Precessing Binaries: Astrophysical Expectations

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Precession and Inspiral Waveforms

Compact object binaries can *precess* if spins are of significant magnitude and *misaligned* with respect to the orbital angular momentum.

Precession can *modify* inspiral *waveforms* and decrease the *detection efficiency* of standard non-precession searches.

Precession effects are more important for binaries of *high mass ratios (BH-NS)* and with *spin tilt angles* of the massive object *in excess of ~30°*.

*(Apostolatos 95)*
Q: What is the origin of spin tilt angles in compact object binaries?

Mass transfer episodes in binaries tend to align spin and orbital angular momentum vectors.

Asymmetric supernova explosions can tilt the orbital plane relative to the spin of the non-exploding star.
Q: What are the expected spin tilt angles?

> model BH-NS progenitors and SN kick effects

BH-NS binaries are expected to have significant spin tilt angles
Precessing inspiral binaries

with **non-precessing templates**: detection rate decreases

$R_{\text{det}}$ decrease depends on spin magnitude and tilt angle:

**templates that can mimic the precession effects**

can increase the detection rate:

For a 10-1.4 $M_\odot$ BH-NS binary

![Graph 1](image1)

![Graph 2](image2)
Rate drop expected from *astrophysical predictions* for spin tilts in BH-NS binaries

**Expected rates:**

**BH-NS**
- $1.5 \times 10^{-1500}$ per yr
- $3 \times 10^{-4} - 0.3$

**BH-BH**
- $15 - 10,000$ per yr
- $4 \times 10^{-3} - 3$

*Grandclement, Ihm, VK, Belczynski 2003*