An electromagnetic precursor to binary pulsar coalescence?

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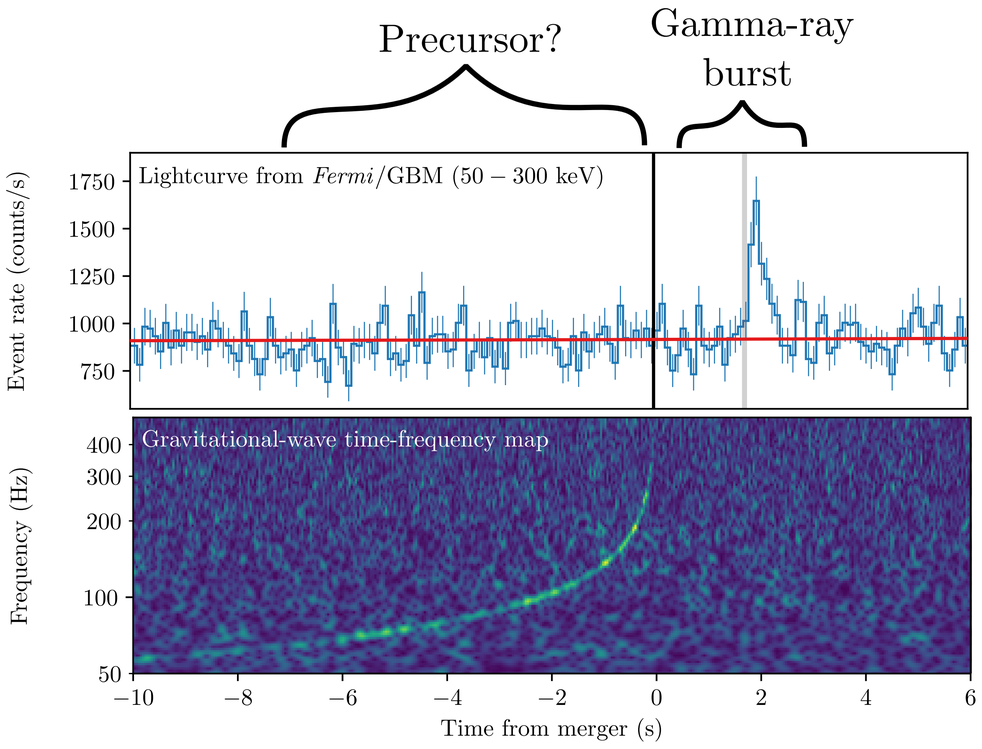
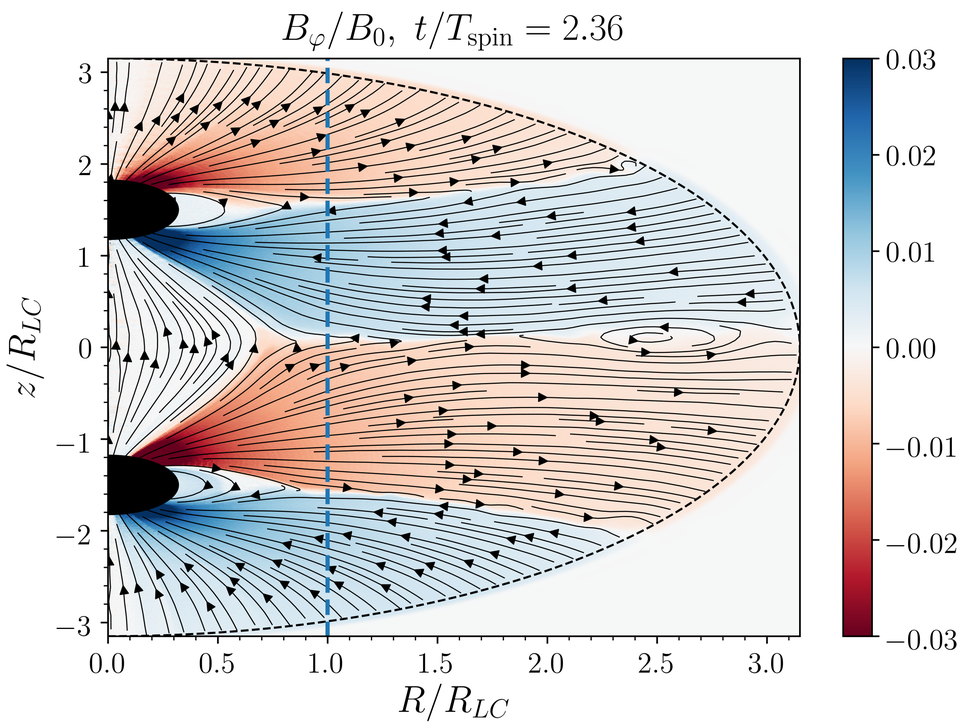
Context



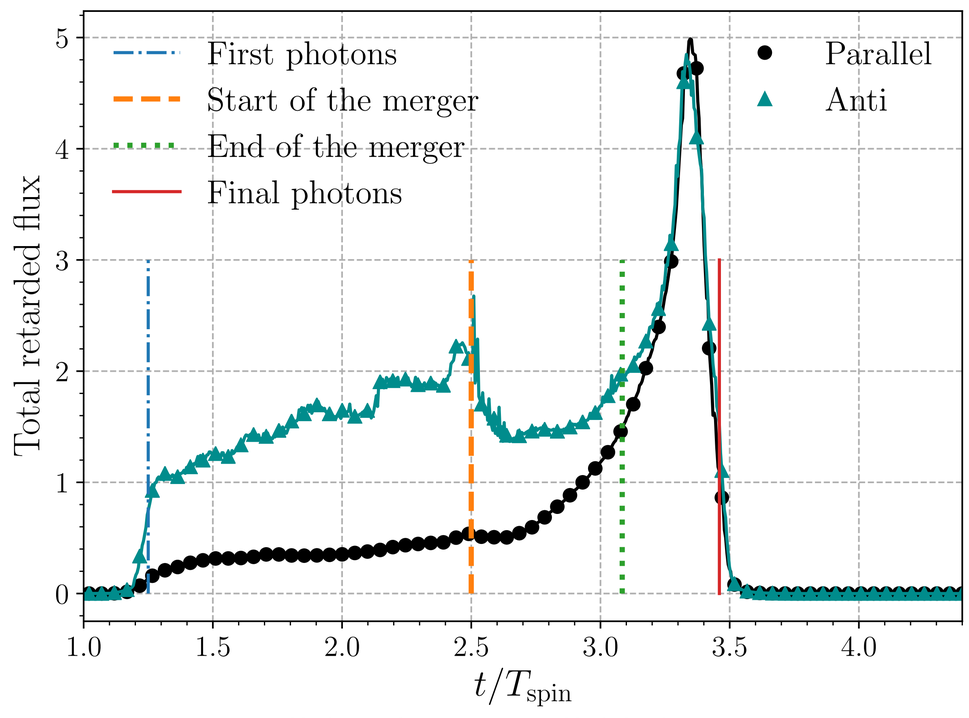
- Recent joint detection of EM and GW waves (*Abbott et al. 2017*) ⇒ Signature of a binary neutron star merger
- Young pulsars emit non-thermal high-energy radiation → Suggests an electromagnetic counterpart prior to the merger?
- Electromagnetic energy is transferred to particles, which then radiate away this energy into an observable signal
- MHD simulations cannot capture particle acceleration → Need for kinetic simulations: particle-in-cell
- **Goal**: determine the lightcurve of the merger from first principles

Results



Toroidal magnetic field in the parallel configuration

- **Parallel spins**: Dissipation even in the absence of relative motion between the pulsars in a midway current sheet
- **Anti-parallel spins**: Relative motion ⇒ Electromotive force ⇒ Pair creation between the stars



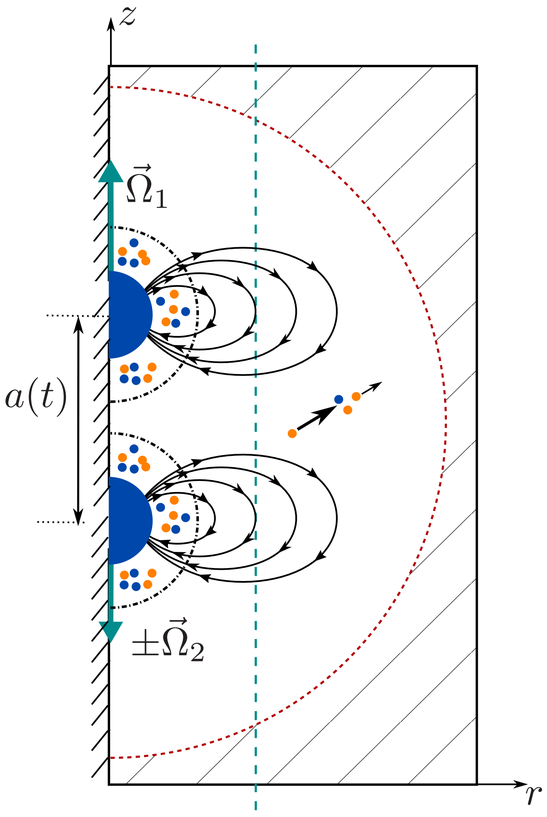
Parallel and anti-parallel lightcurves

Numerical setup

- Simulation of the magnetospheric plasma in a simplified 2D-axisymmetrical setup
- Magnetic and spin axes aligned → orbital motion neglected
- Inspiral due to the emission of GW: the relative distance decreases as

$$a(t) = a_0(1 - 4t/\tau)^{1/4}$$

- Two configurations studied: parallel or anti-parallel spins



Conclusions

- After the merger begins, similar lightcurves for both configurations, the output signal is not strongly anisotropic
- Great increase in bolometric luminosity: the total radiated power increases by one to two orders of magnitude
- For a Crab-like pulsar: $\mathcal{P} \sim 10^{38}$ erg/s, to be compared to the merger event GW170817: $\mathcal{P}_{\rm out} \sim 10^{46}$ erg/s → Precursor probably to faint in γ or X-ray
- Hope for radio detection though, origin of Fast Radio Bursts?

Outlooks

- Asymetric simulations ($B_{0,\rm up}/B_{0,\rm down} = 4$, $\Omega_{\rm up}/\Omega_{\rm down} \sim 0.25$): more realistic system
- 3D simulations with orbital motion would probably yield a more powerful outburst

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