iPTF13bxi is the first afterglow discovered solely based on a GBM localization. Real-time image subtraction, machine learning, human vetting, and rapid response multi-wavelength follow-up enabled us to quickly narrow a list of 27,004 optical transient candidates to a single afterglow-like source. The bright afterglow and emerging supernova offered an opportunity for extensive panchromatic follow-up. Furthermore, our discovery of iPTF13bxi represents an important step towards overcoming the challenges inherent in uncovering faint optical counterparts to comparably localized gravitational wave events in the Advanced LIGO and Virgo era.