Gamma-ray Burst and Gravitational Wave Counterpart Prospects in the MeV Band with AMEGO

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Abstract: The All-sky Medium Energy Gamma-ray Observatory (AMEGO) Probe mission concept is uniquely suited to address open questions in Gamma-ray Burst (GRB) science including the search for counterparts to gravitational-wave events. AMEGO is a wide field of view instrument (~60 deg radius) with a broad energy range (~200 keV to >10 GeV) and excellent continuum sensitivity. The sensitivity improvement will allow for probes of GRB emission mechanisms and jet composition in ways that have not been accessible with previous instruments. Potential for polarization measurement may also have profound impacts on the understanding of GRB mechanisms. AMEGO will also be an excellent facility for the search for gravitational wave counterparts to binary mergers including at least one neutron star, which are thought to produce short duration GRBs. This poster will describe how the AMEGO will advance these fields.

INTRODUCTION TO AMEGO

- ***Probe Concept: 2020 NASA Astrophysics Decadal Review***
- Observing strategy: survey (80% sky/orbit, ~2.5 sr FoV)
- Well ***understood***, ***tested*** technologies with ***space heritage***
- Optimized for ***continuum*** (200 keV - 10 GeV) sensitivity, also with ***polarization*** and and nuclear line ***spectroscopic*** capability
- *See [1,2] for more details on the AMEGO mission, instrumentation, and simulations.*
- Science topics include:
  - **Galactic Sources** (pulsars, magnetars, binaries, supernova remnants, pulsar wind nebulae) [3,4,5]
  - Extragalactic **Variable** and **Transient** Sources (active galaxies [6], gamma-ray bursts, supernovae)
  - **Discovery Potential** (Dark Matter [7], Gravitational Wave Counterparts, Neutrino Counterparts)
- AMEGO will be an excellent instrument to monitor the sky for medium-energy gamma-ray transients

GAMMA-RAY BURSTS

- Brightest transients in the Universe with durations from <1 s to thousands of seconds in keV - MeV prompt gamma-rays followed by longer-lived broadband afterglows
- AMEGO will detect both prompt emission and afterglows, and potentially prompt polarization [8]
- Simulations (based on [8]) suggest that AMEGO will be a prolific detector of GRBs including many at high redshifts

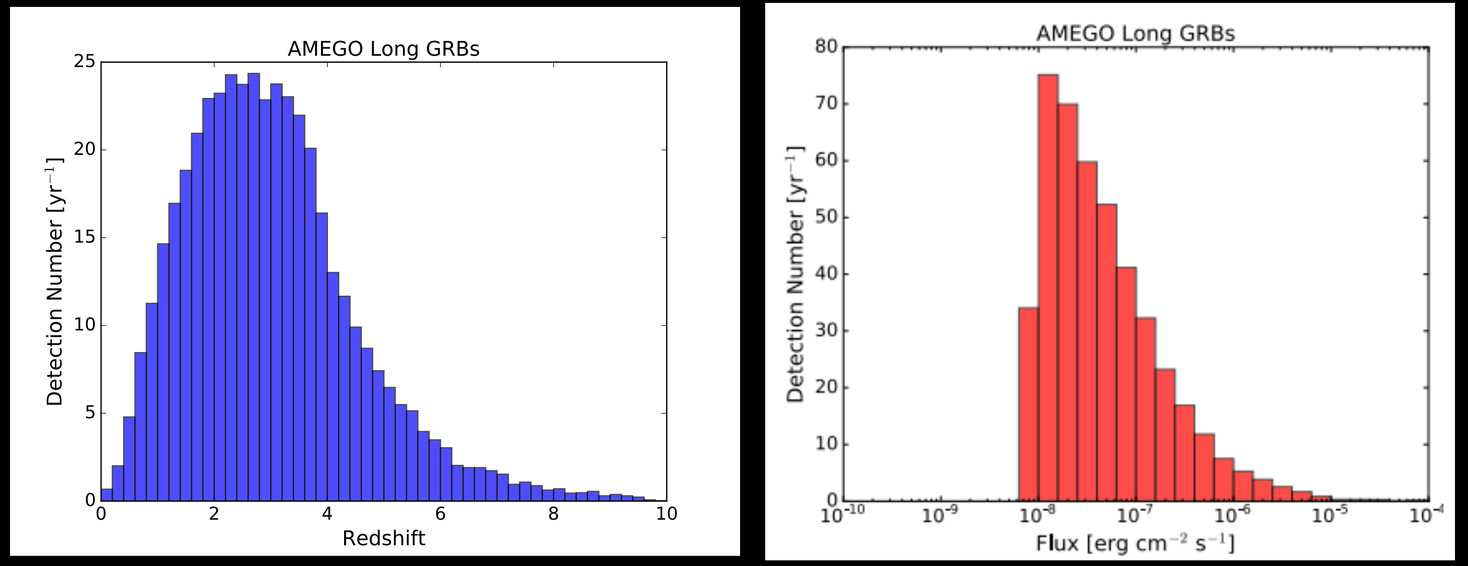

Figure 1: Thanks to AMEGO's wide field of view and sensitivity, it will detect ~400 long duration GRBs per year out to high redshifts. Using simulations of the intrinsic properties of GRBs [9], we predict the peak flux (left) and redshift (right) distributions.

GRAVITATIONAL WAVE COUNTERPARTS

- LIGO/Virgo/KAGRA Binary Merger Events
  - Short duration GRBs are most probable counterpart to gravitational wave events from binary neutron star and perhaps neutron star - black hole mergers (Figure 2).
  - AMEGO will be a **prolific detector of short GRBs** due to its wide field of view sensitivity and survey operations.
  - AMEGO will detect **both** short duration (< 2 s) **prompt emission and longer lived afterglows**.
  - Strong heritage from Fermi observations [9,10,11,12] of LIGO/Virgo mergers
  - Gamma-ray counterparts provide improved localizations which enable redshift and host galaxies identifications, temporal and spectral evolution, energetics measurements

- AMEGO will also be an excellent follow-up instrument to search for counterparts to LISA mergers events [13], and to identify supermassive black hole binaries for PTAs.

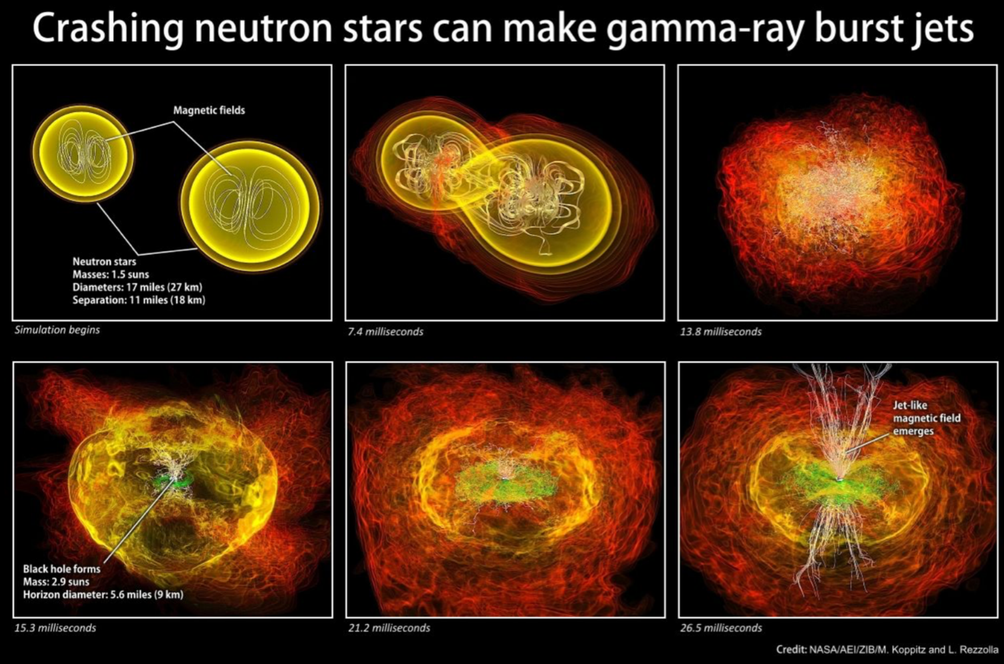

Figure 2: Simulations (from [14]) of binary neutron star mergers show that they can produce both short GRBs and gravitational waves with relativistic jets along the rotation axis.

SIMULATED AMEGO GRB

- Preliminary simulations of AMEGO instrument performance using MEGAlib package [14]

- Input Fermi-GBM BGO observation of bright short duration GRB 090510
  - Uses BGO background which is extremely conservative (Figure 3).
  - AMEGO background is significantly lower, requires pulse modeling to characterize light curve more accurately

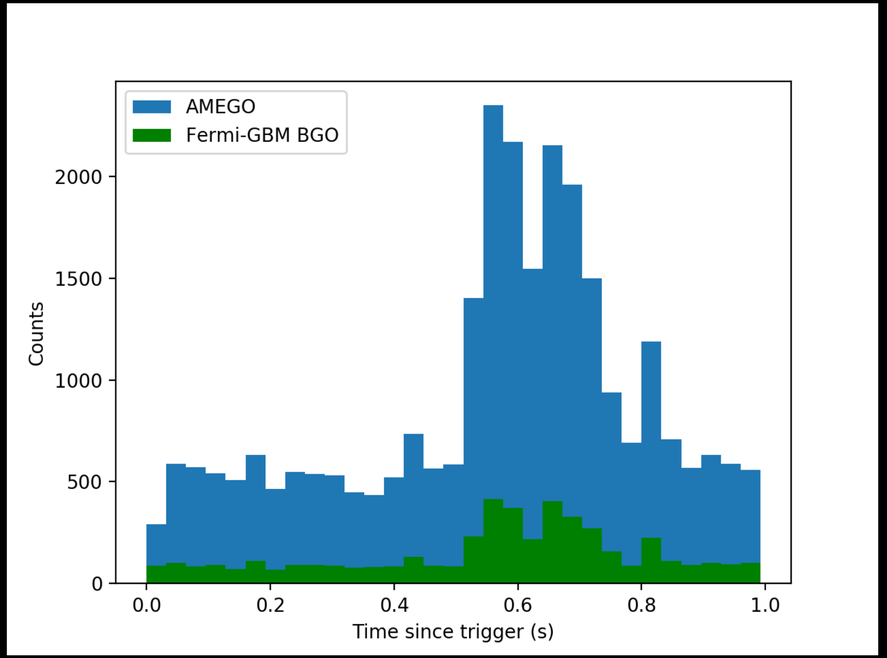

Figure 3: Preliminary simulation of GRB 090510 light curve, showing that AMEGO will be very sensitive to GRBs.

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