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Stochastic averaging of quasi partially integrable Hamiltonian systems under fractional Gaussian noise

Qiang-feng LÜ, Mao-lin DENG, Wei-qiu ZHU

Key words: Fractional Brownian motion (fBm); Fractional Gaussian noise (fGn); Quasi partially integrable Hamiltonian system; Stochastic averaging method; Stationary response

◆Fractional Guassian noise (fGn)

- Many real excitations in nature have property of long-range spatial and/or temporal correlations (long memory). These excitations can be modeled as fGn.

- FGn has already been applied as excitation model in physics, finance, and biology, etc.

characteristics

- ➢ self-similarity
- ➢ long range dependence (see Fig.1: Auto-correlation function $R(\tau)$ of fGn)

- The response of dynamical system to fGn is not Markov process.

Hurst index of fGn $\longrightarrow$ $1/2<H<1$

- The power spectral density(PSD) of fGn is meaningful physically only when $1/2<H<1$. Thus, only $1/2<H<1$ is considered in this paper. (see Fig.1: PSD $S(\omega)$ of fGn)

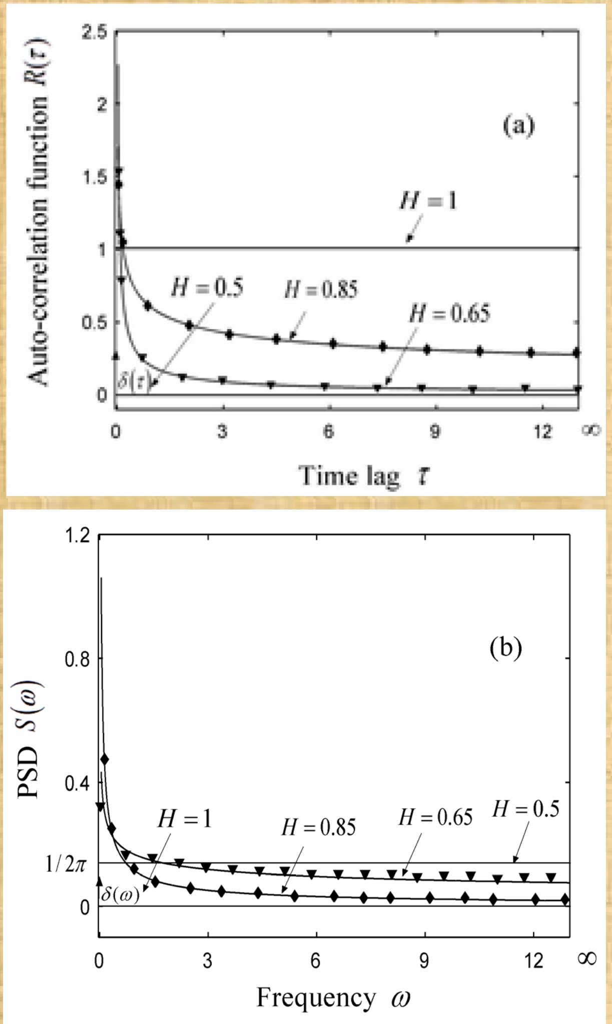
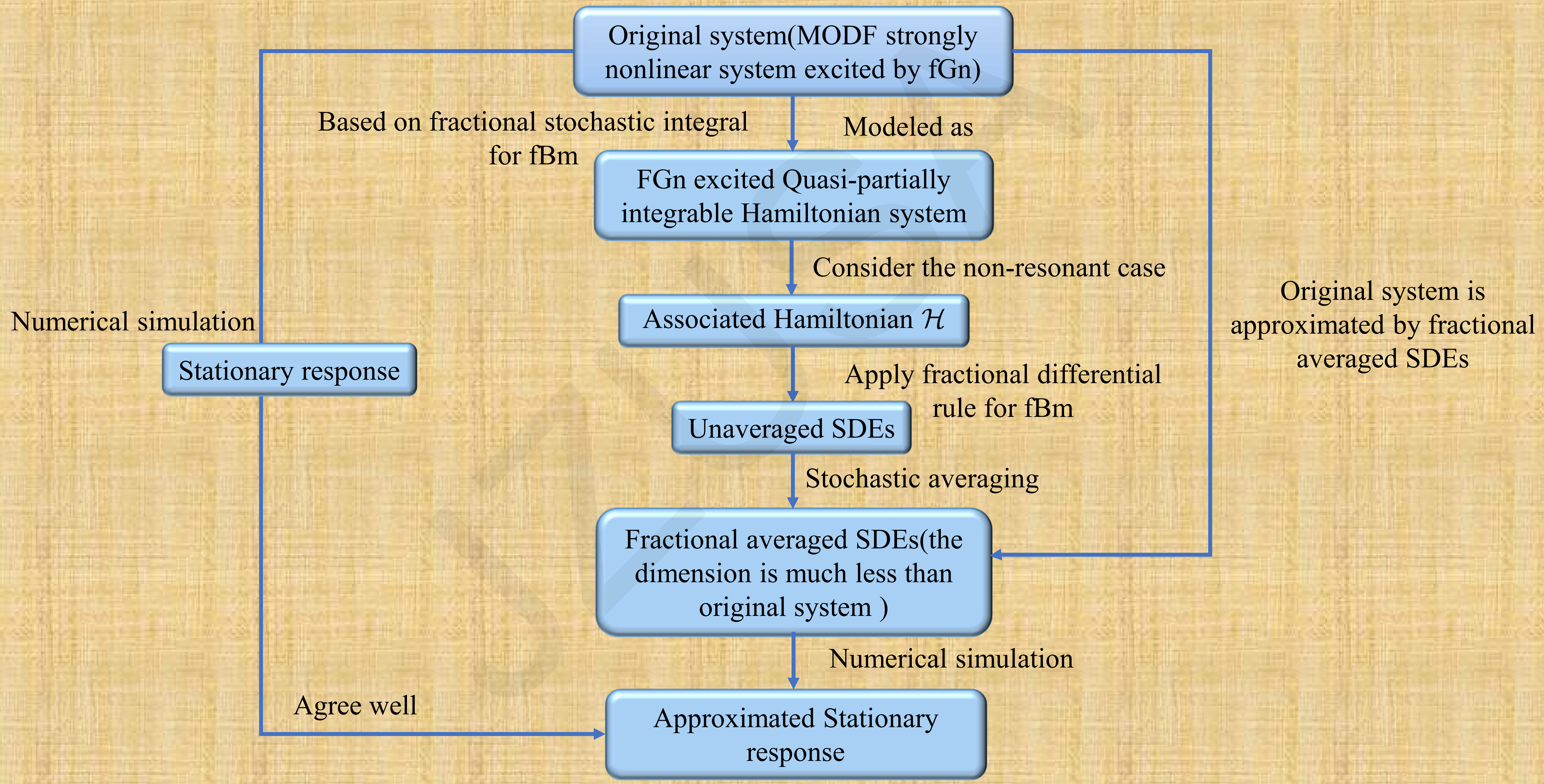


Fig. 1 Auto-correlation function $R(\tau)$ (a) and PSD $S(\omega)$ (b) of fGn $W^H(t)$ with the simulated results (▼ ◆ indicate simulated results)

◆Stochastic averaging method



◆Results and conclusion

- Two examples are worked out to illustrate the proposed stochastic averaging method.

Advantages

- ◆ **Effectiveness:** The probability density and statistics of first integrals calculated from averaged SDEs and those from the original system agree well while the error is acceptable.
- ◆ **Efficiency:** The dimension of the original system is greatly reduced. Thus, the computation time for simulating averaged fractional SDEs is much less than that for original system.

- Thus, in the future, it is promising to apply the proposed averaging method to do more study work.