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Mixed Gaussian processes: a filtering approach

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We present a new approach to the analysis of mixed processes: for $t \in [0, T]$

$$X_t = B_t + G_t,$$

where B_t is a Brownian motion and G_t is an independent centered Gaussian process.
We obtain a new canonical innovation representation of X, using linear filtering theory.

When the kernel

$$K(s,t) = \frac{\partial^2}{\partial s \partial t} E G_t G_s, \quad s \neq t$$

has a weak singularity on the diagonal, our results generalize the classical innovation formulas beyond the square integrable setting.
For kernels with stronger singularity, our approach is applicable to processes with additional "fractional" structure,
including the mixed fractional Brownian motion from mathematical finance.
We show how previously known measure equivalence relations and semimartingale properties follow from our canonical representation in a unified way, and complement them with new formulas for Radon-Nikodym densities.

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