On and Off Axis Orphan Afterglow from Low Lorentz Factor Jets – Candidate Electromagnetic Counterparts to Gravitational Wave Sources

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ABSTRACT:

Short gamma-ray bursts (SGRB) are believed to be produced by ultra-relativistic jets from the merger of neutron stars (NSNS) or a neutron star and black hole (NSBH). Observations of such events are currently triggered by gamma-rays from the prompt emission but if the Lorentz factor distribution for such jets is dominated by low Lorentz factors <30 then the prompt gamma-rays would be suppressed. Such low Lorentz factor jets would produce x-ray/optical/radio transients as the jet collides with the ambient medium. For a simple power-law distribution of Lorentz factors of index -1.75, approximately 78% of merger-jets within 300 Mpc (the LIGO detection distance limit for face-on NSNS mergers) would produce failed-GRB transients; such transients are expected to peak in x-ray and optical 0.1-10 days after a merger, with good sky localization they will be detectable by Swift XRT, and brighter than 21st magnitude in 85% of cases. The radio peaks narrowly around 10 days with a peak flux 10-100 mJy at 10 GHz and ~0.1 mJy at 150 MHz. If the jets of SGRB are structured, then such orphan afterglow would also be associated with observations made at angles greater than a narrow core angle; such on axis (within the jet opening angle) failed-GRB afterglows as well as the off axis (after jet break) afterglows should be considered when searching for the electromagnetic counterparts to gravitational wave detections from NSNS(NSBH) mergers.