The final merger of comparable mass binary black holes is expected to be the strongest source of gravitational waves for LISA. Since these mergers may occur for binaries over a broad range of mass-scales, from tens of solar masses to millions.

Since the largest part of the kick is produced during the strong-field merger, fully general relativistic simulations of black hole mergers are needed to provide accurate values for the kick velocity. Table 1 lists our predictions for the kick parameters for various binary black hole mergers.

Calculating Kick Velocities
We have modeled our results based on scalings for the effects of mass- and spin-asymmetry in the post-Newtonian (PN) approximation. We assume that the magnitudes of the kicks induced by mass- and spin-asymmetries each scale independently with the PN-predicted scaling, but that the directional alignment of these two contributions to the kick may differ by some angle. The total kick would then take the form:

\[ V = r \sqrt{2\alpha (1+q) \left(1 + q^2 + 2(1-q) \cos \theta + K_a^2 \right)} \]

where

- \( r \) is the initial separation
- \( q \) is the mass ratio
- \( \theta \) is the angle between directions of spin and \( q \)-induced kicks
- \( K_a \) is the relative scaling of spin and \( q \)-induced contributions
- \( \theta \) is the angle between directions of spin and \( q \)-induced kicks

We have tested our formula using data from our simulations, as well as from published results from Koppitz et al. (2007) and Herrmann et al. (2007). Our best fit to all simulation data gives the following values for the parameters: \( V_1 = 276 \text{ km/s}, \theta_0 = 0.58 \text{ rad}, k = 0.85 \).

The table at left compares our predictions with the kick velocities obtained by numerical simulations.

**ABSTRACT**
The final merger of comparable mass binary black holes is expected to be the strongest source of gravitational waves for LISA. Since these mergers may occur for binaries over a broad range of mass-scales, from tens of solar masses to millions.